CHARACTERIZATION OF MILK PRODUCTION SYSTEM AND OPPORTUNITY FOR MARKET ORIENTATION: A CASE STUDY OF MIESO DISTRICT, OROMIA REGION, ETHIOPIA

M.Sc. Thesis

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April 2007

Haramaya University

CHARACTERIZATION OF MILK PRODUCTION SYSTEM AND OPPORTUNITY FOR MARKET ORIENTATION: A CASE STUDY OF MIESO DISTRICT, OROMIA REGION, ETHIOPIA

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By

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As *Thesis* Research advisor, I here by certify that I have read and evaluated this thesis prepared, under my guidance, by Kedija Hussen, entitled **''***Characterization of Milk Production System and Opportunity for Market Orientation: a Case Study of Mieso District, Oromia Region, Ethiopia*''. I recommend that it can be submitted as fulfilling the *Thesis* requirement.

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External Examiner	Signature	Date

DEDICATION

I dedicate this thesis manuscript to my elder sister Bedriya Hussen, who lives outside the country and I know her less than a year in my life, but she was steadfast to treat me more than a mother and for her good guidance in my successful life and to my mother Fatuma Osman and for my brother Abdu Semed Hussen for nursing me with affection and love and for their dedicated partnership in the success of my life.

STATEMENT OF THE AUTHOR

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ABBREVIATIONS

AFC	**Age at First Calving.**
CI	**Calving Interval.**
CSA	**Central Statistical Authority.**
FAO	**Food and Agricultural Organization of the United Nations.**
GDP	**Gross Domestic Product.**
IAR	**Institute of Agricultural Research.**
IDRC	**International Development Research Institute.**
IFPRI	**International Food Research Institute.**
ILCA	**International Livestock Center for Africa.**
ILRI	**International Livestock Research Institute.**
IPS	**International Project Service.**
IRC	**International Rescue Committee.**
Kg	**Kilogram.**
m.a.s.l	**Meters above sea level.**
MOA	**Ministry of Agriculture.**
NGOs	**Non Governmental Organizations**
OoPRD	**Office of Pastoral and Rural Development.**
PPS	**Proportional Probability to Size.**
TLU	**Total Livestock Unit.**
UNDP	**United Nation Development Program.**
UNDP/RRC	**United Nation Development Programme/Relief and Rehabilitation Commission.**

BIOGRAPHICAL SKETCH

The Author was born on January 11, 1982 in Addis Ababa. She attended her elementary school at Haleluya and secondary school at Medhaniallem Comprehensive High School. She joined Alemaya University of Agriculture in 2000 and graduated with a B.Sc. degree in Animal science on June, 2003.

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TABLE OF CONTENTS

TABLE OF CONTENTS (*CONTINUED*)

TABLE OF CONTENTS (*CONTINUED*)

TABLE OF CONTENTS (*CONTINUED*)

LIST OF TABLES

Table **page**

LIST OF TABLES (*CONTINUED*)

LIST OF TABLES (*CONTINUED*)

LIST OF TABLES (*CONTINUED*)

LIST OF TABLES IN THE APPENDIX

Appendix Table **Page**

LIST OF TABLES IN THE APPENDIX (***CONTINUED***)

LIST OF TABLES IN THE APPENDIX (***CONTINUED***)

LIST OF TABLES IN THE APPENDIX (***CONTINUED***)

CHARACTERIZATION OF MILK PRODUCTION SYSTEM AND OPPORTUNITY FOR MARKET ORIENTATION: A CASE STUDY OF MIESO DISTRICT, OROMIA REGION, ETHIOPIA

ABSTRACT

This study was conducted in Mieso district in western Hararghe Zone of Oromia Regional State to characterize milk production and marketing system and identify opportunity for market orientation. This study was initiated with the objectives of generating baseline data in the area of milk production and marketing system. The study was undertaken in five purposely selected rural kebeles of Mieso district; and these were Dire-kalu, Welda-jejeba, Hunde-misoma, Gena, and Huse-mendera. Farmers from each rural kebeles were selected using Proportional Probability to Size (PPS) approach for each rural kebele. A total of 120 farmers were selected based on the number of households. The sample households in each rural kebeles were stratified in to female and male headed households. For the market study, two market sites were purposively selected namely, Mieso and Asebot markets due to the accessibility of the area. Milk marketing was monitored over two seasons, i.e., rainy and dry seasons. The average pasture land size of the sampled households was 1 ha, with a range of 0.25-10 ha. On average, there were more number of goats (6.03 ± 0.30) holdings than cattle (5.69 ± 0.35) and camel (1.83 ± 0.92) per household. However, the average numbers of animals per species found in the studied rural kebeles was highest for goats (723), than for cattle (683) and camel (220). The proportion of female to male ratio of cattle in the district was 2.57: 1. Traditional hand milking was the major type of milking practices in the whole parts of studied area. During the study period, about 99.2 % of the households had milking cows, and 97.5 % of these households indicated that only female members of the household are responsible for milking. However, 2.5 % of the households indicate that not only females, but also males take part in milking of cows. Almost all of the households indicated that cows are milked twice during the wet season and once during the dry season. About 72 % of the respondents indicated that camels are milked up to thrice a day during the wet and dry seasons. Milk and milk product sale (96 % of the respondents) and crop sale (95 % of the respondents) take the highest percentage of source of income. All the respondents indicated that

cattle, camels and goats are fed principally on communal natural pasture throughout the year. Agricultural byproducts, mainly crop residues of sorghum and maize are the major feed resources in the studied area. Traditionally, sorghum and maize plantation used as fodder for livestock feed, and it is locally called as chinki. As an additional feed, mineral soil salt, locally known as ''haya'', it is used by 40 % of the respondents during wet as well as in the dry season.

All milk animals in the study area are indigenous breeds and have not been characterized. The overall mean (mean ± SE) age at first calving for cows and she camels were 52.49 ± 0.91 and 63.37 ± 1.55 months, respectively. The overall mean calving interval for cows and she camel were 16.01 ± 0.49 and 18.53 ± 1.02 months, respectively. The estimated mean milk yield/head/day was 1.24 ± 0.02 liter for cows and lactation yield per cow was 271.4 liters over an average lactation period of seven month (7.29 ± 0.17). Overall estimated mean camel milk yield/head/day was 2.4 ± 0.06 and lactation yield head was 797 liters over an average lactation period of eleven months. The estimated average total milk produced per household per day in the wet and dry seasons was 4.80 ± 0.22 and 2.37 ± 0.11 liters, respectively for cows. Similarly, the average total milk produce per household per day in the wet and dry seasons was 13.19 ± 0.945 and 7.63 ± 0.82 liters, respectively for camels. The majority of the households sale whole milk (78 %) than whey (4.2 %). Butter is produced for sell by about 67 % of the respondents. About 72% of the respondent indicated that they sale cow milk during both the dry and wet seasons. The average volume of cow and camel milk sold per household per day during the rainy season was 3.55 ± 0.28 and 3.61 ± 0.45 liters, respectively. However, during the dry season, the respective volumes decreased to 2.15 ± 0.22 and 2.58 ± 0.37 liters. Cow and camel milk supply to the market decreases by 39 % and 28 % during the dry season, respectively. This indicates that camel milk sale increases during the dry season. The amount of milk sold in Mieso market per day was significantly ($P \leq 0.05$) higher for cow (496.6 ± 19.12 liters) as well as camel milk (187.89 ± 19.12 liters) than the Asebot market site. The price of cow and camel milk during the wet season is lower (1.88 ± 0.10 Birr/liter and 1.63 ± 0.10 Birr/liter) than during the dry season (3.38 ± 0.10 Birr/liter and 2.98 ± 0.10 Birr/liter), respectively. Generally, there are two milk marketing systems; namely, traditional milk associations or groups and the producer themselves (individual seller). The traditional milk association or group is locally known as 'Faraqa

Annanni'. From the total (n=94) households who sell milk, only 22 (23 %) were involved in the milk association or groups. An average amount of milk sale by group (3.94 ± 0.18 liter/person) were significantly (P≤ 0.05) higher than individual (1.64 ± 0.06 liter/person). The total amount of milk sold (liter/person/day) at the two market sites differed significantly, being higher in Mieso (3.27 ± 0.17 liters/person) than in Asebot (1.91 ± 0.06 liters/person). The number of individuals per Faraqa Annenni/day was not significantly (P > 0.05) different between Asebot (2.94 ± 0.12) and Mieso (3.05 ± 0.22). However, there was more number of seller groups in Mieso. This may be due to the involvement of pastoral milk seller groups from the adjacent district of Mullu in Somalia Region.

As the logit regression result indicates the availability of Faraqa Annenni in the area had significant (P ≤ 0.1) positive relation with the participation decision of the household to sale cow milk. The other variable which has a significant (P ≤ 0.05) impact on the decision behavior of the household is its location from the market. As the model output indicates, the farther the household is away from the market center the less will be its participation to the cow milk sale. Education level of the household heads were negatively (P ≤ 0.05) correlated with participation decision on cow milk sale. This negative correlation of education level of the household heads with participation on cow milk sell indicates that rather than milk sale, decision on other activities were more. Contrary to the expectation, amount of goat and camel milk produced in the household were negatively and significantly (P≤ 0.01 and P≤ 0.1) related to market participation decision of the household on cow milk sale. This indicates that more production of camel and cow milk tends to shift the household consumption pattern from camel and goat milk to cow milk, which reduces the available cow milk for sale.

Most of the respondents indicated that milk sale was highly affected by small milk quantity (73 %) followed by distance to market (38 %). Only 7.6 % of the respondents indicated cultural taboo as a limiting factor for milk market participation. Therefore, the figure indicating that this issue is not a serious problem in the area.

Overall cattle and camel pre-weaning mortality rates were 61.7 ± 5.2 and 66.7± 14.7. Mortality due to diseases was identified as a major cause of loss in cattle (65% of respondents) and camels (67%) in the study area. Mastitis, Anthrax, pasteurolosis, diarrhea, Blackleg and FMD (Foot and Mouth Diseases) were the major diseases that affect cattle in the area.

Only 33 % of the respondents indicated that they have access to extension services on dairy animal production. The farmers contact with extension staff once or twice a year and there is no strong and regular visit and follow-up.

Generally, among the problems of dairy production in the area, seasonal feed and water shortage, security problem, and poor access to veterinary services were the major ones. In addition to this, low knowledge capacity and the limited number of the development agents were also reported to be common problems in the extension service. All milk animals in the study area have not been characterized. There is no any milk cooperatives organized in the area. Instead there are traditional self organized milk seller groups, Faraqa Annanni. Milk sale was highly affected by small milk quantity followed by distance to market. In addition, milk sale was also affected by non-availability of Faraqa Annanni in the area. Accordingly, improve the available natural pasture and implement rangeland management systems, introduce and develop improved forages as sole crops or integrated with cereal crop production should be made. There should due attention to the way of dealing with conflicts over use of resources in the district, conflict resolution method should be addressed and community should be a starting point for ideas to develop a strategic plan. There should be training for development agents and extension staff in the district about milk production, handling and processing techniques. It is necessary to improve animal health services through paravet training and drug supply system with close monitoring and supervision. Breed improvement should consider the multipurpose utility of local breeds, where it is feasible with improved feeding and proper management systems. Furthermore, establish milk collecting and processing unit through encouraging the already existing self organized group, 'Faraqa Annanni'.

1. INTRODUCTION

Ethiopia is a landlocked country in the horn of Africa located at 8.0^0 N and 38.0^0 E (The World Fact Book, 2002). The country has diverse topographic and climatic conditions. These consists of a high central plateau ranging from 1800 to 3000 meters above sea level, the rift valley that divides the country from north to south with altitudes ranging from 1000 to 1800 masl, and lowland plain areas of less than 1000 m.a.s.l. in altitude (Alemayehu, 1987). Depending on the altitude, temperature ranges from less than 10^0 C in alpine areas to 35^0 C and higher in the lowlands (Alemayehu, 1987).

The total land area of the country is 1.1 million sq. km and the total population is around 74,777,980 (The World Fact Book, 2006). The total population sex ratio, is 1 male(s)/female and with a population growth rate of 2.31% (The World Fact Book, 2006). More than 80 % of the Ethiopian population is dependent on agricultural based economy of which livestock plays a very significant role (Bureau of Africa 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 Africa Affairs, 2006). The major agricultural export crop is coffee, providing 35 % of Ethiopia's foreign exchange earnings, down from 65 % a decade ago because of the slump in coffee prices since the mid-1990s (Bureau of Africa Affairs, 2006). Other traditional major agricultural exports are hides and skins, pulses, oilseeds, and the traditional "chat," a leafy shrub that has psychotropic qualities when chewed. Sugar and gold production have also become important in recent years (Bureau of Africa Affairs, 2006). The contribution of livestock and livestock products to the agricultural economy accounts for 40%, excluding the values of drought power, transport, fuel and manure (Winrock International, 1992). They are also used as a source of income, food security, and used to indicate prestige and social status in the rural community.

Ethiopia, with average annual per capita income of less than US$ 100, is among the poorest countries in sub-Sahara Africa (SSA) (Bureau of Africa Affairs, 2006). Moreover, the performance of the agricultural sector frequently suffers from drought. The average annual

growth rate of the agricultural sector is only 1.2 %, and could feed only 46 % of the total human population (Brehanu, 2001). Subsistent-oriented smallholder agriculture is the dominant farming system in the country. Levels of malnutrition are consequently high. The Food and Agricultural Organization of the United Nation (FAO) estimated that over two million people are considered chronically food in-secure and need food assistance annually (FAO,2001; The World Fact Book, 2002).

Ethiopia holds the largest livestock population in Africa estimated at about 35 million heads of cattle, 2 million camels, 22.5 million sheep, 17 million goats, 55 million chicken, 2.75 million horses, 5.2 million asses and 0.63 million of mules (ILRI, 2000; FAO, 2002). Despite its huge number, the livestock sub-sector 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 sub-standard feeding, health care and management practices that animals are exposed to the main contributors to the low productivity (Zegeye, 2003).

Ruminant livestock are major components of the agricultural systems in the tropics. In smallholder systems, livestock provides direct cash income, capital assets, produce manure which is used as fertilizer and fuel; source of power for transport and cultivation (Coppock, 1994; De Leeuw *et al., 1999*; Tsehay, 2002). Therefore, these make the livestock much more important in addition to being as a source of food to the community.

Regarding dairying, the national milk production remains among the lowest in the world, even by African standard. The total milk production is estimate at about 1.2 million tones per annum, and increases at a rate of 1.2 % for milk produced from indigenous stock and 3.5 % for milk produced from the improved stock (Tsehay, 2002). The per capita consumption of milk in Ethiopia is about 16 kg per person per year, which is much lower than the African and world per capita averages of 27 kg/year and 100 kg/year, respectively (Saxena *et al.,* 1997). Hence, about 6 million tones 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 potential demands of the growing population of Ethiopia. In order to meet the

demand of the growing population of Ethiopia, milk production has to grow at least at a rate of 4 % per annum (Azage, 2003).

The lag in domestic supply of milk relative to demand in the tropics has resulted from several factors, and Ethiopia is no exception. On the demand side, rapid increase in person income; on the animal side, low animal productivity, inappropriate technologies, inadequate research and extension support, poor infrastructure and unfavorable external conditions have contributed to the poor performance of the livestock sector in general, and of the dairy sub-sector in particular (Williams *et al.,* 1995).

Given the considerable potential for smallholder income and employment generation from high-value dairy products (Staal, 2002), the development of the dairy sector in Ethiopia can contribute significantly to poverty alleviation and nutrition in the country. Dairy production is a biologically efficient system that converts large quantities of roughage, the most abundant feed in the tropics, to milk, the most nutritious food to man (De Leeuw *et al.,* 1999).

Three livestock production systems were found in Mieso district, in which pastoralists make up about 80 % (Save The Children, 2004). The rest of the populations are in agro-pastoralists, while less than 5 % are engaged in crop/livestock and commercial activities in urban or trading centers (Save The Children, 2004). So the production system of Mieso district is characterized by livestock production with minimal investment of agriculture (Save The Children, 2004).

So far, most of the characterization studies were limited to state farms located mainly in higher altitudes where the climate is suitable for milk production. 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.

Therefore, it is apparent that there is a need to study the dairy production system in the lowlands as a systems approach for research and development is recognize as the most

appropriate means of gaining knowledge of the factors which influence decision at farm level (Ibrahim, 1998). Moreover, these approaches are also important to furnish essential information and experiences for future dairy development efforts. Therefore this study was designed to address the following objectives.

Objectives

1. To characterize milk production and marketing system in Mieso district
2. To identify major constraints for the development of market-oriented dairy production and
3. To provide baseline information for scaling up similar development activities in other similar agro-ecologies

2. LITERATURE REVIEW

2.1. Ethiopian Lowlands: Background

The Ethiopian lowlands occur below 1500 masl. They are predominantly pastoral areas of the country and cover about 78 million ha, which is about 61% of the national land area. The agro-ecologies in the lowlands include arid (64 %), semi-arid (21 %), and sub-humid (51%). The lowlands are homes for 12-15 % of the human population. Out of the total inhabitants of the lowland, 93 % are considered to be pastoralists and agro-pastoralists and the remaining 7 % are involved in other activities such as hunter, cultivator or pure cultivator. Pastoral and agro-pastoral own about 28 % cattle, 66 % of goats, 26 % of sheep, and almost all of the camel (CSA, 2003). The human population is composed of 29 Nilotic and Cushitic groups (Dawit, 2000, Coppock, 1994). Pastoralists/agro-pastoralists are the people who are primarily rising and depending on livestock and their product as their source of food and income. They inhabited the lowland periphery of the country. Almost all of the pastoralists and agro-pastoralists are found in marginal boarder areas (Dawit, 2000). The uncertainties of the rainfall and primary production in the rangelands have promoted animal-based life-styles that enabled people to be mobile and opportunistic. Animals are consequently important in social value systems (Coppock, 1994).

Since rainfall rather than livestock, density determines net primary production and vegetation cover, its variability is the most important climatic factor determining the state of the natural resource base. Hence, rainfall variability and net primary productivity of the vegetation correspondingly determines livestock production and productivity. With highly variable rainfall, the pastoral economy is typically of the “bust and boom” type. It is a boom when rain is plentiful, herds and flock grow and produce sufficient amount. It is a “bust” when extended dry periods and drought occur. During this period, livestock production and productivity rapidly decline to the extent of causing mortality (Dawit, 2000).

2.2. Livestock Production System in Lowlands

In the Ethiopian lowlands about 93% of the people are pastoralists or agro-pastoralists, with the remainder being hunter-gatherers or pure cultivators (UNDP/RRC, 1984). As to the system classification for livestock production system: there are pastoral, agro-pastoral and intensive systems of livestock production. In the highlands, where about 70% of the human and livestock populations live, mixed crop-livestock farming is typically practiced within the same management unit. In the lowlands, however, livestock husbandry predominates, and there is little or no crop farming (Siegefreid and Berhan**,** 1991).

2.2.1. Pastoral production system

This system is broadly defined both as a way of life and as a socio-economic entity, which is based primarily on livestock production by utilizing the available scarce range resource. This is also cyclical seasonal movement of herds in synchrony with the rainfall regime, in order to exploit the forage and temporary water resources in an agrarian area whose stockmen have the technical mastery by custom certain rights (Pagot, 1992).

Pastoralism is the major system of milk production in the lowlands. However, because of the rainfall pattern and related reasons, and shortage of feed, milk production is generally low and highly season dependent (Ketema and Tsehay, 1995). When the area exploited by a herd cannot continue to ensure its maintenance and the stockman cannot do any thing about this deterioration, the animals should be moved. The insufficiency of the available forage and water resources also aggravate the mobility of the pastoralists (Pagot, 1992).

Therefore, production system is considered to be ecologically fit and environmentally sound in that it allows production of livestock by employing generation long traditional resource management. Besides the production system has its own goals, management strategies, defined production practices adaptable to high, and unpredicted environmental variability.

The goals are set based on risk reduction, livestock productivity, and conservation of the natural resource (Dawit, 2000).

2.2.2. Agro-pastoralists

Agro-pastoralists are segments of the pastoral society who promote opportunistic crop farming to improve food security. Traditionally its one way of maintaining ownership rights over the use of land. It enables the production of crops to be used by both humans and livestock (Beruk and Tafesse, 2001). AGROTECH/CRG/SEDES association stated that 1/3rd of the breeder's practices cultivation mostly in the area where near to road or towns. Cultivation is wider practices in pastoral area depending on rainfall. In more mesic situations where cropping caries less risk, pockets of agro-pastoralists have developed and will continue to expand.

Compared with similar African systems, densities of people and livestock to human ratios suggest that preconditions now exist to force a widespread shift to agro-pastoralism on the plateaus where the environment permits and in the absence of other development opportunities. A shift to agro-pastoralism could allow some Boran to procure more food energy and still restrict sales of animals for grain purchases so that herd capital can be retained for other purposes (Coppock, 1993).

2.2.3. Crop and livestock integrated production system

According to Janke (1982) the crop and livestock production integrated farming systems can further be divided in to two broad sub-divisions namely: crop-livestock and livestock -crop systems. In the crop/livestock system, cropping is primary and the more important farming activity, while livestock is secondary. In the livestock/crop system, the livestock is the primary activity and cropping takes secondary position in terms of farming importance.

The second production system is available in most of the lowlands of Ethiopia. In the lowlands, livestock are important than cropping due to the rainfall limitation in the area.

Drought has been found to be eliciting at least a temporary reliance on the cultivation by pastoralists until livestock productivity and numbers recover. Under recent condition of restricted resources, farming can persist in a pastoral society because a mixed system has greater proven flexibility and reliance (Jonsen *et al.,* 1989). Opportunistic cultivation is one of the few alternatives that pastoralists have to partially compensate for such a long-term trend. Droughts can permanently turn poor pastoralists in to farmers by the unfortunate depletion of their smaller herds (Coppock, 1994).

2.3. Milk Production System

Livestock are raised in all of the production systems of Ethiopia by pastoralists, agro-pastoralists, and crop/livestock farmers (Ahmed *et al.,* 2003). Milk production system can be broadly categorized in to three systems, based on marketing situations, such as urban, peri-urban and rural milk production system (Tsehay, 2002). The main source of milk production in Ethiopia is from the cow, but small quantities of milk obtained from goat and camel is also used in some regions particularly in pastoralist areas (IPS, 2000).

2.3.1. Urban milk production system

This system is developed in major cities and regional towns, which have a high demand for milk, and they are a largest source of milk producer. A total of about 5167 small-medium and large-scale dairy exist in and around Addis Ababa. Total milk production from these dairy farmers amounts to 34.649 million liters per annum. Of this total 73% is sold, 10 % is left for household consumption, 94% goes to calves and 7.2 % is processed, mainly in to butter and *ayib* (cottage cheese) (Azage and Alemu, 1998).

Producers deliver milk to consumer or consumers may collect it at the producer's gate. Payment to producers is generally on the monthly bases. The milk marketed in this system is of questionable quality, it is not pasteurized, and there is a possibility of adulteration.

Moreover, price is high even when quality is low. No standardize quality control mechanisms or dairy policy exists to safeguard consumers (Tsehay, 2002).

2.3.2. Per-urban milk production

This system includes smallholder and commercial dairy farmers near Addis Ababa and other regional towns (Ahmed *et al.,* 2003). Most of the improved dairy stock is used for this type of dairy production. Currently small holder farmers' milk marketing units, the DDE (Dairy Development Enterprise), Mama agro-industry, and private dairy farmers in and around Addis Ababa are supplying dairy products to the city market (Tsehay, 2002). Generally, the primary objective of this milk production system is to sale milk as a means of additional cash income (Tsehay and Ketema, 1994).

2.3.3. Rural milk production

This dairy system is part of the subsistence farming system. According to Staal and Shaprio (1996), it is the predominant production system accounting for over 97% of national milk production. This system includes pastoralists, agro-pastoralists, and crop-livestock producers. Largely, the system is based on low producing indigenous breeds of zebu cattle. The livestock are kept under traditional management conditions and generally obtain most of their feed from native vegetation, aftermath grazing and crop residues (Tsehay, 2002).

Pastoralism is the major system of milk production in lowlands. However, because of the low rainfall, shortage of feed and water availability, milk production is low and highly influenced by season (IPS, 2000; Tsehay, 2002). The system is not market oriented and most of the milk produced in it is retained for home consumption (Ahmed *et al.,* 2003) or household processing. Processing is usually done using traditional technology in to products such as butter, ghee, *ayib* and sour milk. Milk and milk products are usually marketed through the informal market after the households satisfy their needs (Tsehay, 2002).

2.4. Land Holding and Crop Production

The high population densities in the highland area imply that farm size will be small. In the rural areas of the Harari milk shade, mean size of cropland was 3.41 ha, with the large farm of about 6 ha in the lowlands. The small croplands were in the highland of the Harari region, namely the Galmashira, Deyetayara, and Awbarakale farmer association with 1.1, 1.36, and 1.18ha/household respectively. The mean size of landholding in the Harar milk shed is much larger than the average holding of the Harari region and surrounding high lands, which is estimated at about 0.5 ha (Kurtu, 2003). In most area of the western Kenya highlands, average farm size is 1.9 ha in the coffee growing zone while the average farm size is somewhat lower, between 0.6 and 1.0 ha (Place *et al.,* 2003).

During long rainy season in Borena plateau, on average 0.42 hectare of land were under cultivation and during short rain about 0.15 ha on average will be cultivated (Coppock, 1994). The major crops grown in Harari region are sorghum, maize, groundnut, and *chat* (Kurtu, 2003). It is also supported by IPS (2000) who reported that, in Somalia area and elsewhere in Harrergae area groundnut and chat are grown by farmers, and sorghum and maize are the most stable food and feed for humans and animals.

2.5. Herd Composition and Structure

Herd structure and number are determined by drought condition, management practices (health care and nutrition) and depending on the available feed in the area. For instance, herd size in southern Ethiopia was 31 and 149 in south Kenya but due to drought effect the herd size in both south Ethiopia and Kenya decreased to 7 and 98, respectively (Ndikumana *et al.,* 2000).

2.5.1. Livestock holding

The herd composition and number of ruminants in the lowlands depend on the agro-ecological nature of a particular area. Moreover, the variability and proximity of watering points as well as the proportion of brows to grasses are the determining factors. Livestock are used for various purposes in the lowland areas. The primary reason for keeping cattle and camels is for milk production, which is the mainstay of the human population. Small ruminants (sheep and goat) are reared to generate income when cash is needed in pastoral areas (IPS, 2000).

According to Ndikumana *et al.* (2000), in the east African countries the flock size of small ruminant is higher in pure pastoralists than the agro-pastoralists, averaging 125 and 60 animal/household, respectively. However, the number of cattle was higher in agro-pastoral than pastoral areas. The distribution of livestock species owned by a household in Somali pastoralists consists of 58.1 % cattle, 53.2% goats, 45.3 % sheep, and 33.1 % camel (IPS, 2000). The same survey reported that the average number of livestock per household to be 7 cattle, 20 sheep, 20 goats, and seven camels; while the ranging is 4-20 cattle, 5-50 goats, and 1-32 camels. More commonly, 95 % of the rural populations keep a mix of different type of livestock species usually cattle, sheep and goats (IPS, 2000). The livestock own ship in pastoral and agro-pastoral area of Kenya and Chad as reported by Ibrahim (1998) are shown in the Table 1 below:

Table 1. Herd composition in pastoral and agro-pastoral area of Kenya and Chad

	Kenya		Chad	
Country	Average households (head/household			
Production system	Pastoral	Agro-pastoral	pastoral	Agro-pastoral
Cattle	157.3	11.8	36.4	133.3
Sheep	44	5.4	43.5	2.0
Goats	83.1	13.6	45	46.3

Source: Ibrahim H. 1998. Small ruminant production techniques

As reported by Samuel (2005), in the Yerer watershed of eastern Showa out of 150 farmers, 13.3 %, 19.3 % and 43.3 % farmers owned goats, milking cows and oxen respectively. This

indicates that more farmers owned oxen than cows, which mainly because of the high demand for drought power in the highland areas.

2.5.2. Herd structure

The age and particularly the sex composition of herds are regulated largely by the main herd functions (Wilson, 1986). Herd structure can indicate the owner's management objectives, birth or death rate, and herd productivity in the system (ILCA, 1990). The age and sex structure of cattle are generally similar across agro-ecological zone of the Oromia region and in all production systems (Workneh and Rowland, 2004). However, the proportion of female cattle is higher in pastoral management system than in other production system (ILCA, 1990; Coppock, 1994; Kahsay, 2002; Workneh and Rowland, 2004). The mean composition of the cattle herds in East Africa pastoral area by cattle herd category as a ratio of 1:4:1:1 for bull, cows, heifers, calves, respectively (Ndikumana *et al.,* 2000).

Increase in the proportion of adult males as the livestock density increased was markedly higher in the agro-pastoral systems than in pastoral system (Workneh and Rowland, 2004). The proportion of female to male in Borana cattle herds found by Mulugeta (1990) was 74:26, and this ratio is in agreement with the ratio of 71:29 reported by Coppock, (1994) and a ratio of 79:29 reported by Belete (1997) for the Afar pastoral area. This is similar for other pastoral and agro-pastoral groups throughout sub-Sahara Africa.

Table 2 Herd structure pastoral and agropastoral area oromia region, Ethiopia

Production system	**Cattle %**			
	Young male	**Young female**	**Adult male**	**Adult female**
Agro-pastoral	**16.2**	**17.8**	**27.5**	**37.6**
Pastoral	**15.6**	**18.6**	**17.9**	**47.9**

Source:Workneh and Rowland (2004).

The average cattle herd structure in the three ranches of Olkarkar, Merueshi and Mebricani, in Maasai, Kenya is also presented in Table x.

Table 3 Cattle herd structure in Kenya ranch

Class	Age (years)	Mean
Males		
Calves	0-1	7.8
Bulls	> 4	5.3
Females		
Calves	0-1	9.8
Heifers	1-4	20.5
Cows	> 4	36.1

Source: derived from King *et al.* (1984).

The high proportion of the female in pastoral herds is thought to help stabilize milk production by off setting the longer calving interval characteristics of the system. On the other hand, males not needed for reproduction are sold to generate income for the purchase of food and other purposes (ILCA, 1990).

2.6. Division of Labour for Dairy Animal Production

Allocation of labour to different tasks is used to overcome labour shortage. Herding arrangement needs more labour than other activities such as, watering, grazing operation, care of young stock and animal health care (Grandin *et al*., 1991)**.** In Massai there are culturally prescribed norms for the division of responsibilities and labour between age groups and sexes (Grandin *et al*., 1991) and this is also agreed with the report of Coppock (1994) in the Borana of southern Ethiopia.

The strict allocation of tasks to various age and sex groups in Borena encampments is typical of pastoral system in general (Fratkin, 1987). Married men in Maasai are primary managers and supervisors. They decide on herd movement, watering locations, daily orbit of grazing, observe the animals whether they give birth or are sick, buying and administrating of drug, and on decision which animals will be sold (Grandin *et al*., 1991). Farming is typically the activity of men but as Coppock (1994) reported in Borena platue of agro-pastoral system, both

male and female participating in cultivation. This idea is also supported by Grandin *et al.* (1991) in Maasai pastoralists of Kenya.

Grandin *et al.* (1991) reported that in Maasai pastoralists in Kenya, children did almost all of the herding (92 %), while women did most of the milking (83 %) than milking done by children (19 %). Children spent 4-5 hours a day in herding and one hour on livestock works. Men spent 5.5 hours on livestock related works. Women spent one hour and a half a day on livestock management, just an hour on milking and 6 hours on domestic chores. Children (starting from the age of 3 or 4 years old) make much of the Maasai household work. They care for the young animals such as kids and lambs in or around their house. Herding of calves starts at the age of 8 or 9 years.

Men are largely the strategists for livestock production, while women carry out day-to-day management and retain primary responsibility for dairy-related activities. Widowed women may have greater managerial and strategic roles in the society than married women in general. Labour allocation is profiled on a daily basis for married women in different seasons, and for males and females at the encampment and regional level of resolution. Herding and watering animals dominate labour requirements overall and labour budgets suggest that labour is likely to be a common constraint in dry seasons (Coppock, 1993).

Married women typically perform calf management. Somalia women in the dry season spent nearly all of their time hauling water. At other times of the year the women divided their time mostly among domestic chores (milking, milk processing), care of livestock (collecting and feeding the collected fodder to the young stock), and cultivation and also they make most of the decisions about milk off-take (Massay, 1989). In Borana pastoralist also management by women includes gathering cut-and-carry forage and hauling water for relatively immobile calves which are kept in or near the family hut (Coppock, 1993)

2.7. Importance of Livestock

Keeping different species of animals can reflect management objectives. Mixed species production increases the likelihood of meeting basic consumption needs particularly in terms of milk in pastoral areas (ILCA, 1990). The first and the most important purpose of dairy cattle production are to provide milk for family use and for sale. In pastoral systems, the major product is milk, and the main function of the livestock is subsistence through social and cultural functions are also important (Jahnke, 1982).

The demand for animal products in sub-Sahara Africa and generally in the developing countries is likely to rise significantly as the result of population growth, urbanization and rising income in the face of relatively low level of consumption at present. Increase the demand for livestock products raises profound implications for food security, poverty alleviation and the environment. By the year 2025 it is projected that the demand for meat and milk will exceed 19 million tons. This level of production requires a 4 % annual rate of increase of livestock productivity compared with the estimate current rate of 2.5 % (Dalgado *et al.,* 1999). In the developing world, by the year, 2020 the demand for livestock products will have a direct and dramatic effect on demand for cereals used as a food (Smith, 2000).

In India, dairying is interwoven with socio-economic fabric of the rural people. Traditionally dairying animals have performed multiple functions of producing milk for household consumption, male animals as a source of draght power in agricultural operations. Besides, dairy animals have often performed an important function of saving bank account with offspring as interest. Animals generate a continuous flow of income and act as a cushion against income shocks arising due to crop failure. Milk is a ‘cash crop’ for smallholders; converting low value agriculture by products and crop residues and using family labour in to a value added market commodity (Taneja and Birthal, 2005).

2.7.1. Dairy animals as a source of food

A pastoral herd tends to have as many cows as possible to produce milk for human consumption. Cattle and camels are the two important species in the pastoral areas due to their ability to provide more milk to the family consumption, while sheep and goats have fewer acceptances. Most of the pastoralists keep cattle, sheep, goats, and camel principally for milk production as a mainstay of their diet (IPS, 2000). In most of the lowlands in Ethiopia with the exception of very few agro-pastoralists that produce crop through opportunistic farming, almost all of the populations are livestock raisers whose food security is highly associated to their livestock (Beruk and Tafesse, 2000).

Livestock products especially milk can offer unique contribution to human nutrition to the poor in the developing countries by providing micronutrient such as vitamin A, in addition to carbohydrate, protein and calcium. Poor smallholder dairy producer meet trade expensive calories (milk and meat) for the cheap calories (cereals), thereby, improving total food consumption (Alderman, 1987).

2.7.2. Dairy animals as a source of income

The proportional importance of livestock to household income differs from one culture to another and within production system. For instance, mixed crop livestock farmers have opportunities for obtaining income from a variety of sources, thus, income from livestock probably contributes a smaller proportion to their household food. By contrast, most pastoralists depend on livestock for a large proportion of their income although this is changing (Thornton *et al.,* 2002). In the Borana plateau, roughly 40 % of gross revenue is derived from milk and the remainder from live animals and meat. Nearly all of the food and income for pastoralist is ultimately derived from livestock (Coppock, 1994). AGROTECH/CRG/SEDES association (1974) noted that 20 % of the annual income in Borana household is derived from animal products predominantly from milk and butter and 30 % of the household budget is from dairy sale.

In certain occasions in the lowlands when the need arises for the purchase of items, the common practices are to sale animals. For this purpose small ruminants are the immediate income generating animal sources in the herd. Most of the time, the pastoral society who depends on livestock resources, income is used to purchase food grains, clothes, other household items. Other sources of income include sale of animals and products and hiring of drought animals to the highlanders (Beruk and Tefesse, 2000; Jean Pagot, 1992).

Despite the lower absolute volume of dairy sales, income from dairy sale provided 37 % of the annual income of poor pastoral households that are close to market, for the wealthy this was 22 %. The poor with few animals, to sale with out endangering their herd capital, had no variable alternative to sell milk in order to get money. Compared to animal sales, dairy sale permits purchasing of quantities of grain that are more convenient to handle by the household (Coppock, 1994). The Borana pastoralists obtain greater than 80 % of their incomes from livestock sales. Cash from the sale of livestock is the most important means of financing household expenditure. Livestock make an important contribution to most economies (Desta, 1999).

The overall pattern of livestock use during drought suggests that animals were not held for quick disposal or sale during times of stress. Instead, they appear to be assets which are held as long as possible in anticipation that conditions will soon improve. Families are apparently willing to undergo great hardship before they are forced to sell animals. This behavior has large implications for exacerbating drought impacts on the population (Coppock, 1993).

2.7.3. Dairy animals as a social value

The notion that pastoralists have an irrational propensity to expand their holdings of livestock beyond the carrying capacity of the range, resulting for overstocking, is not true. There are wide varieties of economic and non-economic reason for individual owners to attempt to expand their cattle holding which include prestige, bride price, and the like (Sere *et al.,* 1996).

The accumulation of livestock in pastoral areas is also considered as a means of wealth indicator of statues in societal hierarchy. Thus, livestock are used to cover social expenses, including weddings, funerals, human and animal health care etc. weave a web of obligations of dependent relationships, of subordination, which assume the cohesion of families and a social groups and form a hierarchies between different groups (Belachew, 2003; Pagot, 1992).

The Borana seek to accumulate animals to promote prestige and protect themselves from perturbations have been long recognized as important elements of pastoral behavior. That the Borana attempt to avoid cattle sale by diversification in to small ruminants and cultivation to help them endure increasing population pressure is another important side effect of their behavior with implications for system transformation.

2.8. Reproductive Performance

The reproductive performance of the breeding female is probably the single most important factor that is a prerequisite for sustainable dairy production system and influencing herd/flock productivity due to, all forms of out put, milk, meat, traction, fuel as well as provision of replacement animals. Reproductive performance is influenced by feed, genetics, diseases and a huge variety of management practices (ILCA, 1990; Perera, 1999).

Reproductive performance is one of the major factors other than milk production that affect productivity and profitability of a dairy herd. Reproductive performance is a biologically crucial phenomenon, which determines the efficiency of animal production. The production of milk and reproductive stock is not possible unless the cow reproduces. It has been indicated that genetic improvement virtually of all traits of economic importance is closely related to reproduction rate (Kiwuwa, 1983). Poor reproductive performance is caused by failure of the cow to become pregnant primarily due to anoestrus (pre- pubertal or post-partum); failure of the cow to maintain the pregnancy; and calf losses (Mukasa-Mugrwa, 1989; Perera, 1999). This causes delays in age at first calving and long calving interval.

Most of the research in Ethiopia is on cattle reproductive performance and there is limited information on camels. Moreover most of the work done on camels is undertaken in Jijiga and Shinile Zones of Somalia region in Eastern Ethiopia (Zeleke, 1998).

2.8.1. Age at first calving (AFC)

2.8.1.1 Cattle

First calving makes the beginning of a cow productive life and influences both the production and reproduction life of the female, directly through its effect on her life time calf crop and milk production and indirectly it is influence on the cost invested for up-bringing (Mukasa-Mugerwa, 1989) and it is influenced by the time of conception (Perera, 1999).

Acceptable and optimum performance of age at first calving under improved smallholder system in the tropics is less than 30 and 36 months, respectively (Perera, 1999). Heritability of age at first calving is generally low, indicating that this trait is highly influenced by environmental factors such as feed and health (Mukasa-Mugerwa, 1989). For instance, age at first calving of Borana cattle ranged between 45.5-51.1 months (IAR, 1991). But under better management in Kenya, the Borena breed calved remarkably at earlier age of 34-36 months. Age at first calving for Fogera breed was reported to be 47.61 months (Addisu, 1999).

In Ethiopia the productivity of the indigenous breed is low. Usually cows do not produce their first calve earlier than 35-53 months of age (Mukasa-Mugerwa and Azage, 1991). Age at first calving in pastoral and agro-pastoral areas with indigenous cattle is 4 years (IPS, 2000) and as the same result reported by Mulugeta (1990) were 4-5 years. In the Borana pastoral system cows have their first calf at 4 to 4.5 years of age (Coppock, 1994). These figures are higher than mean of 3.6 year for *Bos indicus* found in a number of traditional systems reviewed by Mukasa-Mugerwa (1989). Ages at first calving in the Harar milk shed was 50 months in the lowlands and 54.5 months in the highlands (Kurtu, 2004). In general, the ages at first calving for local cows in the same area were 52 months and for crossbreed were 31.06 months (Kurtu,

2004). Workneh and Rowland (2004) reported that age at first calving for pastoral and agro-pastoral production system of Oromia region in general is 51 and 48.4 months, respectively.

2.8.1.2. Camel

The age at first calving of Somalia camel was 57.4±12.8 months (Frah *et al.,* 2004). But the average age at first calving in eastern Ethiopia reported by Tefera and Gbreah (2001) was longer (5 years) than Somalia camel. Ahmed *et al.* (2005) reported that the age at first calving for camels in Afder zone of Somalia region was 5.2 years.

2.8.2. Calving interval of cows (CI)

2.8.2.1. Cattle

Calving interval refers to the period between two consecutive calving and is a function of a days open and gestation length. Since gestation length is more or less constant for a given breed, the number of days open becomes the sole variable of calving interval. Long open periods, and hence the long calving intervals, generally reflects problems associated with management but may also given some indication of the condition of the cow's reproductive organ. Calving intervals have low heritability and can be improved through nutrition and early breeding (Mulugeta, *et al.,* 1991).

In order to maintain optimum economic benefits under modern intensive dairy systems, it is generally accepted that the CI should be around one year. However, under many dairy systems in tropical countries a one-year CI is often difficult or impossible to achieve and, in some situation, even undesirable. In Ethiopia, zebu cattle raised under traditional management in the highlands, calving interval averaged 26 months (Perera, 1999). The overall calving interval of cows in Oromia region is 18.6 months. In pastoral and agro-pastoral areas shorter calving intervals of 15.5 months than 19 months, respectively have been reported (Workneh and Rowland, 2004). In Zebu cattle, calving interval is estimated to range from 12 to 22 months with annual calving rate of 50-60% (Mukasa-Mugerwa, 1989).

The relative importance's of factors that affect reproductive performance vary in the different smallholder farming systems. For instance, under extensive free grazing system nutritional fluctuation due to seasonal shortage cause delays in puberty and the post-partum cycle (Perera, 1991) and calving interval in the Borana are strongly influenced by the environment, as 90% of the conceptions and births occur either in the longer or shorter rains. The shorter calving interval in lowland could be due to the reduced period of anoestrus; as high producing animals sacrifice more of their body stores to support milk production and the next conception is thus delayed (Mulugeta, 1990).

2.8.2.2. Camel

In Pakistan, the average calving interval for different breeds of camels was 764.87 days (Baloch, 2002). In Somalia, Frah *et al.* (2004) reported that calving interval for Somalia camel was 27.4 ± 9.3 months. In Eastern Ethiopia, the average calving interval for camel was 2 years (Tefera and Gbreah, 2001). Similarly, the mean calving interval in Afder zone of Somalia region was 2 years (Ahmed *et al.,* 2005).

2.9. Lactation Length and Milk Yield

2.9.1. Cattle

Indigenous breed of cows are generally considered low milk producers. However, they are the major source of milk in Ethiopia that account for 97 % of the total milk production in the country (Abaye *et al.,* 1991). Milk yield has remained extremely low with national average of 1.09 liter/day/cow (Dagenae and Adugna, 1999). Similarly, Lemma *et al.* (2005) reported that the average milk yield of local Arsi cows was 1.0 liter/head/day. For Fogera cattle the overall average estimate lactation yield was 506.78 liters, which is very low due to poor genetic make up and shortage of feed and poor management conditions (Mulugeta, 2005) and also shorter lactation length (Gebeyehu, 1999).

Milk production per day per head is very low and this is further affected by relatively short lactation length and extended short lactation length and extended post-partum anoestrus resulting in low production efficiencies (Azage and Alemu, 1997). The mean milk off-take of cattle in Maasai pastoralists in the wet and dry seasons was 1.09 and 0.79litres/cow/day (Semenye, 1987). The indigenous (or traditional) mixed farming and pastoral/agropastoral systems rely mainly on local breeds, which produce 400-680 kg of milk per cow per lactation period of less than seven months (Siegefreid and Brhan**,** 1991).

The average milk yield of local cows found in Somalia region is less than two liters per day which could reach up to 488 liters over a 249 days lactation period in all pastoral areas elsewhere (IPS, 2000). Kiwuwa *et al.* (1983) reported that Arsi and Zebu cattle as averaged 869 kg of milk over 287 days of lactation. Mukasa-Mugerwa *et al.* (1989) noted that Zebu cattle under traditional management yield about 524 liters over 239-days lactation period, which is about 2.2 liters per day. In the Harar milk shed mean lactation length for local cows was 212 days Kurtu (2003). The average lactation length in Maasai pastoral area was 12 months, and the shortest lactation length reported was 6 months (Semenye, 1987). According to CSA (1996), an average lactation length of cows in private holding raged from 5- 7 months. Lemma (2005) however reported a longer lactation length of 9.5 months for local cows in the East Showa zone of Oromia.

2.9.2. Camel

As the report of Ahmed *et al.* (2005) indicated the breeding practices of camels after parturition in Ethiopia is mostly done after they complete 300-365 days. Therefore, this has a positive effect on milk yield as reported by Mukasa-Mugerwa (1981); breeding practices in early lactation of the dam will decrease milk yield as well as lactation length. Milk off take is reliable and consistent throughout the seasons (Elmi, 1991). The daily milk off-take in dry and wet season in Jijiga was 5 and 4 kg, respectively. It was 3 kg for both seasons in Shinile (Tezera and Hans, 2000).

The average daily milk yield of camel in eastern Ethiopia was 2.5 liters and lactation length was one year (Tefera and Gbreah, 2001). In Pakistan Baloch (2002) reported that milk yield and lactation length averaged 1894.93 liters and 445.58 days, respectively. The lactation yield and lactation length of camel in Jijiga was 2009 kg and 15 months, respectively (Tezera and Hans, 2000). The same study reported lactation yield and lactation length of 1244 kg and 13 month, respectively for camels in Shinile Zone (Tezera and Hans, 2000).

2.10. Mortality Rate

Differences in mortality rates between species are largely a reflection of management techniques used by the herders and the capacity of each species to resist stress conditions. Mekibib and Asseged (2003) illustrated that calf mortality is an important constraints under Ethiopian farming conditions, but this was analyzed for dairy calves under one year of age.

As this is supported by the idea of Ndikumana *et al.* (2000), the 1995-97 drought as well as 1997-98 El Nino rains had significant adverse effect on the livestock population. During the drought, cattle mortality rates were highest in southern Ethiopia and northern Kenya, increasing to 49 % and 35 %, respectively. The small ruminant mortality rates were also higher in southern Ethiopia and northern Kenya, increasing to 52 % and 43 % respectively.

The mortality rate during normal period for Afar pastoral for cattle, goat and camel were 3.5 %, 15 % and 1.1 %, respectively (Belete, 1979). The major killer disease for goat was contagious caprine pluro-pnuemonia (CCPP). However, Kahsay (2002) found that the mortality pattern for the small ruminants was similar to that of cattle- mortality across all the zone of Eritrea. In the lowlands of northern west area of this country, the death rate for goats was higher than the cattle and camel due to CCPP.

Overall calf death rates average 20.7 % and 6.4 % in two different farms, Ihimbu and Kibebe in Tanzania**.** The major calf killers diseases were ranked to be diarrhea /scour, pneumonia and tick born diseases. Pre-weaning mortality rate at the two farms, were 8.1 and 3.3 % respectively (Kifasro and Temba, 1990). In Bako area when caves were managed indoors,

mortality was higher in the first three months of age (8.80%) than the second three months (5.86%) probably because of deficient in calf immune system (Gebre-egzabiaher Gebre-Yohannes**,** 1991). Calf mortality was low up to 4 month of age due to the efficient management system that Massai in Kenya have adopted for young calves which were kept in and around *boma* and rely exclusively on their dams' milk. Mortality increased somewhat when calves were sent out to graze, 12 % will die up to 7 months of age and survival rate is high when the calf's age is between 7-18 months, with 2-4 % mortality.

With an increase in age, mortality rate decreased probably because of improved adaptability of animals to both climatic and nutritional factors. Higher mortality was observed in Bako area in the first year of age (39.21 %), followed by the second (29.21 %) and the third (19.67 %) (Gebre-egzabiaher Gebre-Yohannes**,** 1991).

The small amount of rain coupled with a high temperature in the immediate season favors multiplication of parasites than the wet season when there is a high rainfall and the dry season when there is a high temperature and no rain (Gebre-egzabiaher Gebre-Yohannes**,** 1991). Therefore, high mortality in the intermediate season can be caused by parasites. Among the seasons, mortality rate was highest during the intermediate short rainy season (38.9%), followed by the dry (32.62%) and the wet (28.01%) seasons. During the immediate season and the end of the rainy season, feed is abundantly available (Gebre-egzabiaher Gebre-Yohannes**,** 1991).

In Fulani cattle herds, calf mortality to 1 year of age was 43 %, including 7 % abortions, and this was caused by poor milk production and diseases. Mortality in the 1-4 years age group was approximately 5%, while for the stock older than 4 years it averaged 8% (Wagenaar *et al*., 1986). Abortion in agro-pastoral system of central Mali was 3.3 %, and mortality rate for the herds was 31.6 % (excluding abortion) and if these are included, the figure would be 34.9% (Wilson, 1986). Death to weaning (at about 7 months) age was about 9 %, and the major risk of dying is during the first month of life. There is a lower percentage of death between weaning and one year of age. A major crises period for the young animals was during their second year of life, this being followed again by a low death rate between 2 and 3

years of age and an almost negligible risk of dying in the forth year. The death rate for the adult cattle (greater than 4 years) was 5.01% (Wilson, 1986).

The mortality rates of two zebu breeds, Sahiwal and Tharparkar, were 14.35 % and 7.21 %, respectively as reported by Prasad *et al.* (2004) in Karnal of India. This finding is in agreement with the established fact that that mortality of calves is higher during their early life because of stress and high infection pressure (Radostits, 1994). The report showed from Williamson and Payne (1978), in the tropics where calf losses have been known as high as 50 % of the calf crop, and the maximum tolerant level is 5 %, respectively. These losses have invariably been attributed to bad management.

2.11. Milk Marketing

Market refers to a set of buyers and sellers who interact and influence price. However, the existence of the market by itself does not ensure an exchange to take place. There should be a channel. In pastoral area milk production is seasonal while consumption is throughout the season (IPS, 2000). Moreover, there is no preservation and processing techniques, and physical infrastructure, like roads and market facilities are limited (Ketema and Tsehay 1995; Jabbar *et al.,* 1997). However, where there is access to market, dairying is preferred to meat production since it makes more efficient use of feed resources and provides regular income to the producer (De Leeuw, 1999).

2.11.1. Milk consumption and marketing pattern

The consumption of milk and milk products varies geographically between the highlands and the lowlands and the level of urbanization (Ahmed *et al.,* 2003). In the lowlands, all segment of the population consumes dairy products while in the highlands the major consumers primarily include children and some vulnerable groups such as the elderly and women (Ahmed *et al.,* 2003).

Earlier reports indicate that in most parts of Ethiopia the milk produced on farm is used for calves, consumed by the family members and sold to local markets (O'Mahony and Ebrahim, 1985; Coppock, 1994; Zelalem, 1999). In some households, only the husband has the privilege to drink milk though it depends on the number of milking cows they have. Usually it is the husband and rarely babies of less than one year age that have access to fresh milk. Milk and milk product form part of the diet of many Ethiopians. At the household level, the consumption pattern is defined as the combination of the types, quantities and frequencies of dairy product consumed (Mullins *et al.,* 1994).

Consumption of processed dairy products was observed even less frequently among the rural low-income households, indicating that the majority of the populations do not consume processed products (butter) to any substantial degree (Coppock, 1994; Lemma *et al.,* 2005). The limited consumption of butter may be due to the higher price associated with it and the need for cash income to buy some necessities. Butter is often consumed on holydays and special occasions in rural low-income households because it fetches routine cash income (Lemma *et al.,* 2005). Butter fetches a higher price compared to other milk products.

In intra-urban of Addis Ababa, producers stated that they produced milk both for sale and for home consumption. Small producers regularly sell two-thirds of their total milk off take, leaving one-third for home consumption. Only five out of the 20 large producers reportedly sold their entire off take during that period while the other 15 estimated that they sold 80% of their total off take, leaving the other 20 % for home consumption (Siegefreid and Brhan, 1991).

In pastoral areas, the diet is based on fresh or sour milk and left over milk is poorly utilized. The herd size per household is large and hence there is great surplus of milk per person than in the highlands (Tsehay, 2002). Fluid milk production and consumption is limited by seasonal variations and lead to fluctuate in price (IPS, 2000). Milk in the lowlands is primarily used as fresh whole milk for consumption. Surplus milk during the rainy season is fermented and processed in to butter (Siegefreid and Brhan**,** 1991; Getachew, 2003). When milk supply exceeds daily household demand during and soon after extended rainy periods, secondary

products such as butter, ghee or long term fermented milk are most likely to be produced for home consumption and for marketing (Coppock, 1994).

In the lowland when milk supply in the household increase due to season or high number of herd, they increase their household consumption other than a prerequisite for dairy sale. For instance, in the Borana household, out of the total milk off-take 66% is consumed at household and 24 % is sold or given to other households (Coppock, 1994). However, in Eastern Showa zone of Oromia region out of the total production about 1.2 kg per week (85.7 %) was marketed and the remaining, 0.2 kg was used for home consumption. On average about 3.0 liters of milk was produced/household/day, out of which about 2.5 litters (88.3 %) was accumulated for further processing and the remaining 16.7% was consumed on daily basis. On average about 1.4 kg of butter was produced per household per week (Lemma *et al.,* 2005). About 96.7 % of the respondents in Adami Tulu and Arsi Negelle and about 93.3 % in Lume districts did not sell fresh milk due to insufficient production and cultural taboo (Lemma *et al.,* 2005).

2.11.2. Market orientation for dairying

In the past, most of the interventions to develop the dairy sector focused more on increasing production, with less attention to input supply and marketing. Government engagements have focused on input supply oriented systems 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).

Market orientation of the agricultural production system would secure food supply to the rapidly growing non-farming community, create employment opportunities and promote economic development in rural societies. Marketing service is critical to rural as well as to urban food security (Tsehay, 2002). For instance, as long as lives of nursing calves are not in danger, dairy marketing would generally contribute to the food security of poor households in

the lowland areas from the direct effect of providing cash income and indirect effect of delaying sales of animals for some other crisis in the future (Coppock, 1994).

2.11.2.1. Milk marketing system

In Ethiopia, fresh milk is distributed through the informal and formal marketing systems. The informal market involves direct delivery of fresh milk by producers to consumers in the immediate neighborhood and sales to itinerant traders or individuals in nearby towns (Siegefreid and Brhan, 1991). Marketing of milk in the rural areas of Harari region is mostly of traditional nature. There are also a number of informal milk traders, agents, retailers, and self-help (rural women milk delivery association) milk groups from the farmers that are involved in milk delivery channel. The differences in distance to different milk market places in the Harar milk shed affect the price of milk (Kurtu, 2004). Milk is transported to towns on foot, by donkey, by horse or by public transport, and commands a higher price there than when sold in the neighborhood (Siegefreid and Brhan, 1991).

There were generally three different milk outlets identified in the Harar milk shed, namely traditional milk associations or groups, milk collectors (traders) and the producer themselves (Kurtu, 2004).. In the milk delivery association, locally known as *Faraqa annanni,* each woman in this group sales whole milk contributed from each member and uses the income generated for herself and this happens on turn or shift basis (Kurtu, 2003). In Somalia pastoralist, fluid milk is sold on road side or directly supplied to the individual consumer and hotel owners near the town (IPS, 2000).

In the Borena plateau, households close to the market are only able to sell milk more frequently. Effect of distance to market varies with household wealth, and wealth has been found to be a critical factor in dairy marketing (Coppock, 1994). A big upsurge in dairy marketing activity could be expected during the early stages of a drought and during the post drought recovery period when there is sufficient milk to sell, but not enough to sustain households. The degree of dairy marketing therefore is likely to be variable from year to year. (IPS, 2000).

2.11.3. Market constraints

Enhancing the development of stallholder farmers to reach markets and engage them in marketing activities poses a pressing development challenge. Difficulty in market access restricts opportunities for income generation. Remoteness results in reduced farm gate prices increased input costs and lower returns to labour and capital. This in turn, reduces incentives to participate in economic transaction and results in subsistent rather than market oriented production systems (Ahmed *et al.,* 2003).

In Ethiopia milk marketing system is not well developed (Ahmed *et al.,* 2003) especially, market access in pastoral production system is a critical factor (Tsehay, 2002). This has resulted in difficulties of marketing fresh milk where infrastructures are extremely limited and market channel has not been developed. In the absence of organization rural fresh milk market, marketing in any volume is restricted to peri-urban areas. Milk being perishable and demand being high for urban consumption, efficiency in collection and transportation of this bulk from widely scattered rural sources, requires a well-defined method of preservation and distribution. This would impact on the amount that would be available for consumption through losses in quality (Ahmed *et al.,* 2003).

Dairy product marketing is limited by the distance of the market from producers, lack of transport facility, and seasonal variation in the volume of milk production which leads to seasonal fluctuation in prices. The scattered nature of the production units, the poor communication system, the low rate of urbanization and its concomitant low infrastructure to road facilities may also not warrant the establishment of processing plants (IPS, 2000).

A pastoral community depends mainly on milk and milk products for its survival and therefore, these items are not perceived to be for commercial purposes. Thus it's only the households who are in a walking distance from the urban centers who sell milk and milk products to urban consumers (IPS, 2000). In few cases, however, small assemblers go to water points and buy directly from the pastoralist and sell to the next urban areas. They use donkey as a means of transport to carry milk from the water points to the urban center. In

general, in pastoral and agro-pastoral area of Somalia region, milk is the main diet to households and also it is affected by season of the year, and even during the rainy season this production system is affected by the absence of transport facilities to markets (IPS, 2000).

2.12. Milking and Preservation Methods

Milking and milk processing activities are usually performed by female members of the family (wives and daughters). Calves are allowed to suckle prior to milking. Milking is usually not complete in order to leave some milk for the calf (Zelalem and Inger, 2000). Farmers' practice hand milking as in the case throughout rural Africa (Brokken and Senait, 1992). In East Showa zone of Oromia region majority of the women (85.5%) follows limited sanitary procedure before and after milking, only few women (14.5%) wash the udder of the cow before milking (Lemma, *et al.,* 2005).

In areas where the climate is hot and humid, the raw milk is spoiled easily during storage. Therefore, the smallholder with non-access to the modern preservative and cooling mechanism should seek products with a better shelf life by converting milk in to a more stable product like butter or by treating it with traditional preservatives (Coppock, 1994).

When milk production increases during the rainy season, ghee provides the Borena people with a high-energy food with an excellent shelf life of 7 months to 1 year. The remaining milk is store to be fermented, for a longer term for up to 30-60 days used as '*ititu' (*a social food commonly reserved for guests). Where there is no access to liquid milk to markets, the only available option for preserving milk is converting it in to longer shelf life products such as butter and sour milk (Coppock, 1994).

There are different types of plants used for smoking and cleaning of milking, storing, processing and marketing utensils in different parts of the country. In semi-arid pastoral system of Ethiopia, the most commonly used smoking plants are *Acacia nilotica*, *Cordia glarfa*, and *Cordia ovalis* (Coppock *et al.,* 1992). In Eastern Showa zone of Oromia region,

about 53.3% of the women in Lume district used "Guftee" (*Sida cuneifolia)* and "Hiddii hooiotaa" (*Cucumis prophetarus*) leaves to clean the milk vessels and processing, while about 47 % and 40 % of the women in Adami Tulu and Arsi Negelle, respectively used "Kosorata" (*Ocimum hardiense*). "Ejersa" (*Olea Africana)* is the most frequently used plant for smoking milk vessels followed by *Juniperous procera* and *Ocium hardienes* (Coppock, 1994; Lemma *et al.,* 2005).

2.13. Feed Resource and Feeding Systems

Livestock feed resources in Ethiopia are mainly natural grazing lands and browses, crop residues, pasture, forage crop and agro-industrial by products. Feeding systems include communal or private natural grazing and browsing, cut and carry feeding, hay and crop residues. At present, livestock are fed almost entirely on natural pasture and crop-residues. Using of improved forages and agro-industrial by products is minimal and most of agro-industrial byproducts are concentrated in urban and peri-urban areas (Alemayehu, 2005).

Inadequate supply of quality feed and the low productivity of the indigenous cattle breeds are the major technical factors limiting the productivity of the dairy sector in Ethiopia. Feed, usually based on fodder and grass, is either not available in sufficient quantities due to fluctuating weather conditions or, when available, is of poor nutritional quality (Ahmed *et al.,* 2003).

The available feed resources are essentially of low digestibility such as tropical pastures (both green and mature), crop residue (straw and stover). The availability of crop residue is closely related to the farming system, the type of crop produced and the intensity of cultivation. Therefore, in integrated crop/livestock systems the potential of using crop residue as feed for livestock are greatest (Alemayehu, 2005). In Harari region, sorghum and maize are the major crops, providing stable food to people and various forms of feed and by products to livestock (Kurtu, 2003). On these feed resources overall productivity is low, animals reach puberty at a late age (often four years) and inter-calving interval is often 18- 24 months resulting in a small number of dairy animals in a national herd being in milk at any one time (Leng, 1999).

Feeding systems in smallholder dairying are primarily based on grazing of native pasture of low productivity (Ranjhan, 1999). 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. Households in this system are typically subsistence-oriented and based on seasonal milk production. The livestock herders are dependent on natural pasture and grazing area and to some extent on grazing crop residues in crop systems after harvest. As such the adoption of improved forages is irrelevant since livestock owners usually do not own cropland. However, a transition to agro-pastoralists occurs in different parts of pastoralists areas. In these emerging systems, improved forage is becoming increasingly feasible (Ahmed *et al.,* 2003).

In the Harar milk shed, farmers in rural areas use different feed resource for their animals, such as natural pastures, maize, sorghum thinning, weed and crop residues from sorghum and maize production, groundnut residues and other supplementary feeds like cactus and household waste. In the dry season when feed shortage is critical, protein and mineral supplementation is highly necessary in the Afar region. In agro-pastoral area supplementing livestock with hay and crop residue is practiced. Pastoralists traditionally take their livestock during the dry season (mainly cattle) to areas were salt/mineral, hot springs, lakes or soils are found (Beruk, 2000).

About 72 % of the rural livestock keepers in Harari region make use of natural pasture. In the highlands natural pasture is mostly used as a cut and carry and in the lowlands it is mostly grazed. The remaining 28 % of the rural farmers do not have natural pasture available (Kurtu, 2003). The same author also indicated that almost half of the surveyed rural household supplemented their animal with feedstuffs that included cactus, grain by-products from household waste including bran from maize and sorghum home milling, especially during the dry seasons. No agro-industrial by-products are used in the rural areas. Mineral supplement sources included common salt, various soils, crush rocks and lake soils or water from wells (Kurtu, 2003). The use of improved forage and supplementary feed by the pastoralists in the Afar region is insignificant, rather the primary feed sources of livestock in the region are the

rangelands composed of indigenous specious of grasses, shrubs and fodder trees (Beruk, 2000).

2.14. Constraints in Milk Production

The traditional smallholder dairy system makes up the largest characterized mode of milk production, and uses low input feeding and management requirement and the indigenous genotypes (Jabbar *et al*., 1997). The characteristics of the improved dairy production system vary substantially in terms of intensification, management systems; genotype used, type and method of marketing and processing of milk and dairy products.

2.14.1. Shortage of feed

Availability, quality and quantity of feed vary among varies production systems. Cattle largely depend on rangeland grazing or crop residues that are of poor nutritive value. Feed is not uniformly supplied and the quality is poor (Ibrahim and Ololaku, 2000).

Natural pasture, browse and bushes accounts to the major food sources of livestock owned by pastoralists. Seasonal fluctuation in the availability and quality of feed has been a common phenomenon, inflecting serious changed in livestock production (Alemayehu, 1998). The feed shortage mostly happens in dry season of the year (Ibrahim and Ololaku, 2000). In contrast, under normal circumstances in lowlands when there is sufficient feed for cow, milk tends to be adequate for home consumption as well as for market (Beruk and Tafesse, 2000).

2.14.2. Shortage of water

Since rainfall rather than livestock density determines net primary production and vegetation cover, its variability is the most important climatic factors determining the state of the natural

resources base. Hence, rainfall variability and net primarily productivity of the vegetation correspondingly determines livestock production (Sere *et al.,* 1996).

Ruminates require water to maintain the water content of the body, and water availability affects voluntary feed intake; less water leads to inadequate intake of dry matter. For animals kept under pastoral production system, the frequency of watering is very important. During the dry season water is available only from wells and some lakes and streams (Ibrahim and Olaloku, 2002). This leads to over grazing around watering points. Water intake increases as watering frequency is decreased and feed conversions efficiency becomes lower as watering interval increase (Ibrahim and Olaloku, 2002).

One unusual feature of the Borana is the high degree of water restriction of cattle during the dry seasons such that animals may be watered once every three, two, or four days (Coppock, 1994). This practice is permitted probably, in part, by the relatively cool ambient temperatures, which help cattle conserve body water otherwise used for thermo-regulation. Restricted watering is a long-held practice by the Borana that has positive attributes in terms of saving human labour, extending grazing radii from water points and increasing water-use efficiency (Coppock, 1994).

2.14.3. Animal health care

Animal health care and improved health management is also one of the major constraints of dairy development in Ethiopia, which caused poor performance across the production system. Many of the problems result from the interaction among the technical and non-technical constraints themselves. For instance, poorly fed animals have low disease resistance, fertility problems, partly because the animal health care system relays heavily on veterinary measures. Moreover, poor grazing management systems continue to cause high mortality and morbidity (e.g. internal parasites), many of the diseases constraints which effect supply are also a consequence of the non-technical constraints, for example, insufficient money to purchase drugs or vaccines (Ibrahim and Olaloku, 2002).

Contact of livestock brought from varies localities through the use of communal pastures and watering as well as marketing places play an important role in the transmission of economically significant infectious and parasite diseases. Such livestock movements could be the cause of direct or indirect transmission of varies economically important livestock diseases (Zinash, 2004). The low veterinary service performance in the lowlands is the outcome of the government-monopolized services. Government veterinary staffs are few in number and can not cover such a vast area to adequately address the veterinary needs of livestock keepers. Besides government staffs need adequate mobile facilities, for which currently the government does not have the capacity to provide (Tafesse, 2001).

2.14.4. Lack of productive breeds

The livestock genetic resources of Ethiopia's have involved largely as a result of natural selection influenced by environmental factors. This has made the stock better conditioned to withstand feed and water shortages, diseases challenges and harsh climates. But the capacity for the high level of production has remained low (IPS, 2000).

The consequence of the low genetic potential of indigenous breed for productive traits makes total national milk production to be low (Mukasa-Mugerwa, 1989). The indigenous Zebu breed produces about 400-680 kg of milk/cow per lactation compared to grade animals that have the potential to produce 1120-2500 liters over 279 day lactation. In most of the highlands of Ethiopia, milk production per head is low as compared to the highlands of Kenya due to the wide adoption of upgrading the indigenous breeds through cross breeding (Perera, 1999).

3. MATERIAL AND METHODS

3.1. Description of the Study Area

3.1.1. Location

The study was conducted in Mieso district of Oromia region. Mieso is located 300 km east of Addis Ababa and at about 200 km east of Adama town. The rail way from Addis to Dire Dawa passes through the district. Mieso is located northwest of Somali Regional State and south and southwest of Afar Regional State. The total land area of the district is 196,026 ha (IPMS, 2006).

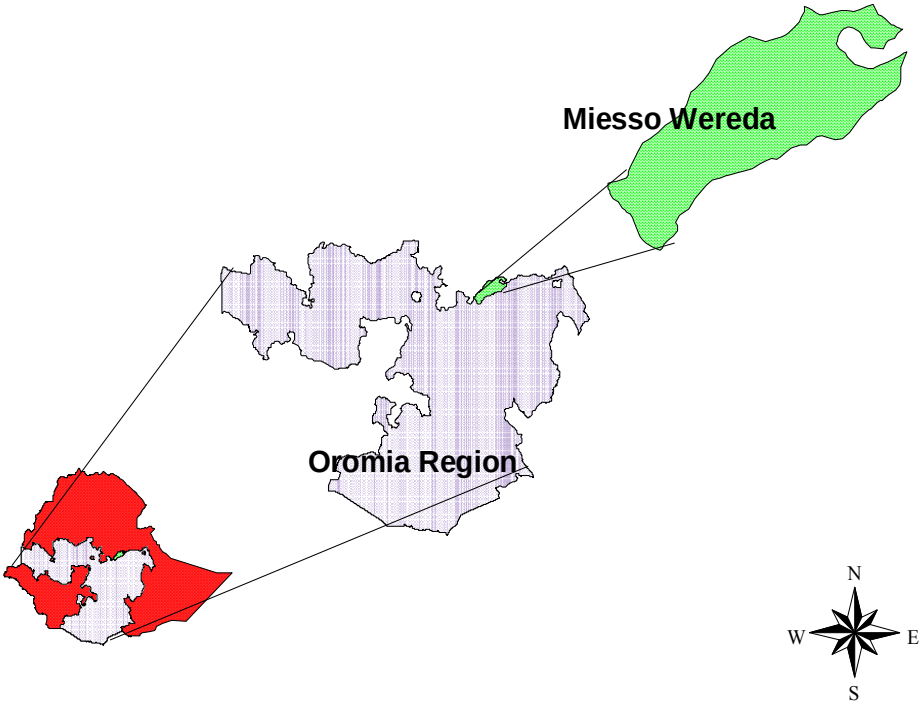

Figure 1. Location of the study district in oromia region

3.1.2. Agro-ecological zone

The district's altitude ranges between 900-1600 m.a.s.l. The mean annual temperature varies between 24^0C-28^0 C (from meteorology of the region) and soils in the region are of different types, most of which are vertisoils (IPMS, 2006).

Agro ecologically the district is classified as Kola (lowland). The mean annual rainfall ranges from 400 to 900 mm, with an average of about 790 mm (IPMS, 2006). Although the amount of rainfall seems relatively sufficient, the erratic nature and limit crop production. Most of the rain is received in only few months, and most of the months are dry. As a result relief aid is a regular source of livelihood for many rural families (IPMS, 2006).

3.1.3. Vegetation

About 38 % (73,658 ha) of the total land area is covered by bushes, forests, and grazing land. This is the major feed resources in the district. The vegetation of the area is *Acacia* dominated 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).

3.1.4. Demographic structure

The total human population of the Mieso district is estimated at 128,889; out of this 66,335 and 62,554 are male and female, respectively. The population density is 50.1/km^2 (IPMS, 2006).

3.1.5. Farming systems

There are two types of farming system found in the district; crop/livestock and pastoral production system. From the total land area coverage, only 12 % are suitable for crop

production. This shows that the area is much of a rangeland where livestock rearing is the major activity. The area receives a bimodal rainfall where small rains occur between March and April while the main rains occur between July and September. During the main rains farmers plant sorghum, this takes about 8 months (April to November) to harvest. Other crops grown in the area include maize, ground nut, and sesame. The rainfall is erratic and crop failure is regular (IPMS, 2006).

3.2. Data Collected

Both qualitative and quantitative data were generated using exploratory and diagnostic survey and secondary information.

General characterization of the study area was performed using group discussions and a questionnaire. The data collected included major on farm and off-farm activities; current practices and technologies, major constraints, strategy in risk management, amount and type of milk marketed, price information, and market information.

Participatory Rural Appraisal (PRA) methods and structured questionnaire were the major tools used during the survey phase of the study. The primary data used for the study was collected using diagnostic survey, which includes the data groups of household characteristics such as family size by sex, age and educational background; labour input including household available labour, hired labour, labour use in terms of sex and age; household budgets and assets data: assets inventory source, income source, type of expenditure; animal production. Herd composition of the household, herd structure by age and sex; reproductive performance: age at first calving and calving interval; Production performance: lactation length and milk yield; type of crop grown, purpose of crop grown, type of feed, feed source, seasonal availability of feed; traditional milking practices, herd management such as calf management, feeding and watering strategy, housing, herding and breeding practices: breeding strategy, selection criteria for breeding bull and cow.

Major livestock diseases and method of diseases prevention and mortality in the herd was also collected through interviewing the owner. Hence, mortality was calculated by using the formula given by (ILCA, 1990).

I-Pre weaning (PWMR) and post weaning mortality rate (POMR) were calculated by

$$\text{PWMR (\%)} = \frac{\text{No of death before weaning}}{\text{No of calves born}} \times 100$$

II-post-weaning mortality

$$\text{POMR (\%)} = \frac{\text{No of death after weaning age}}{\text{No of cattle/camels in the herd}} \times 100$$

To collect information on amount and type of milk produced, consumed and marketed at the household level, seasonal availability of milk, and constraints on milk marketing, a single-visit formal survey method was employed (ILCA, 1990).

Monitoring

Daily milk yield of cows and camels was measured at each lactation stage. Daily milk yield of cows was measured at morning and evening while in the case of camel, milk yield was measured three times a day, at morning, mid-day and evening for each sampled camels by stratifying to different lactation stages of early (1-2 months), mid (3-4 months) and late (5-6 months) and; early (1-3 months), mid (4-6 months) and late (7-9 months) months for cow and camel, respectively.

Amount of cow and camel milk delivered to the market through different market routes was measured at two market sites, Mieso and Asebot, for two weeks. Milk samples were taken from different markets to check whether it is adulterated or not using a lactometer and thermometer.

3.3. Data Generation

3.3.1. Sampling procedures

From the Mieso district, five potential peasant associations, Dire-kalu, Welda-jejeba, Hunde-misoma, Gena, and Huse-mendera were selected using purposive sampling which is based on the accessibility, and security condition of the area. Preliminary survey was conducted in the rural *kebeles* in order to obtain the total number of the households who have dairy animals (cattle or/and camels). For selection of sample size of the farmers or dairy farmers using updated list, farmers from each rural *kebeles* were selected using Proportional Probability to Size (PPS) approach for each rural *kebeles*, and a total of 120 farmers were selected based on the number of households. From each rural *kebeles* the individual households were selected using systematic random sampling methods. To capture gender effects in the overall production system the sample household on each rural *kebeles* was stratified in to female and male headed households, at this level which guide to determine the number, with using proportional probability to size (PPS) approach.

For market study, from the three existing market sites two were purposively selected namely, Mieso and Asebot markets due to the accessibility of the areas. Milk marketing was monitored for two seasons, in rainy and dry seasons. The study covered 28 days, one week from each market for two seasons. To asses the milk marketing data a well-developed questionnaire was used in order to collect amount of milk delivered to the market, price and number of the individuals who sale milk. Based on the outcome of this information average individual who come to sell milk was taken from the total number of individuals who sell milk at different days at each market. The milk sample was checked for adulteration from the individuals, who dispose their milk to the Mieso and Asebot market site.

3.3.2. Data collection methods

Three approaches namely, participatory rural appraisal (PRA) for base line information and formal (diagnostic) survey using well-structured questionnaire and monitoring of daily milk yield, milk disposal to the market were used to generate qualitative and quantitative data for the study.

3.3.2.1. Survey

In the PRA phases, group discussion was undertaken with key informants such as elders and agricultural bureau staff to investigate and have an overview about the overall milk production and marketing system. The information generated in participatory rural appraisal phases was used for the preparation and development of the questionnaire for the formal survey. In addition, in designing the questionnaire, information was taken from the previous reports (ILCA, 1990). Pre-testing of the questionnaire was made before the actual data were collected on sampled households in order to modify the questionnaire and to decrease error by excluding the unimportant data to be considered and revised accordingly. The enumerators were trained and they practiced by interviewing each other to ensure that they correctly understood each question. Finally the formal survey was conducted by enumerators under close supervision and participation of the researcher.

Moreover, secondary survey was collected based on published and unpublished data such as district and zone bureau of agriculture and council, IRC (International Rescue Committee) from library of International Livestock Research Institute (ILRI), and related website such as FAO, World Bank, IPMS-Ethiopia.

In the formal survey stage of the study, all required data was collected for a specific period (2005-6 G.C. or 1997 E.C.) from 120 individual pastoralists or agro-pastoralists.

3.3.2.2. Monitoring

Before the start of milk yield monitoring at 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) 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. For the monitoring study, about 10 percent of the total lactating cows and camels in each lactation stages for each rural *kebeles* were used. Daily cow milk yield (morning and evening) was measured using a calibrated plastic jogs for a period of one week. For camels, daily milk yield was measured three times a day (morning, mid-day and evening).

In order to address marketing data such as milk marketing and delivering system two market areas namely, Mieso and Asebot markets sites were selected for the study. The amount of milk delivered to the market was monitored for 28 days by assigning the enumerators at each marketing gates/routs. In the market sites, farmers were briefed about the objective the study before monitoring in order to ensure their cooperativeness. Elders who are familiar with the community were used as facilitators and then the researcher tested the milk by taking sample from each milk seller and checked for adulteration of cow milk.

Procedure:

- Mix the milk well and pour to it until it fills the calibrated jog sufficiently
- Lactometer was held at the tip of the jug and sink slowly into the milk sample
- When the lactometer completely rests and the reading was taken at the upper meniscus
- Thermometer was inserted into the milk and read immediately
- The reading from the lactometer was adjusted by a correction factor depending on the temperature reading, if the temperature of the milk is different from 20^0 C (O'Connor, 1994).

- Adulteration was checked by measuring the specific gravity and normal milk is expected to have a specific gravity of 1.026-1.032g/ml which implies a lactometer reading range of 26-32 L^0 (O'Connor,1994).

The formula used for calculation of specific gravity was,

$\frac{L^0}{1000} + 1$ = specific gravity (sp.gr.); L0 – lactometer reading (O'Connor, 1994)

The following correction factors were used to determine L:

Temp (^oC)	17	18	19	20	21	22	23	24
Correction	-0.6	-0.4	-0.2	0	+0.2	+0.4	+0.6	+0.8

3.3.3. Analytical techniques

To give sense out of the data collected different statistical tools were employed based on the available data obtained. The computer software Excel was used for data managing and most of the data were analyzed with SPPS version 12.1 software. Simple descriptive statistics such as mean, range and percentile for family size, family labour unit, crop and grazing land holding, livestock holding, 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 pasture land holdings, livestock holdings, age at first calving, calving interval, amount of cow and camel milk produced and marketed. Mean comparison were done using SAS procedures with multiple regression (cropland size with family size and number of ox holding and family size with crop land holding). Chi-square test was used to examine difference between levels of significant of different variables among rural *kebeles* or between household heads for parameters such as education level of the household heads, labour availability in the household, type of income and expenditure, importance of dairy animals, feeding calendar, constraints in dairy production, feed and water shortage. Simple and multiple correlation was used to estimate degree of relationship among the parameters such as crop and grazing land holding, number of animal holding, livestock holding with size of family members. GLM (General Linear Model) with T-test and Duncan

multiple range tests was used to test age at first calving, calving interval at different rural *kebeles*, variability of price for cows and camel milk at different season, amount of milk disposed to the market in wet and dry season.

The market participation of dairy farmers was analyzed using logit model by using Stata version 8 software program. This model consider different variables that affects participation of households to cow milk sell, such as dairy production, education of the household head, age and sex of the household head, distance from market, extension support, and availability of *Faraqa Annenni* (milk seller group). The application of linear regression model when the dependent variable is binary has some fundamental problem. Thus a qualitative choice model was used to determine the probability that an individual with a given set of attributes will make one choice rather than the alternative. Binary choice models assume that an individual faced with a choice between two alternatives and that has choice depends on their characteristics (Pindyck and Rubinfeld, 1991). It was assumed that cattle herder who produce milk for various reason may or may not be participate in marketing, may sell or otherwise. This dependent variable is descript consists of two outcomes, yes or no, therefore, logit model is appropriate for dichotomous dependent variables.

The impact of cow milk sale on market orientation was analyzed in the logit model. The dependent variable in the model was the logarithm of the odds that a given household is market oriented that is

$II(X) = 1/1 + e^{-(\beta_0 + \beta_i)}$ ..... (1)

This question can be written as:

$II(X) = 1/1 + e^{-zi}$ ..... (2)

Where: II (X) is the probability of participating in the market for the i^{th} dairy producers and ranges from 0-1

1- $II(X) = 1/1 + e^{-zi}$ is the probability non participation in the market

Then, the odds ratio in favor in market participation is given by

II (X)/ (1- II (X)) ..... (3)

By taking the natural log of equation (1) we get the following

$Li = In [II (X)/ 1- II (X)] = Zi$ .....(4)

With the error term incorporated, the logit model will have the following form

$Zi = II (X) = \beta_0 + \beta_1 D_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_n X_n + U_i$ …….. (5)

Where, X2, X3…….X_n are the explanatory variable of the model, $D_1 = 1$ if the household sale cow milk and 0 otherwise.

β_0 is the intercept

$\beta_1, \beta_2, \beta_3 \ldots \beta n$ are the coefficient to be estimated in the model and U_i is the error term.

Definition of explaratory variables for market participation decision on cow milk sale

Dairy production: different types of milk and product are expected to have a positive contribution in market participation of milk producers. Production of cow and camel milk or an increase in production has significant effect in motivating market participation for cow milk sale. More milk production from camels and goats is expected to have direct contribution on cow milk sale. Production of cow milk beyond consumption may be processed or consumed at household level. The processed product may be consumed or marketed. Amount of milk available in the household depends on the number of lactating animals.

Distance from market: closeness to market would reduce trekking time; reduce loss due to spoilage, better access to information and facilities. This improves returns to labour and increase farm gate price, in turn it encourages market participation.

Education of the household head: intellectual capital or education is assumed to have positive effect on market participation and sale decision, depending on cultural barriers.

Age of household heads: this variable is measured in terms of age of household head. Aged household are believed to be wise in resource allocation and use, and it is expected to have a positive effect on decision to participate on sale.

Sex of the household head: most of the time milk sale is the major task of women especially married women. However, lack of capital and access to institutional support may affect women participation and efficiency in ruminant livestock production.

Extension support: the availability of extension support in advice and input support on milk production have effect on decision on dairy animal production and efficiency. Support encourages and derives them to market participation.

Availability of *Faraqa Annenni* (milk seller group): this type of milk seller group save time and money. Therefore, availability of this group is expected to have direct influence on market participation.

4. RESULTS AND DISCUSSION

4.1. Household Structure

4.1.1. Family size

There was a significant deference in family size observed among rural *kebeles* and between households headed by male and female (Table 1)**.** The mean family size (Mean ± SE) in the studied household was 6.62 ± 0.22. However, the average family size for female headed household (5.56 ± 0.42) was lower than male headed household (6.92 ± 0.25). This is may be due to the female head of the household may be widows or divorced in their early age.

Table 1. Family size distribution of households among rural *kebeles*

Rural *kebeles*	N	Mean ± SE	Sig. (P≤ 0.05)
D/kalu	15	7.93 ± 0.83	
Gena	21	6.05 ± 0.33	
H/mendera	34	6.15 ± 0.51	0.022
H/misoma	27	6.15 ± 0.43	
W/jejeba	23	7.52 ± 0.49	
Household head sex			
Female	27	5.56 ± 0.42	0.009
Male	93	6.92 ± 0.25	
Total	120	6.62 ± 0.22	

Sig.=Significant value, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, H/mendera= Huse-mendera, SE= Standard Error of mean, N=Total number of respondents

Family size may, in turn influence the availability of labour in the households for herding and cropping. Family labour was significantly (P ≤ 0.01) and positively correlated with TLU (Appendix Table 14), as this linked to the use of available family labour for different activities. The result agrees with earlier report that indicated that large household sizes usually have large herds or flocks (ILCA, 1990; Solomon *et al.*, 1991).

4.1.2. Household age structure and education level

The mean (Mean ± SE) age of the household head in the study area was 39.7 ± 0.88 years. Most of the household heads were between the ages of 31 to 41 (46.7 %) and age group of 41-50 (21.7 %).

Table 2. Average age (years) of household heads based on rural *kebeles* and sex of the household heads in the Mieso district

Rural *kebeles*	N	Mean ± SE	Sig. (P≤ 0.05)
D/kalu	15	40.27 ± 1.30	
Gena	21	36.10 ± 2.16	
H/mendera	34	39.35 ± 1.93	0.351
H/misoma	27	41.63 ± 2.02	
W/jejeba	23	40.91 ± 1.61	
Household head sex			
Female	27	41.33 ± 1.75	0.323
Male	93	39.24 ± 1.02	
Total	120	39.71 ± 0.88	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, SE= Standard Error of mean, Sig.= Significant value, N=Total number of respondents

As indicated in Table 2 there were no significant (P > 0.05) variations observed in the average age of the household heads among rural *kebeles* or between male and female headed households.

Table 3. Distribution of family members based on age group in male and female headed households of Mieso district

Age category	Household head sex	N	Mean ± SE	Sig.(P≤ 0.05)
< 10 years	Female	27	2.37 ± 0.19	0.001
	Male	93	3.37 ± 0.15	
	Average	120	3.14 ± 0.13	
10-14 years	Female	27	1.37 ± 0.25	0.982
	Male	93	1.38 ± 0.12	
	Average	120	1.38 ± 0.11	
15-64 years	Female	27	1.63 ± 0.18	0.016
	Male	93	2.05 ± 0.08	
	Average	120	1.96 ± 0.07	
> 64 years	Female	27	0.11 ± 0.06	0.694
	Male	93	0.09 ± 0.03	
	Average	120	0.09 ± 0.03	

SE= Standard Error of mean, Sig.= Significant value, N=Total number of respondents

Generally, when comparison was made by age groups between the two household heads in the district (Table 3), there was a significant difference ($P \leq 0.05$) for the age group of less than 10 and between 15-64 years in female and male household head. Majority of the family size in the male headed household consists an average (Mean ± SE) of 3.37 ± 0.15 persons for age group of <10 years and 2.05 ± 0.08 for the age group of 15-64 years. This result indicates that in the male household head there is more number of people who had greater capability of contribution for livestock herding than cultivation. However, in the case of female headed households, the majority of family members were found to be in the age group of less than 10 years. Also as indicated in the Appendix Table 15, there was a significantly ($P \leq 0.05$) higher labour unit for male headed household (4.29 ± 0.32) than female headed households (2.77 ± 0.49). However, when comparison made between female and male headed household, more family member in female headed household found in the age category less than 10 years while in male headed household more family members found in the age group of 15-64 years. Therefore, in the female headed households there is a serious shortage of family labour for any agricultural activity.

Table 4. Distribution of family members based on age group in different rural *kebeles* in Mieso district

Age category	Rural *kebeles*	N	Mean ± SE	Sig.
< 10 years	D/kalu	15	3.60 ± 0.40	
	Gena	21	2.67 ± 0.24	
	H/mendera	34	3.24 ± 0.21	0.390
	H/misoma	27	3.15 ± 0.33	
	W/jejeba	23	3.13 ± 0.29	
10-14 years	D/kalu	15	1.87 ± 0.32	
	Gena	21	1.49 ± 0.25	
	H/mendera	34	1.09 ± 0.19	0.005
	H/misoma	27	1.04 ± 0.22	
	W/jejeba	23	2.04 ± 0.22	
15-64 years	D/kalu	15	2.13 ± 0.40	
	Gena	21	1.95 ± 0.15	
	H/mendera	34	1.76 ± 0.09	0.274
	H/misoma	27	1.89 ± 0.09	
	W/jejeba	23	2.22 ± 0.18	
> 64 years	D/kalu	15	0.27 ± 0.12	
	Gena	21	0.05 ± 0.05	
	H/mendera	34	0.03 ± 0.03	0.088
	H/misoma	27	0.07 ± 0.05	
	W/jejeba	23	0.13 ± 0.07	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, SE= Standard Error of mean, Sig.= Significant value, N=Total number of respondents

Table 4 indicates that households at Dire-kalu had significantly more ($P \leq 0.05$) number of household members than the other rural *kebeles*. However, there was no significant difference detected among rural *kebeles* for the rest of the age groups. More number of family sizes in the age group of less than 10 years in the Dire kalu might be due to the labour needs of the households for herding as they have more number of goats, cattle and camels than in the other rural *kebeles* and this age group is more active in livestock herding.

Table 5. Educational level of the household heads in Mieso district

	Educational level (%)								
	Total HH(N)	Illiterate		Read & write		Joined elementary		Religious school	
Rural *kebeles*		N	%	N	%	N	%	N	%
D/kalu	15	11	73	4	27	0	0.0	10	67
Gena	21	15	71	3	14	3	14.0	13	62
H/mendera	34	26	77	6	18	2	6.0	21	62
H/misoma	27	24	89	2	7	0	0	13	48
W/jejeba	23	20	87	3	13	0	0	9	39
HH sex									
Female	27	25	93	1	4	0	0	10	37
Male	93	71	76	17	18	5	5	56	60
Overall	120	96	80	18	15	5	4.2	66	55

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, HH(N)= Total number of respondents, N=Sampled respondents

As indicated in Table 5, there was no any significant ($P > 0.05$) difference on educational level was observed among rural *kebeles*. However, there was significant difference was detected between household headed by female and male, and the majorities (93 %) of the female headed households were illiterate compared with about 76 % of the male headed households (Appendix Table 8).

4.2. Labour Use for Dairy Animal Production

Household members are participating in various dairy animal managements in the studied area and this was dependent not only on the sex and age of the family members, but also on the type of the herd. Grandin *et al*. (1991) also noted that allocation of labour to different tasks by different age and sex of the family member is a strategy used to overcome labour shortage and this strict allocation of tasks to various age and sex groups is a typical of pastoral system in general (Fratkin, 1987).

Herding

Assignment of herding of animals depends on the sex and age of the household members. According 60.8 % of the respondents, female members of the household are responsible only for herding of cattle and goats. About 22.7 % (Appendix Table 2) of the respondents also indicated that female members of the household are responsible for herding of camel if it is around their encampment especially during the wet season. As reported by 90 % (Appendix Table 4) of the respondents, cattle and goat herding is the task of children in the age group of less than 10 years. However, according 22.5 % of the respondents, this task could start from the age of 7 years both for male and female members of the households, while 28.3 % of the respondents indicated that children from the age of 6 years are responsible for herding of goats. Similarly, in Borana households herding may involve males and female members of the household from 6 to 25 years of age (Coppock, 1994). This finding is also in line with the report of Grandin *et al.* (1991) in Maasai people of Kenya, 92 % of the respondents indicates that the herding of kids and lambs starts at the age of 3 or 4 years. However, herding of calves starts from the age of 8 or 9 years. Therefore, those reports indicate that herding is the major activity for children in lowlands.

Barn cleaning

According to the respondents, men are not involved in barn cleaning; it is done by women. For about 16.7 % of the households, barn cleaning could start from the age of 7 years (Appendix Table 6). However, majority of the household indicated that this work could start from the age of 8 (32.5 %) or 9 years (22.3 %). The full responsibility of this task is given to married women.

Feed collection

Division of labour among various sexes in the household for feed collection depends on the availability of feed in the area. According to 89.2 % (Appendix Table 1) 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 this task can be shared with women; if there are young animals in the house. According to the availability of crop residue or c*hinki* (failed crops through purposely over sowing of maize or sorghum in the field to be used as animal feed) on the farm, females take all the responsibility to cut and carry the *chinki* and to collect crop residue from the farm to feed calves that stay around the house for the whole day and also for other animal to feed at night when they return from the field. 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.

Milking

Of the total 99.2 % of the households who had milking cows during the study period, 97.5 % of the household indicated that only female members of the household are responsible for cow milking (Appendix Table 1). Only 2.5 % of the household indicated that not only females but also males take part in milking of cows, and this happens if the cow is aggressive, the woman is unable to easily manage the animals and if the woman is too busy with other activities. In Borana men are largely the strategists for livestock production, while women carry out day-to-day management and retain primary responsibility for dairy-related activities (Coppock, 1993).

Participation of household members in dairy animal management also depends on the type of the herd. All households interviewed during this study stated that all of the camel milking is the responsibility of men. Goat milking is left for woman and children.

Assignment to milk animals is also given to different age groups of the household members. About 51.7 % of the households reported that females from the age of 10 years on wards are responsible for cow milking (Appendix Table 3). According to 13.3% of the respondents, milking of goats starts from the age of 7 years. Out of 25.8 % of camel holders, it was evident that 57.5 % of the household indicated that male members of the household could start to participate in camel milking before the age of 11 years (Appendix Table 6). However, 88 %

and 100 % of the households indicated that full responsibilities of camel milking are given to the age groups of 10-14 and after 15 years, respectively (Appendix Table 5).

Milk and milk product marketing

Milk marketing is a specialized activity for female members of the household. This is similar to the reports from the Borana plateau, that milk product marketing and processing are 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 at the age of 10 years (Appendix Table 5), and 52 % of the households indicated that females take full responsibility after the age of 11 years (Appendix Table 6).

Live animal marketing

About 58.3 % of the households indicated that live animal marketing is the responsibility of both men and women (Appendix Table 1). But, 33.3 % of the households indicated that male members of the family are responsible to participate in this task.

As reported by 59 % of the respondents, female members of the household start to sell live animals when they reach the age groups of 10-14 years (Appendix Table 3). However, almost all of the respondents indicated that full responsibility is given after 15 years of age. 59 % of the household indicated that male members start to sell animals if they are in the age group of 10-14 years. They are, however, accompanied by a senior member of the household until they reach the age of 15 years. Out of 67.5 % of the respondents who participate in sell of live animals, 68 % indicated that females are responsible for marketing of both cattle and goats. However, 12.5 % indicated that females for goats marketing are responsible by females only (Appendix Table 2).

Generally, the role of women in farm activities especially in dairying, milking, feeding , live animal selling, health care, barn cleaning, and also their parts in decision making independently or as part of the group in feeding, breeding, management, health care and

marketing of milk and milk products, all should to be assessed for future development activities.

4.3. Labour Shortage and Supply

As indicated in Table 6, about 69 % of the respondents reported that they face labour shortage for dairy management especially for livestock herding and watering and/or in feed collection. The households who had labour shortage indicated that labour shortage becomes critical during the short rainy season due to the fact that more family labour is required for land preparation and at the same time animals are more mobile in search of feed and water.

Table 6. Variation in labour shortage for dairy activity in different rural *kebeles* and gender of household heads

Rural *kebeles*	Total household (N)	Labour shortage for dairy activity		X^2 P-value
		N	%	
D/kalu	15	5	33	
Gena	21	9	43	
H/mendera	34	31	91	0.00
H/misoma	27	18	67	
W/jejeba	23	20	87	
HH sex				
Female	27	21	78	0.27
Male	93	62	67	
Total	120	83	69	

D/kalu=Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma,HH sex=Household Head sex, (N) = Total respondents, N= Sampled household who face labour shortage

As shown in Appendix Table 9, about 88 % of the households indicated that herding and watering are the major labour intensive activities that are given priority for allocation of labour as compared to feed collection (12 %). However, there was no significant ($P > 0.05$) variation among rural *kebeles* or sex of the household heads in labour allocation. Moreover, labour allocation for herding and watering of animals was significantly ($P \leq 0.05$) different compared to feed collection. This is due to the shortage of water and feed which forces livestock holders to be mobile with their animals for a long distance rather than collecting

feed for a large number of animals. A similar report from Massai of Northern Kenya indicated that herding and watering of animals dominate labour requirements than other activities such as, care for young stock and animal health care (Grandin *et al*., 1991).

Table 7. Measures taken to overcome dairy labour shortage among rural *kebeles* in Mieso district

Measure taken for labour shortage	Rural *kebeles*										Total	
	D/kalu (N=5)		Gena (N=9)		H/mendera (N=31)		H/misoma (N=18)		W/jejeba (N=20)			
	N	%	N	%	N	%	N	%	N	%	N	%
Relatives/neighbor	1	7	5	24	5	15	0	0	5	22	16	13
Family labour & tethered	0	0	2	10	4	12	3	11	2	9	11	9
Hire labour	0	0	0	0	8	24	0	0	2	9	10	8
Family labour	2	13	2	10	11	32	41	5	6	26	22	21
Relative/neighbor & family labour	2	13	0	0	1	3	0	0	5	22	8	7
Tethering	0	0	0	0	2	6	10	37	0	0	12	10

(N)= Number of households who face labour shortage, N=Sample respondents, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, Relatives/neighbor=given too the relatives/neighbor, Family labour & tethered=Use family labour with shift & tethered animal around the hut.

There was a significant ($P \leq 0.05$) variation among rural *kebeles* in measures taken to cope with labour shortage for different dairy animal managements (Table 7). Out of the total households interviewed 36.9 %, prefer to use family labour rather than hired labour (8.3 %). According to these respondents labour is hired on the basis of giving one live animal (calf, heifer or cows) per year or by providing basic needs (food, shelter and/or clothes) instead of cash.

4.4. Land Holding and Use

4.4.1. Crop land holding

Results from the survey indicates (Table 8) that majority (47 %) of the household heads had crop land which was in the range of 1- 1.5 ha.

Table 8. Crop land size (per household) distribution in the Mieso district

Cropland (ha)	Frequency	Percent
1- 1.5	56	46.7
2- 2.5	49	40.8
3- 4	15	12.5

Only about 13 % of the households have crop land in the range of 3 to 4 ha. This indicates that land is a scarce commodity and this might be due to the increasing population pressure. In addition, the rural *kebeles* included in this study are relatively peaceful than other rural *kebeles* in the district and this has resulted in migration of more people to these rural *kebeles* due to tribal conflict. This has created serious shortage of cropland as well as grazing land.

In the study area the mean (± SE) crop land holding was 1.76 ± 0.06 ha (Table 9). There was a significant ($P \leq 0.05$) difference among the five rural *kebeles* in crop land holding. Dire kalu had more farm size (2.46 ± 0.13 ha) than the rest of the rural *kebeles*, while farmers in Gena rural *kebeles* had the smallest area of crop land (1.48 ± 0.73 ha).

Table 9. Variation in cropland holding size (ha) among the rural *kebeles* and between genders of the household heads in Mieso district

Rural *kebeles*	N	Mean ± SE	Sig.
D/ kalu	15	2.46 ± 0.13	0.00
Gena	21	1.48 ± 0.16	
H/mendera	34	1.97 ± 0.12	
H/misoma	27	1.50 ± 0.10	
W/jejeba	23	1.57 ± 0.07	
HH sex			
Female	27	1.46 ± 0.11	0.008
Male	93	1.85 ± 0.07	
Overall	120	1.76 ± 0.06	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma,HH sex=Household Head sex, SE= Standard Error of mean, Sig.= Significant value, N= Total number of respondents

Table 9 also indicates that there was significant ($P \leq 0.05$) difference on holdings of crop land size between households headed by male and female. Male headed households had larger (1.85 ± 0.07) hectare of land than female headed household heads (1.46 ± 0.11). According to

the respondents this may be due to the fact that male are polygamous and they had at least one half hectare of land for each wife and totally have big size of cropland. As indicated in Table 3, the other reason might be due to less members of active age in families headed by females, which could hinder to hold large crop land as labour was short in the family. While in male headed households large members were found in the age group of 15-64 years, who are active agricultural workers of family for cultivation. This might have resulted in large crop land holding size.

Positive correlation was detected between the number of oxen holding and family size on cropland holdings. Significantly ($P \leq 0.05$) positive correlation (Appendix Table 12) of cropland holding on family size and oxen holding was equated as follow.

$$\textit{Cropland size (ha)} = 1.136 + 0.26\ \textit{(ox number)} + 0.159\ \textit{(family size)}$$

According to this regression equation, an increase of 0.26 ha of land will result with increase of oxen number by one and also an increase of cropland size by 0.159 results to increase family size by one.

4.4.2. Pasture land holding

Out of the total households interviewed only 33 % of the households had pasture land. From this, 75.5 % and 24.3 % of the sampled farmers had *temporary and permanent grazing* land. Temporary land indicates make use of land temporary either by making enclosure or without it, during rainy season on the cropland or on the communal lands. While, permanent grazing land is a marginal lands or the land not used for cultivation or any other purposes, and this land is not used privately instead communally.

Table 10. The overall pasture land distribution in the Mieso district

Pasture land (ha)	Frequency	Percent
0.25- 0.75	29	74
1- 2	6	15
>5	4	10

As indicated in the Table 10, the size of pasture land owned per household ranges 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 land to crop land and due to the conflicts between different tribes, which does not allow to use pasture land properly instead forced to use the available pasture by over grazing.

The average pasture land 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 pasture land holding (Table 11). Dire-kalu had significantly large size (6.8 ± 1.71 ha) of pasture land than other sampled rural *kebeles*.

Table 11. Variations in pasture land (ha) holding by rural *kebeles* and by household heads in Mieso district

Rural *kebeles*	Total HH (N)	N	Mean ± SE	Sig.
D/kalu	15	5	6.80 ± 1.71	0.000
Gena	21	6	0.50 ± 0.09	
H/mendera	34	8	0.31 ± 0.04	
H/misoma	27	3	0.83 ± 0.58	
W/jejeba	23	17	0.62 ± 0.06	
Household head sex				
Female	27	7	0.68 ± 0.23	0.439
Male	93	32	1.49 ± 0.48	
Overall	120	39	1.32 ± 0.39	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, HH=Household head, (N)= Total number of respondents, N= Sample respondents, SE= Standard Error of mean. Sig.= significant value

As indicated in Table 11, the households in the Dire-kalu rural *kebeles* allocate their lands largely (6.8 ± 1.71 ha) for grazing rather than for cultivation (2.46 ± 0.13 ha). This is due to the fact that their livelihood is dependent more on animal rearing than cultivation.

4.5. Types of Crop and Purpose of Cultivation

The types of crop grown in the studied area are sorghum, maize, groundnuts, white pea, and chickpea, sesame and '*chat*'. However, as indicated in Table 12 the majority of the respondents indicated that the major staple crops grown are sorghum (100 %) and maize (98%).

According to the Table 12, male headed households produce significantly more white pea (77 %), sesame (43 %) and chat (22 %), than female headed households, they produce white pea (52 %), sesame (15 %) and chat (19 %). However, there was no significant difference in the production of different types of crops among the different rural *kebeles*.

Table 12. Crops grown in different rural *kebeles* and by gender of household heads in Mieso district

Rural *kebeles*	Total HH (N)	Type of crop grown												X^2 P-value
		Sorghum		Maize		White pea		Sesame		Groundnuts		*Chat*		
		N	%	N	%	N	%	N	%	N	%	N	%	
D/kalu	15	15	100	15	100	13	87	3	20	0	0.0	6	40	
Gena	21	21	100	20	95	15	71	6	29	3	14.0	2	9.5	0.08
H/mendera	34	34	100	33	97	20	59	19	56	2	5.9	9	26	
H/misoma	27	27	100	27	100	21	78	10	37	1	3.7	9	3.3	
W/jejeba	23	23	100	22	96	17	74	6	26	0	0.0	0	0.0	
HHsex														
Female	27	27	100	25	93	14	52	4	15	0	0.0	5	19	0.00
Male	93	93	100	92	99	72	77	40	43	6	6.4	21	23	
Total	120	120	100	117	98	86	72	44	48	6	5.0	26	22	

HH (N) = Total household head number, N= households who grow crops, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, HH sex=Household Head sex

For about 92.5 % of the households sorghum is a major source of cash income in addition to its important role for household consumption (Appendix Table 17). However, 70 %, 53 %, 20 % and 2.5 % of the households indicated that maize; white pea, chat, and groundnuts also contribute for household income generation.

4.6. Herd Composition and Structure

4.6.1. Herd composition

As indicated in the Tables 13 that on the average there were larger number of goats (6.03 ± 0.30) than cattle (5.69 ± 0.35) and camels (1.83 ± 0.92) per household in the Mieso district. There were more numbers of goats (44 %), than cattle (42 %) and camels (14 %) in the study area as a whole.

Table 13. Overall species composition of herds in Mieso district

Animal type	Number of households own animals (N=120)	Number of animals	Mean ± SE	% from the total herd composition
Goats	113	723	6.03 ± 0.30	44
Camels	33	220	1.83 ± 0.92	14
Cattle	120	683	5.69 ± 0.35	42

SE= Standard Error of mean. Cv= coefficient of variance

However, contrary to the present result, in Somali region that distribution of livestock species owned by a household consists of large number of cattle, 58.1 %, 53.2 % goats, 45.3 % sheep, and 33.1 % camels (IPS, 2000).

The higher proportion of goats in the study area may be due to the strategy that the households made for risk aversion as there is a high bush encroachment in the area than grasses and goats make better use of it and control the encroachment effectively than cattle. This result was in line with IPS (2000) report which indicated that the herd composition and number of ruminants in lowlands are depending 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. However, according to the respondents the present distribution of camels in the area has been decreasing from time to time due to the tribal conflict that other tribes mostly steal camels and this has decreased camel holdings by pastoralists in the area.

4.6.2. Herd structure

The age and particularly the sex composition of herd are regulated largely by the main functions of herd (Wilson, 1986). Herd structure can indicate the owner's management objectives, birth or death rate, and herd productivity in the system (ILCA, 1990).

As indicated in Table 14 there was a significant ($P \leq 0.05$) variation among rural *kebeles* for different species of animals holding in respect to their age category. In one of the Rural *kebeles*, Dire-kalu there was significantly large number of female cattle calves (2.53 ± 0.67), cattle heifer (2.1 ± 0.50), adult cow (4.13 ± 1.13), female (1.87 ± 0.65) and male calves (1.4 ± 0.31) of camel holding than the other rural *kebeles*. This result may be due to the large pasture land holding of the area that might had effect on keeping large replacement stock and on the other hand since households in the Dire-kalu had small size of crop land, most of their life relay on livestock keeping rather than cultivation.

Table 14. Herd structure of dairy animal holdings among rural *kebeles* in Mieso district

Animal type		D/Kalu		Gena		H/Mendera		H/Misoma		W/Jejeba		Sig.
		N	Mean±SE	N	Mean±SE	N	Mean±SE	N	Mean±SE	N	Mean±SE	
Cattle		15	9.67 ±2.15	21	4.52 ± 0.35	34	5.15 ± 0.26	27	4.59 ± 0.31	23	6.26 ± 0.56	0.00
Calves	F	15	2.53 ± 0.67	21	1.19 ± 0.19	34	1.21 ± 0.13	27	1.07 ± 0.18	23	1.35 ± 0.24	0.01
	M	15	1.00 ± 0.37	21	0.33 ±0.13	34	0.56 ± 0.09	27	1.82 ± 0.25	23	0.78 ± 0.17	0.11
Heifer		10	2.10 ± 0.50	11	1.18 ± 0.12	16	1.19 ± 0.10	2	1.00± 0.00	13	1.62 ± 0.24	0.08
Adults	F	15	4.13 ± 1.13	21	1.71 ± 0.18	34	1.88 ± 0.19	27	1.81 ± 0.18	23	2.83 ± 0.29	0.00
	M	15	1.93 ± 0.15	19	1.37 ± 0.11	33	1.61 ± 0.09	22	1.73 ± 0.23	22	1.55 ± 0.11	0.15
Goats		15	8.67 ± 1.74	18	5.94 ± 0.50	34	6.35 ± 0.32	23	5.74 ± 0.52	23	6.00± 0.43	0.05
Kids	F	10	1.90 ± 0.55	13	1.46 ± 0.24	28	1.18 ± 0.07	16	1.44 ± 0.16	14	1.14 ± 0.09	0.66
	M	12	1.50 ± 0.19	11	1.36 ± 0.15	14	1.14 ± 0.09	18	1.39 ± 0.16	10	1.10 ± 0.10	0.31
Adults	F	15	4.33 ± 0.90	19	2.68 ± 0.27	34	3.35 ± 0.22	22	2.95 ± 0.23	23	3.35 ± 0.32	0.79
	M	14	1.86 ± 0.38	13	1.46 ± 0.22	30	1.93 ± 0.13	14	1.36 ± 0.36	20	1.65 ± 0.13	0.30
Camel		13	8.77 ± 2.09	2	3.00 ± 1.00	7	6.71 ± 1.13	8	3.87 ± 0.35	3	7.33 ± 0.88	0.62
Calves	F	15	1.87 ± 0.65	21	0.24 ± 0.10	34	0.26 ± 0.11	27	0.26 ± 0.09	23	0.30 ± 0.17	0.00
	M	15	1.40 ± 0.31	21	0.00 ± 0.00	34	0.15 ± 0.08	27	0.07 ± 0.05	23	0.04 ± 0.04	0.00
Heifers		9	2.22 ± 0.49	-	-	3	1.00 ± 0.00	3	1.00 ± 0.00	3	1.33 ± 0.33	0.43
Adults	F	13	4.08 ± 1.04	1	1.00 ± 0.00	7	3.70 ± 0.61	8	2.38 ± 0.46	3	3.30 ± 0.33	0.47
	M	10	2.00± 0.39	2	1.00 ± 0.00	7	1.14 ± 0.14	8	1.00 ± 0.00	3	1.33 ± 0.33	0.50

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, H/mendera= Huse-mendera, SE= Standard Error of mean. F= female class of animals, M=male class of animals, N= Sample respondents

In the Appendix Table 21 shows that the proportion of female to male cattle in the district was 72: 28. This result is in agreement with several reports in low land of Ethiopia. In Borana the proportion of female to male cattle found by Mulugeta (1990) was 74:26, this ratio agrees with ratio of 71:29 (Coppock, 1994) and as Belete (1979) reported female to male ratio was 79:21 in Afar pastoral area. Breeding female to male ratio of cattle was 63: 27 and the milking to dry cow was cover 48:52 (Appendix Tables 22, 23). As indicated by Wilson (1984) a herd structure consists of 50 % breeding females is recommended. Therefore, above recommended proportion of breeding female in the study area indicates that it was suitable for getting more or less a continues supply of milk to the household. The high proportion of female animals in pastoral herds is thought to help stabilize milk production by off-setting the longer calving interval characteristics of the system. On the other hand, males that are not needed for reproduction are sold to generate income for food and other purposes (ILCA, 1990).

Table 15. Variation in lactating animal holding among rural *kebeles* of the Mieso district

	Lactating animals					
	Cows		Camels		Goats	
Rural *kebeles*	N	Mean ± SE	N	Mean ± SE	N	Mean ± SE
D/kalu	15	2.33 ± 0.36	13	2.15 ± 0.22	15	2.73 ± 0.37
Gena	20	1.35 ± 0.11	1	1.00 ± 0.00	18	2.00 ± 0.18
H/Mendera	34	1.15 ± 0.06	7	1.71 ± 0.29	32	1.88 ± 0.15
H/Misoma	27	1.33 ± 0.09	8	1.13 ± 0.13	22	2.00 ± 0.16
W/Jejeba	23	1.96 ± 0.20	3	2.33 ± 0.33	23	2.43 ± 0.23
Sig.	0.000		0.017		0.032	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, SE= Standard Error of mean, N=Sample respondents, Sig.= Significant level

As indicated in the Table 15, there were significantly higher ($P \leq 0.05$) number of lactating cows at Dire-kalu than other rural *kebeles*. This might be due to the fact that they had significantly ($P \leq 0.05$) high number of adult cows (4.13) and it may contribute for having large number of lactating cows. Moreover, in Dire-kalu (Table 10), farmers reserve more land (6.8 ha) for grazing and it subsequently increases feed supply, resulting in large number of lactating animals. This agreed with the report by Mukasa-Mugerwa (1989) who indicated that feed has influence highly the reproduction performance of animals.

Table 16. Mean number of lactating animals owned by female and male headed households in Mieso district

Household head sex	Animal type	N	Mean ± SE
Female	Goats	25	1.84 ± 0.13
	Cows	27	1.33 ± 0.09
	Camel	4	1.75 ± 0.25
Male	Goats	85	2.25 ± 0.12
	Cows	92	1.59 ± 0.09
	Camel	28	1.79 ± 0.16
Total	Goats	110	2.15 ± 0.09
	Cows	119	1.53 ± 0.08
	Camel	32	1.78 ± 0.14

SE= Standard Error of mean, N= Sample respondents

4.7. Types of Income and Expenditure

4.7.1. Types of income

Contribution of sale of milk and milk by products and crop sale were major income sources for 96 % and 95 % of households as a whole, respectively. Majority (93 %) of the respondents indicated that sorghum and maize were the major cash crops in the area (Appendix Table 17). As indicated in the Table 17 the majority (95 %) of the households in Gena rural *kebeles* were involved in crop sale rather than other type of income source. However, Gena was the least to involve in off-farm activities (2 %). This may be explained by the farming behaviour of the households who live near the market sites. Most of the households who live around the market centers engage in milk and crop production. As a result, they are less dependent on off-farm activities as a source of income. The closeness of the household to the market center encourages them to sell the available resources in the household than searching for other off-farm activities (employee */kebele* chaireman/, sale of fire wood, charcoal, and different items in shop).

Table 17. Variation among rural *kebeles* and gender of household heads in generation of household income in the Mieso district

	Sources for household income generation (%)							
	Crops sale		Animal sale		Milk and milk product sale		Off-farm activity	
Rural *kebeles*	N	%	N	%	N	%	N	%
D/kalu	13	86.70	9	60.00	5	33.30	7	46.70
Gena	20	95.20	14	66.70	20	95.20	2	9.50
H/mendera	23	67.60	23	67.60	29	85.30	11	32.40
H/misoma	18	66.70	18	66.70	26	96.30	11	40.70
W/jejeba	21	91.30	17	73.90	16	69.60	5	21.70
Household head sex								
Female	21	77.80	12	44.40	22	81.50	6	22.20
Male	74	79.60	69	74.20	74	79.60	30	32.30
Overall	95	79.20	81	67.50	96	80.00	36	30.00

N=Sample respondents, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma,H/mendera=Huse-mendera

Thirty percent of the respondents indicated that off-farm activities were one means of an income source in the household. Significantly, most ($P \leq 0.05$) of the farmers at Hunde-misoma (96%) used milk and milk product sale as their income sources followed by, Gena (95 %). This may be due to the short distance to the market (3.9 km to the Asebot, and 5.05 km for Mieso market) place. However, off-farm activities were equally important for all rural *kebeles* and gender of households. As reported by respondents, the type of off-farm activities available for farmers include, sale of charcoal, firewood, employee (*kebele* chaireman), and selling of different items in shop. Significantly more male headed household were engaged in animal sale than female headed households. This might be due to the large animals holding (10.13 ± 0.14 TLU) of the male household than female (7.44 ± 0.65 TLU) which encouraged them to use the available resource as an income source.

4.7.2. Types of expenditure

Farmers were spending their assets not only in cash but also in kind (giving their animals as a gift for purpose of bride price or given for the poor families or relatives). In general out of 120

households interviewed 61 % (n=73) of the household used animals for different social values (as an expense in kind).

Table 18. Variation in cash expenditure for dairying among the rural *kebeles* and gender of household heads in Mieso district

Rural *kebeles*	Cash expense/year of the household		Sig.
	N	Mean±SE	
D/kalu	15	20.00 ± 20.00	
Gena	21	194.00 ± 67.75	
H/mendera	34	252.00 ± 61.69	0.358
H/misoma	27	217.00 ± 97.69	
W/jejeba	23	162.00 ± 67.31	
Household head sex			
Female	27	166.00 ± 64.85	0.671
Male	93	199.00 ± 38.80	
Overall	120	192.00 ± 33.33	

SE= Standard Error of mean. Sig.= Significant value, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, N= Sample respondents

As indicated in Table 18 the overall cash expense in the district was 192 ± 33.3 Birr/household/year and there were no difference ($P > 0.05$) exist among rural *kebeles* and between households headed by female and male for cash expenses. According to the respondents, cash expenses of the household in the study area were for purchasing of live animals, feed, water, and medicine.

Table 18 shows that there were households who did not spend their money on any livestock management activities; and this indicates that the households use what ever is available at no cost. This means that they use available natural pasture or raised crop residue as an animal and in case of veterinary service they use traditional treatments for their animals.

Table 19. Proportion of farmers giving dairy animals as a gift and the reason for gift giving in Mieso district

Animals type by sex	Animal expense through a gift		Reason for animal given as a gift					
			Bride price		Help poor		Distribute asset to family	
	Yes (N)	%	Yes (N)	%	Yes (N)	%	Yes (N)	%
Goats			20	69	7	24	2	6.9
Female	19	15.8						
Male	10	8.3						
Cattle			46	84	8	15	0	0
Female	34	28.6						
Male	21	17.5						
Camel			1	33	2	67	0	0
Female	3	2.5						
Male	0	0						

(N)= sample households use animals as a gift

As indicated in the Table 19, for the majority (84 %) of the households indicated that cattle are mostly used for bride price than goats (69 %) and camels (33 %). According to the respondents (Table 19), most of the time female cattle especially heifers are used as occasional gift such as bride price in the family (intended for rearing) followed by small stock, goats (69 %), intended for income generation. This type of off-take of animals through a gift was also reported in the Maasai-pastoralist of Kenya that most common gifts given occasionally were steers and young female calves, but gifts of mature females of any species were rare (Solomon *et al.,* 1991).

4.8. Animal Management

4.8.1. Feeding management

All the respondents (100 %) in the studied area indicated that, cattle, camels and goats were fed principally on natural pasture or pasture on non-arable lands maintained under rain-fed conditions, that it makes green feed available. Kurtu (2003) on the other hand indicated that only 72 % of the rural livestock keepers in Harari region make use of natural pasture.

Agricultural by-products such as crop residues are mainly obtained from sorghum and maize stover and house waste is also used as a feed source in the study area. Feeding systems include communal or private natural grazing and browsing, and cut-and-carry system and stall feeding. The different types of additional feeds that is being used is indicated in Table 20.

In all the season, wet and dry, animals were allowed to graze entirely on natural pasture on communal grazing land. There were some improved forages (*Sesbania* and *Leuceana*) introduced in the crop-livestock production system, but there is no practice of supplementary feeding of animals. Similarly, as indicated by Beruk (2000) the use of improved forage and supplementary feed by the pastoralists in the 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.

Table 20. Variation in additional feed resources used among rural *kebeles* and between male and female household heads in Mieso district

	Total HH (N)	Type of additional feed sources										X^2 p-value
		Crop-residue (*Kera*)		Mineral Soil (*haya*)		Grain (Sorghum)		Industrial-by product		Failed maize or sorghum (*Chinki*)		
Rural *kebeles*		N	%	N	%	N	%	N	%	N	%	
D/kalu	15	15	100	15	100	1	6.7	0	0	10	67	
Gena	21	21	100	10	48	4	19.0	1	4.8	19	90	0.00
H/Mendera	34	34	100	12	35	2	5.9	1	2.9	30	88	
H/misoma	27	27	100	2	7.4	10	37.0	2	7.4	27	100	
W/jejeba	23	23	100	9	39	1	39.0	0	0.0	15	65	
HH sex												
Female	27	27	100	4	15	3	15.0	0	0.0	21	78	
Male	93	93	100	44	47	15	16.0	4	23	89	96	0.94
Total	120	120	100	48	40	18	15.0	4	3.3	100	83	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, SE= Standard Error of mean. Sig.=Significant value, HH sex=Household Head sex, HH=Household, (N)= Total number of respondents, N= Sample respondents

As indicated in the Table 20 that almost all the households use residues of sorghum and maize. Similarly, in the Harari milk shed sorghum and maize are the major crops providing various forms of feed and by products to livestock (Kurtu, 2003). However, sorghum stover is

used more than maize for dairy animals in the study area. The herders believe that feeding maize straw increases body weight rather than milk production therefore, mostly they use maize stover for fattening animals (mainly oxen) while, sorghum stover is used as a major feed resource for dairy animals in the study areas.

Traditionally, farmers in the study area grow sorghum and maize as a fodder for livestock. Fodder from sorghum and maize is produced through intentionally by over sowing above the recommended quantity as a strategy to produce fodder to feed their livestock through gradual cutting. It is locally called as *'chinki'*. Eighty three percent of the respondents use *chinki* as a secondary feed source followed by crop residues. Field observation and interview indicate that feeding of *chinki* for animals was the major task of female members of the household by the method of cut-and-carry system from the field.

Soil salt, locally known as *haya*, is used by 40 % of the respondents during the wet as well as the dry season. However, the respondents indicated that the frequent use was made in the dry season to compensate the feed shortage. If water is available in the area, provision of *haya* in dry season is preferable, otherwise more is use during availability of water in wet season. They feed *haya* by taking the animals to salt area or by taking the salt to their homesteads. All the respondents believed that the animals that lick salt get strong during the dry season. Respondents also believed that salt licking improve milk production. This type of feeding of salt was also reported by Ahmed (2002) in the Somali region that herders travel to their potential salt rich areas when the dry season approaches or pastoralists transport salt to their dwelling sites. This report is also in line with the report of Abule (2004) who indicated that in middle Awash valley that mineral salt feeding to cow were perceived to increase milk production. Only 3.3 % of the respondents indicated that they use industrial by-products when milk production is decreased or when animals become weak due to diseases.

Some 15 % of the farmers provide boiled sorghum grain mixed with salt to sick animals, milking animals, during the dry season, as well as to recently delivered animals (weak dams due to high bleeding during parturition) as a supplementary feed. Use of this type of additional feed source (Boiled sorghum) may it be an indication for the intervention of other

technology that use of other supplementary feed if it is affordable and accessible in their vicinity.

Stall feeding is practiced during the cropping season and during cultivation. During the cropping season as all the farm land is covered by crops, stall feeding is done to protect the crop from being damaged by livestock. Oxen and calves and some times milking and pregnant animals are the only group of animals that are fed by tethering as other animals are moved to other area for grazing.

The farmers indicated that animals are fed on conserved feed (by making *Kusa*). Kusa is a means of feed conserving mechanism made by storing of crop residue on the farm field (from sorghum only) in triangular form by open system, without any cover. This type of storing system exposes the feed to moisture and underground pests and insects. Due to such type of poor feed conservation practices, farmers mostly failed to get conserved feed up to the dry season due to wastage by fermentation. This type of feeding is practiced from crop-harvesting to end or start of the dry season. Therefore, this stimulation leads most of the time to shortage of feed.

4.8.2. Housing

Animals were housed in open (*Mora*) and closed type of houses (in house hold hut) depending on age and types of animal. All the respondents indicated that young cattle, and young and mature goats are housed separately in the family hut. It is constructed inside the family hut with wood and walled by a mud. However, mature cattle, young and mature camels were housed in the open field around their encampment by fencing it with available piece of thorn wood and different bush plants. This type of house is locally called as '*Mora'*.

Mora and mud house are constructed with the main objectives of protecting the animals from predators during night time. However, if the animals were sick, the enclosure was used to prevent movement of animals during day time. The herders believes that the major reason that the goats of all ages groups kept in the family house during night time is due to the fact that goats are not able to defend themselves from predators while other animals, cattle and camels,

are able to defend them selves first by giving sign for their herders when predators come. Housing of animals is practiced only during night time and *Mora* cleaning performed by married women.

Cattle calves were housed in well-protected enclosures until they reach one month old. However, after one month of age, they are tethered in *Mora* on the day time and occasionally taken out to graze. During the dry season women sometimes cut grass and carry it home for calves. The more severely of the dry season, the more important this becomes. In case of camel calves, they are always kept in the *Mora* from the time of birth up to the time they go out for grazing after one month.

4.8.3. Calf management

Young animals were managed in a traditional way. Nursing calves are kept separate from their dams except when calves are used to stimulate milk let-down. Nursing calves are tethered near the fire-side in the main room of the family hut or in special pens constructed inside the hut.

Traditionally, calves are allowed to suckle two teats at the left side while the women milk the other two. Calves are always used to stimulate milk let-down. If a calf dies the skin may be stuffed and add salt on the skin. By standing the stuffed skin on a stick, allow the dam to lick and to feel as if her calf is present, to stimulate milk let-down.

Younger children and females in general, do most of the tending of small ruminants and calf herds 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. However, calf management is typically performed by married women.

Herders are well aware of colostrum feeding for the new born animals after calving and effect on health status of young. However, they believe that too much suckling of colostrum can harm a calf and could result in diarrhea. Weaning age is determined by season when the

calves were born, health status of the dam and the need for milk by the family. However, complete weaning was done when dams ceases to lactate or became pregnant. Then at this time, forced weaning is practiced. Calves start forage feeding after allowing of soil salt licks. This is done because of herders believe that direct exposure of calves to forage immediately after cessation of feeding milk causes diarrhea. Therefore, training of calves by providing of mineral soil before forage grazing was practiced.

Table 21. Weaning age of cattle and camels in different rural *kebele*s and by gender of household heads in Mieso district

	Weaning age (month)			
	Cattle calves		Camel calves	
Rural *kebeles*	N	Mean ± SE	N	Mean ± SE
D/ kalu	15	7.00 ± 0.45	13	10.50 ± 0.55
Gena	21	6.70 ± 0.31	2	12.00 ± 4.72
H/Mendera	34	8.30 ± 0.39	7	11.90 ± 0.63
H/misoma	27	6.70 ± 0.17	8	10.90 ± 0.58
W/jejeba	22	7.10 ± 0.35	3	7.00 ± 3.21
HH sex				
Female	27	7.20 ± 0.39	4	10.80 ± 1.25
Male	92	7.30 ± 0.18	29	10.40 ± 0.50
Total	119	7.30 ± 0.17	33	10.60 ± 0.46

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, SE= Standard Error of mean, N= Sample respondents

An average weaning age of cattle and camel calves in the study area was 7 ± 0.17 and 11 ± 0.46 months, respectively. The recent result agrees with the report of Coppock (1994) who found 7- 12 months weaning age for Boran cattle. If the dams seem weak or gets ill, the farmers practiced forced weaning at 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 their wounded nose touches the teat), and smearing of teats with animal dung is another practice.

On average around the first months (36 ± 2.12 days for cattle and 46 ± 6.02 for camel calves, Appendix Table 25) of life of the calf diet consists of milk and a combination cut-and-carry

forage or the calves graze around the encampment. The amount of milk that a calf receives varies with season, and the human demand for the milk.

Married women are mainly responsible for day-to-day management of nursing calves. This includes construction, maintenance and cleaning of calf pens, forage collection, removal of external parasites, and transport of water for calf consumption during the dry seasons and the allocation of milk to calves.

During one or two weeks of age calves are tethered inside the family hut or in pens separately from the dam except when they get out in the morning and evening for suckling. At this period calves depend fully on milk. This type of management causes high pre-weaning mortality (61.7 ± 5.2 and 66.7 ± 14.7 for cattle and camels, respectively) especially during the one or two weeks of life as the calves stays starved for the whole day without suckling.

Calves born during the long rainy season when feed resources are abundant, could be allowed to graze around the encampment around third month of their life and they receive cut-and-carry forage in addition to restricted access to milk. This feeding pattern continues until calves are completely weaned. If calves are born during short rainy season, they rely much on cut-and-carry forage. On the other hand, if the calves are born during the dry seasons, the dams milk production decreases sharply and calves are hand-fed with forages to minimize competition between the calves and the family for milk. Grazing may be enhanced depending on the health and general condition of the dams. If the dam is weak to support its calf, calves as young as two weeks of age can join an outdoor grazing group (supervised by children) near the family encampment.

4.9. Reproductive Performance

4.9.1. Age at first calving

The estimated overall mean (± SE) age at first calving for cows and camels are 52.49 ± 0.91 months, and 63.37 ± 1.55 months, respectively (Table 22).

Table 22. Reported overall age at first calving of cows and camels in Mieso district.

Animal types	Total HH (N)	N	Age at first calving (months)
			Mean ± SE
Cow	120	120	52.49 ± 0.91
Camel	33	32	63.37 ± 1.55

SE= Standard Error of mean, (N)= Total number of respondents, HH=Household, N= Sample respondents

The age at first calving obtained in this study for cows is higher than the value of 47.61 months reported for agro-pastoral production system (Workneh and Rowland, 2004). This is perhaps due to feed shortage in the area. This fact is in line with the report by Mukasa-Mugerwa (1989) who indicated that heritability of age at first calving is generally low, indicating that this trait is highly influenced by environmental factors, feed and health. Age at first calving was more affected by environmental factor than heritability. However, the result obtained in this study fall in the range reported by Mulugeta (1990) of 4-5 years and similarly 4 to 4.5 years in Borana pastoral system as reported by Coppock (1994). In addition, the result obtained is also similar with the report (52 months) by Kurtu (2003) from Harar milk shad. But the result of the current study is higher than mean value of 3.6 year for *Bos indicus* found in a number of traditional systems reviewed by Mukasa-Mugerwa (1989).

According to the camel herder, mean age for first calving of camels was 63 ± 1.55 months. This result is similar to the report of Tefera and Gebreah (2001) that average age at first calving of camels in eastern Ethiopia is five years and it is similar with that reported by Ahmed *et al.* (2005) who indicated that age at first calving for camels in Afder zone of Somalia region to be 5.2 years. However, age at first calving of camel observed in the present

study is 5 month lower that reported by Frah *et al.* (2004) which was 57.4 ± 12.8 months for camels in Somalia.

4.9.2. Calving interval

As indicated in Table 23, the overall mean calving interval of cows and camels was 16.01 ± 0.49 months and 18.53 ± 1.02 months, respectively. There were significant ($P \leq 0.05$) variations among rural *kebeles* in calving intervals of cows and camels (Appendix Table 27).

Table 23. Overall calving intervals (CI) of cows and camels animals in Mieso district

Animal types	Total HH (N)	Calving interval (months)			
		N	Mean ± SE	Min.	Max.
Cows	120	120	16.01 ± 0.49	11	24
Camels	33	32	18.53 ± 1.02	12	24

SE= Standard Error of mean, Min.= minimum, Max.= maximum, HH=Household, (N)= Total number of respondents, N= Sample respondents

The result obtained in this study agrees with the findings of Workneh and Rowland (2004) which indicated calving interval of cows in pastoral area of Oromia region was 15.5 months for cows but it was longer for the overall calving interval of cows taken in the region, 18.6 months. Besides this the result also falls within the range of calving interval for Ethiopian zebu cattle of 12-22 months reported by Mukasa-Mugerwa (1989).

The average (mean ± SE) calving interval for camels in Mieso district was 18.5 ± 5.74, which is lower than mean calving interval of 2 years reported for camels in Afder zone of Somalia region (Ahmed *et al.,* 2005). In Eastern Ethiopia, calving interval of 2 years has been reported for camels (Tefera and Gebreah, 2001) and as Frah *et al.* (2004) also reported calving interval of 27.4 ± 9.3 months for camels in Somali. This lower calving interval observed in this study could probably be due to the relative advantage in using of forced weaning to dry off of the dam, which contribute to decreased lactation length and reduced anoestrus period for early breeding. Calving intervals have low heritability and can be improved through nutrition and early breeding (Mulugeta, *et al.,* 1991).

4.9.3. Lactation length

Indigenous breed of cows are generally considered as low milk producers. However, they were the major source of milk in the study area. The lactation length of animals in the study area depends mostly on the management objective of the herder, may the herder may prolong the lactation length for the sake of continues milk production or dry off the dam at early stage for the purpose of breeding the cows. As indicated in the Table 24 the average lactation length for cows was 7.29 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. But it is lower than 9.5 months reported by Lemma *et al.* (2005) for local cows in the East Showa zone of Oromia region. There was a significant ($P \leq 0.05$) different lactation length encountered in the case of cattle holders (Appendix Table 28).

Table 24. Overall reported lactation length of cows and camels in different rural *kebeles* in the Mieso district

Animal types	Total Household (N)	N	Lactation length (months)		
			Mean ± SE	Min.	Max.
Cow	120	119	7.29 ± 0.17	5	12
Camel	33	32	11.25 ± 0.56	7	24

SE= Standard Error of mean, Min.= minimum, Max.= maximum, (N)= Total number of respondents, N= Sample respondents

Lactation length in Huse-mendera was significantly longer (8.3 ± 0.39 months) than the other rural *kebeles* in the district (Table in the Appendix 28). It may be due to the reason of having less number of lactating (1.15 ± 0.06) cows in the household tends to milk their cows for long or the feed shortage in the area. This is important to ensure the consistency of milk production and marketing as a whole.

The present average lactation length of cows agrees with the 212 days reported for local cows by Kurtu (2003) in the Harari milk shed. However, the result obtained contradicts with the result reported by Semenye (1987) that indicated an average lactation length of cows in

Maasai pastoral area to be 12 months. This shorter lactation length may be due to the purposive drying-off of cow that the herders used or due to the death of the calf which creates problem in milk let-down.

As indicated in Table 25, an average amount of cow milk yield/head/day at first, second, and third lactation stages was 1.37 ± 0.02 liters, 1.86 ± 0.03 liter and 0.49 ± 0.01 liters, respectively. The overall cow milk yield/head/day for the monitored cows was 1.24 ± 0.02 liters. This is similar to the national average of 1.09 liter/day/cow (Dagena and Adugna, 1999). Lemma *et al.* (2005) also report that the average milk yield of local Arsi cows was 1.0 liter /head /day. There was a significant ($P \leq 0.05$) variation among rural *kebeles* in daily milk yield/head. There was a significantly ($P \leq 0.05$) high overall milk yield (liter/head/day) in Hunde-misoma (1.48 ± 0.06 liters) than the other rural *kebeles*, while the least average milk yield per cow per day was estimated at Gena rural *kebeles* (1.03 ± 0.04 liters).

Lower milk production per day per head in Gena rural *kebeles* is may be due to short extended lactation length (6.7 ± 0.33 liters, in Appendix Table 28). Milk production per day per head is very low and this is further affected by the relatively short lactation length due to forced dry-off the cows. Short lactation length and extended post-partum anoestrus is resulting in low production efficiencies (Azage and Alemu, 1997).

Table 25. Milk Yield performance of cows in different stages of lactation at different rural *kebeles* in Mieso district

Rural *kebeles*	Daily yield per head (liters)							
	I stage of lactation		II stage of lactation		III stage of lactation		Over all	
	N	Mean ± SE	N	Mean ± SE	N	Mean ± SE	N	Mean ± SE
D/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
H /mendera	110	1.38 ± 0.03	215	1.78 ± 0.03	95	0.51 ± 0.02	95	1.23 ± 0.02
H/misoma	40	1.43 ± 0.08	55	2.24 ± 0.09	35	0.49 ± 0.02	35	1.48 ± 0.06
W/jejeba	105	1.28 ± 0.04	25	1.87 ± 0.08	10	0.49 ± 0.05	10	1.24 ± 0.05
Total	380	1.37 ± 0.02	390	1.86 ± 0.03	190	0.49 ± 0.01	190	1.24 ± 0.01
Sig.		**0.123**		**0.00**		**0.125**		**0.00**

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, SE= Standard Error of mean, N= Sample milking cows

Lactation milk yield of cows/head/lactation period was 271.4 liters within an average lactation period of seven months, 7.29 ± 0.17 (Table 24). This result was agreed with over all average estimated lactation milk yield of Fogera cattle which was 238.35 liters (Mulugeta, 2005). However, this was less than the average milk yield of local cows found in Somali region which reaches up to 488 liters within 249 days in all pastoral areas (IPS, 2000). Mukasa-Mugerwa *et al.* (1989) noted that Zebu cattle under traditional management yielded about 524 liters over 239-days lactation. The low lactation milk yield found in the current study may be due to poor genetic make up, shortage of feed, or shorter lactation length or may be due to poor management conditions.

Table 24 shows that, the mean (Mean ± SE) lactation length for camels was 11.25 ± 3.18 months and there were no significant ($P > 0.05$) difference in lactation length of camels among rural *kebeles*. Tefera and Gebreah (2001) reported that the average lactation period of camels in eastern Ethiopia in general was one year. Baloch (2002) also reported that lactation length for Pakistan camels to be 445.58 days. Tezera and Hans (2000) also reported lactation length of camels in Jijiga was 15 months and that in Shinile Zone to be 13 months. Nevertheless, the present result is within the range of 8 months to 2 years reported for east African camels (Schwartz and Dioli, 1992). This shorter lactation length in the present study

may be due to small number of the sample taken or due to forced drying of camel that the households practiced.

Table 26. Milk Yield performance of camels in different stages of lactation at different rural *kebeles* in Mieso district

Rural *kebeles*	Daily yield per head (liter)							
	I stage of lactation		II stage of lactation		III stage of lactation		Overall	
	N	Mean ± SE	N	Mean ± SE	N	Mean ± SE	N	Mean ± SE
D/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
H/mender	15	2.71 ± 0.17	20	3.57 ± 0.17	4	1.44 ± 0.12	39	3.02 ± 0.15
H/misoma	14	1.85 ± 0.08	45	2.72 ± 0.09	21	1.36 ± 0.09	80	2.21 ± 0.09
W/jejeba	11	2.44 ± 0.19	6	3.29 ± 0.62	35	1.29 ± 0.040	52	1.76 ± 0.12
Total	85	2.41 ± 0.07	101	3.11 ± 0.08	80	1.37 ± 0.03	266	2.36 ± 0.06
Sig.	**0.00**		**0.00**		**0.139**		**0.00**	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, H/mendera=Huse-mendera, SE= Standard Error of mean. Sig.= Significant value, N= Sample milking camels

Table 26 shows that the overall estimated camel milk yield (liter/head/day) was, first (2.4 ± 0.07 liter), second (3.11 ± 0.08 liter) and third (1.36 ± 0.03 liter) lactation stage. The overall estimated camel milk yield per head per day was 2.4 ± 0.06 liters and lactation yield was 797 liters, over an average lactation period of eleven month. This result is similar to the report of Tefera and Gebreah (2001) who found that the average daily milk yield of camels in eastern Ethiopia in general was 2.5 liters per day over a lactation period of one year. However, the current result for lactation milk yield and lactation period was lower than the reports of Baloch (2002) that milk yield and lactation length in Pakistan averaged 1894.93 liters and 445.58 days, respectively. The shorter lactation period and lower lactation milk yield result found in this study may be due to feed shortage in the area or there may be a breed difference or the early breeding practices done after parturition in the study area may have resulted in the low performance.

The report of Ahmed *et al.* (2005) indicated that the breeding practices of camels after parturition in Ethiopia is mostly done after they complete 300-365 days of lactation. Therefore, this may have effect on milk yield as reported by Mukasa-Mugerwa (1981) who

indicated that breeding practices in early lactation of the dam will decrease milk yield as well as lactation length.

4.10. Mortality Rate

The differences in mortality rates between the species were largely the reflection of management technique used by the herders and the ability of each species to resist stress conditions.

Table 27. Pre-weaning and post-weaning mortality (%) of dairy animals based on owners response in Mieso district

Animal type	Average mortality rate				Overall mean
	Pre-weaning age		Post-weaning age		
	N	Mean ± SE	N	Mean ± SE	
Goat	10	41.70 ± 8.00	14	27.60 ± 6.60	30.00
Cattle	27	61.70 ± 5.20	41	32.60 ± 4.40	43.70
Camel	2	66.70 ± 14.70	10	23.50 ± 0.83	35.30

SE= Standard Error, N= sample households who encountered loss in dairy animals due to diseases

As indicated in Table 27, the overall percentage pre-weaning mortality rates for goats, cattle and camels was 41.7 ± 8.00, 61.7 ± 5.20 and 66.70 ± 14.70, respectively. However, the post-weaning mortality rate was lower than the pre-weaning mortality rate, showing a decrease as the age increased. The respective percentages of post-weaning mortality rates were 27.6 ± 6.60, 32.6 ± 4.40 and 23.50 ± 0.83 for goats, cattle and camels.

Mortality decreased as age increased due to improved management provided for young animals which are 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-egzabiaher *et al.* (1991) who indicated that with an increase in age, mortality rate decreased probably because of improved adaptability of animals to both climatic and nutritional factors. The overall mortality rates for the cattle herd was 43.70 ± 5.20. However, Wagenaar *et al.* (1986) reported that in Fulani cattle herds, calf mortality up to one year age was 43 %, and

decreased to 7.5 % for post weaning mortality. This result may be caused by lower immunity of the calves as they are suckled inadequately. The present result indicates that the extremely high pre-weaning mortality rate of 62 %, which is greater than the 50 % calf crop loss, reported by Williamson and Payne (1978) for tropical areas. These high losses have invariably been attributed to bad young management practices.

As indicated in Table 28, mortality due to diseases is the major (65 %) cause in all the species of dairy animals than drought (15 %), abortion (7 %) and predators (7 %). The least cause of animal death was poison (5 %). The major cattle, goats and camel killer diseases reported by herders in the study area were anthrax, FMD, diarrhea, blackleg, and pasteurollosis; respiratory tract infections, and internal and external parasites. Similarly, as a report from the Maasai pastoralist indicates the major cause of death for young and adult goats diseases and it was 76 % and 54 % of mortality, respectively than injury (4 %), predators (11 %) and (19 %) for young and adult goats, respectively (Grandin *et al.,* 1991).

Table 28. Causes of death of cattle, camels and goats in Mieso district.

Reason of death	Number of animals lost due to different reasons						Total animals (N=104)	
	Cattle (N=68)		Camel(N=12)		Goats (N=24)			
	N	%	N	%	N	%	N	%
Disease	44	64.70	8	66.7	16	66.70	68	65.00
Drought	15	22.00	0	0.00	1	4.20	16	15.40
Poison herbs	2	2.90	2	16.60	1	4.20	5	4.80
Abortion	4	5.90	1	8.30	2	8.30	7	6.70
Accident/ Predators/	3	4.40	1	8.30	3	12.50	7	6.70

(N)= Total number of animals, N= Sample animals

4.11. Importance of Dairy Animals

Keeping different species of animals can reflect management objectives. In most of the lowlands of Ethiopia, with the exception of very few agro-pastoralists that produce crop through opportunistic farming, almost all of the populations are livestock raisers whose food security is highly associated to their livestock (Beruk and Tafesse, 2000). Farmers in the Mieso district keep dairy animals either for consumption (milk or meat), economic (sale of

milk and milk products and live animals) or for social reasons. However, the main purposes of keeping dairy animals as identified by the livestock keepers are presented in Table 29.

Table 29. Purposes of keeping different animals in the Mieso district

Animal type	Total HH (N)	Purpose of keeping animals							
		Milk production		Income source		Traction		Cultural values (Bride price)	
		N	%	N	%	N	%	N	%
Goats	113	112	97.00	57	50.00	-	-	55	48.00
Cows	120	120	100.00	5	4.20	-	-	63	53.00
Ox	120	-	-	29	2.40	120	100.00	36	30.00
Camels	33	33	100.00	10	31.00	-		2	6.30

HH=Household, (N) = Total number of respondents, N= Sample respondents

The primary reason for rearing of dairy animals, cows, camels and goats were for milk production. However, almost all the respondents indicated that raising of cows and camels were for milk production. Moreover, keeping of goats had more advantage in risk diversion as it could be an immediate source of income generating (50 %) when cash is needed in the household.

Cows are the most important animals for cultural values. According to 53 % of the respondents, female cattle are the most important animals than oxen for the purpose of dowry. However, heifers are the more preferred, depending on availability, than adults for this purpose. Almost all of the households indicated that no one needs to slaughter their animals for consumption. Therefore, most of the households prefer flow (milk and draft power) rather than the end products (meat, hides and skins). This is agrees with the report of Jahnke (1982) who reported that the first and the most important purpose of dairy cattle production are to provide milk for family use and for sale. In pastoral systems, the main product is milk, and the main function of the livestock is subsistence, though social and cultural functions are important.

In the study area traditionally dairy animals perform multiple functions of producing milk for household consumption and, male calves as a source of drought power in agricultural

operations. Besides, dairy animals serve as saving bank account with offspring as interest. Animals generate a continuous flow of income and act as a cushion against income shocks arising due to crop failure, especially dairy goats. Livestock make an important contribution to most economies (Desta, 1999).

4.12. Milking Management

4.12.1. Milking practices

Traditional hand milking is the major type of milking practices in the whole district. Milking is usually under the control of women and there was no proper sanitary procedure followed during milking. During milking washing of teats is not practiced, and the producers believe that during calf suckling for milk let-down, the teat get washed by the saliva of calf and therefore it is not as such important to wash the teat before milking. Labour division for milking was, however, dependent on the species of 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 dam before (to initiate milk let-down) and after milking (to drain whatever is left in the udder).

As indicated in Table 30, cows were milked once or twice a day whereas camels are milked from 1- 6 times a day depending on 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.

There were no differences among rural *kebeles* and gender of household heads in the frequency of milking of cows during the wet and dry seasons. Almost all of the households indicated that in case of cow milking, twice milking is a common practice in wet season. However, as indicated by 98 % the cattle owners milking frequency decreases to once milking in the dry season (Table 30). Milking frequency in the area depends on feed availability. As indicated by respondents, once milking is practiced in the dry season in the evenings. Evening milking in the dry season is practiced because cows are kept far from the homestead for grazing during the day time. Milk produced in the evening is marketed in the next morning

after through proper processing such as washing and smoking of utensil by different herbs properly.

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 30). 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 Somalia region is thrice per day and twice per day during the wet and the dry season, respectively. There was a significant difference in camels milking among rural *kebeles* but not between genders of household heads. Most of the camel herders (33 %) in Dire-kalu rural *kebeles* practiced thrice milking of camels per day in the dry season than the other rural *kebeles*.

Some camel holders practice six times a day milking depending on season, lactation stages and the need of milk for the family. This was practiced during wet season and /or during at early stage of lactation.

Table 30. Variation of responses for milking frequency of dairy animals 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*
	N	%	N	%	N	%		N	%	N	%	N	%		N	%	N	%	N	%	
D/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	
H/mender	34	100	34	100	0	0	0.32	0	0	7	21	0	0	0.00	1	0	3	8.8	4	12	0.00
H/misoma	27	100	27	100	0	0		0	0	10	37	0	0		0	0	1	3.7	9	33	
W/jejeba	23	100	22	96	1	4		4	17	1	4	1	4.3			4.3	1	4.3	2	9	
HH head sex																					
Female	27	100	26	96	1	4	0.48	0	0	5	19	0	0	0.81	1	3.7	0	0	5	19	0.22
Male	93	100	92	99	1	1		7	8	18	19	3	3.2		6	6.5	9	9.7	19	20	
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						

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, N= Sample respondents

4.12.2. Traditional preservatives

Milking vessels used in the study area was usually gourd and was generally washed with hot water (83 %) and herbs of different species (used as disinfectants) and smoked for aromatic purposes.

As indicated in the Table 31 that majority of the households used *Dhirii (Acalypha fruticosa*) (95 %), *Kortatuma (unidentified)* (22 %), *Sukae (Ocimum iamifolium)* (20 %) *and Hulunko (unidentified)* (17 %) as a cleaning of milking utensils. Producers reported that tail skin of cattle was used to wash the milking utensil, this material called *hoyso*. This is prepared from cattle tailed skin by attaching it with stick to give it strength. *Hoyso* was used to clean the utensil before and after smoking. In Table 31 and Table 32 provides different herbs are indicated based on the farmers' response which are used for washing and /or for fumigation of milking utensils and storing and selling utensils in the district.

Table 31. Herbs and plant parts used for cleaning of milk utensil based on the respondents response in Mieso district

Plants Local* (scientific) names	Parts used	Rural *kebeles*										Overall	
		D/kalu		Gena		H/mendera		H/misoma		W/jejeba			
		N	%	N	%	N	%	N	%	N	%	N	%
Dhiri (*Acalypha fruticosa*)	Leave and stem	12	80	21	100	33	97	25	93	23	100	114	95
Badano *(Balanites aegyptiaca*)	Leaf	6	40	3	1.4	3	8.8	6	22	6	26	24	20
Birreessa *(Terminalia brownii*)	Leaf	5	33	0	0	0	0	0	0	0	0	3	2.5
Sukae(*Ocimum iamifolium)*	Leaf and stem	1	6.7	0	0	22	65	1	3.7	0	0	24	20
Sapansa *(Acacia mellifera*)	Leaf	4	27	0	0	0	0	0	0	1	4.3	5	4.2
Obosha	Leaf	1	7	0	0	0	0	0	0	2	8.7	3	2.5
Kortatuma	Leaf	1	7	4	19	4	12	15	56	2	8.7	26	22
Urgesa *(Premna schimperi)*	Leaf	0	0	0	0	1	2.9	0	0	0	0	1	0.8
Butubora	Leaf	0	0	0	0	2	5.9	0	0	1	4.3	3	2.5
Adegude	Leaf	0	0	2	9.5	0	0	0	0	0	0	2	1.7
Yewof-kollo	Leaf	0	0	0	0	1	2.9	0	0	0	0	1	0.8
Ejersa *(Olea africana)*	Leaf	0	0	0	0	8	24	1	3.7	1	4.3	10	8.3
Hulunqoo	Leaf	1	7	1	4.8	3	8.8	14	52	1	4.3	20	17
Loloha(Loloqaa) *(Panicum maximum*)	Leaf	0	0	0	0	1	2.9	0	0	1	4.3	2	1.7
Qurquraa (*Ziziphus mucronata)*	Leaf	6	40	1	4.8	1	2.9	2	7.4	1	4.3	11	9.2
Midhaan dubraa *(Lantana rhodesiensis)*	Leaf	3	20	1	4.8	1	2.9	1	3.7	2	8.7	8	6.7

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, N= Sample respondents

* Local language used for the identification of plants names were Oromiffa

In the study area women practiced different smoking systems. Most of the women fumigate the milk utensils simply by inserting the fire wood into the utensil and shake it well or simply keep the fired stick on the top of utensil and fumigate well until the utensil is sufficiently smoked. While others use a special wall called '*Bolakoya'*, a place where smoking is performed, in which the fired wood is put inside and the utensils is kept at the top of the hole. This type of smoking method prevents the pieces of the fire wood not to be left in the milk utensil.

Table 32. Herbs used for smoking of milk utensils in different rural *kebeles* in Mieso district

Plants Local* (scientific) names	Parts used	Rural *kebeles* N (%)										Overall	
		D/kalu		Gena		H/mendera		H/misoma		W/jejeba			
		N	%	N	%	N	%	N	%	N	%	N	%
Ejersa *(Olea Africana)*	Stem	15	100	21	100	34	100.0	27	100	23	100	120	100
Badano *(Balanites aegyptiaca*.)	Stem	10	67	0	0	5	15.0	4	15	20	87	39	33
Birreessa *(Terminalia brownii*).	Stem	4	27	4	19	9	26.0	2	7.4	1	4.3	20	17
Dhodoti (*Dhaddacha) (Acacia tortilis)*	Stem	0	0.0	11	52	1	2.90	5	19.0	3	13	20	17
Sapansa *(Acacia mellifera*)	Stem	7	5	0	0	1	2.90	1	3.7	2	8.7	11	9.2
Obosha	Stem	0	0.00	6	29	19	56.0	0	0.00	0	0.00	25	21
Agamsa/Dhagamsa/ (*Carissa edulis*)	Stem	0	0.00	0	0	0	0.00	0	0.00	1	4.3	1	0.8
Rukeessa (*Combretum molle)*	Stem	1	7.00	0	0	1	2.90	1	3.70	1	4.3	4	3.3
Dheekkaa (*Grewia tembensis*)	Stem	0	0.00	1	4.8	0	0.00	0	0.00	0	0.00	1	0.8

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, H/mendera=Huse-mendera, N=Sample respondents

* Local language used for the identification of plants names were Oromiffa

Smoking of milk handling utensils is done to improve aroma and flavor of the milk. As indicated in Table 32, there were different plants are used by households for the purpose of smoking; however, the major plants are used for smoking were *Ejersa (Olea africana)* (100%), *Badano (Balanites aegyptiaca)* (33%) and *Obosha (unidentified)* (21%).

Table 33. Number of days that the cow-milk stays fresh without fermentation by using different herbs in Mieso district

Rural *kebeles*	Days that cows' milk stays fresh		Sig.
	N	Mean ± SE	
D/kalu	15	1.70 ± 0.02	0.00
Gena	21	2.14 ± 0.13	
H/mender	34	1.71 ± 0.11	
H/misoma	27	1.44 ± 0.09	
W/jejeba	22	1.86 ± 0.12	
Household head sex			
Female	27	1.04 ± 1.70	0.185
Male	92	0.07 ± 1.78	
Total	119	1.40 ± 0.06	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, H/mendera=Huse-mendera, SE= Standard Error of mean. Sig.= Significant value, N= Sample respondents

The period that raw cows' milk stays fresh was significantly (P≤ 0.05) shorter (1.4 day) at H/misoma as compared to other rural *kebeles*. This may be associated with the type or methods of preservatives used either for cleaning or fumigation of milking utensil in Hunde-misoma.

4.13. Milk Consumption and Marketing

4.13.1. 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 in the area. However, cheese was not produced among the surveyed households. Culturally fermented milk is not sold; rather cows' fresh whole milk, butter, camel milk and rarely goat milk are sold in the market.

Traditionally, milk is consumed in the household in the form of '*hoja'* a drink which prepared from goats', camels', or rarely from cows' milk by mixing it with water, and then adding of coffee husk, and boil it, rather than consumed milk in fresh form. *Hoja* is mostly prepared from goats' milk than camels' and cow s' milk. It is a traditional drink that is given to guests as well. Children are the major consumers of goats' milk at home. Goat milk is not marketed

in the market place; rather it is sold at the farm gate or in a form of contract to neighbors for feeding children. It is believed that children who drink goat milk are healthy and grow well. Goat owners reported that goat milk is also used to cure wounds by mixing it with different herbs.

Table 34. Household milk consumption pattern in Mieso district based on the species of dairy animals

Fresh milk type	D/kalu (N= 15)		Gena (N=21)		H/mender (N=34)		H/misoma (N=27)		W/jejeba (N=23)		Total (N=120)		X^2 P-value
	N	%	N	%	N	%	N	%	N	%	N	%	
Cows'	13	87	20	20	29	29	23	23..2	14	14.1	99	82.5	
Camels'	2	13	0	0.0	3.0	8.8	3	11.1	3	13.3	11	9.2	0.047
Goats'	0	0.0	1	5.0	2.0	5.9	1	3.7	6	26.1	10	8.3	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, (N)= Total number of respondents, N= Sample respondents

As presented in Table 34, 83 % of the farmers indicated that at household level priority is given for cow milk consumption. Cow milk is preferable to be consumed at household level rather than selling in the market. This is may be due to the importance of the by-products (Butter and fermented milk) one gets from the processed cow milk.

Table 35. Type of milk and milk products sold by the households in the different rural *kebeles* and by household heads in Mieso district

Rural *kebeles*		Total HH (N)	Milk and milk product sale						X^2 P-value
			Fresh milk		Whey		Butter		
			N	%	N	%	N	%	
D/kalu		15	5	33	0	0.0	7	47	
Gena		21	19	90	1	4.8	19	90	
H/mendera		34	28	82	3	8.8	23	68	0.00
H/misoma		27	26	96	1	4.8	15	56	
W/jejeba		23	16	70	0	0.0	16	70	
HH sex	Female	27	21	78	2	7.4	18	61	0.63
	Male	93	73	78	3	3.2	62	67	
Total		120	94	78	5	4.2	80	67	

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, HH= Household, (N)= Total number of respondents, N= Sample respondents

The majorities of the households sell whole milk (78 %) and butter (67 %). Some 4.2 % of the farmers also reported that they sell whey. There were highly significant ($P \leq 0.05$) variation among rural *kebeles* for the sale of fresh milk, butter and whey but there was no statistical differences 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 respondent indicated that milk is produced for home consumption as well as for selling. According to interview, the priority to milk consumption is given to husband, guests, children and then for wives, sequentially. The consumption of milk and milk products varied geographically between the highlands and the lowlands and the level of urbanization (Ahmed *et al.,* 2003). However, in the highlands the major consumers of milk and milk products primarily include children and some vulnerable groups of women (Ahmed *et al.,* 2003).

About 72 % of the respondents indicated that cow milk is sold both during the dry and the wet seasons (Appendix Table 42). However, 8.3 % of the respondents sell milk during the wet season only. Participation of majority of the households in milk sales during both seasons shows that dairying is a predominant source of income generation. Milk sales during both seasons was significantly higher ($P \leq 0.05$) in Hunde-misoma (93 %) and Gena (86 %) rural *kebeles* than other rural *kebeles*. This result might be due to the nearness of both rural *kebeles* to the market sites, Asebot and Mieso, and it encourages them to sale milk rather than use for home consumption. 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.

Table 36. Variation in marketed whole cow milk due to seasons in different rural *kebeles* in Mieso district

			Cow milk marketed (out of total herd milk off-take per households per day)							
			Wet season				Dry season			
	Total HH		One-forth		Half		One-forth		Half	
Rural *kebeles*	(N)	N	N	%	N	%	N	%	N	%
D/kalu	15	5	0	0.0	5	100	1	33	2	67
Gena	21	19	3	16	16	84	17	94	1	5.6
H/mendera	34	27	7	26	21	78	23	92	1	4.0
H/misoma	27	26	11	42	15	58	25	100	0	0.0
W/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

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, HH=Household, (N)= Total number of respondents, N= Sample respondents

As indicated in Table 36, 29 % of the households indicated that only one fourth of the milk was delivered to the market. However, the rest indicated that mostly the morning milk is sold but 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 off take, 66 % is consumed at the household and 24 % is sold or given to other households. However, in Eastern Showa zone of Oromia region out of the total production, about 1.2 kg per week (85.7 %) is marketed and the remaining, 0.2 kg is used for home consumption (Lemma *et al.,* 2005).

A high percentage of respondents (78 %) indicated that 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 prices decrease during the wet season due to increases in supply.

According to the response of the producers the average cow milk yield per head/day in the wet and dry seasons was 3.26 ± 0.07 liter and 1.63 ± 0.04 liters, respectively. Lower milk yield and mean milk off-take have been reported in the wet season (1.09 liters/cow/day) and in the dry season (0.79 liters/cow/day) for cows in Maasai pastoralists (Semenye, 1987). This variation may be due to differences in feed supply and genetic make up of the animals.

As shown in Table 37, there were variations among rural *kebeles* in milk yield per head per day in wet season, and values ranged from 2.60 ± 0.21 liters in Dire-kalu to 3.68 ± 0.12 liters in Huse-mendera. The overall average cow milk production per household per day in the wet and the dry season was 4.80 ± 0.22 liter and 2.37 ± 0.11 liter, 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 liters) than in Dire-kalu rural *kebele* (2.60 ± 0.21 liters). Cow milk yield per household in wet season in the two rural *kebeles*, Welda-jejeba (6.2 ± 0.69) and Dire-kalu (5.80 ± 0.75) were significantly high than the other three rural *kebeles* (Gena, Huse-mendera and Hunde-misoma), which produced an average of 4 liters of milk per household similarly.

In the dry season, milk production per household was the lowest ($P \leq 0.05$) in Dire-kalu (1.43 ± 0.15) than in the other rural *kebeles*. The lowest milk yield per household per day in Dire-kalu may be due to the relatively higher amount of milk left for the calves to suckle. However, milk yield/household in dry season was equally high in Dire-kalu (3.10 ± 0.38) and Welda-jejeba (3.08 ± 0.35). These two rural *kebeles* had significantly ($P \leq 0.05$) higher milk production per household per day than the other rural *kebeles*. The lowest cow milk production per household was estimated for farmers in Gena rural *kebele* (1.80 ± 0.18), and this was may be due to fewer number of cow holdings in the area and the immobile nature of the households during the dry season. As a result, there is reduced feed availability in the dry season, and feeding of animals is more based on purchased crop residue than natural pasture. Average cow milk sale per household during the wet (3.60 ± 0.28) and the dry (2.20 ± 0.22) season did not differ significantly between rural *kebeles*.

There were no significant ($P > 0.05$) variations in camel milk yield per head/day during the wet (7.10 ± 0.33 liters) and the dry (3.80 ± 0.20 liter) seasons. However, the average camel milk produced per household per day in the wet (13.19 ± 0.95 liters) and the dry (7.62 ± 0.82 liters) season differed significantly ($P \leq 0.05$) among the rural *kebeles*. The least camel milk produced per household was observed in Gena rural *kebele*. This may be the low number of observation or less 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 liters) and the dry season (2.58 ± 0.37 liters).

There was a highly significant ($P \leq 0.05$) difference between the amounts of cow milk produced and cow milk sold in the wet and the dry seasons (Appendix Table 39). Similarly, the amount of camel milk produced and marketed differed significantly ($P \leq 0.05$) between the dry and the wet season. Hence, in the study area contrary to other pastoral areas, as cow milk production per household increases, there is also an increase in milk sale. In the lowlands when there is a seasonal increase in milk production in the household, there is a tendency to increase household consumption rather than milk marketing (Coppock, 1994). A recent study in Oromia Region by Lemma *et al.* (2005) reported that on average about 3.0 liters of milk was produced/household/day and about 2.50 litters (88.3 %) was accumulated for further processing into butter and the remaining 16.7 % was consumed at the household on a daily basis. On average about 1.4 kg of butter was produced per household per week.

Table 37.Estimated amount of cow and camel milk produced and marketed on wet and dry season in Mieso district based on producer response

Rural *kebeles*		Cow milk /head in wet season, L	Cow milk/ head in dry season, L	Cow milk/HH in wet season	Cow milk /HH in dry season	Avg. cow milk sale/HH in wet season	Avg. cow milk sale/HH in dry season	Camel milk / head in wet season	Camel milk /head in dry season	Camel milk/ HH in wet season	Camel milk/HH in dry season	Camel milk sale/HH in wet season	camel milk sale/HH in dry season
D/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
	N	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
	N	21	21	20	20	19	19	2	2	2	2		
	SE	0.18	0.13	0.41	0.18	0.25	0.15	0.00	0.13	0.11	0.00		
H/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
	N	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
H/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
	N	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
W/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
	N	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**
Total	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
	N	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

L=Litre, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, N= Sample respondents

The average cow and camel milk sale per household per day in the wet season was 3.55 ± 0.28 and 3.61 ± 0.45 liters, respectively. This volume decreased to 2.15 ± 0.22 and 2.58 ± 0.37 liters, respectively in the dry season.

Cow and camel milk supply to the market decreased by 39 % and 28 %, respectively during the dry season. This indicates that sale of camel milk decreases at a relatively lower rate than cow milk sale during the dry season. 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 and this is in line with the reports of Zeleke (1998).

Huse-mendera rural *kebele* has significantly ($P \leq 0.05$) more cow milk supply in wet as well as in dry seasons to the market than the other rural *kebeles*. However, there was no significant ($P>0.05$) seasonal variation in milk sale between male and female headed households.

Table 38. Quantity of milk sold and price of cows' and camels' milk in Asebot and Mieso market places

Dependent Variable	Market place	Milk type	Mean ± SE (liter)	95% Confidence Interval	
				Lower Bound	Upper Bound
Amount of milk sale	Asebot	Cow	343.34 ± 19.22	304.70	382.00
		Camel	193.28 ±19.22	154.60	231.90
	Mieso	Cow	496.57 ± 19.12	458.10	535.00
		Camel	187.89 ± 19.12	149.40	226.40
Price	Asebot	Cow	2.54 ± 0.104	2.30	2.74
		Camel	2.19 ± 0.104	1.98	2.39
	Mieso	Cow	2.71 ± 0.103	2.51	2.92
		Camel	2.43 ± 0.103	2.22	2.64

SE= Standard Error of means

As indicated Table 38, amount of milk sale in Mieso market was significantly ($P\leq 0.05$) high for, cow (496.60 ± 19.12 liter) milk as well as camel milk (187.89 ± 19.12 liter) than Asebot market site., the amount of cow milk sold per day in Mieso market was significantly ($P \leq 0.05$) higher (496.60 ± 19.12 liters) than in Asebot market (343.34 ± 19.22 liters) (Table 38). The reverse was true for camel milk. This is perhaps for the reason that the Mieso market is more central for more

number of rural *kebeles* and since Mieso town is the district's capital, there is more demand for cow milk. From personal observation and interview with producers, farmers and pastoralists from the adjacent district of Mullu in Somali pastoral areas are major milk suppliers to Mieso town. Therefore, Mieso market site has more potential to access cow milk than Asebot market. However, prices of cow and camel milk in the two markets did not differ significantly ($P > 0.05$).

Table 39. Quantity of milk sold and price of cows' and camels' milk based on season in Mieso district

Dependent Variable	Milk type	Season of milk sale	Mean ± SE (liter)	95 % Confidence Interval	
				Lower Bound	Upper Bound
Amount of milk sale	Cow	Wet season	551.29 ± 19.22	512.6	589.9
		Dry season	288.62 ± 19.12	250.1	327.08
	Camel	Wet season	211.92 ± 19.22	173.2	250.50
		Dry season	169.25 ± 19.12	130.8	207.70
Price	Cow	Wet season	1.88 ± 0.10	1.67	2.09
		Dry season	3.38 ± 0.10	3.16	3.58
	Camel	Wet season	1.63 ± 0.10	1.42	1.85
		Dry season	2.98 ± 0.10	2.77	3.19

SE=Standard Error of means

According to Table 39, the amount of milk sold per day in the wet season was significantly ($P \leq 0.05$) higher for both cows' (551.29 ± 19.20 liters) and camels' milk (211.92 ± 19.12 liters) than in the dry season (288.62 ± 19.12 liters) and (169.25 ± 19.12 liters), respectively. In the case of price of milk, seasonal difference was not significant for both cows's and camels' milk. However, the average prices during the wet season were lower (1.88 ± 0.10 Birr/liter and 1.63 ± 0.10 Birr/liter) than during the dry season (3.38 ± 0.10 Birr/liter and 2.98 ± 0.10 Birr/liter) for cows' and camels' milk, respectively. Price for cow and camel milk at the two market sites did not differ significantly ($P > 0.05$). Since the camel milk is not preferred by consumers for processing into various dairy products, it is sold at a lower price compared to cow milk.

Table 40. Quantity of milk sold and price of cows' and camels' milk based on season in Mieso and Asebot market places

Dependent variable	Market place	Milk type	Seasonal milk sale	Mean ± SE	95% Confidence Interval	
					Lower Bound	Upper Bound
Amount of milk sale	Asebot	Cow	Wet season	473.30 ± 27.336	418.310	528.297
			Dry season	213.38 ± 27.044	158.972	267.782
		Camel	Wet season	243.13 ± 27.336	188.132	298.119
			Dry season	143.43 ± 27.044	89.023	197.834
	Mieso	Cow	Wet season	629.29 ± 27.044	574.880	683.691
			Dry season	363.86 ± 27.044	309.452	418.262
		Camel	Wet season	180.71 ± 27.044	126.309	235.120
			Dry season	195.07 ± 27.044	140.666	249.477
Price	Asebot	Cow	Wet season	1.94 ± 0.147	1.643	2.236
			Dry season	3.14 ± 0.146	2.850	3.436
		Camel	Wet season	1.42 ± 0.147	1.122	1.714
			Dry season	2.96 ±0.146	2.671	3.257
	Mieso	Cow	Wet season	1.82 ± 0.146	1.528	2.114
			Dry season	3.61 ± 0.146	3.314	3.900
		Camel	Wet season	1.86 ± 0.146	1.564	2.150
			Dry season	3.00 ± 0.146	2.707	3.293

SE=Standard Error of means

As indicated in Appendix Table 44, amount of milk sale at different sites in different seasons for different milk types was not different. However, price of milk at different market sites for different milk types in different seasons was significantly different and high at Mieso market in wet as well as dry season (Table 40).

4.13.2. Milk marketing system

Marketing of milk in the Mieso district was mainly a traditional type. There were generally two different milk outlets identified namely traditional milk associations or groups and the producer themselves (individual seller). The traditional milk producer associations or group called *Faraqa Annanni*. These groups are traditionally self- organized group which involves women who have milking cows or camels. The number of women that participate in the *Faraqa Annanni* ranges

from 2 to 10 per group. Members are organized on the bases of selling whole fresh milk of cows and / or camels.

Table 41. Distribution of *Faraqa Annanni* and number of participants in the *Faraqa Annanni*

Rural *kebeles*	Availability of *Faraqa Annanni* in the area		Individuals participating in the *Faraqa Annanni*	
	N	%	N	%
D/kalu	0	0.00	0	0.00
Gena	15	71.00	3	16.00
H/mender	20	58.80	9	33.00
H/misoma	18	66.60	10	38.00
W/jejeba	0	0.00	0	0.00
Household head sex				
Female	10	47.60	4	15.00
Male	43	58.90	18	19.00
Total	53	44.00	22	23.00

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, N= Sample respondents

From the total (n=94) households who sell milk, only 22 (23 %) were involved in the milk seller groups. This indicates that majority of the household were individual sellers, therefore, marketing of milk was not organized. As a result of disorganization farmers were struggling for existence only and could not save their money, and use it only for daily expense. In the *Faraqa Annanni* (milk delivery association) each woman in this group are tends to sale the whole milk contributed from each member at her turn or shift and uses the income generated for her own. This system has several advantages, as it saves their time and labours (as they go to market once or twice a week depending on group size) and, saves money since they generating income on weekly or monthly bases.

Producers reported that the disadvantage of *Faraqa Annanni* was decreasing of the group member when their milking cow will dry, adding of water from the member, no risk sharing among the member if milk was not sold but only on the shoulder of the person who sale milk in her turn, cheating of the group member to sell milk without their turn; this may happen since no recording were practiced. The problem of traditionally managed milk groups should be another relevant area for immediate research focus. Price of milk is determined more by the consumers

than the producers. Consumers influence the producers on price decision 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 on milk marketing in the district.

Table 42. Variability of reasons for non participation in *Faraqa Annanni* in Mieso district

Rural *kebeles*	Total HH (N)	Low milk quantity		Prefer to be processed		Always go to market to sell or buy other materials [A]		No *Faraqa Annanni* organized in the area		Income need on daily basis		X^2 P-value
		N	%	N	%	N	%	N	%	N	%	
D/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	
H/Mendera	19	6	32	2	11.0	0	0.0	4	21	7	37	0.00
H/misoma	16	7	44	0	0.0	1	6.0	6	38	2	13	
W/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	

[A] Superscript indicate women involved in other business and go to market every day, HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, HH=Household, (N)= Total number of respondents, N= Sample respondents

As indicted in Table 42, there were variations in the reasons for not being involved in the milk marketing groups among the rural *kebeles*. According to 44 %, 32 %, 25 %, and of the respondents in Hunde-misoma, Huse-mendera and Gena, respectively the major reason for lack of group marketing was due to the small quantity of milk produced in the rural *kebeles*. For about 100 % and 75 % of the respondents in Dire-kalu and Welda-jejeba, the absence of organized milk marketing group was raised as a problem. Daily income need from milk sale was also identified as a reason for not participating in *Faraqa Annanni* for 50 % and 37 % of the respondents in Gena and Huse-mendera rural *kebeles*. In general, 39 % and 32 % of the households indicated that the absence of *Faraqa Annanni* group and the small quantity of milk produced, respectively to be the major reasons for not being involved in milk marketing group. The participation of the households around the market center is more influenced by the availability of *Faraqa Annanni* in their village.

For 35 % of female headed households, small quantity of milk produced hinders participation in group marketing of milk. About 24 % of the women headed households also indicated the cash need on a daily basis to cover household expenses as a major reason for not participating in group marketing. There was a significant ($P \leq 0.05$) difference between the overall total amount of milk sold by individuals and milk marketing groups. The average amount of milk sold by an individual was 1.64 ± 0.06 liters/person compared to a group 3.93 ± 0.18 liters/person (Appendix Table 33). The total amount of milk sold (liters/person) at Mieso (3.27 ± 0.17 liters/person) was significantly ($P \leq 0.05$) higher than at Asebot (1.91 ± 0.06 liters/person). The number of individuals per *Faraqa Annanni* per day was not significantly ($P > 0.05$) different between Asebot (2.94 ± 0.13) and Mieso (3.05 ± 0.22) markets. However, there was more number of seller groups in Mieso. This may be due to the involvement of milk seller groups from the adjacent District in Somalia Region, who are predominantly pastoralists.

4.13.3. Market orientation for dairying

Nine independent variables were included in the logit model to explain the factors that affects the participation decision on cow milk sale. Out of these variables six were found to have a significant effect on their participation decision at one, five and ten percent probability levels. The result of the estimated logit model is indicated in the following table.

Table 43. Factors affecting participation of producers on sale of cows' whole milk in Mieso district

Factors	Coefficients	SE	Marginal effects	Sig.	Odds ratio
Distance	-0.28	0.17	-0.02	0.098*	0.76
Edu.level	-1.89	0.94	-0.19	0.049**	0.16
Frk-anen	2.21	0.94	0.14	0.019**	9.11
Amt. cows' milk	0.16	0.23	0.01	0.491	1.17
Amt. camels' milk	-0.15	0.07	-0.01	0.041**	0.86
HH age	-0.04	0.04	-0.00	0.314	0.96
Family size	0.24	0.16	0.02	0.120	1.27
Butter	3.76	0.99	0.24	0.000***	42.85
Amt. goats' milk	-1.17	0.61	-0.07	0.055*	0.31
Constant	2.137	1.995	0.13	0.284	8.47

$R^2 = 0.6$

*** Significant at less than one percent probability level

** Significant at five percent probability level

* Significant at ten percent probability level

HH age= household head age, Edu.level=educational level of household head,, *Frk-anen*.=availability of *Faraqa Annenni* in the area, Amt. goats' milk = amount of goats' milk in the household, Amt. cows' milk = amount of cows' milk produced in the household, Amt. camels' milk = amount of camels' milk produced in the household, Butter= quantity of butter sold(kg), Distance= distance to the market site, Constant=constant values,Sig.=Significant value, Coef= coefficients, SE= standard error

The other variables which have a significant ($P \leq 0.05$) impact on the decision behavior of the household is its location from the market. As the model output indicates, the further household is away from the market center the less will be its participation to the cow milk sale. This result is consistent with the hypothesized relation between the two variables (market participation and distance to the market). The closer the households to the market, its participation to cow milk sale increases by odds ratio of 0.76 factors. By keeping other factors constant, an increase distance will decrease the participation of the household by 1.74 % for cow milk sale.

Contrary to the expectation, significantly ($P \leq 0.005$) negative correlation of educated household heads to cow milk sale indicates that rather than cow milk sale, decision to participate on other activities were more important. When the household heads educated, participation on cow milk sale decreased by factor of 0.16 odds ratio. As the household heads became educated, the participation on cow milk sale decreases by 20 %.

As the logit regression result indicates the availability of *Faraqa Annanni* in the area had significant ($P \leq 0.1$) positive relation with the participation decision of the household to sell cow milk. This is in conformity with what was hypothesized. The odds ratio of this variable was 9.11, this means that, the availability of *Faraqa Annanni* in the area will increase the odds in favor of participation decision by a factor of 9.11. Availability of *Faraqa Annanni* in the vicinity increases the opportunity of the household for cow milk sale by 14 %.

Contrary to the expectation, amount of goat and camel milk produced in the household were negatively and significantly ($P \leq 0.01$ and $P \leq 0.1$) related to market participation decision of the household on cow milk sale. This indicates that more production of camel and goat milk tends to shifts the household consumption pattern from camel and goat milk to cow milk, which reduces the available cow milk for sale. This result is consistent with the descriptive results indicated in Table 34 that the household prefers cow milk over goat and camel milk for consumption. The reason behind their preference is the possibility of processing cow milk into different products. This gives them the opportunity to sell the value added products (fermented milk, butter, and whey) and to consume the by-products as well as the whole milk at home. However, goat and camel milk are perceived as un-process able because of the absence of the knowledge and technology. The odds ratio has a value of 0.31 for goats and 0.86 for camel milk. This indicates that an increase in the amount of goat milk in the household increases odds ratio in favor of selling cow milk by 0.31 while amount of camel milk produced increases the odds ratio by 0.86 factors. By keeping other factors constant, an increased amount of goat milk produced in the household will increase the participation of the households for cow milk sale by 7.4 % and by keeping other factors constant, amount of camel milk produced in the household contribute for an increase of household cow milk sale participation by 0.9 %.

Amount of butter sell indicates more milk production in the household and, hence, are positively related to cow milk sale. This indicates that the households who participate on large amount of butter sale participate more on milk sale. Amount of butter sale has positively significant ($P \leq 0.001$) effect on cow milk sale. An increase on amount of butter sale increases cow milk sale by 24 %.

Adulteration

About 114 milk samples from households that supplied milk to Mieso and Asebot markets were taken to see the percentage of adulterated milk in the district. The result indicated that 78%, 18%, and 4 % were normal, adulterated and skimmed, respectively. However, there were no significant (P> 0.05) variations between the two market sites in terms of adulteration of milk.

Table 44. Milk test for adulteration at Mieso and Asebot market site in Mieso district

	Market site				Total		
	Mieso (N=69)		Asebot (N=45)		(N=114)		
Parameter	N	%	N	%	N	%	X^2 P-value
Normal	53	76.8	36	80	89	78	
Adulterated	15	21.7	6	13	21	18	0.203
Skimmed	1	1.4	3	7	4	4	

(N)= Total number of milk sample, N= Sampled milk from the total

Based on the researcher's observation and interview, most of the milk adulteration happened during dry season to compensate for milk shortage in this season. Most of the adulterated milk was found mostly in milk seller groups with youngest age than elders.

Milk consumers have different traditional mechanisms of testing milk against adulteration or spoilage at the market site during purchasing. Some identify adulterated milk by holding few drops of milk on the mouth for few minutes. If they feel that the milk is viscous, the milk is normal otherwise it is classified as adulterated. On other hand, adulteration is tested by putting of drops of milk on hand and if it looks watery, it is adulterated. To detect spoilage, after purchasing of milk from market, they take drop of milk on a spoon and by heating on fire. During heating if it is speckled, and is not homogeneous mixture, then it is classified as spoiled. If the milk is spoiled, the sellers are willing to take back the milk and turn the money.

4.13.4. Milk marketing constraints

As shown in Table 45, the major constraints for milk marketing identified by the producer in Mieso district are insufficient amount of milk produced (73 %), long distance to market (38 %), cultural limitation (8 %), high cost of transport (12 %), and spoilage (19 %). The mean (± SE) distance women travel to sell milk was 5.89 ± 0.19 km, and ranges from 1 to 12 km. The long distance to market of households in Dire-kalu rural *kebele* decreases their participation in milk marketing (Appendix Table 45).

Cultural taboo is indicated as a limiting factor for milk marketing by only 7.6 % of the respondents. This result is contrary to the report of Lemma *et al*., (2005) in east Showa zone of Oromia, that among the many reasons reported by farmers, insufficient amount of milk production and cultural restriction were the most common hindering factors. Also according to Alganesh (2002) about 21.3 % and 19 % of the women in Eastern Wollega did not sell fresh milk due to scarcity and cultural restriction, respectively.

Table 45. Reasons for non participation in milk marketing based on the response of producers in different rural *kebeles* in Mieso district

	Less milk quantity		Distance to market		Cultural taboo		High cost of transport		Spoilage		X^2 P-value
Rural *kebeles*	N	%	N	%	N	%	N	%	N	%	
D/kalu	4	40	8	80.00	2	20.00	1	6.70	2	13.00	
Gena	2	100	0	0.00	0	0.00	0	0.00	0	0.00	
H\Mendera	7	100	0	0.00	0	0.00	2	5.90	1	2.90	0.003
H\misoma	1	100	0	0.00	0	0.00	0	0.00	0	0.00	
W\jejeba	5	71	2	29.00	0	0.00	0	0.00	2	28.60	
HH sex											
Female	4	67	3	50.00	2	33.00	2	33.00	3	50.00	0.09
Male	15	75	7	35.00	0	0.00	1	5.00	2	10.00	
Total	19	73	10	38.00	2	7.60	3	11.50	5	19.00	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma=Hunde-misoma, H/mendera= Huse-mendera, HH sex=Household Head sex, N= sampled respondents

Constraints faced by producers among rural *kebeles* were significantly ($P \leq 0.05$) different. Low milk quantity was equally important in Gena, Huse-mendera, and Hunde-misoma rural *kebeles*. However, this was less important problem for Dire-kalu, probably due to high number of animal holdings than other rural *kebeles*.

Distance to market (80 %), cultural restriction (20 %), high transport cost (7 %), and spoilage (13%) were the major constraints that faced by Dire-kalu households than other rural *kebeles*. This all were caused by remoteness of the area from market sites.

Generally, the fact that there is low limited cultural taboo (8 %) in milk marketing is an opportunity to develop market-oriented dairy development in the area. Moreover, the other limiting factors 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 through out 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. This all needs government intervention 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.

4.14. Constraints to Dairy Production

According to the respondents there were different challenges faced in dairy production in the district. These include shortage of forage and pasture, 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 46). Among those 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. Forage and pasture shortage, and water shortage were equally

important to 32 % of the respondents in the study area. About 30 % of the respondents indicated that veterinary service was a serious problem in all the districts. This is due to the distance to veterinary service in towns, irregular visit by the veterinarian, due to shortage of experts and lack of transport.

Table 46. Problems encountered in dairy animal production in Mieso district

Problems	Total HH(N)	Problem Priority in dairy animal production							
		1st		2nd		3rd		4th	
		N	%	N	%	N	%	N	%
Forage and pasture shortage	120	51	41.00	40	32.00	17	14.00	7	6.00
Water shortage	120	37	30.00	40	32.00	10	8.00	9	7.00
Security problem	120	18	15.00	11	9.00	29	23.00	29	23.00
No enough access to vet. Service	120	10	8.00	12	10.00	39	31.50	37	30.00
No transport access to sell milk	120	4	3.00	4	3.20	14	11.30	19	15.00
No improved dairy breed	120	0	0.00	13	11.00	11	8.90	12	10.00
No credit service	120	0	0.00	0	0.00	0	0.00	1	0.80
No extension service	120	0	0.00	0	0.00	0	0.00	4	3.00
X^2 P-value					0.032				

HH=Household, (N)= Total number of respondents, N= Sample respondents

Similarly, the shortage of feed and water are similar problems in all traditional livestock production systems as the production is subsistent. The traditional smallholder dairy production is characterized by its low input, feeding and management requirements and the use of indigenous genotypes (Jabbar *et al.,* 1997).

Security problem in the area is the most unregulated factor that forced the herders to lead unstable life. Tribal conflicts among the Oromo, Afar, and Somali people are based on 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 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.

Feed shortage during the dry season is becoming a more serious problem as mobility by inside or outside tribes were restricted due to conflict. According to the herders, this conflict does not only limit the use of available feed resources, but is changing of the production system leading to crop production by migration to more suitable areas for crop production. This has direct implication to animal production. In addition, camel holding is decreasing due to theft. The farmers have made some suggestions to improve animals production in the area (Appendix Table 58). These include effective conflict resolution (100 % of respondents), access to veterinary services (74 %), and training on feed conservation methods (67 %), improve marketing infrastructure (62 %), and introduce improved breeds (29 %). During interviews, the issue of conflict was very pronounced. Therefore, conflict resolution should be addressed urgently by government, NGOs and the communities.

4.13.1. Feed shortage

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

Table 47. Reasons for feed shortage in different rural *kebeles* in the Mieso district as reported by the respondents

Rural *kebeles*	Reasons for feed shortage										X^2 P-value
	Poor feed conservation practices		Lack of forage seed		Expansion of crop land		Lack of rain		Security problem		
	N	%	N	%	N	%	N	%	N	%	
D/kalu	0	0.00	2	13.00	5	33.00	15	100.00	15	100.00	
Gena	15	71.40	1	4.80	20	95.00	21	100.00	18	85.70	
H/Mendera	11	32.00	0	0.00	29	85.00	34	100.00	32	94.00	0.034
H/misoma	16	59.00	0	0.00	25	92.50	27	100.00	20	74.00	
W/jejeba	10	43.50	1	4.30	19	82.60	23	100.00	23	100.00	
Total	52	43.00	4	3.30	98	81.60	120	100.00	108	90.00	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma =Hunde-misoma, H/mendera= Huse-mendera, N= Sample respondents

As shown in Table 47, that the major reasons for feed shortage as indicated by the respondents were lack of rainfall (100 %), security problem (90 %) and expansion of croplands (82 %). Poor feed conservation practices (43 %) and lack of forage seeds (3 %) were rated least by the respondents. The major feed resources are natural pasture and crop residue and these are of poor quality affecting the fertility of cows and milk production. 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 residue (straw and stover) and pastures (both green and mature) are of low digestibility and, on these feed resources the overall productivity of animals is reduced, animals reach puberty at a late age (often four years) and calving interval is often 18- 24 months resulting in a few number of dairy animals being milked.

4.13.1.1. Strategies to alleviate feed shortage

Almost all the households in the district face seasonal feed shortage. Sorghum and maize stover are by far the most important fodders. 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 and feeding management. During feed shortage, dry season grazing

may be replaced by crop residues. For example, about 12 % of the respondents purchase *kera (stover)*, 82 % use *kera* from their own stock and 44 % use *Burana* (roots of grasses). Farmers use stover from the stocked feed up to the middle of the dry season and then purchase feed as required. However, the last measure farmers take to cope up with feed shortage is either mobility or sale of animals. So far, there has been very little effort to improve the utilization of the available feed resources in the district.

Table 48. Variation 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 residue		Use of grass root (*burana)*		Sell animal		Mobility		Use cut and carry		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
D/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	
H/Mendera	31	91	25	74	4	12	20	59	2	6	24	71	1	3	
H/misoma	26	96	25	93	4	15	16	59	1	3	24	89	1	4	
W/jejeba	20	87	14	61	0	0.0	7	30	0	0.0	21	91	1	4	
HH sex															
Female	17	63	13	48	3	11	8	30	1	4	16	59	2	7	0.01
Male	81	87	65	70	11	12	45	48	3	3	84	90	1	1	
Total	98	82	78	65	14	12	53	44	4	3	100	83	3	3	

H sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, N= Sample respondents

The availability of crop residue in the dry season is closely related to the stocking system, and /or the type of crop produced (maize or sorghum). Because the 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. From the observation by visual assessment in the study area, most of the conserved crop residue was left unfed as it was fermented. Since maize stover could not keep 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 this forces household to either purchase additional feed to move with their animals in search of feed and water.

Table 49. Distance traveled in search of feed by households in the different rural *kebeles* and by gender of household heads in Mieso district

	Distance travel in search of feed (Km)				Sig.
Rural *kebeles*	N	Mean ± SE	Min.	Max.	
D/kalu	15	5.7 ± 0.74	4.00	15.00	0.008
Gena	20	3.8 ± 0.33	2.00	7.00	
H/Mendera	33	9.3 ± 1.27	1.50	40.00	
H/misoma	26	6.6 ± 1.29	0.50	20.00	
W/jejeba	22	6.4 ± 0.73	2.00	16.00	
HH sex					
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	

Sig.= Significant value; HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, SE= Standard Error of mean, Min.= minimum, Max.= maximum, N= Sample respondents

In the study area herding around settlements and herding over long distance by herders are the two main systems of grazing on communal land. During the dry season, households move on average 7 km and ranging from 0.5-40 km (Table 49). Under these conditions, conflicts may arise among different ethnic groups of the Afar, Oromo, and Somali region. Similarly, as reported by Ahmed *et al*. (2004) in Somali region of Afder Zone that during grazing, particularly during the dry season, camels cover large area on the average 8-10 km from the household depending on the size of the herd.

There was no significant difference in the distance herds cover between herds owned by female and male headed households. However, there was a significant ($P \leq 0.05$) difference between rural *kebeles* in the distance herds 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 less number of livestock holdings (6.3 ± 0.53, see Appendix Table 18). 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 residue from their own farm (71 %) (Appendix Table 48). 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 proving minerals and water. On the other hand, households with relatively large number of animals may have no other option rather than mobility. Smallholders in developing countries have limited resource available to feed their ruminant livestock, and they often do not have the luxury of being able to select the basal diet, they use whatever is available and at no or low cost (Leng, 1999).

4.14.1.2. Feeding calendar

Natural pasture and crop residues are the dominant feed resources available for livestock in the district. In addition, farmers 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 practiced 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 the animal 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).

Table 50. Crop residue feeding calendar among rural *kebeles* in the Mieso district based on farmers' response

Feeding calendar	Rural *kebeles*										Total	
	D/kalu		Gena		H/mendera		H/misoma		W/jejeba			
	N	%	N	%	N	%	N	%	N	%	N	%
All year	0	0.00	5	23.80	3	8.80	1	3.70	0	0.00	9	7.50
Sept-Oct	1	6.70	1	4.80	2	7.40	1	4.30	6	5.00	11	9.20
Nov-Jan	13	86.70	21	100.00	34	100.00	27	100.00	23	100.00	118	98.10
Feb-May	1	6.70	8	38.00	9	26.50	3	11.10	7	30.40	28	23.30
Jun-Aug	7	46.70	8	38.10	13	38.20	15	55.60	14	60.90	57	47.50
Nov-May	0	0.00	5	23.80	1	2.94	0	0.00	0	0.00	6	5.00
X^2P-value	0.01											

Sep=September, Oct=October, Nov=November, Jan=January, Feb=February, Jun=June, Aug=August, N=Sample respondents

As indicated in Table 50 that 98 % of the respondents showed that the bulk of sorghum residue is available from November to January. For the period from June to August, 48 % of the respondents indicated that short growing season maize is available. A relatively small proportion of farmers (23.3 %) indicated crop residue availability between February and May. Seasonal availability and use of crop residue for animal feed in different season differed significantly ($P \leq 0.05$) among rural *kebeles*. Farmers in Gena rural *kebele* make use of crop residue (24 %) all year round which is significantly higher ($P \leq 0.05$) than in the rural *kebeles*. This may be due to the fact that they purchase crop residues in addition to using feed from own source. However, feeding strategies did not differ between male and female headed households across seasons.

Table 51. *Burana* (grass root) feeding calendar among rural *kebeles* in the Mieso district based on farmers' response

Feeding calendar	Rural *kebeles*										Total	
	D/kalu		Gena		H/mendera		H/misoma		W/jejeba			
	N	%	N	%	N	%	N	%	N	%	N	%
All year	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Dec-Feb	1	6.70	3	14.00	1	2.90	2	7.40	0	0.00	7	5.80
Mar-Apr	15	100.00	21	100.00	34	100.00	27	100.00	23	100.00	120	100.00
May-Jun	2	13.00	9	42.80	4	11.80	2	7.40	1	4.00	18	15.00
X^2P-value	0.04											

Dec=December, Feb=February, Mar=March, Apr=April, Jun= June, N= 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 51). During the dry season *burana* is also fed to cows and farmers believe it increases milk yield as the water content of *burana* is higher than crop residues.

Table 52. C*hinki* feeding calendar among rural *kebeles* in the Mieso district based on farmers' response

Feeding calendar	Rural *kebeles*										Total	
	D/kalu		Gena		H/mendera		H/misoma		W/jejeba			
	N	%	N	%	N	%	N	%	N	%	N	%
All year	0	0.00	0	0.0	0	0.00	0	0.00	0	0.00	0	0.00
Sep-Oct	1	6.70	3	0.14	2	0.06	0	0.00	0	0.00	6	5.00
Apr-Jun	3	20.0	21	100	23	0.68	22	0.81	20	0.87	89	74.00
Jul-Sept	15	100.00	21	100	34	100.00	20	0.74	21	0.91	111	92.50
X^2P-value	0.618											

Sep=September, Oct=October, Apr=April, Jun= June, Jul= July, N= Sample respondents, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma

Chinki (thinned maize and/or sorghum) feeding is a major source of feed for livestock for 74 % of the respondents during the short rainy season and for 93 % of the respondent during the long rain season (Table 52). 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.

4.14.2. Water shortage and managements

There are different sources of water in the district (Table 53). According to the respondents, water sources include rivers (78 % of the respondents), springs (65 %), ponds (36 %), 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. Ruminates require water to maintain their body water content, for metabolism. Availability of water also affects voluntary feed intake (Coppock, 1994). Majority of the households used the available water sources i.e., river, spring water and pond, respectively. They access those water sources, after 1-30 km of journey depending on season.

Table 53. Water sources used by the households in different rural *kebeles* in Mieso district

Rural *kebeles*	Type of water source used by households												X^2 P-value
	River		Well		Lake		Spring water		Pond		Pipe line water		
	N	%	N	%	N	%	N	%	N	%	N	%	
D/kalu	3	20.00	0	0.00	0	0.00	14	93.00	0	0.00	0	0.00	
Gena	20	95.00	3	14.00	7	33.00	14	67.00	4	19.00	0	0.00	
H/Mendera	28	82.00	11	32.00	2	6.00	25	74.00	12	35.00	0	0.00	0.001
H/misoma	24	89.00	4	15.00	0	0.00	11	41.00	13	48.00	21	91.00	
W/jejeba	19	83.00	4	17.00	0	0.00	14	61.00	14	61.00	0	0.00	
Total	94	78.00	22	18.00	9	7.50	78	65.00	43	35.80	6	5.00	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, N= Sample respondents

Overall, the majority of households use river (78 %), spring (65 %) and ponds (35.8 %) as the major water resources for livestock. River water is important for farmers in Gena (95 %), Hunde-misoma (88.9 %), Welda-jejeba (82.6 %) and Huse-mendera (82 %) rural *kebeles*. The use of shallow hand dugs wells is important in Huse-mendera rural *kebele* (32 %). Springs are important sources of water for livestock in Dire-kalu (93 %), Huse-mendera (73.5 %), Gena (66.7 %), and Welda-jejeba (60.8 %) rural *kebeles*. Ponds are also important in Welda-jejeba (60.8 %), Hunde-misoma (48 %) and Huse-mendera (35 %) rural *kebeles*. Lake is an important source of water for livestock in Gena rural *kebele* (33 %). Farmers in Hunde-misoma (91 %) have access to pipe line water supply. 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 watering frequency of different classes of livestock in different rural *kebeles*.

Table 54. Watering frequency of animals in different seasons in Mieso district

Watering frequency	Wet season				Dry season			
	Cattle		Camel		Cattle		Camel	
	N	%	N	%	N	%	N	%
Every day	120	100.00	0	0.00	8	6.70	0	0.00
Once in two day	0	0.00	0	0.00	95	79.00	2	6.00
Once in three day	0	0.00	1	3.00	12	10.00	7	21.00
Once in a week	0	0.00	1	3.00	0	0.00	10	30.00
Once on two week	0	0.00	4	2.50	0	0.00	3	9.00
Once a month	0	0.00	9	27.00	0	0.00	0	0.00
Not watered	0	0.00	6	18	0	0.00	0	0.00

N= Sample respondents

As presented in Table 54, 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. In the case of camels, according to 30 % of the respondents the frequency of watering in the dry season was once a week as once a month (27 %) or not allows watering (18 %) in the wet season. 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.

In addition, farmers tend to move with their animals in search of water as means of overcoming water shortage. As indicated in Appendix Table 46, 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 (river in year round, or pipe water).

The overall average distance traveled in search of water was 6.6 ± 0.52 km, and ranging from 1 to 30 km per day. The distance traveled varied significantly ($P \leq 0.05$) between rural *kebeles*, and was the longest in Welda-jejeba rural *kebele* (8.0 ± 0.72 km) and in Gena rural *kebele* (3.1 ± 0.32 km). The shortest distance for Gena was due to the availability the Mieso river in the area.

Table 55. Distance moved for searching water among rural *kebeles* and by household heads in Mieso district

	Distance moved for water searching (Km/day)				Sig.
Rural *kebeles*	N	Mean ± SE	Min.	Max.	
D/kalu	15	7.2 ± 0.74	4	10	
Gena	21	3.1 ± 0.33	1	8	
H/Mendera	33	7.3 ± 1.27	2	30	
H/misoma	26	7.3 ± 1.29	2	30	0.004
W/jejeba	22	7.9 ± 0.73	3	20	
HH sex					
Female	25	6.1 ± 1.45	1	15	
Male	92	6.8 ± 0.53	1	30	0.511
Total	117	6.6 ± 0.52	1	30	

Sig.= Significant value; HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, SE= Standard Error of mean, Min.= Minimum, Max.= Maximum, N= Sample respondents

According to herders, the consequence of the long distance traveled and the less frequent watering of animals, especially during the dry season, results in loss of body weight and substantial decrease in milk production of cows. Similarly, results from trials conducted under ranch conditions at Boran plateau indicated that cattle watered once every three days during the dry seasons lose body weight faster than those on a daily watering frequency. This is because restricted watering reduces forage intake and reduces milk production by about 13 % (Coppock, 1993).

4.14.3. Animal health care

Diseases pose a major threat to cattle production in Mieso district. The extent of losses due to diseases was very high as compared to losses due to other causes. Mortality due to diseases was the major cause for cattle (65 %) and camels (67 %). According to the respondents and personal observation in the study area, there is a 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 illegal drugs to treat their animals. Poor animal health service and lack of improved management are the major constraints for dairy development in Ethiopia, which caused poor performance across the production systems (Ibrahim and Olaloku, 2002).

About 53 % the respondents indicated that affordability of veterinary drugs and services are expensive while 37 % indicated that it is fair (Appendix Table 53). Almost all the respondents (99 %, Appendix Table 52) across the rural *kebeles* indicated that they have serious problem in accessing veterinary services. As a result, a wealth of indigenous knowledge in animal health care is the major means of treating animals in the district.

Table 56. Variations on measures taken to treat sick animals in different rural *kebeles* in Mieso district

	Methods for treating sick animals				X^2 P-value
	Traditional		Traditional and vet. service		
Rural *kebeles*	N	%	N	%	
D/kalu	12	80	3	20	0.002
Gena	11	52	10	48	
H/Mendera	19	56	15	44	
H/misoma	12	44	15	56	
W/jejeba	17	74	6	26	
Household head sex					
Female	14	52	13	48	0.437
Male	60	65	33	35	
Total	74	62	46	38	

D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera= Huse-mendera, H/misoma= Hunde-misoma, Vet.= veterinary, N= Sample respondents

As presented in Table 56, 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 member of the household is responsible in collecting the herbs from the field. Almost all the animal health care when on the shoulder of women, thus priority should be given in training women in animal health care.

Table 57. Reasons for poor access veterinary services among rural *kebeles* and between household sexes in Mieso district

	Problem related to access to veterinary service								X^2 P-value
	Financial problem (for medicine and service)		No regular visit by veterinarian		Long distance to vet service		Shortage of experts		
Rural *kebeles*	N	%	N	%	N	%	N	%	
D/kalu	1	66.60	10	66.70	13	86.70	4	26.70	0.00
Gena	5	23.80	21	100.00	10	47.60	12	57.00	
H/Mendera	2	5.90	32	94.00	20	58.80	21	61.70	
H/misoma	15	55.60	25	92.60	17	62.90	18	66.70	
W/jejeba	2	8.60	22	95.60	18	78.00	15	65.00	
HH sex									
Female	5	18.50	23	85.00	19	70.00	15	55.60	0.186
Male	20	21.50	87	93.50	59	63.00	55	59.00	
Total	25	20.80	110	91.7	78	65.00	70	58.00	

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, N= Sample respondents

As indicated in Table 57, majority (92 %) of the respondents indicated that there is no regular visit occurred by veterinarians followed by long distance to the veterinary clinics (65%). Those things aggravate the loss of animals due to diseases. Tafesse, (2001) reported that the poor performance of veterinary service in the lowlands is the outcome of the government-monopolized service. Government veterinary staffs are few in number and can not 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 (Tafesse, 2001). Therefore, training community based paravets from the community is an important intervention.

Table 58. Major diseases that affect dairy cattle in Mieso district

Diseases type	Rural *kebeles*										Overall HH (N)	
	D/kalu		Gena		H/mendera		H/misoma		W/jejeba			
	N	%	N	%	N	%	N	%	N	%	N	%
Anthrax	3	20	4	19	6	17.6	7	25.9	7	30	25	20.8
Pasturolosis	4	27	3	14	4	11.7	5	18.5	2	8.6	18	15
Blackleg	2	13	2	9.5	1	2.9	3	11	1	4.3	9	7.5
FMD	2	13	1	4.7	2	5.8	0	0.0	1	4.3	6	5
Mastitis	3	20	11	52	20	58.8	12	44	14	60.9	55	45.8
Diarrhea	2	13	5	23.8	2	5.9	0	0.0	2	8.6	11	9
Thick	4	26.6	2	9.5	9	26	5	18.5	4	17	2	1.7
X^2 P-value	0.016											

HH = household, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, FMD=Foot and Mouth Diseases, N= Sample respondents

Responses by farmers indicate that Mastitis (45.8 %), Anthrax (20.8 %), Pasturolosis (15 %), Diarrhea (9 %), Blackleg (7.5 %), FMD (5 %), and thick infestation were the major diseases that affect cattle. As 21 % and 15 % of the household indicated that Anthrax and pasturolosis, respectively were the major diseases that cause animal death in the area (Table 58).

A high incidence of clinical mastitis in milking cows was observed during the course of the study. However, there may be high incidence of sub-clinical cases. This disease has received little attention. This disease is an economically important 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* (leave), *harinio* (leave), *Buri* (red root), and *kenkelcha* (leaf).

The herders reported that vaccinations are given against on three important diseases, such as that pasturolosis (85 %), blackleg (86 %), and Anthrax 60 % (Appendix Table 54). There is variation among rural *kebeles* in access to vaccination. Dire-kalu and Welda-jejeba rural *kebeles* have less access to vaccination service due to remoteness of these rural *kebeles* from the veterinary clinic or due to the mobility of the herders with their animals. The major limiting factor in access to vaccination is the delay in service during outbreaks.

4.14.4. Breed type and breeding management

All dairy animals in the study area are indigenous zebu breeds and have not been characterized. The majority of the farmers prefer local cows claiming that crossbred animals are susceptible to feed shortage and diseases. There has been no effort to improve milk production through crossbreeding in the district. IPS (2000) indicated that the genetic of Ethiopia's lowland livestock have involved 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 climates.

Bulls are 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.

As indicated in Appendix Table 55 large body size (63 %), large tail (39 %) and equal sized testicle (19 %), large neck (18 %), broad bone (17 %), and long tail were criteria used for bull selection with dairy traits.

Table 59. Selection criteria given by respondents for dairy cows in Mieso district

Criteria for selection	N	%
Long tail that is thin at the tip	94	78
Large udder and teat	31	26
Equal teat	8	6.7
Broad at the hind side	86	72
Large body size	26	22
Not have long horn	3	2.5
Circular depression at top of tail	3	2.5
Concave fore head and long face	4	3.3
Black hooves	2	0.8
Long and thin neck	9	7.5
Large sheath	9	7.5
Thin body	2	1.7
Large ear	2	1.7

N= Sample respondents

As presented in Table 59, the majority (78 %) of the households selected dairy cows based on selection criteria of long tail that is thin at the tip. This is one of the indications that a cow is high milk yielder and can protect herself from flies. Thin at the front and wide at the hind is also another criterion that the herders (72 %) follow during selection. Large udder and teats and large body size were also important criteria used by 26 % and 22 % of the respondents for selecting dairy type animals, respectively. Circular depression at the upper tip of the tail was the other criteria that 2.5 % of the households described as an indication of a dairy type animal. This type of selection criteria were not reported else where in other studies. Concave and long face was another unique criteria not reported earlier.

4.14. Institutional Support for Dairy Production

Both governmental and non-governmental organizations operate in the study area. Most of the non governmental organizations found in the district were not concerned with animal production. However, non-governmental organizations such as ILRI (International Livestock Research Institute), IRC (International Rescue Committee), and Mercy-corps were the ones involved in the promotion of animal production in the district. However, Mercy-corps operates through joint works with office of Pastoral and Rural Development (OoPRD) by providing drugs and vaccines

for type B diseases and also direct help on provision of improved forages for farmers. ILRI's contribution include establishment of milk cooperatives, improvements in animal feed utilization, training and consultation. These activities are being implemented in collaboration with the all department found in the OoPRD. IRC develops water resources through establishment of pipe line water from underground water resources and water harvesting ponds with a plastic sheet (*Haro*).

From the government side, Saftynet program helps the farmer through micro-credit for small livestock production such as poultry and goat production. The program targets marginal and poor farmers 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 in balance with the large size of the district and huge livestock population. Therefore, these available inputs do not cover all the rural *kebeles* in the district, and the support is not efficient with the weak no extension supports in the district.

Table 60. Institutes that provide training/consultation on improved milk production system among rural *kebeles* and household heads in Mieso district

	Rural *kebeles*										HH sex				Total	
	D/kalu		Gena		H/mender		H/misoma		W/jejeba		Female		Male			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
OopRD	0	0.0	14	67	22	65.0	21	78.0	1	4.0	15	56.0	44	47.0	59	49.0
ILRI	0	0.0	1	5.0	3	9.0	1	4.0	0	0.0	1	4.0	4	4.0	5	4.0
X^2 P-value						0.00							0.75			

N= Sample respondents

As indicated in Table 60, about 49 % of the households 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, about 33 % (Appendix Table 56) of the households get support. It appears that the producer has a strong attachment with the extension experts, but consultations are done once or twice a year without a strong and regular visits. Limitation in the number and capacity of the development agents was found to be a common problem in the extension service.

ILRI has provided training and consultation support on milk collection and marketing system through establishing cooperatives, especially with the existing milk seller group (*Faraqa Annenni*). During interviews, some producers mentioned bad previous experience with producers cooperatives during the Derge regime that they do not have full trust on 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 for them to benefit from collective marketing and input and service provision.

Table 61. Number of households and genders of household heads who gets improved forage from different institutes in the different rural *kebeles* in Mieso district

	Rural *kebeles*										HH sex					
	D/kalu		Gena		H/mender		H/misoma		W/jejeba		Female		Male		Total	
Institute	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Merci-corps	0	0	1	4.8	2	5.9	3	11	0	0	2	7.4	4	6.5	6	5
OopRD	0	0	1	5	1	3	2	7	0	0	1	3.7	3	3.2	4	3
ILRI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X^2 P-value					0.005								0.976			

N= Sample respondents

There were no significant variations among rural *kebeles* and sex of household heads for access to improved forage cultivation (Table 61). Larger number of farmers in Hunde-misoma (18.5 %) has planted forages in their farm yard. Very few farmers (8 %) in the study area have been exposed to improved forage cultivation. 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.

5. SUMMARY AND CONCLUSIONS

5.1. Summary

This study was undertaken with the objective to characterize milk production and marketing system in Mieso district of Oromia Region. The study was undertaken in the five purposely selected rural *kebeles* of Mieso district; namely Dire-Kalu, Welda-jejeba, Hunde-misoma, Gena, and Huse-mendera. Farmers from each rural *kebeles* were selected using Proportional Probability to Size (PPS) approach for each rural *kebeles*. A total of 120 farmers were selected based on the number of households in each rural *kebeles*. To capture gender effects in the overall production system, the sampled households in each rural *kebele* was stratified in to female and male headed households, which guided the determination of the number of farmers, using PPS (Proportional Probability to Size) approach. For the market study, two major milk market sites were purposively selected namely, Mieso and Asebot markets based on accessibility. Milk marketing was monitored over two seasons; the wet and dry seasons. The study covered 28 days, one week at each market at each market for two seasons.

The overall mean family size (Mean ± SE) was 6.62 ± 0.22. The average (Mean ± SE) crop land holding was 1.76 ± 0.06 ha. The average pasture land size of the sampled households was 1.1 ha, and ranged from of 0.25-10 ha. The average goats (6.03 ± 0.30) per household was higher than cattle (5.69 ± 0.35) holdings and camel (1.83 ± 0.92) holdings. However, the total numbers of animals found in the rural *kebeles* was higher for goats (723), followed by cattle (683) and camels (220). The female to male ratio in the cattle population among the rural *kebeles* was 72: 28.

Traditional hand milking is the major type of milking practice used in the study area. At the time of the study, about 99.2 % of the households had milking cows, and 97.5 % of the households indicated that only female members of the household are responsible for cow milking. Almost all of the households indicated that cows are milked twice during the wet season. However, 98 % of

the cattle owners decrease milking frequency to once a day during the dry season. Out of the total camel owners, 72 % of the respondents indicated that camels are milked thrice a day in the wet as well as in the dry season.

Milk and milk product sale (96 %) and crop sale (95 %) are the major sources of income for the farmers, indicating that both commodities are equally important. All the respondents indicated that, cattle, camel and goats are principally fed on natural pasture on non arable lands maintained under rain fed conditions. In all the season, wet and dry, animals are allowed to graze entirely on natural pasture on communal grazing land. Agricultural by-products such as crop residues mainly sorghum and maize stover and household waste also serve as important feed resources. Feeding systems include communal or private natural pasture grazing and browsing, and cut and carry feeding and stall feeding. Traditionally, sorghum and maize are used as fodder for livestock feed through deliberate over sowing during planting; the crop field is thinned over time to produce what is locally known as *chinki,* and fed to livestock in fresh form. As an additional feed, mineral soil salt, locally known as *haya*, is used by about 40 % of the respondents during the wet as well as the dry season. However, frequent use of *haya* was reported to occur during the dry season to compensate for the feed shortage. Very few farmers (8 %) had exposure to improved forage cultivation and use. The rest of the farmers interviewed were not aware of improved forages and their importance as livestock feed.

All milk animals in the study area are indigenous breeds and have not been characterized. The overall mean (mean ± SE) age at first calving for cows and camels was 52.49 ± 0.91 months and 63.37 ± 1.55 months, respectively. The overall mean calving interval of cows and camels was 16.01 ± 0.49 months and 18.5 ± 1.02 months, respectively. The estimated average cow milk yield per head per day was 1.24 ± 0.02 liters and lactation yield was 271.4 liters over an average lactation period of about seven months (7.29 ± 0.17 months). Overall estimated camel milk yield per head per day was 2.4 ± 0.06 liters and lactation yield was 797 liters over an average lactation period of eleven months. However, season has a substantial effect on milk yield. According to the respondents, average cow milk yield per head/day in the wet and the dry seasons was 3.26 ± 0.07 liters and 1.63 ± 0.04 liters, respectively. Similarly, camel milk yield per head/day in the

wet and dry season was 7.12 ± 0.33 liters and 3.85 ± 0.203 liters, respectively. The estimated average cow milk produced per household per day during the wet and the dry season was 4.80 ± 0.22 liters and 2.37 ± 0.11 liters. Similarly, the estimated average camel milk produced per household per day was higher during the wet (13.19 ± 0.95 liters) than the dry season (7.63 ± 0.82 liters).

The majority of the households sell whole milk (78 %), butter (67 %). Whey is sold by only 4.2 % of the respondents. 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 percent of the household indicated that only one fourth of the total household milk production is delivered to the market. However, the rest of the respondents indicated that mostly the morning milk is sold but the evening milk is often used for home consumption.

The average cow and camel milk sold per household per day during the wet season was 3.55 ± 0.28 liters and 3.61 ± 0.45 liters, respectively. However, during the dry season the respective volumes decreased to 2.15 ± 0.22 and 2.58 ± 0.37 liters. Cow and camel milk supply to the market decreases by 39 % and 28 %, respectively during the dry season. The amount of cow and camel milk sold per day was significantly ($P \leq 0.05$) higher for in Mieso market (496.6 ± 19.12 liters) than in Asebot market (187.89 ± 19.12 liters). Milk sold per day during the wet season was significantly ($P \leq 0.05$) higher than during the dry season for both cow (551.29 ± 19.2 liters) and camel milk (211.92 ± 19.12 liters).

The prices of cow and camel milk did not differ significantly over seasons. However, prices were lower during the wet season (1.88 ± 0.10 Birr/liter and 1.63 ± 0.10 Birr/liter) than during the dry season (3.38 ± 0.10 Birr/liter and 2.98 ± 0.10 Birr/liter) for cows and camel milk, respectively. The amount and type of milk sold at the two markets during the wet and dry seasons was not significantly different. However, prices for cow and camel milk were higher in Mieso than Asebot market during both the wet as well as the dry season.

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 (23 %) households 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 liters/person) than individual sales (1.64 ± 0.06 liters/person). The total amount of milk sold (liter/person/day) at the two market sites differed significantly, being higher in Mieso (3.27 ± 0.17 liters/person) than in Asebot (1.91 ± 0.06 liters/person). The number of individuals per *Faraqa Annanni*/day was not significantly ($P > 0.05$) different between Asebot (2.94 ± 0.12) and Mieso (3.05 ± 0.22) markets. However, there was more number of seller groups in Mieso. This may be due to the involvement of pastoral milk seller groups from the adjacent district of Mullu in Somali Region.

The other variable which has a significant ($P \leq 0.05$) impact on the decision behavior of the household on cow milk sale is its location from the market. As the model output indicates, the farther household is away from the market center the less will be its participation to the cow milk sale. By keeping other factors constant, an increased distance will increased the participation of the household by 1.74 % for cow milk sale.

Contrary to the expectation that significantly ($P \leq 0.05$) negative correlation of education level of the household heads on cow milk sale indicates that rather than milk sale decision on other activities were more. As the household heads became educated, the participation on cow milk sale decreases by 20 %.

As the logit regression result indicates the availability of *Faraqa Annanni* in the area had significantly ($P \leq 0.1$) positive relation with the participation decision of the household to sale cow milk. Availability of *Faraqa Annanni* in the vicinity increases the opportunity of the household for cow milk sale by 14 %.

Contrary to the expectation, amount of goat and camel milk produced in the household were negatively and significantly ($P \leq 0.01$ and $P \leq 0.1$) related to market participation decision of the household on cow milk sale. This indicates that more production of camel and cow milk tends to shift the household consumption pattern from camel and goat milk to cow milk, which reduces the available cow milk for sale. By keeping other factors constant, an increased amount of goat milk produced in the household will increase the participation of the household for cow milk sale by 7.4 % and by keeping other factors constant amount of camel milk produced in the household contribute for an increase of household cow milk sale participation by 0.9 %.

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 as a limiting factor on market participation was identified by only 7.6 % of the respondents, indicating that this issue is not a serious problem in the area.

The overall cattle and camel pre-weaning mortality rate were 62 % and 67 %, respectively. However, the post weaning mortality rate was by far lower for both cattle and camels. Mortality rate due to diseases was identified as a major cause of loss in cattle (65 % of respondents) and camels (67 %) in the study area. Anthrax, pasturellosis, diarrhea, Blackleg, Mastitis, tick infestation, and FMD (Foot and Mouth Diseases) were the major diseases that affect cattle. About 21 % and 15 % of the households indicated that Anthrax and pasturellosis, respectively were the major diseases that cause animal death. Therefore, training community based paravets could be an important consideration to improve animal health status in the area.

Among the problems in dairy animal production, feed scarcity, water shortage, security problem, and limited access to veterinary services were identified as the major and first level problems by 41 %, 30%, 14.5 % and 8 % of the respondents, respectively. Non governmental organizations such as ILRI (International Livestock Research Institute), IRC (International Rescue Committee), and Mercy-corps are involved in promotion and consultation on animal production in general in the district. Mercy-corps provides indirect assistance to farmers through joint activities with the Office of Pastoral and Rural Development (OoPRD) by providing of drugs and

vaccines for type B diseases and also direct help on provision of improved forages for farmers. ILRI's (International Livestock Research Institute) contribution is its effort on the establishment of milk cooperative and on animal feed utilization by providing training and consultation. These activities were implemented in collaboration with all departments in the district. OoPRD and IRC develop water resources in the study area by establishing pipe line water using underground water resources and water harvesting ponds, locally known as *Haro*. About 49 % of the households get support from government in the form of consultation and training on cooperative establishment, and feed and resource allocation. However, only 33 % of the respondents indicated that they have access to extension services on dairy animal production the farmers contacts with extension staff once or twice a year and there is no strong and regular visit and follow-up. The low knowledge capacity and the limited number of the development agents were also reported to be a common problem associated with the extension service.

5.2. Conclusions and Recommendations

The major technical constraints to dairy animal production in Mieso district were feed scarcity, water shortage, poor veterinary service and limited access to markets. Contribution of milk production and marketing depends largely on assured supply of accompanying inputs such as feed, veterinary services and improved milk marketing facilities. Based on the present study, the following areas need attention if dairy production is to develop into a market-oriented business operation in the district.

- Improve the available natural pasture and introduce hay making; develop and implement rangeland management systems.
- Introduce and develop improved forages as sole crops or integrated with cereal crop production (sorghum or maize system).
- Improved sorghum and maize stover conservation and enhance utilization by chopping, and treating with urea molasses.
- Breed improvement should consider the multipurpose utility of local breeds, efforts should be made to characterize the breed.
- Consider the possibility of selection and cross-breeding in locations where it is feasible with improved feeding and proper management systems.
- Improve animal health services including paravet training and drug supply system with close monitoring and supervision.
- Strengthen diseases surveillance and reporting system.
- Establish milk collecting and processing unit through encouraging the already existing self organized group '*Faraqa Annanni'*.
- Introduce a technology for the processing of goats and camel milk. As a result it could fulfill their demand for processed product in the household in order to strengthen the market participation position of the household in case of cow milk sale.
- Develop marketing linkage between the producer and consumer of milk products.

- Examine the possibility of credit provision for improved dairy production, processing, and marketing.
- Training of district staff, development agents and farmers (mainly women) on dairy production, processing and marketing
- Seriously consider way of dealing with conflicts over resources in the district,
- Conflict resolution method should be addressed; community should be a starting point for ideas to develop a strategic plan, to address conflict issues.

As a scope for future research work in the study district, the following points can be considered:

- Use of mineral soil supplement, is essential for camels, cow and calves, therefore chemical composition, contribution to the cow, camel and calves health and milk production should be studied.
- Study the use of various herbs, plants and plant parts used for ethno-veterinary medicine and for cleaning and disinfecting milk utensils.
- Economic feasibility in utilization of feed resource during dry season, *Burana*, and during growing season, *chinki*, should be studied.

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7. APPENDICES

7.1. Appendix I. Appendix Tables

Appendix Table 1. Division of labour for different activities in different sex of family member at Mieso district

Activity	Total HH	HH member					
		Female		Male		Both	
		N	%	N	%	N	%
Herding & 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 selling	120	120	0	0	0	0	0
Live animal selling	120	10	8	40	33	70	58
Feed collection	120	1	0.8	107	89	12	10

Appendix Table 2. Division of labour for different work based on age of family members of sex of household among rural *kebeles* in Mieso district

Activity type	HH member sex	Type of animals	Rural *kebeles*										Total	
			D/kalu		Gena		H/mender		H/misoma		W/jejeba			
			N	%	N	%	N	%	N	%	N	%	N	%
Herding and watering	**Female**	goats	8	53.3	1	4.8	3	8.8	1	3.7	1	4.3	14	11.7
		Cattle & goats	3	20.0	17	81.	20	58.8	17	63	16	69.6	73	60.8
		Cattle, camel & goats	4	20.8	3	14.3	11	32.4	6	22.2	4	17.4	28	22.7
	X^2 P-value					0.00								
	Male	goats												
		Cattle & camel	3	20	0	0	0	0	0	0	2	8.7	5	4
		Cattle, camel, & goat	12	80	21	100	34	100	27	100	21	91.3	115	95
	X^2 P-value					0.00								
Milking	**Female**	cow	15	100	21	100	34	100	27	100	23	100	120	100
		Goat	15	100	21	100	34	100	27	100	23	100	120	100
		Camel	0	0	0	0	0	0	0	0	0	0	0	0
	X^2 P-value					-								
	Male	cow	0	0	1	4.8	1	2.9	0	0	1	4	3	2.5
		Goat	0	0	0	0	0	0	0	0	0	0	0	0
		Camel	15	100	21	100	34	100	27	100	23	100	120	100
	X^2 P-value							0.760						
Animal marketing	**Female**	goats	6	40.0	0	0	0	0	2	7.4	7	30.4	15	12.5
		Cattle and goats	4	26.7	15	71.4	30	88.2	11	40.7	5	21.7	65	54.2
		Cattle, camel & goats	0	0	1	0.8	0	0	0	0	0	0	1	0.8
	X^2 P-value							0.00						
	Male	Cattle and camel	2	13.3	0	0	0	0	0	0	0	0	2	1.7
		Cattle, camel& goat	12	80.0	19	90.5	33	97.1	26	96.3	19	82.6	109	90.8
	X^2 P-value					0.027								
Feed collection	**Female**	-	5	33	9	43	12	35	6	26	3	13	35	29
	Male	-	15	100.0	16	76.2	30	88.2	23	85.2	22	100	107	89.2
	X^2 P-value			0.137										

Appendix Table 3. Division of labour for different work based on age of family members of sex of household among rural *kebeles* in Mieso district

Activity type	Male HH member	Age group of the family	D/kalu		Gena		H/mender		H/misoma		W/jejeba		Total	
			N	%	N	%	N	%	N	%	N	%	N	%
Barn cleaning	**Female**	< 10 year	3	20	4	19	13	38	9	33	2	8.7	31	26
		10-14	15	100	19	90	25	74	23	85	22	96	104	87
		15-64	15	100	21	100	34	100	27	100	23	100	120	100
		> 64	2	13	6	28.6	2	5.9	1	3.7	4	17	15	13
		X^2 P-value						0.011						
Milking	**Female**	< 10	11	73.3	12	57.1	9	26.5	10	37.0	20	87.	62	51.7
		10-14	15	100	21	100	34	100	27	100	23	100	120	100
		15-64	15	100	21	100	34	100	27	100	23	100	120	100
		> 64	15	100	21	100	34	100	27	100	20	86.9	120	100
		X^2 P-value						0.00						
	Male	< 10	12	80.0	2	9.5	0	0	0	0	12	52.2	26	22
		10-14	15	100	21	100	34	100	27	100	23	100	120	100
		15-64	15	100	21	100	34	100	27	100	23	100	120	100
		> 64	15	100	21	100	34	100	27	100	20	87.0	117	97.5
		X^2 P-value						0.001						
Animal marketing	**Female**	< 10	0	0	0	0	0	0	0	0	0	0	0	0
		10-14	5	33	16	76	29	85	12	44	9	39	71	59
		15-64	15	100	21	100	34	100	27	100	23	100	120	100
		> 64	7	46.7	6	28.6	22	64.7	10	37.0	6	26.1	51	42.5
		X^2 P-value						0.21						
	Male	<10	3	20.0	0	0	0	0	0	0	1	4	4	3
		10-14	5	33	13	61.9	23	67.6	19	70	11	48	71	59
		15-64	15	100	21	100	34	100	27	100	34	100	120	100
		> 64	15	100	16	76	32	94	26	96	21	91	110	92
		X^2 P-value						0.71						
Feed collection	**Female**	<10	0	0	1	5	0	0	0	0	0	0	1	0.8
		10-14	1	7	2	10	14	41	3	11	2	9	22	18
		15-64	15	100	21	100	34	100	27	100	34	100	120	100
		> 64	2	13	5	24	10	29	10	37	9	39	36	30
		X^2 P-value						0.677						
	Male	<10	1	6.7	1	4.8	0	0	1	3.7	5	21.7	8	6.7
		10-14	11	73	17	81	22	65	22	81	12	52	84	70
		15-64	15	100	21	100	34	100	27	100	34	100	120	100
		> 64	3	20	4	19	2	5.9	3	11.1	7	30.4	19	15.8
		X^2 P-value						0.051						

Appendix Table 4. Division of labour for different work based on age of family members of sex of household among rural *kebeles* in Mieso district

Activity type	Gender of HH member	Age group of the family	Rural *kebeles*										Total	
			D/kalu		Gena		H/mender		H/misoma		W/jejeba			
			N	%	N	%	N	%	N	%	N	%	N	%
Camel herding	**Female**	< 10 year	2	13	0	0	0	0	0	0	1	4	3	2.5
		10-14	2	13	2	10	8	24	3	11	4	17	19	16
		15-64	1	7	2	10	3	9	3	11	2	9	11	9
		> 64	0	0	0	0	0	0	0	0	0	0	0	0
		X^2 P-value						0.002						
	Male	< 10 year	12	80	1	4.8	5	14.7	6	22	3	13	27	22.5
		10-14	13	86.6	2	9.5	7	20.5	8	29.6	3	13	33	27.5
		15-64	13	86.6	2	9.5	7	20.5	8	29.6	3	13	33	27.5
		> 64	0	.0	2	9.5	2	5.9	1	3.7	0	0.0	4	3.3
		X^2 P-value						0.00						
Cattle herding	**Female**	< 10	14	93	19	90	31	91.2	24	88	20	86.9	108	90
		10-14	15	100	21	100	34	100	27	100	22	95.6	119	99.2
		15-64	15	100	21	100	34	100	27	100	23	100	120	100
		> 64	0	0	0	0	2	5.9	0	0	0	0	2	1.7
		X^2 P-value						0.001						
	Male	< 10	9	60	20	95	30	88	25	92.5	16	69.6	100	83
		10-14	15	100	21	100	34	100	27	100	23	100	120	100
		15-64	15	100	21	100	34	100	27	100	23	100	120	100
		> 64	6	40	2	9.5	1	2.9	2	7.4	4	17.4	15	12.5
		X^2 P-value						0.00						
Goat herding	**Female**	< 10	11	73	20	95	34	100	24	70	22	96	111	93
		10-14	15	100	21	100	34	100	27	79	23	100	120	100
		15-64	9	60	15	71	14	41	19	70	15	65	72	60
		> 64	1	6.7	0	0.0	1	2.9	1	4	2	8.7	5	40
		X^2 P-value						0.001						
	Male	< 10	13	87	21	100	34	100	27	100	23	100	118	98
		10-14	15	100	21	100	34	100	27	100	23	100	120	100
		15-64	4	27	5	24	13	38	10	37	7	30	39	32.5
		> 64	7	0	1	4.8	2	5.9	1	0	0	0	3	2.5
		X^2 P-value						0.00						

Appendix Table 5. Division of labour for different work based on age of family members in Mieso district

Started from which age	Age category	Rural *kebeles*										Total	
		D/kalu		Gena		H/mender		H/misoma		W/jejeba			
		N	%	N	%	N	%	N	%	N	%	N	%
Camel milking	< 10	9	60	3	14	1	2.9	0	0	11	48	24	20
	10-14	14	93	18	85.7	34	100	27	100	12	52	105	88
	15-64	15	100	21	100	34	100	27	100	34	100	120	100
	> 64	4	27	3	14	1	2.9	0	0	10	43	18	15
	X^2 P-value						0.004						
Cow milking	< 10	7	47	7	33	6	18	9	39	3	13	32	27
	10-14	10	67	11	52	24	71	15	65	6	26	66	55
	15-64	15	100	21	100	34	100	27	100	34	100	120	100
	> 64	15	100	21	100	34	100	27	100	34	100	120	100
	X^2 P-value						0.00						
Milk marketing	< 10	9	60	17	81	22	65	20	74	2	9	70	58
	10-14	15	100	21	100	21	62	27	100	16	70	100	83
	15-64	15	100	21	100	32	94	26	96	23	100	117	98
	> 64	11	100	21	100	32	94	26	96	12	52	102	85
	X^2 P-value						0.004						

Appendix Table 6. Starting age for work and division of labour for livestock management in Mieso district

Activity type	HH member	Labour use at different age group for livestock management																			
		6 yrs.		7 yrs.		8 yrs.		9 yrs.		10 yrs.		11 yrs.		12 yrs.		13 yrs.		14 yrs.		15 yrs.	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Herding & watering	F	34	28.3	27	22.5	33	27.5	12	10	4	3.3	3	2.5	1	0.8	0	0	0	0	0	0
	M	4	3.3	34	28.3	52	43.3	14	11.7	11	9.2	1	0.8	3	2.5	1	0.8	0	0	0	0
Barn cleaning	F	0	0	20	16.7	39	32.5	28	23.3	28	23.3	2	1.7	3	2.5	0	0	0	0	0	0
	M	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Milking cattle	F	0	0	1	0.8	25	20.8	25	26.7	45	38	11	9.2	6	5.0	0	0	0	0	0	0
	M	-	0																		
Milking goats	F	1	0.8	10	8.3	23	19	32	27	29	0	0	0	0	0	0	0	0	0	0	0
	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Milking camels	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M	0	0	0	0	1	0.8	2	1.7	7	5.8	9	7.5	3	2.5	1	0.8	10	8.3	0	0
Milk selling	F	0	0	1	0.8	10	8.3	18	13.3	41	34.2	24	25	10	8.3	5	4.2	1	0.8	1	0.8
	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Live animal selling	F	0	0	0	0	0	0	0	0	0	0	21	17.5	15	12.5	24	20.0	11	9.2	9	7.5
	M	0	0	0	0	0	0	0	0	1	0.8	8	6.7	19	15.8	16	13.3	18	23.3	39	32.5
Feed collection	F	0	0	0	0	0	0	0	0	0	0	3	2.5	1	0.8	6	5.0	2	1.7	0	0
	M	0	0	0	0	0	0	8	6.7	19	15.8	9	7.5	14	11.7	23	19.2	23	19.2	24	20.0

Appendix Table 7. Age structure of the household heads for different rural *kebeles* in Mieso district

Rural *kebeles*	Household head age, years											
	≤ 20		21-30		31-40		41-50		51-60		≥61	
	N	%	N	%	N	%	N	%	N	%	N	%
D/kalu	0	0	0	0	9	0.6	6	40	3	20	0	0
Gena	0	0	8	38	8	38	4	19	0	0	1	4.8
H/mendera	2	5.8	7	20.6	14	41	5	14.7	6	17.6	0	0
H/misoma	0	0	4	14.8	13	48	5	18.5	4	17	1	3.7
W/jejeba	0	0	2	8.7	12	52	6	26	3	13	0	0
Total	2	1.7	21	17.5	56	46.67	26	21.67	13	10.83	2	1.6

Appendix Table 8. Educational level of household heads in Mieso district

Rural *kebeles*	Educational level (%)							
	illiterate		Read & write		Joined elementary		Religious	
	N	%	N	%	N	%	N	%
D/kalu	11	73	4	27	0	0.0	10	67
Gena	15	71	3	14	3	14.0	13	62
H/mendera	26	77	6	18	2	6.0	21	62
H/misoma	24	89	2	7	0	0	13	48
W/jejeba	20	87	3	13	0	0	9	39
X^2 P-value					0.412			
HH SEX								
Female	25	93	1	4	0	0	10	37
Male	71	76	17	18	5	5	56	60
X^2 P-value					0.021			
Overall	96	80	18	15	5		66	55

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 9. Variation in giving priority for allocation labour in dairy activity in different rural *kebeles* and gender of household head

Rural *kebeles*	Total HH (N)	Priority for labour allocation				X^2 P-value
		Herding and watering (N =120)		Feed collection (N =120)		
		N	%	N	%	
D/kalu	15	13	86.7	2	1.7	
Gena	21	17	81	4	3.3	0.68
H/mendera	34	32	94	2	1.7	
H/misoma	27	24	89	3	2.5	
W/jejeba	23	20	87	3	2.5	
HH SEX						
Female	27	23	19	4	15	0.563
Male	93	83	69	10	11	
Total	120	106	88	14	11.7	

Appendix Table 10. Cropland holding among rural *kebeles* and gender of household in Mieso district

Rural *kebeles*	Mean±SE	N	Min.	Max.	Sig.
D/kalu	2.5± 0.133	15	2.00	3.00	
Gena	1.5±0.159	21	1.00	4.00	
H/mender	1.9±0.116	34	1.00	3.00	0.00
H/misoma	1.5±0.103	27	1.00	3.00	
W/jejeba	1.7±0.072	23	1.00	2.00	
HH sex					
Female	1.5±0.106	27	1.00	3.00	0.008
Male	1.8±0.069	93	1.00	4.00	
Total	1.8±0.060	120	1.00	4.00	

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma , Sig.= significant level

Appendix Table 11. ANOVA table for regression analysis of cropland on number of ox holding and family size in Mieso district

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.685	2	2.842	7.031	0.001(a)
	Residual	47.297	117	0.404		
	Total	52.981	119			

a Predictors: (Constant), Family size, total ox holding
b Dependent Variable: ha of crop land holding

Appendix Table 12. Regression analysis model of cropland on number of ox holding and family size in Mieso district

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	SE	Beta			Zero-order	Partial	Part	Tolerance	VIF
Constant	1.13	0.191		5.95	0.00					
Total ox holding	0.22	0.07	0.26	2.93	0.00	0.29	0.26	0.26	0.97	1.03
Family size	0.04	0.02	0.16	1.79	0.08	0.20	0.16	0.157	0.97	1.03

a Dependent Variable: ha of crop land holding

Appendix Table 13. Sources of household income generation in the Mieso district

Rural *kebeles*	Sources for household income generation (%)							
	Crops sale	P-values	Animal sale	P-values	milk and milk product sale	P-values	off-farm activity	Sig.
D/kalu	13 (87)		9(60.0)		5 (33.3)		7 (46.7)	
Gena	20(95.2)	0.025	14(66.7)	0.934	20 (95.2)	0.000	2 (9.5)	
H/mendera	23(67.6)		23(67.6)		29 (85.3)		11(32.4)	0.075
H/misoma	18(66.7)		18(66.7)		26 (96.3)		11 (40.7)	
W/jejeba	21(91.3)		17(73.9)		16 (69.6)		5 (21.7)	
HH sex								
Female	21 (78)	0.840	12 (44)	0.004	22 (81.5)	0.827	6 (22.2)	0.316
Male	74 (80)		69 (74)		74 (79.6)		30 (32.3)	
Total	95(79.2)		81(67.5)		96(80.0)		36 (30.0)	

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma ,Sig.= significant level

Appendix Table 14. Correlation of family size with TLU

		Family size	TLU
Family size	Correlation Coefficient	1.000	0.176(**)
	Sig. (2-tailed)	.	0.007
	N	120	120

** Correlation is significant at the 0.01 level (2-tailed).

Appendix Table 15. Distribution of labour unit among rural *kebeles* and gender of household head in Mieso district

Rural *kebeles*	N	Mean± SE	Min.	Max.	Sig.
D/kalu	15	2.6 ± 0.41793	1	7	
Gena	21	3.69 ± 0.597	0.8	12.4	
H\Mendera	34	4.04 ± 0.425	0.8	10.4	0.340
H\misoma	27	4.27 ± 0.638	0.8	11.30	
W\jejeba	23	4.59 ± 0.842	1	15.0	
HH sex					
Female	27	2.77 ± 0.498	0.8	12.4	0.020
Male	93	4.29 ± 0.316	0.8	15	
Total	120	3.95 ± 0.274	0.8	15	

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, Min.=minimum, Max.=maximum

Appendix Table 16. Type of crop grown in different rural *kebeles* and gender of household heads

Type of crop grown	Rural *kebeles*										HH sex				Total	
	D/kalu		Gena		H/mender		H/misoma		W/jejeba		Female		Male			
-Sorghum ,maize and sesame	0	0.0	2	9.5	6	18	3	11	1	4.3	0	0	12	12	12	10
-Sorghum, maize, white pea,	5	33	9	43	8	24	6	22	12	52.2	7	26	33	36	40	33
-Maize	0	0.0	1	5	1	3	0	0	1	4.3	2	7	1	1	3	3
-Sorghum ,maize and sesame, white pea,	2	13	4	19	6	18	6	22	5	21.7	3)	11	20	22	23	19
-Sorghum ,maize and sesame, white pea, chat	1	6.7	0	0	4	12	1	4	0	0	0	0	6	7	6	5
-Sorghum ,maize and white pea, and chat	5	33	2	10	2	6	8	30	0	0	4	15	13	14	17	14
-Sorghum ,maize and sesame, chat	0	0	0	0	3	9	0	0	0	0	1	4	2	2	3	3
-Sorghum and maize	2	13	3	14	4	12	3	11	4	17	10	37	6	7	16	13

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, H/mendera= Huse-mendera

Appendix Table 17. Purpose of different crop grown in different rural *kebeles* and gender of household heads in Mieso districts

Type of crop	Purpose of grown	Rural *kebeles*										X^2 P-value	HH sex				X^2 P-value	Total	
		D/kalu		Gena		H/mender		H/misoma		W/jejeba			Female		Male				
		N	%	N	%	N	%	N	%	N	%		N	%	N	%		N	%
Sorghum	1 Consumption and animal feed	0	0	0	0	2	5.8	3	11	1	4.3		1	3.7	5	5.4		6	5
	2 Income, consumption & animal feed	15	100	20	95.2	31	91.2	24	88.9	21	91.3	0.825	24	88.9	87	93.5	0.214	111	92.5
Maize	1 Consumption and animal feed	4	26.7	3	14.3	8	23.5	11	40.7	11	47.7		9	33.3	44	29.1		37	30.6
	2 Income, consumption & animal feed	11	73.3	18	85.7	26	76.5	16	59.3	13	56.5	0.138	18	66.7	66	71.0	0.703	8	70.
White pea	1 income source	1	6.7	1	4.8	1	2.9	1	3.7	2	8.7		1	3.7	5	5.4		6	5.0
	2 consumption	4	26.7	1	4.8	3	8.8	8	29.6	6	26.1		3	11.1	19	20.4		22	18.3
	3 Income& consumption & animal feed	7	46.7	13	61.9	19	56	10	37.0	8	34.7	0.422	12	44.4	45	48.4	0.120	57	47.5
	4 Income, consumption	2	13.3	1	4.8	0	0.0	2	7.4	2	8.7		0	0.0	7	7.5		7	5.8
Groundnut	1 Income source	0	0.0	1	4.8	2	5.8	0	0.0	0	0.0	0.029	0	0	3	3.2	0.816	3	2.5
Sesame	1 income source	1	6.7	2	9.5	6	17.6	5	18.5	1	4.3	0.293	2	7.4	13	14.0	0.630	15	12.5
	2 Income& consumption	0	0	2	9.5	4	11.8	1	3.7	0	0.0		2	7.4	5	5.4		7	5.8
Chat	1 Income& consumption	6	40	0	0.0	7	21	11	41	0	0.0	0.000	4	14.8	20	21	0.026	14	20
	2 consumption	1	6.7	0	0.0	0	0.0	0	0.0	0	0.0		1	3.7	0	0.0		1	0.8

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 18. Distribution of TLU among rural *kebeles* and gender of household head in Mieso district

Rural *kebeles*	N	Mean± SE	Min.	Max.	Sig.
D/kalu	15	21.01 ± 4.83	8.4	81.97	
Gena	21	6.32 ± 0.531	1.94	10.18	
H\Mendera	34	8.39 ± 0.732	3.45	19.59	0.000
H\misoma	27	7.175 ± 0.576	2.64	16.99	
W\jejeba	23	9.412 ± 1.119	3.52	22.56	
HH sex					
Female	27	7.44 ± 0.646	3.2	15.74	0.154
Male	93	10.13 ± 0.137	1.94	81.97	
Total	120	9.53 ± 0.788	1.94	81.97	

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, Min.=minimum, Max.=maximum

Appendix Table 19. Ratio of number of cows per total adult cattle number based on sex of household heads in Mieso district

Group	Weighted Mean	95% Confidence Interval for Weighted Mean		Min.	Max.	SD	Price Related Differential	Coefficient of Variation
		Lower Bound	Upper Bound					Median Centered
Female	0.62	0.58	0.669	0.33	0.80	0.13	0.988	20.9%
Male	0.64	0.61	0.665	0.25	1.00	0.12	0.964	20.7%
Overall	0.63	0.61	0.658	0.25	1.00	0.12	0.968	20.3%

Appendix Table 20. Ratio of number of cows per total adult cattle number based on rural *kebeles* in Mieso district

Group	Weighted Mean	95% Confidence Interval for Weighted Mean		Min.	Max.	SD	Price Related Differential	Coefficient of Variation
		Lower Bound	Upper Bound					Median Centered
D/kalu	0.71	0.656	0.764	0.50	0.80	0.081	0.962	11.8%
Gena	0.65	0.593	0.712	0.25	1.00	0.155	1.010	23.3%
H/mender	0.59	0.559	0.629	0.33	0.80	0.106	0.979	17.9%
H/misoma	0.58	0.535	0.626	0.25	0.80	0.128	0.983	21.9%
W/jejeba	0.63	0.580	0.684	0.33	0.83	0.112	0.977	18.8%
Overall	0.63	0.607	0.658	0.25	1.00	0.125	0.968	20.3%

Appendix Table 21. Distribution of total female to male number of cattle in household of different rural *kebeles* and household heads in the Mieso district

Rural *kebeles*	Mean ± SE	N	Min.	Max.	Variance	Sig.
D/kalu	0.48 ± 0.05	15	0.25	1.00	0.038	
Gena	0.64 ± 0.13	21	0.00	3.00	0.367	
H/mender	0.78 ± 0.06	34	0.25	2.00	0.139	0.089
H/misoma	0.87 ± 0.12	27	0.25	3.00	0.357	
W/jejeba	0.68 ± 0.08	23	0.20	2.00	0.135	
HH head sex						
Female	0.71 ± 0.09	27	0.25	2.00	0.208	0.931
Male	0.72 ± 0.04	93	0.00	3.00	0.229	
Total	0.72 ± 0.04	120	0.00	3.00	0.223	

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, Min=minimum, Max.=maximum, Sig.=significant value

Appendix Table 22. Variation in proportion of milking cows to total number of cows in different rural *kebeles* of Mieso district

Group	Mean	95% Confidence Interval for Mean		Min.	Max.	SD	Price Related Differential	Coefficient of Variation
		Lower bound	Upper bound					Median Centered
D/kalu	0.41	0.299	0.514	0.20	1.00	0.194	1.196	48.5%
Gena	0.49	0.392	0.588	0.25	1.00	0.210	1.107	42.0%
H/mender	0.41	0.361	0.461	0.25	1.00	0.144	1.095	41.0%
H/misoma	0.56	0.476	0.647	0.25	1.00	0.216	1.123	45.1%
W/jejeba	0.53	0.442	0.613	0.286	1.00	0.198	1.066	40.0%
Overall	0.48	0.444	0.516	0.20	1.00	0.197	1.137	39.7%

Appendix Table 23. Variation in proportion of milking cows to total number of cows in different household heads of Mieso district

Group	Mean	95% Confidence interval for mean		Min.	Max	SD	Price Related Differential	Coefficient of variation
		Lower bound	Upper bound					Median Centered
Female	0.48	0.414	0.554	0.25	1.0	0.178	1.089	35.7%
Male	0.48	0.437	0.521	0.20	1.0	0.204	1.149	41.0%
Overall	0.48	0.444	0.516	0.20	1.0	0.197	1.137	39.7%

The confidence intervals are constructed by assuming a Normal distribution for the ratios,Min=minimum, Max=maximum, SD= standard deviation.

Appendix Table 24. Weaning age of cattle and camel in different rural *kebeles* of Mieso district

Rural *kebeles*	Weaning age (month)					
	Cattle		Sig.	Camel		Sig.
	N	Mean ± SE		N	Mean ± SE	
D/kalu	15	7.0 ± 0.45		13	10.5 ± 0.55	
Gena	21	6.7 ± 0.31		2	12.0 ± 4.72	0.09
H\Mendera	34	8.3 ± 0.39	0.002	7	11.9 ± 0.63	
H\misoma	27	6.7 ± 0.17		8	10.9 ± 0.58	
W\jejeba	22	7.1 ± 0.35		3	7.0 ± 3.21	
HH sex						
Female	27	7.2 ± 0.39	0.869	4	10.8 ± 1.25	0.87
Male	92	7.3 ± 0.18		29	10.4 ± 0.50	
Total	119	7.3 ± 0.17		33	10.6 ± 0.46	

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 25. Half feed and milk providing age of cattle and camel in different rural *kebeles* of Mieso district

Rural *kebeles*	Half feed and milk providing age (month)					
	Cows			Camels		
	N	Mean± SE	Sig.	N	Mean± SE	Sig.
D/kalue	15	17.7 ± 5.31	0.00	13	27.5 ± 10.28	0.085
Gena	21	38.5 ± 4.46		2	45.0 ± 13.3	
H/Mender	34	41.0 ± 3.43		7	68.6 ± 7.92	
H/misoma	27	45.6 ± 3.62		8	56.3 ± 6.79	
W/jejeba	22	26.5 ± 5.90		3	45.0 ± 22.91	
HH sex						
Female	27	34.2 ± 4.89	0.648	4	16.5 ± 14.51	0.059
Male	92	36.5 ± 2.35		27	50.3 ± 6.23	
Total	119	35.9 ± 2.123		31	45.9 ± 6.021	

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/mendera=Huse-mendera, H/misoma= Hunde-misoma, N= Sample respondents

Appendix Table 26. Age at first calving of dairy animals among rural *kebeles* and household head sex in Mieso district

Rural *kebeles*	Age at first calving					
	Cows			Camels		
	N	Means± SE	Sig.	N	Means± SE	Sig.
D/kalu	15	50.80 ± 3.04	0.003	13	67.38 ± 2.56	0.171
Gena	21	53.14 ± 1.57		2	66.00 ± 6.00	
H/mendera	34	56.47 ± 1.79		7	58.29 ± 3.13	
H/misoma	27	46.85 ± 1.54		7	60.00 ± 2.62	
W/jejeba	23	53.74 ± 1.98		3	64.00 ± 4.00	
HH sex						
Female	27	51.11 ± 2.16	0.414	4	72.00 ± 0.00	0.033
Male	93	52.89 ± 0.99		28	62.14 ± 1.64	
Total	120	52.49 ± 0.91		32	63.37 ± 1.55	

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, H/mendera=Huse-mendera, N=sampled respondents, SE= Standard Error of means

Appendix Table 277. Calving interval of dairy animals among rural *kebeles* and gender of different household heads in Mieso district

Rural *kebeles*	Calving interval /month/					
	Cows			Camels		
	N	Mean ± SE	Sig	N	Mean ± SE	Sig.
D/kalu	15	13.20 ± 0.85	0.000	13	14.69 ± 1.24	0.014
Gena	21	13.00 ± 0.63		2	18.00 ± 6.00	
H/mendera	34	15.79 ± 0.93		7	21.43 ± 0.18	
H/misoma	27	17.15 ± 1.02		7	20.57 ± 2.21	
W/jejeba	23	19.6 ± 1.21		3	24.00 ± 0.00	
HH sex						
Female	27	13.89 ± 0.74	0.019	4	15.00 ± 3.00	0.193
Male	93	16.62 ± 0.58		28	19.04 ± 1.07	
Total	120	16.01 ± 0.49		32	18.53±1.015	

HH sex = Household Head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, H/mendera=Huse-mendera, N= sample respondents

Appendix Table 28. Lactation length of cows and camels in different rural *kebeles* in Mieso district

Rural *kebeles*	Lactation length					
	Cows			Camels		
	N	Mean± SE	Sig.		Mean± SE	Sig.
D/kalu	15	6.93 ± 0.44	0.002	13	10.38 ±0.55	0.143
Gena	20	6.70 ± 0.63		2	10.50 ± 1.50	
H/mendera	34	8.29 ± 0.39		7	14.00 ±1.95	
H/misoma	27	6.74 ± 0.17		7	10.71 ±0.64	
W/jejeba	23	7.22 ± 0.34		3	10.33 ±1.67	
Total	119	7.29 ± 0.17		32	11.25 ± 0.56	

Appendix Table 29. Cow milk marketed based on gender of household head at different seasons in Mieso district

HH sex	Cow milk marketed (liters/household/day)							
	Wet season				Dry season			
	One-forth		half		One-forth		half	
	N	%	N	%	N	%	N	%
Female	2	1.7	19	15.8	15	12.5	4	3.3
Male	25	20.8	48	40.0	63	52.5	2	1.7
X^2 P-value			0.088				0.027	
Total	27	28.7	67	55.8	76	63.3	6	5.0

Appendix Table 30. Estimated sale of milk from cows and camels in Mieso districts based on seasons and rural *kebeles* in Mieso district

Rural *kebeles*	Wet season				Dry season			
	Fresh cow milk/liter/day		Camel milk/liter/day		Fresh cow milk/liter/day		Camel milk/liter/day	
	N	Mean ± SE	N	Mean ± SE	N	Mean ± SE	N	Mean ± SE
D/kalu	5	2.8 ± 0.374	3	5.67 ± 0.667	3	1.33 ± 0.33	2	3.5 ± 0.50
Gena	19	2.9 ± 0.279	-	-	19	1.68 ± 0.168	-	-
H/mender	28	4.9 ± 0.751	4	4.0 ± 0.817	26	2.6 ± 0.433	4	2.0 ± 0.408
H/misoma	26	4.2 ± 0.647	6	3.1± 0.833	25	2.14 ± 0.336	6	1.88 ± 0.31
W/jejeba	15	2.4 ± 0.208	1	1.00±0.00	14	1.61± 0.183	2	4.5 ± 2.50
X^2 P-value		0.044		0.267		0.188		0.241
Total	93	3.76 ± 0.31	14	3.74 ± 0.541	87	2.07 ± 0.17	14	2.52 ± 0.41

Appendix Table 31. Estimated seasonal milk sale fluctuation based on gender of the household heads in Mieso district

Household head sex	Wet season				Dry season			
	Fresh cow milk/liter/day		Camel milk/liter/day		Fresh cow milk/liter/day		Camel milk/liter/day	
	N	Mean ± SE	N	Mean ± SE	N	Mean ± SE	N	Mean ± SE
Female	21	3.77 ± 0.60	4	5.0 ± 1.08	20	2.13 ± 0.38	3	2.33 ± 0.67
Male	72	3.76 ± 0.36	10	3.23 ± 0.58	67	2.06 ± 0.19	11	2.57 ± 0.51
X^2 P-value		0.969		0.146		0.874		0.822
Total	93	3.76 ± 0.310	14	3.74 ± 0.54	87	2.07 ± 0.17	14	2.52 ± 0.41

Appendix Table 32. Comparison of adulterated and non adulterated milk variation at Mieso and Asebot market sites in Mieso district

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	23.63	1	23.63	212990.0	0.000
	0.00	2.047	0.00(a)		
Market site	0.00	1	0.00	2.715	0.136
	0.00	8.522	0.00(b)		
Test result	0.00	2	0.00	93.506	0.011
	0.00	2	0.00(c)		
Market site * test result	0.00	2	0.00	1.158	0.318
	0.00	108	0.00(d)		

Test result= lactometer result which indicates adulterated, normal and skimmed ,Sig=significant value

Appendix Table 33. Variation on amount of cow and camels milk sale by individuates and group (*Faraqa Annanni*) sellers at Asebot and Mieso market places

Market place	Milk seller	Milk type	Mean± SE	N	Sum	Minimum	Maximum
Asebot	Individual	Camel	1.86 ± 0.20	34	63.16	0.32	5.00
		Cow	1.47 ± 0.05	203	297.68	0.32	5.00
		Total	1.52 ± 0.05	237	360.84	0.32	5.00
	Group	Camel	3.40 ± 0.27	13	44.30	2.00	5.30
		Cow	2.67 ± 0.13	95	254.10	0.64	9.00
		Total	2.76 ± 0.12	108	298.40	0.64	9.00
	Total	Camel	2.29 ± 0.19	47	107.46	0.32	5.30
		Cow	1.85 ± 0.06	298	551.78	0.32	9.00
		Total	1.91 ± 0.06	345	659.24	0.32	9.00
Mieso	Individual	Camel	2.17 ± 0.34	35	75.80	0.50	10.00
		Cow	1.71 ± 0.10	119	203.92	0.50	9.00
		Total	1.82 ± 0.11	154	279.72	0.50	10.00
	Group	Camel	5.71 ± 0.67	32	182.56	2.00	18.00
		Cow	4.53 ± 0.29	116	525.60	0.64	20.00
		Total	4.78 ± 0.28	148	708.16	0.64	20.00
	Total	Camel	3.86 ± 0.42	67	258.36	0.50	18.00
		Cow	3.10 ± 0.18	235	729.52	0.50	20.00
		Total	3.27 ± 0.17	302	987.88	0.50	20.00
Total	Individual	Camel	2.01 ± 0.19	69	138.96	0.32	10.00
		Cow	1.56 ± 0.05	322	501.60	0.32	9.00
		Total	1.64 ± 0.06	391	640.56	0.32	10.00
	Group	Camel	5.04 ± 0.50	45	226.86	2.00	18.00
		Cow	3.69 ± 0.18	211	779.70	0.64	20.00
		Total	3.93 ± 0.18	256	1006.56	0.64	20.00
	Total	Camel	3.20 ± 0.27	114	365.82	0.32	18.00
		Cow	2.40 ± 0.09	533	1281.30	0.32	20.00
		Total	2.54 ± 0.09	647	1647.12	0.32	20.00

Appendix Table 34. Average number of person involved per *Faraqa Annenni* at Mieso and Asebot market places

Market site	Number of *Faraqa Annanni*/day	Number of person per *Faraqa Annanni* group			Sig.
		Mean± SE	Minimum	Maximum	
Asebot	59	3.05 ± 0.22	2	8	0.621
Mieso	109	2.94 ± 0.125	2	10	

Appendix Table 35. Number of *Faraqa Annanni* and average number of members involved in the *Faraqa Annanni* in each based on rural *kebeles* and gender of household heads in the Mieso district

Rural *kebeles*	Availability of *Faraqa Annanni* in area (Village)		X^2 P-value	Individual involved in the *Faraqa Annanni*		X^2 P-value
	N	%		N	%	
D/kalu	0	0		0	0.0	
Gena	15	71		3	16	
H/mender	20	58.8		9	33	
H/misoma	18	66.6	0.000	10	38	0.004
W/jejeba	0	0		0	0	
HH sex						
Female	10	47.6		4	15	
Male	43	58.9	0.361	18	19	0.591
Total	53	44		22	23	

Appendix Table 36. ANOVA table for cow and camel milk sale by group and individual seller in different market site

			Sum of Squares	df	Mean square	F	Sig.
Amount of milk sale by group * market place	Between Groups	(Combined)	187.24	1	187.24	28.61	0.00
	Within Groups		1635.75	250	6.54		
	Total		1822.99	251			
Amount of milk sale by individual * market place	Between Groups	(Combined)	23.43	1	23.43	13.30	0.00
	Within Groups		686.75	390	1.76		
	Total		710.19	391			

Appendix Table 37. Comparison by Paired samples test for amount of milk sale by individual and group in Mieso district

Parameter	Paired Differences				t	df	Sig. (2-tailed)
	Mean	SE	95% Confidence Interval of the Difference				
			Lower	Upper			
Overall milk amount sale in market - milk seller person	1.15011	0.08	0.98977	1.31045	14.08	646	0.000

Milk seller person= individual and group, sig= significant level at P≤ 0.005.

Appendix Table 38. Seasonal variation in production and sale of cows' milk per household in Mieso district

Parameter	N	Mean (liter)	SE
Cow milk produced in wet season	119	4.80	0.218
Cow milk produced in dry season	119	2.38	0.111
Cow milk sale in wet season	95	3.55	0.280
Cow milk sale in dry season	90	2.15	0.221

Appendix Table 39. Testing of the variation for cow milk produce and marketed at different season in Mieso districts

Parameter	Test Value = 3.5865					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Cow milk produced in wet season	5.573	118	0.00	1.22	0.78	1.65
Cow milk produced in dry season	-10.9	118	0.00	-1.21	-1.43	-0.99
Cow milk sale in wet	2.488	94	0.02	0.69	0.14	1.26
avg cow milk sale in dry	-3.15	89	0.002	-0.69	-1.14	-0.26

Appendix Table 40. Seasonal variation in production and sale of camels' milk per household in Mieso district

	N	Mean (liters)	SE
Camel milk produce in wet season per household	31	15.77	1.78
Camel milk produce in dry season per household	31	7.63	0.82
Camel milk sale in wet season	17	3.61	0.45
Camel milk sale in dry season	16	2.58	0.37

Appendix Table 41. Testing of the variation for camels' milk produce and marketed at different season in Mieso districts

Parameter	Test Value = 10.4095					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Camel milk produced in wet season	3.016	30	0.005	5.36	1.73	8.99
Camel milk produced in dry season	-3.39	30	0.002	-2.78	-4.46	-1.11
Camel milk sale in wet season	1.151	16	0.267	0.51	-0.43	1.46
Camel milk sale in dry season	-1.38	15	0.188	-0.51	-1.30	0.28

Appendix Table 42. Seasonal variation on whole milk of cows sale in different household heads and rural *kebeles* in Mieso district

season	Rural *kebeles*										HH sex				Total	
	D/kalu		Gena		H/mendera		H/misoma		W/jejeba		Female		Male			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Wet season	2	13	1	5	3	8.8	1	4	4	17	2	7	8	9	10	8
Both seasons	3	20	18	86	25	73.5	25	93	12	52	19	70	65	70	84	72
X^2 P-value						0.00						0.937				

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 43. Comparison for variation of seasonal amount milk sale and price at different market site of Mieso and Asebot in Mieso district

Dependent Variable	market place	season milk sale	Mean	SE	95% Confidence Interval	
					Lower Bound	Upper Bound
Amount milk sale	Asebot	Wet season	358.21 (a)	19.12	319.74	396.68
		Dry season	178.40 (a)	19.12	139.93	216.87
	Mieso	Wet season	405.00 (a)	19.12	366.53	443.47
		Dry season	279.46 (a)	19.12	240.99	317.93
Price	Asebot	Wet season	1.68 (a)	0.10	1.47	1.88
		Dry season	3.05(a)	0.10	2.85	3.26
	Mieso	Wet season	1.84 (a)	0.10	1.63	2.05
		Dry season	3.30(a)	0.10	3.09	3.51

a Covariates appearing in the model are evaluated at the following values: market days = 1.1429.

Appendix Table 44. Tests of between-subjects effects to compare variation in amount and price of milk on different market site and seasons

Source	Dependent variable	Type III sum of squares	df	Mean square	F	Sig.
Corrected Model	Amount milk sale	1444071.1(a)	8	180508.89	35.26	0.00
	price	31.15 (b)	8	3.894	26.22	0.00
Intercept	Amount milk sale	325197.95	1	325197.95	63.520	0.00
	price	30.153	1	30.153	203.04	0.00
Mrarketday	Amount milk sale	7993.699	1	7993.699	1.561	0.22
	price	0.038	1	0.038	0.256	0.62
Marketplace	Amount milk sale	76505.72	1	76505.72	14.94	0.00
	price	0.590	1	0.590	3.976	0.05
Milktype	milk sale in market	728634.20	1	728634.20	142.32	0.00
	price	1.400	1	1.400	9.427	0.00
Season	Amount milk sale	326329.07	1	326329.07	63.74	0.00
	price	28.215	1	28.215	189.99	0.00
Marketplace * milketype	Amount milk sale	87109.056	1	87109.06	17.02	0.00
	price	0.014	1	0.014	0.097	0.76
Marketplace * season	Amount milk sale	10310.49	1	10310.48	2.014	0.16
	price	0.028	1	0.028	0.188	0.67
Milktype * season	Amount milk sale	167589.94	1	167589.94	32.76	0.00
	price	0.078	1	0.078	0.523	0.47
Marktplace * milktype * season	Amount milk sale	12372.53	1	12372.53	2.42	0.13
	price	0.842	1	0.842	5.667	0.02
Error	Amount milk sale	240620.72	47	5119.59		
	price	6.980	47	0.149		
Total	Amount milk sale	6903331.38	56			
	price	379.438	56			
Corrected Total	Amount milk sale	1684691.88	55			
	price	38.13	55			

a = R Squared = .857 (Adjusted R Squared = .833),b = R Squared = .817 (Adjusted R Squared = .786), mrarketday= represent market and non market day, marketplace= market lace of Asebot and Mieso, milketype= milk type of cow and camel, season= wet and dry, sig.= significant value

Appendix Table 45. Distance traveled per day to sell milk and milk products

Rural *kebeles*	Mean	N	Minimum	Maximum	Sig.
D/kalu	9.29 ± 0.57	7	8.00	12.0	
Gena	5.05 ± 0.12	19	4.00	7.00	
H/mendera	6.23 ± 0.261	30	4.00	10.00	0.000
H/misoma	3.92 ± 0.22	26	1.00	8.00	
W/jejeba	7.7 ± 0.11	18	7.00	8.00	
HHsex					
Female	6.0 ± 0.46	22	3.00	12.00	0.743
Male	5.9 ± 0.21	78	1.00	10.00	
Total	5.9 ± 0.193	100	1.00	12.00	

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma, Sig= significant level

Appendix Table 46. Number of respondent practice mobility with their animal for feed and water

Rural *kebeles*	Households move in search of feed and water searching					
	Water		X^2 P-value	Feed		X^2 P-value
	N	%		N	%	
D| kalu	15	100		14	93	
Gena	20	95.2		16	76	
H\Mendera	31	91	0.66	32	94	0.047
H\misoma	26	96		17	63	
W\jejeba	22	95.7		21	91	
HH sex						
Female	25	92.6	0.311	22	81	
Male	89	91.8		78	84	0.527
Total	114	95		100	83	

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 47. Variation of number of households on growing improved forage in Mieso district

Rural *kebeles*	Grow improved forage		P-value
	N	%	
D| kalu	0	0	
Gena	1	4.8	0.001
H\Mendera	8	23.5	
H\misoma	0	0	
W\jejeba	0	0	
HH sex			
Female	0	0	
Male	9	9.7	
Total	9	8	

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 48. Crop residue source among rural *kebeles* and gender of household heads in Mieso district

Rural *kebeles*	Additional feed source				P-value
	Own farm		Purchased and Own farm		
	N	%	N	%	
D/kalu	15	100	0	0	
Gena	15	71	6	28.6	
H/Mendera	30	88	4	11.8	0.002
H/misoma	23	85	4	14.8	
W/jejeba	23	100	0	0	
HH sex					
Female	24	89	3	11	0.077
Male	82	88	11	12	
Total	106	88	14	11.6	

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 49. Crop residue feeding calendar based on different household heads in the Mieso district

Feeding calendar	HH head sex				Total	
	Female		Male			
	N	%	N	%	N	%
All year	1	3.7	4	3.3	9	7.5
Sep-Oct	3	11.1	8	8.6	11	9.2
Nev-Feb	26	96.1	92	98.9	118	98.1
Mar-May	10	37	18	19.3	28	23.3
Jun-Aug	13	62.9	44	47.0	57	47.5
Nev-May	0	0.0	5	23.8	6	5.0
X^2P-value		0.312				

Appendix Table 50. *Burana* (grass roots) feeding calendar based on farmers response between genders of household heads in the Mieso district

Feeding calendar	HH head sex				Total	
	Female		Male			
	N	%	N	%	N	%
All year	0	0.0	0	0.0	0	0.0
Dec-Feb	0	0.0	7	7.5	7	5.8
Mar-Apr	27	100	93	100	120	100
May-Jun	2	8.7	16	17	18	15
X^2P-value		0.011				

Appendix Table 51. *Chinki* feeding calendar based on farmers response between genders of household heads in the Mieso district

Feeding calendar	HH head sex				Total	
	Female		Male			
	N	%	N	%	N	%
All year	0	0.0	0	0.0	0	0.0
Sep-oct	1	3.7	5	5.3	6	5
Apr-Jun	12	44	77	82.8	89	74
Jul-Sep	22	81.5	89	74	111	92.5
X^2P-value			0.136			

Appendix Table 52. Proportion of farmers facing problem to get veterinary service in different rural *kebeles* of Mieso district

Rural *kebeles*	Problems face to vet. service		X^2 P-value
	Yes		
	N	%	
D/kalu	15	100	
Gena	20	95	
H/mendera	34	100	0.133
H/misoma	27	100	
W/jejeba	23	100	
HH sex			
Female	27	100	0.588
Male	92	98.9	
Total	119	99	

Appendix Table 53. Affordability of veterinary service in Mieso district based on farmer's response

Rural *kebeles*	Affordability of vet service						X^2 P-value
	Cheap		Fair		Costy		
	N	%	N	%	N	%	
D/kalu	3	20	3	20	9	60	
Gena	1	4.7	4	19	14	67	
H/mendera	1	2.9	18	52.9	12	35	0.057
H/misoma	1	3.7	7	30	18	78	
W/jejeba	2	4	11	47.8	10	43	
HH sex							
Female	2	7	9	33	16	59	0.545
Male	6	6	34	36.7	47	50.5	
Total	8	6.7	43	35.8	63	53	

Appendix Table 54. Variation in vaccination for different diseases based on farmer's response among different rural *kebeles* in Mieso district

Disease type	D/kalu		Gena		H/mendera		H/misoma		W/jejeba		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Anthrax	1	7	15	71	29	85	23	85	4	17	72	60
Pasturolosis	2	13	19	90	34	100	27	100	20	86.9	108	85
Blackleg	5	33	21	100	30	88	25	92.5	22	96	103	86
X^2 P-value						0.047						

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 55. Response of the farmers on selection criteria for selection of dairy bulls in Mieso district

Criteria for selection	N	%
Large tail	47	39
Equal testicle	23	19
Large testicle	4	3.3
Massive neck	21	17.5
Large body size	75	63
Broad bone	20	16.7
Large sheath	4	3.3
Less aggressive	5	4.2
Large dewlap	3	2.5
Brown red and whit color	9	7.5
Fatty	1	0.8
Progeny history	4	3.3

Appendix Table 56. Distributions of household get extension support on dairy production among rural *kebeles* and between gender of household heads in Mieso district

Extensional support	Rural *kebeles*										HH sex				Total	
	D/kalu		Gena		H/mender		H/misoma		W/jejeba		Female		Male			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
	0	0	13	62	19	56	7	25.9	1	4	10	52	37	32	40	33
X^2 P-value						0.00						0.349				

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 57. Number of households getting different extensional-consultation support from experts among rural *kebeles* and between gender of household heads in Mieso district

Type of support	Rural *kebeles*										HH sex				Total	
	D/kalu		Gena		H/mender		H/misoma		W/jejeba		Female		Male			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Housing & reproduction management	0	.0	1	4.8	0	0	0	0	0	0	1	3.7	0	0	1	0.8
Housing & health management	0	0	0	0	2	5.9	0	0	0	0	0	0	2	2.2	2	1.7
Health mang. & feeding	0	0	1	4.8	0	0	0	0	0	0	1	3.7	0	0	1	0.8
Milk production, marketing	0		2	9.5	0	0	0	0	0	0	0	0	2	2.2	2	1.7
Reproduction & housing magt, milk production & marketing	0	0	1	4.8	0	0	0	0	0	0	0	0	1	1	1	0.8
Reproduction & housing magt, milk production & marketing, health and feeding magt.	0	0	0	0	0	0	2	7.4	0	0	1	4	1	1	2	1.7
Housing magt, milk production & marketing, health and feeding magt.	0	0	0	0	1	2.9	0	0	0	0	1	4	0	0	1	0.8
Milk and milk product production and marketing	0	0	6	28.6	7	20.6	4	14.8	1	4	7	26	11	12	18	15
Health management	1	6.7	2	9.5	2	5.9	1	3.7	0	0	3	11	3	3	6	5.0
animal feeding	0	0	1	4.8	7	20.6	0	0	0	0	0	0	8	8.6	8	6.7
X^2 P-value						0.00						0.044				

HH sex = household head sex, D/kalu= Dire-kalu, W/jejeba= Welda-jejeba, H/misoma= Hunde-misoma

Appendix Table 58. Solution for the problem in dairy animal production in the Mieso district

Solutions	N (N=120)	%
Providing of forage materials	11	9
Training on feed conservation methods	80	67
Create conflict resolution methods	120	100
Install permanent water source	79	66
Create access to veterinary service	89	74
Introduction of improved breed	35	29
Improve marketing infrastructure	74	62
Extension service	8	7

Appendix Table 59. Conversion factor for Livestock in to Tropical Livestock Unit

Animal	**TLU**	**Animals**	**TLU**
Goats (young)	0.06	Young bulls	0.0013
Goats (adult)	0.13	Cows and ox	1
Cow (calf)	0.2	Camel	1
Cow (Heifer)	0.75		

Source: Strock *et al.,* 1991

Appendix Table 60. Conversion factor for family members in to Adult equivalent

Labour class	**Age (years)**	**AE**
Children	< 7	0
Children	7-14	0.4
Adult man	15-64	1
Adult female	15-65	0.8
Old men	≥ 65	0.5
Old female	≥ 65	0.5

Source: Strock *et al.* 1991

7.2. Appendix II. Questionnaire Used

QUESTIONNAIRE USED FOR THE FORMAL (DIAGNOSTIC) SURVEY OF THE STUDY

GENERAL

Questionnaire number_____

Altitude_____ Rural *kebeles* name_____ Village name_____

Date_____

Starting _____and ending _____time

Farmers name _____Age _____Sex _____

Enumerator name_____ Signature _____

HOUSEHOLD CHARACTER

Religion _____ Marital statues _____

Family size _____ Education of health _____

Education of spouse _____

Number of working age household members (14-64 year old) male ___ Female ____

Number of children in the HOUSEHOLD < 10 years _____

LABOUR DIVISION IN THE FAMILY FOR DAIRY PRODUCTION

Labour division for dairy animal activities

Responsibility of family member for different livestock activities

	Activities	Sex	Age	Time spent
	Milking and calf caring			
	Livestock herding			
	Livestock watering			
	Barn cleaning			
	Animal marketing			
	Milk and milk Product marketing			
	Feed collection			

Did you hire additional labour for any livestock activities in the past one year?

1. Yes 2. No

If yes please specify the livestock animal activities for which additional labour was hired

Division of labour for different crop activities

Responsibility of family member for different crop activities

	Activities	Sex	Age	Time spent
	Cultivation			
	Seeding			
	Harvesting			
	threshing			
	Field watching			
	Weeding			
	Crop selling			

Labour supply for different agricultural activities

Did you have labour shortage for any livestock activities? 1. Yes 2.

If yes. please specify the type of activity and seasonal labour shortage according to its priority?

If you have labour shortage for any livestock activity, what measure you take to solve the problem?

CROP PRODUCTION AND PRODUCTIVITY

Crop type to be grown by priority and its purpose

Crop type	Purpose of grown
	-For income source,-consumption,- animal feed

At what season good yield or bad yield is obtain for each species of crop type?

Crop type	Grain yield when season		How much product you harvest from the last year (kg)	Remark for good and bad season
	Good (____kg)	Bad (___kg)		

Animal type used for draught power source_____

Did you rent additional cropland in the past one year? 1. Yes 2. No

If you rent, what was the area of the land_____

How much you pay for one hectare of land_____

HOUSEHOLD ASSET, INCOME AND EXPENDITURE

What permanent asset you have? _____

Livestock holding for different class of animal

Species	Male/Adult	Female/Mature	Total
Sheep			
Goat			
Oxen			
Cows			
Camel			

Household income in the past one year

Did you sell livestock for income generation? 1. Yes 2. No

If yes, specify the animal type you sale according to their priority?

Animal type	Age	Number	Frequency	price	Market place	Season

Did you sale animal products for income generation? 1. yes 2. no

If you sale specify the animal product types you sale according to their priority?

Priority	Product type	How much time you sold(frequency)	How much many you get	Market place	price
	Fresh milk				
	Yoghurt				
	Butter				
	Cosmetic butter				
	Meat				

What are your major reasons to sale your animal products? _____

Did you use off-farm activities for income generation? 1. yes 2. no

If yes, specify the type of off-farm activities you use for income generation according to their priority?

Please specify the type of income sources you use according to their priority of importance for?

Different household expenditures (for the past one year)

Did you purchase any livestock in past one year? 1. yes 2. no

If yes, please specify the animal type, number, price and market type you purchase?

Priority	Animal type	No.	Price	Market type
1st				
2nd				
3rd				

Did you purchase any livestock inputs in the past one year? 1. yes 2. no

If yes please specify the animal input type, purchasing frequency, season and price to purchase the input?

Priority	Input type	Frequency	Season	Price
1st	Feed			
2nd	Vet			
3rd	Herding			
4th	Other (specify)			

For what purpose you use the income obtained from animal selling? _____

For what purpose you use the income obtained from milk products? _____

ANIMAL PRODUCTIVITY - Livestock herd and flock structure

Goat flock structure

Age	Number by sex		
	Male	females	Milking goats
0-1year			
1-2			
2-3			
3-4			
>4			

Cattle herd structure

Age	Number by sex		
	male	female	Milking cows
0-1year			
1-2			
2-3			
3-4			
4-3			
5-6			
6-7			
7-8			
>8			

Camel structure

Age	Number by sex		
	Male	female	Milking camels
0-1year			
1-2			
2-3			
3-4			
4			
5			
6			
>7			

Livestock mortality in the past one year

Did you loss your animal at post weaning in the past one year? 1. yes 2. no

If yes, please specify the type of animal, number, age, and reason for mortality?

Animal type	Age at mortality	Number of animals	Sex	Reason of mortality
Camel				
Cattle				
Goats				
Sheep				

Did you loss your animal at pre weaning condition in the past one year?

1. yes 2. no

If yes, please specify the type of animal, number, age, and reason for mortality?

Animal type	Age at mortality	Number of animals	Sex	Reason of mortality
Camel				
Cattle				
Goats				

Precise number of cattle, camel, goat which sold, purchased last year?

Heads of cattle sold last year	Adult		Camel	Cattle	Goat
		Male			
		female			
	Weaned calves				
Heads of cattle purchased last year?	Adult		Camel	Cattle	Goat
		Male			
		female			
	Weaned calves				

DAIRY ANIMAL FEED AND FEEDING

What are the major feed resource you use for dairy animal feeding, please specify according to their priority?

Feed source	Animal type		
	Camel	Cattle	Goats
1st=crop residue			
2nd =Natural pasture			
3rd=improved forage			
Other supplementary feed?			

Did you have experience in growing improved forage species to feed your animals? 1. Yes 2. No

If yes please specify the type of forage you grow? _____

If no, please specify your reason to not grow improved crop?

Did you have experience in giving additional feed for your animals? 1. Yes 2. No

If yes, please specify the type of additional feed you provide for the dairy animals_____

How much additional feed you provide?_____

If yes, where did you obtain these feeds _____

Dairy animal feed availability

Did you have feed shortage problem for your dairy animals? 1. yes 2. no

If yes please specify the period of feed shortage for each animal with in a year?

Animal type	Shortage season	
	From	To
Cattle		
Camel		
Goats		

What measure do you normally take when there is feed shortage for your dairy animal?

1= feed from the stock of the rainy season 2= give feed in smaller quantity

3= Give animals for high landers 4= Give less feed to certain type of animals

5= selling the animal 6=move the animal to long distance

Did you move with your animal for feed and water searching?

If yes, how long you travel? ____km for water &_____km for feed.

On feed shortage or for feeding animal at normal season, at which place you move your animals?

Which type of animal you will move when there is feed shortage, please specify the type of animal ?

Is there any problem during mobility of animal for feed? _____

When the animals move for searching of feed? _____

How do you know where to go? _____-

Please specify the season at which feed from different source would be scarce and surpluses?

Feed sources	Shortage season	Surplus season
Crop residue		
Natural pasture		
Commercial available feed		
Improved forage		
Different crop product/ cereals ( )		

Did you have feed conservation experience when it is available in surplus?1. Yes 2. No

If yes, what method you use to conserve available feed?_____

Did you have private grazing land? 1. Yes 2. No

If yes, please specify the area of your grazing land _____ha

If yes, please specify the location of your grazing land_____

Did you use communal grazing land?

If yes, please specify the problem you face in communal grazing?_____

Did you manage your dairy herd and non dairy herd (with in species milked) separately for feeding?

1= yes 2= no If yes, please specify your reason?

Is there a different feeding management system at different season?, please specify the season?

Feeding management	Season											
	J	f	M	A	M	J	J	A	S	O	N	D
Grazing Owen pasture												
Grazing communal land												
Fed crop residue												
Cut and carry system												
Grass weed from the ground												

Did you have crop (maize, sorghum) treatment experience to improve the palatability of the feed for the animals? 1. yes 2. no

Is there a problem to get agro-industrial by product in your area?

LIVESTOCK AND LIVESTOCK PRODUCT CONSUMPTION AND MARKETING

Did you sale animal in the **market** in the past one year?

1. yes 2. no

If yes, please specify the animal type, season and no of animals sold by sex?

Priority	Animal	season	Number	Reason of selling

	type				
			male	female	
	Cattle				
	Camel				
	Goats				

Did you give any animal as a gift for other during the past one-year?

1. yes 2. no

If yes please specify the animal type, season and number of animals sold by sex?

What are your major reasons to sale your dairy animals?_____

MILK PRODUCTION, PROCESSING AND MARKETING

Do you milk goat? 1. no goats in the house 2. There are goats in the house but not milked

3. There are goats in the house and milked

Do you milk camel?

Do you milk cow?

What type of cow breed you use for milk production? 1. Local 2=cross

Which type of local cows you use for milk production?

1= Doba 2= Arsi bale 3= ogaden 4= other (specify)

How much the daily milk yield of different animal?

Parameters	At each type lactation		
	Cattle	Camel	Goats
Milking frequency per day			
milk yield per day(litter)			
lactation length(month)			

How many times a day do you usually milk? And how much they milk?

Milking time	Litter per milking time		
	Cattle	Camel	Goats
Once in the morning			
Once in the evening			
Morning and evening			
Three times a day			
Night time			

Are there some special cows with exceptional high milk yield? 1= yes 2= no

If yes please specify the type or breed of cows and how much they milk?

At what season of the year your dairy animals give more and less milk yield?

What are the major problems for small quantity of milk?

1= calf feeding (left milk) 2= diseases

3= feed shortage 4= no market (no whole milking)

Is there any treatment for your dairy animals to get more milk? (which feed types you use?)

Species	Treatment
Cow	
Camel	
Goats	

Did you process the different type of milk? If yes please, fill the following table?

	Fermented milk	Butter	Whey(Arera)
Average quantity produced per time of processing			
Average of milk quantity used for each processing			

For which animal you give priority for consumption of milk type?

1= cattle 2= camel 3= goats

Why did you prefer it?

If you milk different species of milk product, please fill the following table

	Priority			Reason
	Cattle	Camel	Goat	
From which species of dairy animal do you prefer to sell fresh milk?				
Which species provide milk with the highest price?				

Did you use hired labourer for milk processing? 1= yes 2= no

If yes, for what milk product you hired? _____

If yes, how many processing labourer/day or wks use? _____

Did you wash the udder of the dairy animal before milking? 1= yes 2= no

Did you wash the milking equipment before milking? 1= yes 2= no

If yes, by what material and water you use?

Specify the plant for washing _____

How much life the material used? _____

Did you use any preservative (aromatic material) for different type of milk?

What are they? _____

How do you them? _____

How do you conserve milk products ? for how long can you keep it?

	Cattle milk	Camel milk	Goat milk
Type of equipment for preservation			
Type of smoking plant			

Is there loss (spoilage) of milk during storage time? 1= yes 2= no

and what do you suggest not to spoil? _____-

MILK PRODUCT MARKETING

What is your priority for marketing milk from different species of animal?

Cattle/camel/goat milk? Specify your reason?

At what season more milk is sold?

Milk type	Season											
	J	F	M	A	M	J	J	A	S	O	N	D
Cattle												
Camel												
Goats												

What type and at what season different milk product you sold?

Milk products	Cattle	Camel	Goats	Season	Quantity of different product sold
Fresh milk					
Butter					
Cosmetics butter					
Yoghurt					
Whey(*Arera)*					

How many KM you travel to sale different product?

Milk product	Km travel for different type of milk		
	Cattle	Camel	Goats
Milk			

Butter			
Cosmetics butter			
Yoghurt			

What is the main problem in disposal of products?

Eg for raw milk**:** related to products

: Related to buyer

: ‘’ price

Are you involved in to trader’s group? (*“faraqa annneni”*?) 1= yes 2= no

If yes, what is the advantage? If no, pleas justify your reason?

What is the problem related to “*faraqa annenni”* and what is your suggestion?

At what distance is your market place is found? _____

What is your closest market place to sale milk product? _____

Where did you need to sale your product? Why did you prefer that market?

What is your market problem related to the different products? _____

1= transport 2= preservation 3= processing capacity 4= other (specify)

In what season more milk is sold? Why? _____

1= due to shortage of milk production in most of the area 2= due to fasting

3= due to off farm activity (crop harvesting season)

What type of milk product you sold in dry season? _____ Why?

SALE OF MILK PRODUCTS AND PRICE

	unit	**Season 1(wet_____)**		**Season 2(dry ____ _____)**		**Reason for choice of the outlet**
		Outlet 1	**Outlet 2**	**Outlet1**	**Outlet2**	
Cow raw milk						
Sales outlet						
Buyer type						
Qty/day or week						
Price/unit						
Mode of payment						
Distance traveled/day						
Time spent/day						
Butter						
Sales outlet						
Buyer type						
Qty per day or week						
Price/ unit						
Mode of payment						
Distance travel per day						
Camel milk						
Sale outlet						
Bayer type						
Qty/day or week						
Price/unit						
Mode of payment						
Distance traveled/day						
Time spent/day						
Transport cost/day						

Code for sale outlet 1= farm gate 2=market place 3=deliver to buyer

Code for mode of payment 1= cash 2= cash in advance 3= credit

4= exchange with goods

Code for type of buyer 1=consumer 2= trader 3= catering shop

3=organization/hospital/school/ hotel

Reason for choice of outlet 1=good price 2= short distance 3= reliable customer 4= mode of payment

In what out let's more milk product delivered? _____

Gender role in milk production and marketing

Is there any different in milking different species of animal?

If yes, which species is milked by women and which is by men?

Species	male	female
	Age	Age
Camel		
Cattle		
Goat		

Who sold the milk or milk product at home or market? 1= male 2= female

Who will be responsible for money, get from the milk sold?

Who will responsible for money get from sale of goat and sheep?

Animal and animal product market place and marketing conditions

What are the major marketing places to sale dairy animals?

Cattle _____ camel _____ goats _____-

What are the major market places to buy animal products? _____

Cattle _____ camel _____ goats _____-

DAIRY ANIMAL HOUSING

Did you keep all classes of animals together in the same shade? 1.yes 2. no

If no, specify your season for not keeping together? _____

What type of house/ barn you use to keep your animals during night time?

Species	House type
Cattle	
Camel	
Goats	

Did you keep your dairy animal in different barn, during their milking period?

If yes, specify your reason? If no, specify your reason?

ANIMAL HEALTH

What are major animals health problems affecting your herd?

Pleas rank them (in decreasing order) and specify the way used to overcome them?

Are your dairy cattle vaccinated, against which diseases, how often and who decide to vaccinate? 1= HOUSEHOLD 2= Government

Vaccination	Vaccinated 1=yes 2= no	Though official campaign (frequent/ year)	By farmer's decision (frequent/ year)
F.M.D/			
Rinder pest			
C.B.Pleuroneumonia			
Anthrax			
Blackleg			

What are the major diseases mostly affect the dairy animals?

Dairy animal type common dairy animal diseases

Cattle

Camel

Goats

What measure you take when your dairy animals become sick?_____

If you take your animal to veterinary clinics, how is the affordability the service?

If you take your animal to veterinary clinics, how is the efficiency of the service?_____

Did you have problem to access the veterinary clinics in the area? 1. Yes 2. No

If yes, please specify the type of problem you have_____

Did you have indigenous knowledge on infertility management ?(on using cultural health treatments) for your dairy animals? 1. Yes 2. No

If yes please specify the type of treatment you use (herbs, plants etc _____

How did you use them(herbs, plants) to treat?

If yes, please specify the efficiency of the treatment _____

REPRODUCTION PERFORMANCE

For each dairy animal in the herd fill the following table

Species	Age	AFC	CI	Last service day	No of parturition	Gestation period	No of offspring
Cattle							
Camel							
Goats							

How long the lactation period extends for different species of animals?

Species	Lactation length	Average milk yield/day		
		Early	Mid	Late
Cattle				
Camel				
Goats				

DAIRY ANIMAL BREED TYPES

Did you have cross or exotic breed of animals? 1. Yes 2. No

If yes, please specify the animal type in your area _____

If no, please specify the type of local animal in the area _____

If no, please specify the reason to not have these cross breeds _____

Which type of local breed mostly you use for milk production?

Species	**Breed type**	**Dominant breed**
Cattle		
Camel		
Goats		

Did you observe special good future of local dairy animal than other breeds?

If yes, specify the dairy animal breed and its good character?

ANIMAL BREEDING SYSTEM

What type of mating system you use to reproduce your dairy animals? **(only for cattle)**

1. natural 2. AI 3. Both

Where did you get the local dairy breed?

Did you have experience in using selection for the improvement of milk production for different species of dairy animals? 1. yes 2. no

Is there an animal identification (*selection criteria*) system for dairy cattle with in your farm? If yes please describe your identification system for different species of dairy animals

Dairy Animals	Identification system(*selection criteria)*
Cattle	
Camel	

Goat	

How do you select the breeding dull for mating?

Are male kept with females? 1=yes 2= no

Did you use forced weaning for new born to stop milk feeding? 1. Yes 2. No

If yes, pleas specify the method you use?

Type of animal	Weaning age	Methods for forced weaning
Calf (cattle) Calf (camel) kids		

Dairy animals watering system

What type of water sources you use for dairy animal watering, specify the type of water source, the average distance to the water source?

Specify the name of water source	Specify the type of water source	Season of availability of the water source	Average distance to the water source(hr)
1	River		
2	Well		
3	Supplied tank, pipe		
4	Ocean		
5	Spring water		
6	Pond		

How frequent you provide water for your dairy animals per day?

Dairy animals		Watering frequency/day by seasons		Watering system
		Wet	Dry	
Cattle	Milking			
	Dry			
Camel	Milking			
	Dry			
Goats	Milking			
	Dry			

ROLE OF INSTITUTE

Institute that provide improved dairy breeds_____ Type of dairy breeds _____

Institute that provide improved forage _____ Type of forage _____

Institute that provide health treatment for animals_____ Type of treatment _____

Institute that provide loan for milk production activities_____ Type of activity you use the money___

Amount of money you rent _____

Institute that provide training/consultancy about improved milk production system___

Type of training _____ Institute name _____-

EXTENSION/ CO-OPERATIVE

Are there any co-operatives in your area? If yes are you part of this scheme? 1= yes 2= no

If there is no any co-operatives in your area, what is the problem not to start this cooperative in your area? 1= no extension staff to support this

2= no awareness 3= we have no many for registration 4= other

Did you have access to livestock extensions services? 1= yes 2= no

If yes, which main aspect of dairying are you advised on by livestock extortionist? If yes, on which aspect ? if you have extension service, how often you use them last year?

Livestock extension service	Available		Number of visit last year
	Yes	No	
Governmental(public) service			

Private			
Co-operatives			

MAJOR CONSTRAINTS

Major constraints and possible solution	**Ranking**
1=there is no enough feed available for increasing production>>buy or product more feed	
2=There is no available credit>> need to get credit	
3=my animals cannot produce more>> change the type of animals	
4=I cannot sell more milk>> find another market	
5=there is no extension service>> we need awareness	
6=dairy animal have poor health>> control animal disease	
7=I can not use more milk>> find processing technique	
8=I could maintain dairy animals>>increase or buy herd size	
9=No increasing milk production	
10=There is shortage of water>> construct water supply	
11=There is shortage of accessible road>>construct road	
12= if other (specify) _____?	