

ADDIS ABABA UNIVERSITY
COLLEGE OF VETERINARY MEDICINE AND AGRICULTURE

**STUDY ON CATTLE MILK PRODUCTION, PROCESSING AND MARKETING
SYSTEM IN ENDERTA DISTRICT, TIGRAY REGIONAL STATE**

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ABBREVIATIONS

AFC	Age at First Calving
AFS	Age at First Service
AI	Artificial Insemination
ANOVA	Analysis of Variance
BOANRDT	Bureau of Agriculture and Natural Resource Development Tigray region
BOARD	Bureau of Agriculture and Rural Development
CL	Calving interval
COMESA	Common Market for Eastern and Southern Africa
CSA	Central statistical Agency
DMY	Daily Milk Yield
FAO	Food and Agricultural Organization of the United Nations
GDP	Gross Domestic Product
ILCA.	International Livestock Center for Africa
ILRI	International Livestock Research Institute
IPMS	Improving Productivity and Market Success of Ethiopian Farmers
LL	Lactation Length
MOA	Ministry of Agriculture
MOARD	Ministry of Agriculture and Rural Development
PA	Peasant Association
SE	Standard Error

ABSTRACT

A study on cattle milk production, processing and marketing was carried out in Enderta district, which is one of the four districts in the southeastern administrative zone of Tigray National Regional State, with the objective of studying the existing cattle husbandry and milk production systems, assessing cattle milk handling, processing and marketing as well as the constraints of milk production and marketing in the study area. A four stage sampling was used to select 150 households from the two livestock production systems of the district (transhumance and sedentary livestock production systems). Data was collected through questionnaire interview, group discussion, discussion with key informants and farm visit. The average landholding of respondents was significantly ($p<0.05$) varied between male (2.08 ± 0.12 ha) and female headed (1 ± 0.08 ha) households but did not differ between the two livestock production systems. The mean cattle number per household was significantly ($p<0.05$) vary between transhumance (11.17 ± 0.71 heads) and sedentary (9.31 ± 0.39 heads) livestock production systems. The major feed resources for local cattle were natural pasture and crop aftermath whereas for crossbred cattle it was reported to be crop residues. Local cattle were watered from rivers, dam and wells while pump water was used for crossbred cattle. The major cattle diseases reported in the district were anthrax, blackleg, bovine pasteurellosis, foot and mouth disease and mastitis. The overall average milk off take per day per household was 6.81 ± 0.57 liters of which, majority (62.94%) was traditionally processed to butter and butter milk. The overall average butter production per week per household was 1.25 ± 0.05 kg of which, 80.2% was allocated to market. Seasonal feed shortage, inefficient animal health and AI services, market shortage, price fluctuation and adulterations were some of the major constraints of milk production and marketing reported in the district. Supporting smallholders with strengthened extension service in proper utilization of available feed resources, improved husbandry practices, market access, AI and animal health services as well as introduction of control measures for quality product are expected to contribute a lot for the development of the dairy sector in the area.

Key words: *Enderta district, transhumance, sedentary, milk, butter, production, processing, marketing*

1. INTRODUCTION

Agriculture is the mainstay of the Ethiopian economy (IBC, 2004). It accounts for 80 percent of national employment, 41 percent of gross domestic product (GDP) and 33 percent of total exports. Livestock production is also an integral part of the system. The sub-sector is estimated to contribute about 12-16% of the total GDP and 30-35% of total agricultural GDP, and 60-70% livelihoods of the Ethiopian population (Halderman, 2004; Michael H., 2004), 15% of export earnings and 30% of agricultural employment (Staal *et al.* 2008). Among the sectors within livestock, the dairy sector contributes to half of the livestock output and about 30 % of employment, where 50% of households in the highland own cattle of which 56% are dairy cattle (Tesfaye *et al.*, 2008).

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). Of these resources, the major species used for milk production in Ethiopia are cattle, camel and goats (MOARD, 2004). Cattle produce 83% of the total milk and 97 % of the cow milk comes from indigenous cattle breeds (MOARD, 2004). But, production per animal is extremely low and the lactation milk yield for the indigenous cows was reported to range from 494–850 kg under optimum management (Belete *et al.*, 2010). More importantly, the total milk production from about 10 million milking cow is estimated at about 3.2 billion liters, which can be translated into 1.54 liters per cow per day (CSA, 2008), which is far below the world's standard. Moreover, selection for high milk production within these indigenous cattle would require a long-term genetic improvement program (Katyega, 1988).

The dairy sector in Ethiopia holds large potential to the commercialization of the agriculture sector due to the country's large livestock population, favorable climate for improved high-yielding animal breeds, and the relatively disease-free environment with potential for animal feeding (Ahmed *et al.*, 2004). However, the national milk production remains among the lowest in the world even by African standard. The total milk production is estimated 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 and supply.

According to Azage *et al.* (2001), in order to meet the growing demand for milk in the country, milk production has to grow at least at a rate of 4% per annum which in turn entails design of appropriate and sustainable milk development strategies based on socio-economic, institutional and agro-ecological circumstances that build on the demand of consumers and the needs and opportunities of producers. In such context, while the response of the private sector to the increased demand for dairy is expected to be significant, the small-scale household farms in the highlands hold most of the potential for dairy development (Mohammed *et al.*, 2004). However, there is poor knowledge on market structure, performance and prices and inadequate for designing policies and institution to overcome perceived problems in the marketing system (Ayele *et al.*, 2003).

The larger volume of milk produced by smallholders is processed into different dairy products for home consumption and sales (Yigezu, 2003). Fresh milk sales by smallholder producers are important only when they are close to formal milk marketing facilities, such as government enterprise or milk groups (Muriuki and Thorpe, 2001.). The low marketable milk output in Ethiopia poses limitations on the possibilities of exploring distant but rewarding markets due to high transaction costs arising from transportation and high opportunity cost of labor involved. Again, dependable marketing system is not yet developed to market milk and milk products. Producers and consumers are spatially separated; most producers are found in the rural areas while consumers or profitable market is found in urban areas (Holloway *et al.*, 2002).

The primary reason to the low productivity and development of livestock sector in general and dairy in particular is the constraint resulted from shortage and fluctuation in quality and quantity

of feed, poor and eroding genetic resource base, poor management practices, diseases, poor market infrastructure, poor service delivery and policy and institutional arrangements (Azage *et al.*, 2006). Moreover, livestock product marketing is inefficient and characterized by high margins and poor marketing facilities and services. The price gap between terminal and primary markets seems to be too wide (CSA, 2006). Under these conditions, producers have no incentives to improve the quality of their animals' products through appropriate management practices.

The Tigray national regional state, is the fourth most cattle populated region in the country next to Oromiya, Amhara and SNNP (Southern Nations Nationalities and People's) regions. It is the home of 2,622,166 cattle of which 49 % are male and 51% are female (MOARD, 2007). In spite of this huge resource, little work has been done about dairying in the region, except the work (characterization of the urban dairy production) of Negusse (2006) in Mekelle and that of IPMS (Improving Productivity and Market Success) in Astbiwenberta and Alemata districts.

Enderta is one of the districts in south east zone of Tigray region and mixed crop- livestock production is the main agricultural system in the area. According to CSA (2006) the district has 71,136 cattle, 111,466 sheep, 21,649 goats, 19,968 donkeys, 2,167 mule, 594 camel, 72 mule, 27,692 poultry and 2,803 bee hives. The capital city of the region Mekelle with population of 169,207 (CSA, 2006), is encircled within Enderta district making it more advantageous from market proximity point of view. However, information on the current cattle husbandry practices, milk production, handling, processing and marketing system is lacking in the district. Such information is critically important for designing appropriate dairy development strategies, market orientations and providing base line information for further research and development. Furthermore, agricultural knowledge and information are key components in commercial smallholder dairy development as these play a significant role in improving productivity, linking producers to remunerative markets, improving competitiveness in markets, and thus leading to improved livelihood, food security and national economies (Tesfaye *et al.*, 2008). In view of the above, the present study was designed with the following objectives.

Objectives:

- To study the existing cattle husbandry and milk production systems in Enderta district
- To assess cattle milk handling, processing and marketing systems in the study area and
- To assess constraints of milk production and marketing in the area.

2. REVIEW OF LITERATURE

2.1. Milk production system in Ethiopia

There are four major milk production systems in Ethiopia. These are pastoral and agro-pastoral, smallholder crop–livestock mixed system, urban and peri-urban, and intensive dairy farming (Azage and Alemu, 1998). Pastoralist and smallholder farmers produce 98% of the country's total milk production (CSA, 2008).

2.1.1. Pastoral milk production system

Although there is no standard definition of pastoralism, it is often defined as a livelihood in which at least 50 percent of a house holds food and income is derived from livestock. Furthermore, pastoralism is characterized by mobility and in particular, the seasonal movement of livestock to access grazing resources and water (COMESA, 2009). Even though information on both absolute numbers and distribution vary, it is estimated that about 30% of the livestock populations are found in the pastoral areas (Belete, 2006). The pastoral livestock production system, which supports an estimated 10% of the human population, covers 50- 60% of the total area mostly lying at altitudes ranging from below 1500 m above sea level.

Pastoralism is the major system of milk production in the lowland areas. Cows, camels and goats are the major dairy animals used for milk production by pastoralists. However, because of the rainfall pattern and related shortage of feed availability, milk production is low and highly seasonal and range condition dependent (Yigezu, 2003; Ketema and Tsehay, 2004). And this system is not market oriented and most of the milk produced in this system is retained for home consumption.

2.1.2. Highland smallholder milk production system

The Ethiopian highlands possess a huge potential for dairy development. These areas occupy the central part of Ethiopia and cover about 40% of the country's land area (approximately 490,000 km²) (Belete *et al.*, 2010). In these areas agricultural production system is predominantly subsistence smallholder mixed farming with crop and livestock husbandry typically practiced within the same management unit. Among the systems, milk production system is the most biologically efficient system that converts large quantities of roughage the most abundant feed in the tropics to milk (Belete, 2006).

In this farming system, the entire feed requirement for ruminant livestock is derived from native pasture and the balance comes from crop residues. Only 0.15% of rural livestock holders reported on-farm production of improved forages like alfalfa and napier grass; the use of industrial by-products like oil cake, bran, and brewery residue was negligible (0.8%); the population of exotic and crossbred dairy cows in rural areas of the country accounted for less than 1% of the total dairy cattle population; and the blood levels of the limited crossbred population were unknown, due to the lack of appropriate breed registration system (CSA, 2008). Other empirical evidences (Azage *et al.*, 2006; Staal *et al.*, 2008) showed that the generic supply-side constraints (feed, breed, animal health etc.) have not yet been resolved; the coverage and quality of support services need significant improvement; private provision of services is underdeveloped.

Cattle are the main source of milk even though they are kept primarily as draught power source with very little or no consideration given to improving their milk production capabilities (Yigezu, 2003). Where there is access to market; dairying is preferred to meat production in the highlands because it makes more efficient use of feed resources and provides a regular income to the producer. It is also labor intensive and supports substantial employment in production, processing and marketing, higher level of production than those achieved in traditional tropical systems often require the introduction of specialized dairy breeds and increased level of inputs (nutrition and health care) and good linkages to market both for milk and input acquisition (Walshe *et al.*, 1991).

Thus, the intensification of smallholder dairy production system through the adoption of dairy production technologies is generally concentrated in areas with good infrastructure close to major markets, although less intensive production may occur in other more distant areas (Walshe *et al.*, 1991). These market factors therefore, play a major part in determining the type of dairy production systems found in the tropics and they are particularly important in influencing smallholder dairy development (Falvey and Chantalakhana, 1999).

2.1.3. Urban and Peri-urban milk production system

Smallholder urban and peri-urban milk farming system is concentrated in and around major cities and towns characterized by a high demand for milk. This system has been developed in response to the fast growing demand for milk and milk products around urban centers (Asaminew, 2007).

In urban and peri-urban milk production system, the main feed resources are agro-industrial by-products. In this system milk is a means of additional cash income. Most of the improved dairy stocks in Ethiopia are used for this production system. One of the largest sources of milk in Addis Ababa/regional towns is that from intra-urban milk producers. The producers deliver milk to consumers or consumers may collect it at the producers' gate. The total milk production from this system accounts to 34.649 million litres /annum. Of this total, 73% is sold, 10% is left for household consumption, 9.4% goes to calves and 7.6% is processed mainly into butter and ayib (Azage and Alemu, 1998).

2.1.4. Large scale commercial milk production system

This is a more specialized dairy farming practiced by state sector and very few individuals on commercial basis. These are concentrated in and around Addis Ababa and other regional capitals and are basically based on exotic high grade or purebred stock. Although these urban, peri-urban and intensive dairy farmers are important and regular suppliers of milk to major urban centers, they produce only 2% of the total milk production of the country (Belete, 2006).

2.2. Dairy cattle husbandry

2.2.1. Feeding management

Except for a compelling reason related to a particular research or teaching protocol, dairy cattle should be fed diets that have been formulated to meet their needs for maintenance, growth, production, and reproduction. Feed ingredients and finished feeds should be wholesome, carefully mixed, and stored and delivered to the cattle to minimize contamination or spoilage of feeds. To ensure freshness, feeds that are not consumed should be removed daily from feeders and mangers, especially high moisture feeds such as silage. Feed should be far enough from waterers to minimize contamination (Albright, 1993).

Space should be adequate for feed and water. Feeders should be designed with smooth surfaces for easy cleaning and increased feed consumption. The recommended linear space per cow at the feed bunk is 61 to 90 cm, which should allow every animal uninterrupted feeding (Malloy and Olson, 1994). Feeder design should permit a natural head down grazing posture to promote intake, improve digestive function, and decrease feed-wasting behavior. At least two watering locations should be provided for each group of cows. Each cow in tie stalls and stanchions should have its own water bowl or drinking cup (Anderson, 1985).

In Ethiopia Livestock feed resources 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. Use 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).

2.2.2. Watering management

Water should be available at all times and should be checked daily for cleanliness and also monitored regularly to ensure that it is free of contaminants that could potentially put zoonotic

agents into the human food chain (Johnston *et al.*, 1986). Water sources should be readily accessible to all stock. Underfoot surroundings in watering areas should be dry and firm. Cattle should not be able to wade in drinking water.

Milk is composed of nearly 87% water. An adequate supply of quality water for dairy cattle is extremely important. Farmers typically provide cows with free access to fresh water at all times. The water requirements of lactating cows are closely related to milk production, moisture content in the feed and environmental factors such as air temperature and humidity. The cow's peak water intake generally occurs during the hours of greatest feed intake (MOA, 2007).

A cow will not drink all the water she needs for the most profitable production of milk unless she can get it frequently without discomfort and at a suitable temperature. If the weather is warm more water is required than in moderate or cold weather. Cows will drink up to twice as much water in hot weather as in cold winter weather. Since cows do not sweat, if so relatively little, they eliminate more water as urine in hot weather in order to cool the body. If the feed is succulent in nature, the cow will consume less water than if she were fed dry feed. In an experiment it has been shown that average producing cows were watered once a day, twice a day and at will. The cows watered once a day drank less and produced less than those watered twice a day and the cows watered twice drank as much but produced less than those watered at will. It was thus found out that the higher the production the greater the benefit derived from frequent watering (Puck *et al.*, 2004).

2.2.3. Housing management

Housing or confinement of livestock has many important effects on production, and in the tropics various types of housing could be seen. Many of the management aspects such as feeding, breeding, disease control and labor inputs is invariably influenced by the type of housing. Under small scale low capital input livestock production system as that found in many tropical region, improvements achieved via small changes or improvements to the existing housing and/or management systems could result in greater economic benefit to the small farmer. Housing refers to the confinement of, or enclosure for animals and activities which provide shelter and/or restrict

the movement of the animals. Housing can also be defined as a location where animals are placed, fed and protected against the adverse effects of an extreme environment such as, too hot or too cold, heavy rain, strong wind, and disturbance from predators, other animals or organisms (Macfarlane, 1981).

Whether cows are housed in cubicles, straw yards or cow sheds in order to maximise performance of the cows and to ensure satisfactory standards of welfare the accommodation must provide for the cow's most basic needs. As an absolute minimum, the housing must provide a comfortable, clean, well drained and dry lying area together with shelter from adverse weather. It must also allow the animal to move freely around without risk of injury. If the housing system does not provide for these basic needs then not only will both production and welfare be compromised but it is likely that you are also failing to comply with the welfare codes and the law relating to animal welfare. Studies have shown that some of the major aspects of housing, such as space allowance and space at the feed-face can affect cow welfare (Bowell *et al.*, 2003).

Housing and handling systems vary widely depending on the particular use of the cattle in research and teaching (Albright, 1987). Recommended facilities for dairy cattle range from fenced pastures, corrals, and exercise yards with shelters to insulated and ventilated barns with special equipment to restrain, isolate, and treat the cattle. Generally, headlocks (one per cow), corrals, and sunshades are used in warm semi-arid regions. Pastures and shelters are common in warm humid areas, naturally ventilated barns with free stalls are used widely in cool humid climatic regions, and insulated and ventilated barns with tie stalls are common in colder climates.

During good weather, to enrich the environment and to improve overall health and well-being, cows should be moved if possible from indoor stalls into the barnyard, where they can groom (Wood, 1977) themselves and one another, stretch, sun themselves, exhibit estrous behavior and exercise (Albright, 1993). Exercise decreases the incidence of leg problems, mastitis, bloat, and calving-related disorders (Gustafson, 1993). Keeping cows out of mud increases their productivity and reduces endoparasitic and foot infections. Current trends and recommendations favor keeping dairy cows on unpaved dirt lots in the Southwest and on concrete in the North throughout their productive lifetimes. Concrete floors should be grooved to provide good footing

and to reduce injury (Albright, 1995). The concrete surface should be rough but not abrasive, and the micro surface should be smooth enough to avoid abrading the feet of cattle.

Table 1. Minimum space allowances in loose cattle housing

Breeding and fattening cattle. (Live weight kg)	Lying area (metres squared per head)	Additional area (metres squared per head)	Total available area (metres squared per head)
Up to 100	1.5	1.1	2.6
Up to 200	2.5	1.9	4.4
Up to 350	4.0	3	7
Above 350	1m ² per 100kg (with a minimum of 5m ²)	0.75m ² per 100kg (with a minimum of 3.7m ²)	1.75m ² per 100kg (with a minimum of 8.7m ²)
Dairy cows	6	4.5	10.5

Source (Bowell *et al.*, 2003)

2.2.4. Herd health management

Herd health and production management programmes make an integrative approach, taking into account in the same time the problems concerning production and nutrition, udder and hoof health, young stock breeding, fertility and vaccination programmes, animal welfare, use of antimicrobials, control of residues and milk quality (Jorristma and Noordhuizen, 2005). The main objective of the Health and Production Management Programme is to help the farmers to reach their goal, but this is different from farm to farm and to implement an integrative programme of health, reproduction and production quality management in dairy cows, identification and control of hazard factors, resulting in cows' welfare and improving of milk quality. Implementation of the health and production management programme imposes regular visits in farms and monitoring a large category of data: general status of animals, clinical exam, trans rectal exam for reproduction, status monitoring, examination of housing conditions, microclimate, hygiene, data concerning milk production and its quality, treatments, etc.

Dairy cow health management requires a continuous evaluation of the animal health (Valle *et al.*, 2007). Animal health assessment can, however, be tackled in several ways. Studies of disease occurrence are possible ways of assessing animal health and can be done by direct cow-side methods as well as by indirect methods. Studies of official health records and performing questionnaires reflecting what farmers can recall or percept are examples of indirect methods. Questionnaire studies tend to be of more subjective nature than the more objective registry and cow-side methods. Health can also be assessed by use of reproductive performance and animal behavior. Reproductive performance is easiest studied by indirect methods, whereas animal behavior is most suited for direct assessment methods. Stereotypic behavior, in contrast to natural behavior is a sign of ill-health. However, the indistinct definition of natural behavior can put a great deal of subjectivity into that kind of assessment (Nils, 2009).

The following key indicators, representing both direct and indirect study:

- Udder health
- General health
- Reproductive performance and length of productive life
- Metabolic profiles

In Ethiopia, Animal health care and improved health management is one of the major constraints of dairy development, 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 relies 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).

In most developing nations, livestock services, like livestock health still remain a government responsibility, while in the more developed countries, some support service functions of the government are being performed in partnership with, or have been transferred to, the private sector (Umali *et al.*, 1992). The low veterinary service performance in Ethiopia is also resulted from the shortage and inadequate number of the government veterinary staffs and cannot 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).

2.3. Production and Reproduction performance of dairy cattle

2.3.1. Age at first service

Age at first service (AFS) is the age at which heifers attain body condition and sexual maturity for accepting service for the first time. AFS signals the beginning of the heifer's reproduction and production and influences both the productive and reproductive life of the female through its effect on her life time calf crop. It occurs when the gonads begin to secrete sufficient steroids to accelerate the growth of the genital organs and the development of secondary sexual characteristics (Mukasa-Mugerwa *et al.*, 1989). Heifers, especially *Bos taurus* can reach puberty and breed at one year old. However, *Bos indicus* reach puberty late. In general, the time taken for zebu cattle to attain sexual maturity and puberty are highly influenced by environmental factors including feed quantity and quality (Mukasa-Mugerwa *et al.*, 1989).

Table 2. Some estimates of age at first service for dairy cattle in Ethiopia

Breed	AFS (month)	Location	Source
Local zebu heifers	42.48	Bure district, Ethiopia	Adebabay,2009
Crossbred HF heifers	27.24	Bure district, Ethiopia	Adebabay,2009
Fogera heifers	44±0.8	ALRC, Ethiopia	Gidey,2001
Crossbred HF heifers	35.7±0.4	ALRC, Ethiopia	Gidey,2001
Local heifers	32.82±1.06	Mekelle, Ethiopia	Negussie,2006
Crossbred HF heifers	25.05±1.26	Mekelle, Ethiopia	Negussie,2006

ALRC= Andassa livestock research center

2.3.2. Age at first calving

Apart from the various other factors age at first calving in dairy cattle makes the milk production uneconomical. Early maturity is considered as a character of great economic importance as from birth to the date of first calving, the animal produces get nothing except dung and urine, the value of which is negligible as compared to the cost of maintenance(Khal *et al.*,1989). 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).

Table 3. Some estimates of age at first calving for milk cattle in Ethiopia

Breed	AFC (month)	Source
Boran	45.2	Mekonnen <i>et al.</i> , (1993)
East African Zebu	35.1	Alberro (1983)
Highland zebu	53	Mukasa-Mugerwa <i>et al.</i> (1989)
Horro	35	Azage <i>et al.</i> , (1981)
Barka	30.3	Goshu (1981)
Fogera	53.8	Asheber, (1992)
Arsi	32.8	<i>Enyew et al.</i> (1998)

AFC= Age at first service

2.3.3. Calving interval

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, 1990).

The general practice in dairy herds with intensive milk production is to breed cows with the aim of establishing a calving interval (CI) of 12 months. However, to achieve a 12 months CI, the insemination of the cow occurs at the peak of production. Consequently, the insemination takes place when the cows are most challenged metabolically (Harrison, *et al.*, 1990). It has also been shown that the risks of fertility problems, such as silent heat and ovarian cysts, increase with increasing milk production (Grohn & Harman, 1994). These kinds of fertility problems obviously make an early conception more difficult.

High milk yields and 12 months CI, the current dominant breeding system, causes general concerns about metabolic diseases. It has been concluded that increasing milk yield leads to an increase in the frequencies of metabolic diseases, such as ketosis and milk fever (Distl, *et al.*,

1989). There are, however, other serious concerns surrounding the current practice and many cows are actually discarded after just one or two lactations. The most common reason for culling is fertility problems, which account for as much as 25% of the culled cows (Swedish Dairy Association, 2002). Another problem concerning calving is that a majority of veterinary problems, including milk fever, ketosis, retained placenta and displacement of the abomasums, occur within the first two weeks of the lactation (Goff and Horst, 1997).

Even though several studies suggest an optimal CI of near 12 months, there are studies that have shown an advantage for a longer period of days open and, consequently, an extended calving interval. Cumulative yield of current and following annualized lactations was greatest at 117 and 98 days open for primi parous and multiparous cows, respectively (BarAnan and Soller, 1979). When discussing an extended calving interval, there may well be other advantages. For example, Ratnayake, *et al.*, (1998), showed that an increase of the CI to 18 months may have a positive influence on reproduction, in terms of a reduced need for the treatment of ovarian disorders and higher conception rates.

Table 4. Some estimates of on station calving interval for indigenous cattle in Ethiopia

Breed	CI (month)	Source
Horro	12.2	McDowell (1971)
Arsi	12.9-15.1	Swensson <i>et al.</i> (1981)
Highland zebu	25	Mukasa-Mugerwa <i>et al.</i> (1989)
Barka	11.8	Goshu (1981)
Fogera	14.5	Goshu (1981)
Fogera	18.6	Gidey (2001)

CI= Calving Interval

2.3.4. Lactation performance

The lactation performance of dairy cattle is usually measured by determining the total milk yield per lactation or per year, average daily milk yield, lactation length, lactation persistency, and milk composition. Generally, the reproductive performance and lactation performance of dairy cattle are closely associated with each other. Breeding failure has a clear negative influence on milk production and farm income and determines the future sustainability of a dairy farming operation (Fikre, 2007). In most modern dairy farms, a lactation length of 305 days is commonly accepted as a standard. However, such a standard lactation length might not work for smallholder dairy cows in which the lactation length is extended considerably in most cases (Teodoro and Madalena, 2003; Masama *et al.*, 2003; Msangi *et al.*, 2005).

The milk production potential of indigenous breeds of cattle is very low. The average milk yield per lactation ranges from 494 to 850 kg under optimum on-station management (EARO, 1999). Therefore, to up-grade, the production of the local cattle, crossbreeding of the indigenous breeds with temperate exotic breeds has been practiced in the country, since the establishment of the Institute of Agricultural Research, with the aim of making use of the high genetic potential for milk production of exotic breeds and the adaptability to the local environment of indigenous breeds. Improvements in daily milk yield of cows could be considered as one of the strategies to increase the overall milk production in the areas i.e. assuming that persistency and lactation length is improved. This could be achieved through nutritional management interventions during the most critical periods of the lactation period and life cycle. Improvements in nutritional management during the later quarter of pregnancy and during early lactation period could increase peak milk yield, improve persistency and increase lactation length (Azage *et al.*, 2003; Belete, 2006 and Adebabay, 2009).

Table 5. Some estimates of lactation performance of milk cattle in Ethiopia

Breed	Lactation performance		Source
	LMY (Kg)	LL (days)	
Boran	494	155	Beyene and Galal (1982)
Horro	559	285	Beyene and Galal (1982)
Barka	552a	128a	Goshu(1981)
Arsi	809	272	Kiwuwa <i>et al.</i> (1983)
Fogera	613a	353a	Goshu(1981)

LMY: Lactation milk yield, LL: Lactation Length, a=first lactation

2.4. Milk and milk products utilization and consumption pattern in Ethiopia

Ethiopia has a low level of milk consumption compared to other countries in the region (Kenya = 90 lt/cap; Uganda = 50 lt/cap). Even though Ethiopia has the largest inventory of milk producing animals (cattle, sheep, goats and camels), per capita consumption of milk is low compared to Kenya with fewer livestock and Sudan. The national per capita consumption of milk and milk products is estimated at 17 kg (Ahmed, 2003). Average expenditures by households on milk and milk products is, only four percent of the total household food budget (Staal, *et al.*, 2008). Ethiopia is unique from other countries in the region because of the number of fasting days, over 200, and the cultural attitude that milk is mainly for children and the sick.

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).

Under current situation, the milk production level in the country is not sufficient to meet the existing demand of the rapidly growing population. It can be said that the production of milk does not keep pace with the growing population and the per capita consumption of milk over the years is declining in Ethiopia (Ketema and Tsehay, 2004). Therefore, the potential of small scale

milk farmers and organizations in meeting current and future consumer needs is recognized as vital to the development of milking in Ethiopia. Moreover, the milk industry needs to be optimized through organizing milk production, processing, preservation and marketing in a well coordinated way to increase the quantity and quality of milk and milk products being offered to consumers (Getachew and Gashaw, 2001). With the increasing demand for diverse and quality animal products, prices are bound to escalate unless production increases proportionally. Bridging the wide gap between demand-supply calls for the designing of appropriate and sustainable milk development strategies based on the specific agro- ecology and felt needs of smallholder farmers.

2.5. Milk handling and processing practices in Ethiopia

In the highlands of Ethiopia, milk produced by smallholders is used for family consumption and for the production of butter and a cottage-type cheese. In areas where the climate is hot and humid, the raw milk spoils easily during storage unless it is cooled or when possible treated with preservatives. In this case, the farmers have to rely on traditional technology to increase the storage stability of milk and milk products either by converting the milk to its stable products like butter or by treating with traditional preservatives, as cooling systems are not feasible because of lack of facilities (Lemma *et al.*, 2005). Milk may be processed fresh or sour (O'Connor, 1995). The choice depends on available equipment, product demand and on the quantities of milk available for processing. Sour milk or yoghurt (Ergo in Amharic) is produced in the traditional system by leaving fresh milk to sour for a few days. Soured milk keeps longer than raw milk, so this process is useful for storing milk during the day of Wednesdays and Fridays, when Orthodox Christians fast are forbidden to consume animal products (Debrah and Berhanu, 1991).

Butter making is an ancient practice that goes back as far as 2000 BC to the time of Egyptian civilization (Tsehay, 2002). This butter making may have begun at a similar time in Ethiopia. According to O'Mahony (1988), there are different reasons forwarded why smallholder milk processing is based on fermented milk. These are mainly high ambient temperature, small daily quantities of milk produced, consumer preference, the improved keeping quality of fermented

milk and the type and capacity of the locally available processing materials and methods used. Traditional system of butter making differs from place to place and their efficiency in terms of milk fat recovery and time requirement could vary. Here the traditional systems of butter making show low rate of fat recovery (90.53%) and longer time than the improved technologies (cream separator and butter churn) and the appropriate technology developed by ILCA (internal agitator) (Zelalem and Inger, 2000)

The procedure for making butter for the traditional Ethiopian practice is, to accumulate the milk for two to three days until it is sour. A clay pot is then used to churn the sour milk. The churning operation started after stirring the content and transferring to another smoked clay pot. The clay pot is agitated until butter grains are formed. The developed gas is released every 2-3 minutes by opening the top of the churn during the first 10-15 minutes of the churning operation. The churning operation, a back and forth movement, is manually performed in a traditional way. The buttermilk remaining after the butter has been separated from the whole milk is used to produce a cottage type cheese (ayib) by heating the buttermilk (Belete, 2006).

2.6. Milk and milk products marketing in Ethiopia

Marketing includes all activities performed in moving commodities from the producer to the consumer. It also includes all the exchange activities of buying and selling; all the physical activities performed to give the commodity increased utility; and all the auxiliary activities such as financing, risk bearing and disseminating information to participants in the marketing process. It involves the transfer of ownership of products through buying, selling, pricing, and renting and physical movement as well as transformation of the commodity into more usable forms through transportation, handling, storage, processing and packaging (Winrock, 1992). Therefore, marketing involves sales, locations, sellers, buyers and transactions (Sintayehu *et al*, 2008).

In Ethiopia milk and milk products is channeled through both formal and informal methods (Mohamed *et al*. 2004). The informal market which is characterized by no licensing requirement to operate, low cost of operations, high producer price compared to formal market and no

regulation of operations, involves direct delivery of fresh milk by producers to consumers in the immediate neighborhood and sale to itinerant traders or individuals in nearby towns (Debrah and Berhanu, 1991). The formal market is, used to describe government official marketing systems (Debrah 1990). Until 1991, the formal market of cold chain, pasteurized milk was exclusively dominated by the DDE (Dairy development Enterprises) which supplied 12 percent of the total fresh milk in the Addis Ababa area (Holloway *et al.* 2000).

2.7. Constraints of milk production and marketing in Ethiopia

2.7.1. Constraints of milk production

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 days 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). According to Emebet (*et al.*, 2003), the institutional constraints, Policy-related constraints and technical constraints responsible for such low productivity, are revolved around three factors:

- 1) Feed availability and quality: seasonal quantitative and qualitative feed shortages, and
- 2) Poor Livestock health: poor veterinary health care and management.
- 3) Low genetic potential for milk production and unavailability of supply of improved genotype

2.7.2. Constraints of milk processing and marketing

In the highlands of Ethiopia, milk produced by smallholders is used for family consumption and for the production of butter and a cottage-type cheese. However, the traditional milk processing to make butter is constrained by long time and low butter fate recovery. According to Belete (2006) for butter making, milk is collected over a period of three or four days in a clay pot. When the milk has soured and sufficient milk has been collected, the clay pot is shaken back and forth until butter granules are formed. This method of butter making may take from two to three hours,

depending on such factors as temperature, the fat content of the milk, the acidity of the milk and the amount of milk in the clay pot. The time taken to make the butter together with the time involved in taking this butter to the market place is a considerable drain to the smallholders, specifically on that of the wife and family.

Furthermore, according to Zelalem and Inger (2000), traditional butter making requires about 21-25 kg milk to produce 1kg of butter with moisture content of 83% and 3.2-4.5 kg Ayib can be produced from subsequent buttermilk. On the contrary, butter making using Internal Agitator and improved technology had required 20kg and 16-18kg of milk to produce 1 kg of butter respectively.

In Ethiopia, the smallholders produce about 93% of dairy product, but it is only small quantity of this production that is marketed in the form of liquid milk; the larger volume is processed into different dairy products for home consumption and sales. The low marketable milk output in Ethiopia poses limitations on the possibilities of exploring distant but rewarding markets due to high transaction costs arising from transportation and high opportunity cost of labor involved. Again, dependable marketing system is not yet developed to market milk and milk products. Producers and consumers are spatially separated; most producers are found in the rural areas while consumers or profitable market is found in urban areas. Market infrastructures and marketing facilities are not well developed in the country. This, in turn, reduces incentives to participate in economic transactions and results in subsistence rather than market-oriented production systems. Therefore, improving the position of smallholders to actively engage in the dairy market is one of the most important development challenges of the country (Holloway *et al.*, 2002).

3. MATERIALS AND METHODS

3.1. Description of the study area

3.1.1. Location

The study was carried out in Enderta district, which is one of the four districts in the southeastern administrative zone of Tigray National Regional State. It is found about 760 kilometers north of Addis Ababa and located at a $13^{\circ}15'00''$ N and $39^{\circ}30'30''$ E with an altitude ranging from 1500 to 2000 meters above sea level. It shares borders with Kilte'awlaelo district in the north, Hintalo Wajirat in the south, Afar regional state in the east and the district of Degu'a Tembien in the west. The Wereda covers a total area of 89,812 square kilometers of which 30,062 hectares is cultivable land.

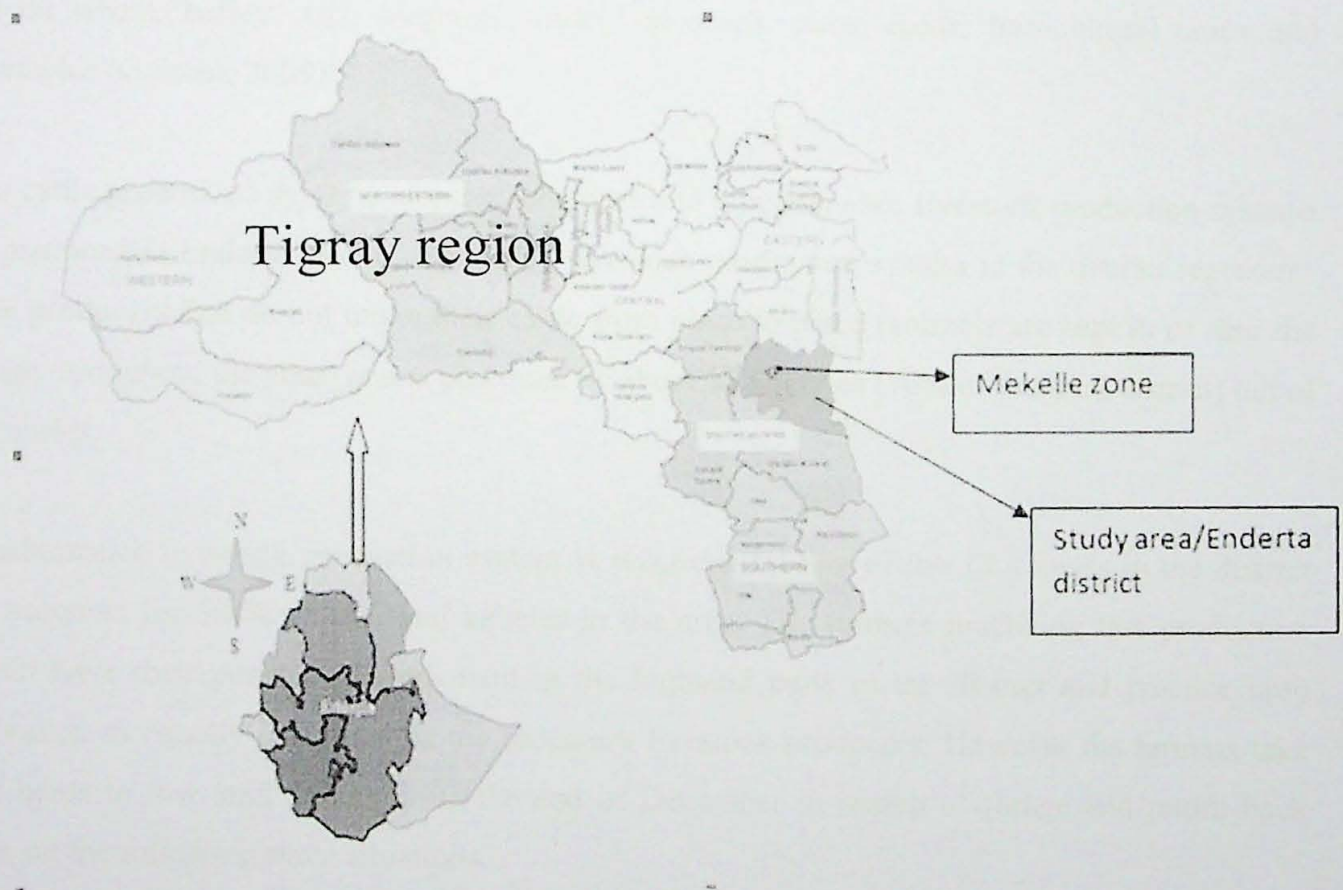


Figure 1: The study area in Tigray region. (Source: BoANRIDT, 2003)

3.1.2. Population and climatic condition

The total population size is 114,277 according to the 2007 population census of the CSA (2008). It has 71,136 cattle, 11,146 sheep, 21,649 goats, 19,968 donkeys, 2167 mule, 594 camel, 72 mule, 27,692 poultry and 2803 bee hives (CSA, 2006).

The agro-climatic state of the district is mainly (96%) warm mild climate (weyna dega), with remaining 3% and 1% hot low land climate and temperate climate respectively. Annual average rainfall ranges from 450 to 550mm. And the average temperature is 15.4- 20.4 degree centigrade.

3.1.3. Farming system

In concurrence to the agro-climatic state of the Wereda, smallholder mixed farming remains the single largest tributary to the livelihoods of the population. Major crops grown in the Wereda include wheat, barley, teff, sorghum, millet, oil seeds, pulse seeds, horticultural crops and vegetables (Goitom, 2009).

Two cattle production systems namely, sedentary and transhumance livestock production systems are practiced in Enderta district. Sedentary livestock production system in the district represents those producers that do not move their cattle from place to place (animals are kept in or near the village throughout the year) and is practiced by about 12 kebelles (70% of the total district) out of 17 kebeles.

Transhumance livestock production system is practiced by five of the 17 kebeles in the district and accounts for 30 % of the total kebeles in the area. The farmers practicing this production system have their permanent settlement in the highland parts of the district and practice crop cultivation as equally important as the sedentary livestock producers. However the farmers take their herds to low land areas during the end of December in search of forage and return back home on the following three situations.

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1. At the time of land cultivation for crop production especially in the end of April and the beginning of June, oxen come back home to cultivate land. Then after crop sowing is completed the oxen are moved back their herds on the low lands.
2. When the district animal health service calls for cattle vaccination
3. During crop harvesting period at the end of September, the whole herd come back to use crop aftermath.

3.2. Study population and sample size determination

The target population was all households who had lactating cows during the study period.

The sample size was determined using the formula recommended by Arsham (2007) for survey studies.

$N = 0.25 / (SE)^2$ Where, N= sample size, SE= standard error of the proportion,

With the assumption of 4% standard error, a total of 150 households were considered for the study.

3.3. Sampling procedure

Before starting the survey over all information of the district was assessed. This was concerned on searching the dairy potential areas of the district and other pre study guide lines important for selecting the kebeles that should be included in the study. Within the two livestock production systems the district is classified in to four livestock sub systems based on the production potential (WOoARD, 2010).

- Milk production zone (*Tseba limat zone*)
- Shoat production zone (*Telebegie limat zone*),
- Bee production zone (*Nihibi limat zone*)
- Poultry production zone (*Derho limat zone*)

Secondly after gathering the information above, four peasant associations, one from transhumance (a kebele called Dergagen) and the rest three (Kebeles called Didba, Kedemay-

weyane and Arato) from sedentary livestock production systems were selected purposively, based on their livestock population within the milk production zone. Following this selection, a rapid appraisal survey was conducted by the agricultural development workers of the respective peasant associations to identify list of farmers who own lactating cows both local and local plus crossbreds.

Based on the above information, Proportional Probability to Size (PPS) method was applied to distribute the total sample size (150) across the two production systems (across the selected kebeles). Then systematic random sampling method was used to take the sample households from each stratum; accordingly 10% of the local farms and 50% of the local plus crossbred farms from each farming systems were considered for the study. This is depicted in figure 2.

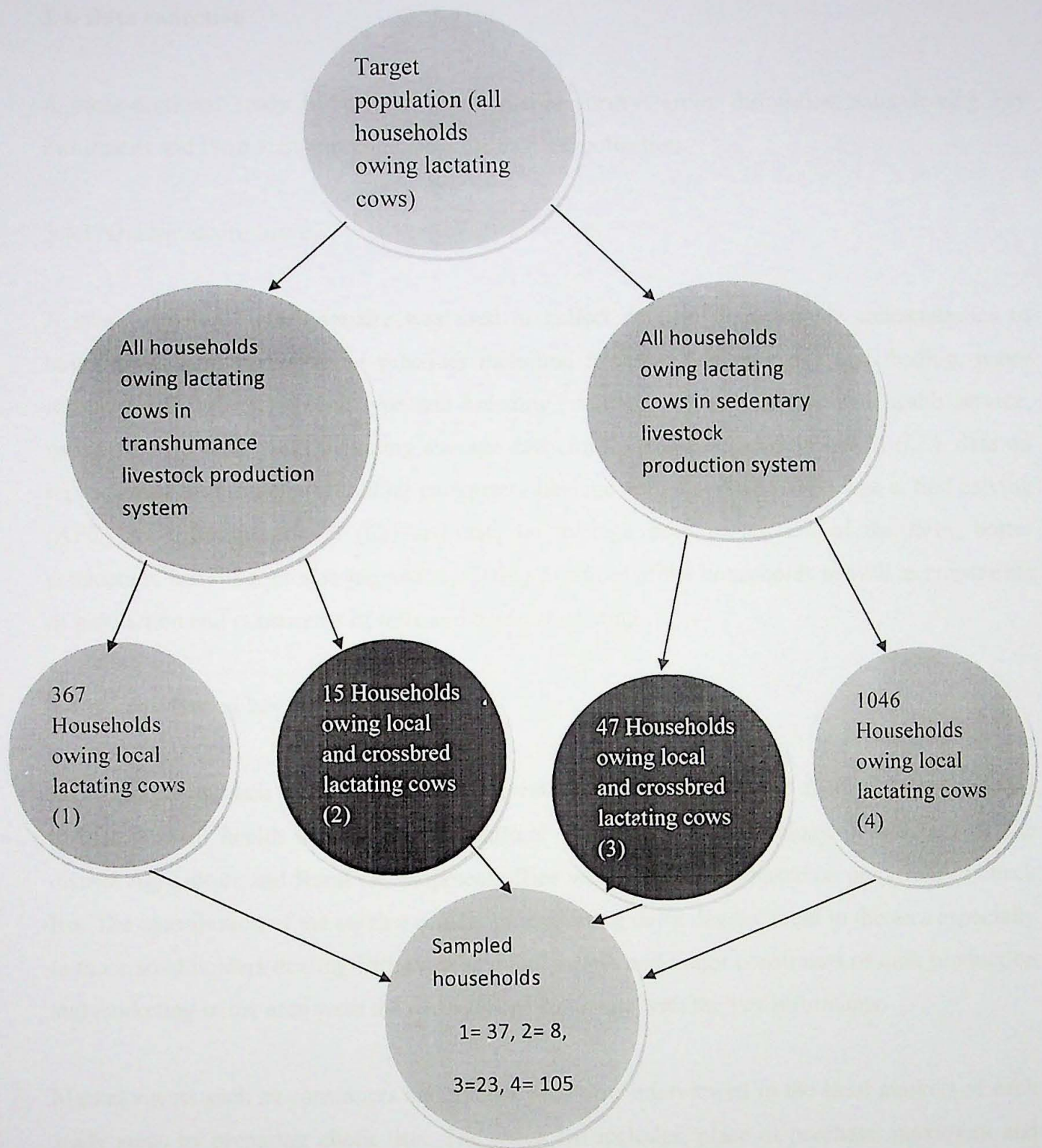


Figure 2: Conceptual depiction of the sampling procedure used in the present study.

3.4. Data collection

A cross-sectional study by way of questionnaire survey, group discussion, interviewing key informants and farm visit was conducted for the data collection.

3.4.1. Questionnaire survey

A semi- structured questionnaire was used to collect data on demographic characteristics of households, farm management practices including housing, feed resource and feeding, water resource and watering, breed type and breeding, milking practices and animal health service, parameters for milk yield including average daily milk yield and lactation length (LL), data on reproductive performance including parameters like age at first service (AFS), age at first calving (AFC) and calving interval (CI) and data on average milk production of the farm, butter production, handling, processing and marketing practices of the households as well as constraints of production and constraints of milk and butter marketing.

3.4.2. Interviewing key informants

Key informants such as team leaders of livestock production, animal feed and nutrition, AI service, animal health service and agricultural extension and technology distribution of the district Agriculture and Rural Development office were interviewed based on pre arranged check list. The contribution of the service centers in supporting dairy development in the area especially to those smallholders dealing with crossbred dairy cows and major constraints of milk production and marketing in the area were the focus discussion made with the key informants.

Market agents such as consumers and traders were also interviewed in the local markets of each study areas by preparing check lists. The check list includes, place of purchase, maximum and minimum volume of purchase, place of product sell, types of buyers, mode of payment and marketing constraints of butter.

3.4.3. Group discussion

In both production systems a discussion group in which one livestock DA, three male and three female household heads participated was organized. Effort was made to include households from each farm types (from local and local plus crossbred farms). The household heads that were participated in the group discussion were selected with the help of development agents working in the area. Issues presented for group discussions were selection criteria for breeding bull, cattle housing system, major cattle diseases and their traditional treatment, milk use categories, reasons for milk processing, constraints of milk production and marketing as well as suggestions for possible improvement of dairy sector in the area.

3.4.4. Farm visit

At the same time with the questionnaire interview, farm inspection was carried out to gather information on:

- Housing types
- Barn hygiene
- Utensils used for milking and milk handling
- Milk processing practices

For indoor feed cattle the farms were monitored to check for the presence of:

- udder injury
- hoof injury
- lameness

3.5. Data management and statistical analysis

The data was entered in to the data base management software Micro-soft-Excel computer program and analyzed using SPSS (version 16.0, 2007). Descriptive statistics (frequencies and percentages) was used to summarize qualitative variables and means for quantitative variables were compared by ANOVA. Chi square test was also applied to test some qualitative variables.

4. RESULTS

4.1. Household demographic characteristics

Out of the total surveyed households, 88% of the sampled respondents were male headed and 12% of them were female head households. The mean family size per household in the transhumance production system was significantly higher than the sedentary livestock production system ($p < 0.05$). The average family size of sampled households also had a significant difference ($p < 0.05$) between male headed and female headed households (Table 6).

Table 6. Mean family size of the sampled households by production system and by sex of household head.

Variables	Group	N	Mean $\pm$ SE
	<i>Over all</i>	150	6.17 $\pm$ 0.14
Farming system	Transhumance	45	6.6 $\pm$ 0.26
	Sedentary	105	5.9 $\pm$ 0.17
	P-value		0.045
Sex	Male	132	6.27 $\pm$ 0.15
	Female	18	5.39 $\pm$ 0.45
	P-value		0.043

N= Number of respondents

According to the survey result indicated in Table 7, in both production systems, majority of the household heads were in the age category of 31-60 years whereas insignificant proportion of the household heads were above 60 years. 69.3% of the respondents were illiterate, 10.7% attended elementary school, 1.3% high school and 18.7% can read and write.

Table 7. Age structure and educational level of sampled households

Variables	Transhumance		Sedentary		<i>Over all</i>	
	N	%	N	%	N	%
Age structure:	45		105		150	
<30	11	24.4	17	16.2	28	18.7
31-60	29	64.5	78	74.2	107	72.1
>60	5	11.1	10	9.5	15	10.0
Educational level:	45		105		150	
Illiterate	34	75.6	70	64	104	69.3
Elementary school	3	6.7	13	12.3	16	10.7
High school	2	4.4	0	0	2	1.3
Read and write	6	13.3	22	21.0	28	18.7

N= number of respondents

4.2. Household income and resource endowment

4.2.1. Land holding

Land holding of the respondents did not significantly ($p>0.05$) vary between the two production systems. But land holding was significantly ($p< 0.05$) higher in male headed households (2.08 ± 0.12 ha) than female headed households (1.00 ± 0.08 ha) (Table 8).

Table 8. Average land holding of households by farming system and sex of household head

Variables	Group	N	Mean $\pm$ SE (ha)
	<i>Over all</i>	150	1.957 $\pm$ 0.11
Farming system	Transhumance	45	2.01 $\pm$ 0.21
	Sedentary	105	1.94 $\pm$ 0.13
	P-value		0.725
Sex	Male	132	2.08 $\pm$ 0.12
	Female	18	1.00 $\pm$ 0.08
	P-value		0.001

N= Number of respondents

4.2.2. Livestock species composition and cattle herd structure

Livestock composition

Cattle constituted 31.54% and 35.48% of the total livestock composition in transhumance and sedentary livestock production systems, respectively. Overall the proportion of cattle was 34.04%, being the largest of all species (Table 9).

Table 9. Livestock composition of sampled households across the two farming systems of Enderta district

Livestock species	Production system						<i>Over all</i>		
	Transhumance			Sedentary					
	N	Population	%	N	population	%	N	Population	%
Cattle	45	469	31.54	105	927	35.48	150	1396	34.04
Sheep	40	303	20.38	69	522	19.98	109	825	20.12
Goat	38	352	23.76	44	291	11.14	82	643	15.67
Camel	4	5	0.34	7	10	0.38	11	15	0.35
Mule	10	13	0.87	21	27	1.03	31	40	0.97
Horse	18	1	0.06	10	3	0.11	28	4	0.35
Donkey	28	48	3.23	62	105	4.02	90	153	3.73
Chicken	41	229	15.4	87	593	22.69	128	822	20.04
Beehives	23	67	4.5	49	135	5.17	72	202	4.90

N= Number of respondents

Cattle herd structure

The average cattle holding (Table10) per household in transhumance was significantly ($p<0.05$) higher than the sedentary livestock production system with overall average cattle herd size of 9.87 ± 0.35 heads per household.

Table 10. Cattle herd structure of sampled households across the two farming system in Enderta district

Cattle type		Transhumance		Sedentary		<i>Over all</i>		P –value
		N	Mean $\pm$ SE	N	Mean $\pm$ SE	N	Mean $\pm$ SE	
Local cattle		45	11.17 $\pm$ 0.71	105	9.31 $\pm$ 0.39	150	9.87 $\pm$ 0.35	0.016
Calves	M	32	1.5 $\pm$ 0.09	69	1.43 $\pm$ 0.06	101	1.46 $\pm$ 0.05	0.545
	F	36	1.47 $\pm$ 0.12	71	1.25 $\pm$ 0.06	107	1.33 $\pm$ 0.06	0.72
Cows		45	3.38 $\pm$ 0.24	73	2.62 $\pm$ 0.14	111	2.85 $\pm$ 0.12	0.04
Bulls		35	1.51 $\pm$ 0.10	67	1.36 $\pm$ 0.07	102	1.41 $\pm$ 0.06	0.19
Heifers		38	1.87 $\pm$ 0.16	104	1.64 $\pm$ 0.10	149	1.72 $\pm$ 0.08	0.072
Oxen		45	2.9 $\pm$ 0.18	105	2.43 $\pm$ 0.10	150	2.55 $\pm$ 0.09	0.021
Crossbred cattle		8	4.00 $\pm$ 0.33	23	4.26 $\pm$ 0.24	31	4.19 $\pm$ 0.19	0.564
Calves	M	5	1.00 $\pm$ 0.00	15	1.07 $\pm$ 0.06	20	1.05 $\pm$ 0.5	0.578
	F	5	1.00 $\pm$ 0.00	12	1.00 $\pm$ 0.00	17	1.00 $\pm$ 0.00	
Cows		8	1.63 $\pm$ 0.18	23	1.52 $\pm$ 0.14	31	1.55 $\pm$ 0.11	0.694
Bulls		2	1.00 $\pm$ 0.00	4	1.17 $\pm$ 0.25	6	1.17 $\pm$ 0.17	0.541
Heifers		7	1.14 $\pm$ 0.14	20	1.45 $\pm$ 0.11	27	1.3704 $\pm$ 0.09	0.159

N= Number of respondents

Ownership pattern of lactating cows

The number of local lactating cows (Table 11) per household in transhumance system is significantly higher ($P < 0.05$) than that of sedentary livestock production system. But the mean number of crossbred lactating cows per household did not significantly ($p > 0.05$) vary between the two production systems. The overall mean lactating cows per household of Enderta district was found to be 2.18 $\pm$ 0.09 heads.

Table 11. Average number of lactating cows holding per household across the two production systems in Enderta district

Breed	Transhumance		Sedentary		Overall		<i>P</i> -value
	N	Mean $\pm$ SE	N	Mean $\pm$ SE	N	Mean $\pm$ SE	
Local	45	2.16 $\pm$ 0.14	105	1.75 $\pm$ 0.07	150	1.87 $\pm$ 0.07	0.006
Crossbred	8	1.25 $\pm$ 0.16	23	1.17 $\pm$ 0.10	31	1.19 $\pm$ 0.08	0.71
Total	45	2.44 $\pm$ 0.19	105	2.07 $\pm$ 0.10	150	2.18 $\pm$ 0.09	0.052

N= Number of households

4.2.3. Income source

The most important source of income (Table 12) in both production systems was crop production followed by sale of live animal (74.7%). Butter sell was reported by 74.4% of the respondents as a third while of farm activity was reported as a fourth important income source in the area.

Table 12. Proportion of households' income source by rank (% of households responded)

Variables	Income source by rank (N=150)							
	1		2		3		4	
	N	%	N	%	N	%	N	%
Crop production	150	100	0	0	0	0	0	0
Sale of live animal	0	0	112	74.7	19	15.7	8	5.3
Butter sell	0	0	33	22.0	112	74.4	4	2.7
Fresh milk sell	0	0	5	3.3	10	9.7	11	7.3
Of farm activity	0	0	0	0	9	0	127	84.7

N= Number of households

4.3. Purpose of cattle keeping

In both production systems, the purpose of rearing local cattle is different from that of crossbred cattle. As shown in Table 13, local cattle are kept mainly for draught purpose, reproduction, milk production and meat. All of the respondents have indicated that milk production is the main purpose for which crossbred cattle are kept.

Table 13. Purpose of local and crossbred cattle keeping in Enderta district

Variables	Purpose of local cattle keeping by rank (N=150)							
	1		2		3		4	
	N	%	N	%	N	%	N	%
Draught power	138	92.0	12	8.0	0	0	0	0
Meat production	0	0	4	2.7	38	25.3	131	87.3
Reproduction	12	8.0	88	58.7	44	29.3	0	0
Milk production	0	0	46	30.7	68	45.3	19	12.67
Variables	Purpose of crossbred cattle keeping by rank (N=31)							
	1		2		3		4	
	N	%	N	%	N	%	N	%
Milk production	31	100	0	0	0	0	0	0
Reproduction	0	0	24	77.42	9	29.03	0	0
Meat production	0	0	0	0	3	9.68	25	80.65
Selling heifers	0	0	7	22.58	19	61.29	6	19.36

N= Number of respondents

4.4. Cattle husbandry practices

4.4.1. Feeding management

Feed resources

In both production systems, the main feed resource for local cattle was reported to be grazing of natural pasture and crop aftermaths and crop residues were given as a supplement when needed. The major crop residues available in the study area are found to be barley, wheat, teff straws and maize stovers. Even if crop residues are the available feed resources for supplementing cattle, the existing way of utilization is poor. Out of the total 150 respondents interviewed only 18% treat the crop residues by Atela (Table 14). There was no other crop residue treatment practice in the district. 85.4% of the respondents indicated that there is lack of knowledge in treating crop residues in the area.

The main feed resource for crossbred cattle in both production systems is crop residues of wheat and barley straw treated by the residue of local beverage called “Atela” to improve its utilization. Farmers have reported that, crossbred cows do not consume the crop residues, unless they are treated by Atela. Some farmers have also indicated that, frequent feeding of Teff straw to crossbred milk cows would lead to dilution of the milk. Others have also reported that frequent use of Atela to result in change of milk odor.



Figure 3. A farmer treating crop residue with Atela to feed his crossbred cow

Atela

As indicated in Table 14, 14.7% of respondents reported that they practice improved forage cultivation. Elephant grass (*Penissetum perparum*), *Leaucenea leacucephala* and *Sesbania sesban* were planted by some farmers who had crossbred milk cows. Respondents indicated that shortage of land (83.6%) and labor (16.4%) are the main factors that hinder cultivation of improved forage species.

Table 14. Treatment of crop residue and practice of growing improved animal fodder species in the two production systems in Enderta district

Variables	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
Treating crop residue to improve utilization:	Total	45		105		150	
	Yes	7	15.6	20	19.0	27	18.0
	No	38	84.4	85	81.0	123	82.0
Reason for not treating crop residue:	Total	38		85		123	
	No knowledge	28	73.7	77	90.6	105	85.4
	No reason	10	26.3	8	9.4	18	14.6
Practice of growing fodder crops:	Total	45		105		50	
	Yes	7	15.6	15	14.3	22	14.7
	No	38	84.4	90	85.7	128	85.3
Reason for not growing animal feed:	Total	38		90		128	
	Insufficient land	29	76.3	78	86.7	107	83.6
	Insufficient labor	9	23.7	12	13.3	21	16.4

N= Number of respondent

As shown in Table 15, 17.8% of the respondents in transhumance production system purchased feed for their animals. Similarly, in the sedentary livestock production system, 32.4% of the respondents reported they buy feed for their animals. In the transhumance livestock production system only the respondents who had crossbred cows purchase feed. None of the respondents that had only local bred cattle buy feed. But in the sedentary livestock production system, other than

the respondents owing crossbred cattle, 11 respondents that own only local cattle purchased feed for local cattle.

Table 15. Animal feed purchased in the two production system of Enderta district

Variable	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
Purchase feed:	Total	45		105		150	
	Yes	8	17.8	34	32.4	42	28.0
	No	37	82.2	71	67.6	108	72.0
Purchased feeds:	Total	8		34		42	
	Hay	7	87.5	22	64.71	29	69.05
	Green grass	0	0	6	27.27	6	14.29
	Wheat bran	8	100	23	67.65	31	73.81
	Salt	5	62.5	21	50.0	26	61.9
	Crop residue	0	0	6	27.27	6	14.29
	Atela	6	75.0	25	59.52	31	73.81

N= Number of respondents

Feeding practice

In both production systems, free grazing is the dominant feeding system for local cattle and stall feeding practiced for cross bred dairy cattle.

While supplementing local cattle with crop residue or hay, farmers group their animals based on sex (72.67%) and age (27.33). But for crossbred cattle individual feeding is practiced by the majority of farmers (77.4%) whereas a small proportion of farmers reported that they use group feeding (22.6%) (Table 16).



Figure 4. Individual feeders of crossbred cows in one farm with three milking cows

Table 16. Feeding practice of dairy cattle in the two production systems of Enderta district

Variable	Group	Transhumance		Sedentary		Overall	
		N	%	N	%	N	%
Feeding of local cattle:	Total	45		105		150	
	Group feeding	45	100	105	100	150	100
Type of group feeding for local cattle:	Total	45	24.44	105		150	
	Age group	11	28.89	30	28.57	41	27.33
	Sex group	34	75.56	75	71.43	109	72.67
Feeding of crossbred cattle:	Total	8		23		31	
	Individual feeding	6	75.0	18	78.3	24	77.4
	Group feeding	2	25.0	5	21.7	7	22.6
Group feeding for crossbred cattle:	Total	2		5		7	
	Age group	1	50	2	40.0	3	42.86
	Sex group	1	50	3	60.0	4	57.14

N= Number of respondents

4.4.2. Water source and watering practice

Water source

All the interviewed respondents in both production systems reported that water source from pumps (the same water as the people drink) was given for crossbred cattle in both seasons. For local cattle, water from river, dam and wells is used within a percentage being 47.3%, 37.3% and 15.3%, respectively. In dry season, water source from wells is the major (37.8%) source for local cattle in transhumance production system while in sedentary livestock production system water source from river is used by the majority (54.3%). In rainy season, water source from river was the major source for local cattle in both production systems. Overall, water source from river (47.3%) and dams/reservoirs (37.3%) have the major contribution of water for local cattle in dry season (Table 17).

Table 17. Water sources in dry and rainy seasons in the two production systems of Enderta district

Variable	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
Water source at dry season:	Total	45		105		150	
	River	14	31.1	57	54.3	71	47.3
	Dam/Reservoir	14	31.1	42	40.0	56	37.3
	Wells	17	37.8	6	5.7	23	15.3
Water source at rainy season:	Total	45		105		150	
	River	26	57.8	60	57.1	86	57.3
	Dam/Reservoir	19	42.2	45	42.9	64	42.7
	Well	0	0	0	0	0	0

N= Number of respondents

Watering practice

Aspects of watering frequency and distance to watering points are represented in Table 18. Accordingly during dry season, water is offered once per day (33.3%) and once in two days (66.7%) under transhumance production system, respectively. While in the sedentary production system 67.6% of the respondents provide water to their cattle once per day and 30.5% of the respondents provide twice per day and 1.9% of the respondents reported to provide provided once in two days. Once watering of crossbred cattle is common practice in rainy season in both production systems. But in dry season twice per day watering of cross bred cattle was commonly practiced.

Most of the respondents (42.2%) in transhumance production system trek their cattle from 5-10 kilometers to the watering point. But in sedentary production system, most of the respondents (49.5%) trek their cattle from 1-5 kilometers to the watering point.

Table 18. Watering practice of local and crossbred cattle in the two production systems of Enderta district

Variable	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
FWLCD:	Total	45		105		150	
	Once per day	15	33.3	71	67.6	86	57.3
	Twice per day	0	0	32	30.5	32	21.3
	Once in two days	30	66.7	2	1.9	32	21.3
FWLCR:	Total	45		105		150	
	Once per day	43	95.6	105	100	148	98.7
	Once in two days	2	4.4	0	0	2	1.3
FWCD:	Total	8		23		31	
	Once per day	5	62.5	19	82.6	24	77.4
	Twice per day	3	37.5	4	17.4	7	22.6
FWCR	Total	8		23		31	
	Once per day	0	0	3	13.0	3	9.7
	Twice per day	8	100.0	20	87.0	28	90.3
ADWP:	Total	45		105		150	
	<1 kilometers	2	4.4	51	48.6	53	35.3
	1-5 kilometers	11	24.4	52	49.5	63	42.0
	5-10 kilometers	19	42.2	2	1.9	21	14
	>10 kilometers	13	28.9	0	0	13	8.7

N= Number of respondents, WFLCD=Watering frequency of local cattle at dry season, WFLCR=Watering frequency of local cattle at rainy season, WFCCD= Watering frequency of crossbred cattle at dry season, WFCCR= Watering frequency of crossbred cattle at rainy season, ADWP= Average distance to watering point

4.4.3. Housing management

The housing practice of local large cattle in both production systems was enclosure without roof. But it had wall made of stone and mud with soil type floor and this house was placed in the camp in line with the main house of the family. This housing system was similar in transhumance

livestock production system only at the time when the cattle were at the farm gate during September to the beginning of January. But when cattle are taken to further areas of grazing lands, all the calves are housed in open fenced paddocks in the grazing land. The only difference of the house of calves from that of large cattle in the grazing lands was the difference between the sizes of the fences. All the respondents reported that, the paddock provided for the calves was carefully fenced to protect the calves from predators like hyena.

As observed during farm visit, all the respondents provided house with roof for crossbred cattle in both production systems even if the house was in the same camp with the family main house. The parts of the house provided for crossbred cattle, as observed in 51.6% of the farms, the roof was corrugated iron and in 48.4% of the farms it was plastic covered. Whereas 12.9% of the respondents provided concrete and 87.1% soil type floor. In 3.2% of the respondents the wall was concrete and in 96.8% of the farms it was made of stone and mud (Table 19).

Table 19. Housing practice of local and crossbred cattle in transhumance and sedentary livestock production systems in Enderta district

Variable	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
Housing local calves:	Total	45		105		150	
	Enclosure without roof	9	20.0	4	3.9	13	8.7
	Enclosure with roof	0	0	29	28.2	29	19.6
	In family house	36	80.0	70	68.0	106	70.7
Housing local cows:	Total	45		105		150	
	Enclosure without shed	45	100	105	100	150	100
Housing crossbred calves:	Total	8		23		31	
	Enclosure with shed	3	37.5	11	47.8	14	45.2
	Improved barn	0	0	1	4.3	1	3.2
	In family house	5	62.5	11	47.8	16	51.6
Housing crossbred cows:	Total	45		105		150	
	Enclosure with shed	8	100	22	95.7	30	96.8
	Improved barn	0	0	1	4.3	1	3.2
Roof	Total	8		23		31	
	Corrugated Iron	3	37.5	13	56.5	16	51.6
	Plastic cover	5	62.5	10	43.5	15	48.4
Wall	Total	8		23		31	
	Concrete	0	0	1	4.3	1	3.2
	Stone	8	100	22	95.7	30	96.8
Floor	Total	8		23		31	
	concrete	1	12.5	3	13.0	4	12.9
	Mud	7	87.5	20	87.0	27	87.1

N= Number of respondents

4.4.4. Breeding practices

Breeding system and source of breeding bull are represented in Table 20. In transhumance production system 17.78% of the respondents used both AI and bull service and the rest 82.2% of the respondents used natural bull service. In sedentary production system 21.9% of the respondents used both AI and bull service to breed their cattle and 78.10% of the respondents were used only natural bull service to breed their cattle.

Out of the total surveyed respondents, 70% of them had their own local breeding bull where as 30% of them did not. As farmers explained during group discussion in both production systems, they see body size, body conformation, color and history of milk yield of his dam while selecting neighbor's bull for breeding purpose.

Table 20. Breeding method and selection criteria of breeding bull in Enderta district

Variable	Groups	Transhumance		Sedentary		Overall	
		N	%	N	%	N	%
Cattle breeding:	Total	45		105		150	
	AI and Bull service	8	17.78	23	21.9	31	20.67
	Bull service	37	82.22		78.1	119	79.33
Having own breeding bull:	Total	45		105		105	
	Yes	35	77.8	70	66.7	105	70.0
	No	10	22.2	35	33.3	45	30.0
If absent, source of bull:	Total	10		35		45	
	Neighbor's bull	7	70.0	30	85.7	37	82.2
	Unknown bull	3	30.0	5	14.3	8	17.8

N= Number of respondents

4.4.5. Milking practice

In both production systems, hand milking was the only way. More over majority of the respondents in the district milk their local and crossbred cows twice per day. The milking practice of crossbred cows was restricted suckling in both production systems. Whereas the milking practice of local cows was partial suckling of which, 70% and 30% of the respondents allow suckling before and after milking and suckling before milking only respectively. As the respondents indicated during the interview, they practiced few suckling before milking and then leave the calves to suckle few seconds and then milking (Table 21). The reason why they did such milking practice was because they believed that the cow stops milk letting down when milking, so if the calf suckled the cow again the cow will let down the milk.

Overall washing udder of local cattle was not common in the district, but all farmers wash udder of crossbred cows of which 35.5% used individual and 16.1% used collective towel but 48.4% of the respondents did not use towel after washing the udder (Table 21). The probable reason farmers reported why they did not practiced washing udder of local milking cows was as the calf suckles the udder of the cow before milking it is no need of washing.

Table 21. Milking practice in Enderta district

Variables	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
Milking practice:	Total	45		105		150	
	Few suckling before and after milking	28	62.2	77	73.3	105	70.0
	Suckling before milking only	17	37.8	28	26.7	45	30.0
WULC:	Total	45		105		150	
	Yes	0	0	0	0	0	0
	No	45	100	105	100	150	100
MFLC	Total	45		105		150	
	Once	1	2.2	7	6.7	8	5.3
	twice	44	97.8	98	93.3	142	94.7
MFCC:	Total	8		23		31	
	Twice	6	75.0	19	82.6	25	80.6
	Three times	2	25.0	4	17.4	6	19.4
WUCC	Total	8		23		31	
	Yes	8	100	23	100	31	100
	No	0	0	0	0	0	0
Use of towel:	Total	8		23		31	
	Individual	2	25.0	9	39.1	11	35.5
	Collective	2	25.0	3	13.0	5	16.1
	No practice of using towel	4	50.0	11	47.8	15	48.4

N= Number of respondents, WULC= Washing udder of local cows, MFLC= Milking frequency of local cows, MFCC= Milking frequency of crossbred cows, WUCC= Washing udder of crossbred cows

4.4.6. Herd health management

Keeping the sanitary of animals and their house is one of the herd health management techniques. So as observed in 31 farms that had in door housed animals (crossbred cows), only in 25.8% farms the body, udder, flank and hind legs of crossbred cows was net, but in the rest (74.2%) it was not. Udder injury of cows was observed in 29% of the farms but not in the rest. Teat injury and leg lameness was not common in all farms.

The source of animal health service in the district was entirely dependent in government service. All the activities including vaccinations and treating diseased animals were given by government employed experts. In both production systems there was no private sector involved in animal health related services such as clinics, shops or pharmacies participating in providing animal services or drugs. Farmers forced to go to Mekelle zone outside the district, to buy drugs for diseased animals.

The common cattle diseases and their traditional treatment methods reported in both production systems during group discussion with farmers were:

- Anthrax “Megerem”, farmers treat the animal by branding around the shoulder.
- Blackleg “Wekei or Shudanger”, farmers incise at the affected part
- Bovine pasteurellosis “Halafito”, farmers incise above the nose
- Food and mouth disease “Afemear” which was serious outbreak during the study period, farmers traditionally treat the diseased cattle by painting the mouse and foot by honey.
- Mastitis “ Himam Tub” farmers paint the teat with honey

As the data gathered from the district office of Agriculture and rural Development, some of the above diseases on which the district health service gives regular vaccination, were:

- Bovine pasteurellosis vaccination given at six month interval
- Anthrax vaccination given yearly
- Black leg vaccination given at six month interval

4.4.7. Waste management and dung utilization

Majority of the respondents in both production systems cleaned the animal barn once per day (82.7) while only 0.7% of respondents clean the barn trice a day (those were some farmers that had crossbred cows in the sedentary production system).

In sedentary production system 13.3% of respondents sell dung while none was in transhumance production system. On an overall base 68.7%, 16% and 14.7% of the respondents used dung for fuel, for soil fertilization and for both respectively (Table 22).

Table 22. Waste management and dung utilization in Enderta district

Variable	Groups	Transhumance		Sedentary		Overall	
		N	%	N	%	N	%
FBC*	Total	45		105		150	
	Once per day	42	93.3	82	78.1	124	82.7
	Twice per day	3	6.7	22	21.0	25	16.7
	Three times per day	0	0	1	0.7	1	0.7
Selling animal dung:	Total	45		105		150	
	Yes	0	0	14	13.3	14	9.3
	No	45	100	91	86.7	136	90.7
Dung utilization:	Total	45		105		150	
	As fuel	31	68.9	72	68.6	103	68.7
	For soil fertilization	14	31.1	11	10.5	25	16.7
	Both	0	0	22	21.0	22	14.7

N= Number of respondents, FBC*= Frequency of barn cleaning

4.4.8. Household labor distribution in dairy farming

As indicated in figure 5, milking was the activity performed by husbands (69.33%) followed by wife (30%) and then male children (16.67%). On the other hand, processing of milk and milk

products and sell of milk and milk products were activities which were mostly the responsibility of wife and female children. Barn cleaning was also mostly done by wife and male children of the household families. But herding was mostly performed by male children (65.33%) followed by husband (30%).

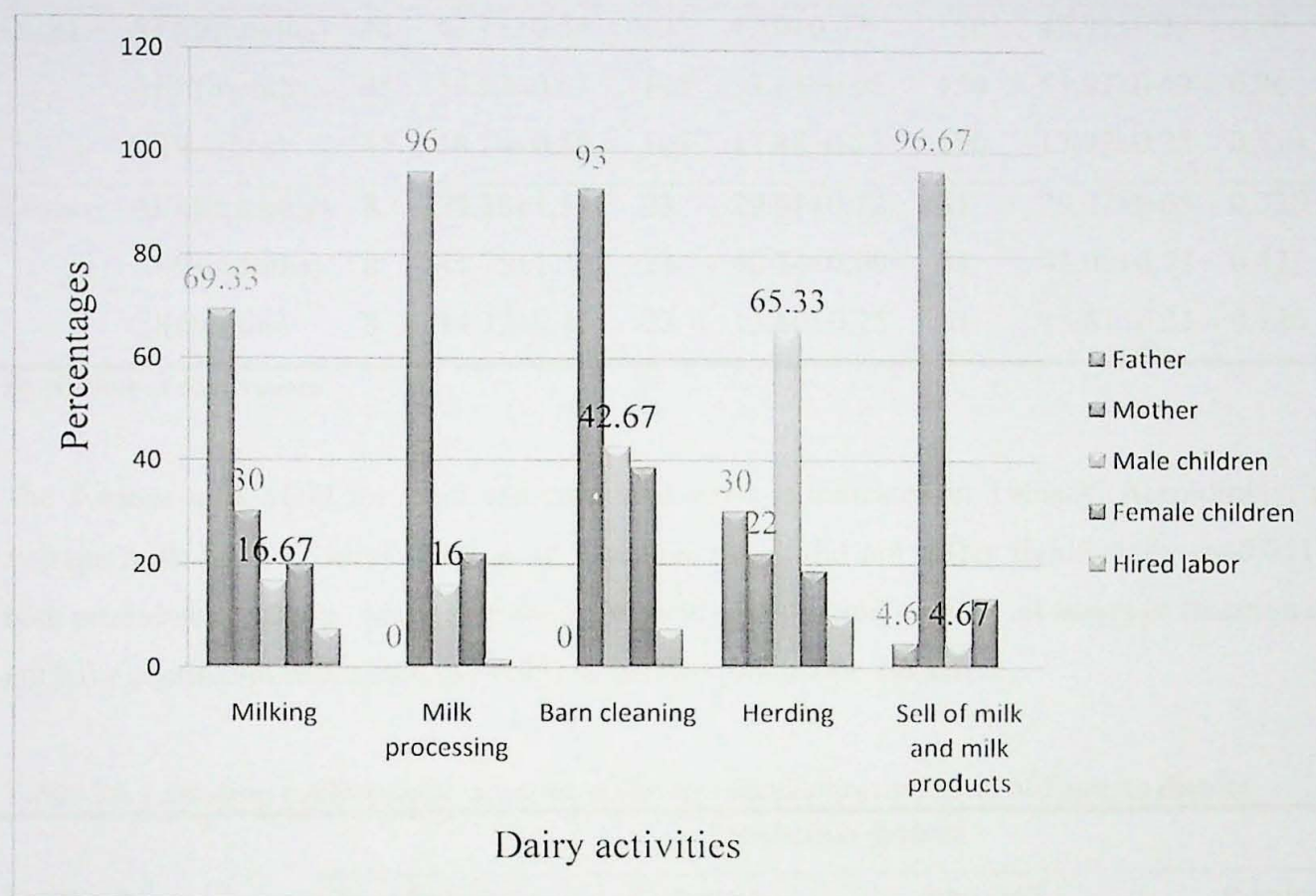


Figure 5: Household labor distribution in dairy farming

4.5. Productive and reproductive performance of cows

As represented in Table 23, the parameters for reproductive performance such as age at first service (AFS,) age at first calving (AFC) and Calving interval (CI) of local cows did not vary significantly ($p > 0.05$) under both production systems, regardless of slight mean difference for each parameter. And also the AFS, AFC and CI for crossbred cows also did not vary with type of production systems.

Table 23. AFM, AFC and CI of local and crossbred cows in Enderta district

Reproductive performance		Production system						
		Transhumance		Sedentary		<i>Over all</i>		P-value
		N	Mean $\pm$ SE	N	Mean $\pm$ SE	N	Mean $\pm$ SE	
Local	AFM(months)	45	43.11 $\pm$ 0.54	105	42.9 $\pm$ 0.47	150	42.97 $\pm$ 0.37	0.79
	AFC(months)	45	54.22 $\pm$ 0.67	105	53.84 $\pm$ 0.65	150	53.97 $\pm$ 0.49	0.26
	CI(months)	45	18.24 $\pm$ 0.50	105	17.88 $\pm$ 0.23	150	17.97 $\pm$ 0.25	0.514
Cross	AFM(months)	8	29.38 $\pm$ 1.53	23	29.91 $\pm$ 0.72	31	29.77 $\pm$ 0.65	0.725
	AFC(months)	8	41.75 $\pm$ 1.32	23	40.74 $\pm$ 0.60	31	41.00 $\pm$ 0.55	0.433
	CI(months)	8	14.37 $\pm$ 0.45	23	13.60 $\pm$ 0.25	31	13.81 $\pm$ 0.23	0.146

N= Number of observations

The average milk yield for local and crossbred cows is indicated in Table24. Accordingly, the average milk yield of local cows at all lactation stages did not differ significantly ($p>0.05$) in both production systems. More over the milk yield of crossbred cows at all stages of lactation did not have significant difference ($p> 0.05$) in the two production systems.

Table 24. Lactation performance of cows in the two production systems of Enderta district

Lactation performance		Production system						P-value
		Transhumance		Sedentary		<i>Over all</i>		
		N	Mean $\pm$ SE	N	Mean $\pm$ SE	N	Mean $\pm$ SE	
Local	Early(liter)	45	1.02 $\pm$ 0.62	105	1.30 $\pm$ 0.53	150	1.16 $\pm$ 0.75	0.458
	Mid(liter)	45	2.29 $\pm$ 0.11	105	2.4 $\pm$ 0.76	150	2.34 $\pm$ 0.62	0.413
	Late(liter)	45	0.98 $\pm$ 0.04	105	1.00 $\pm$ 0.03	150	0.99 $\pm$ 0.03	0.680
	LL(months)	45	7.11 $\pm$ 0.17	105	7.33 $\pm$ 0.12	150	7.27 $\pm$ 0.10	0.287
Cross	Early(liter)	8	11.63 $\pm$ 1.12	23	10.9 $\pm$ 0.69	31	11.27 $\pm$ 0.58	0.840
	Mid(liter)	8	7.31 $\pm$ 0.56	23	6.8 $\pm$ 0.05	31	7.06 $\pm$ 0.52	0.760
	Late(liter)	8	5.00 $\pm$ 1.04	23	5.00 $\pm$ 0.61	31	5.00 $\pm$ 0.51	1.00
	LL(months)	8	9.38 $\pm$ 0.50	23	9.61 $\pm$ 0.26	31	9.55 $\pm$ 0.23	0.666

N= number of observations

4.6. Milk and milk products handling practices

4.6.1. Milk and milk products, handling and storing utensils

As represented in Table 25, in transhumance production system 'kordo'/ plant source (55.6%) were the dominant milking utensil, but in sedentary production system, plastic materials (58%) was dominant milking utensil. On overall basis majority of the respondents (61.3%) used 'Gefho'/clay pot and 38.7% of the respondents were using 'Jerican'/plastic material to store milk for fermentation. 'Laga'/plant source and Jerican/plastic material were used as a churning material in 51.3% and 48.6% of the farms respectively.

Table 25. Milk and milk products handling and storing utensils in Enderta district

Variables	Groups	Transhumance		Sedentary		Overall	
		N	%	N	%	N	%
MHU:	Total	45		105		150	
	Kordo	25	55.6	38	36.2	63	42.0
	Plastic material	20	44.4	67	58.0	87	58.0
YHU:	Total	45		105		150	
	Gefho/clay pot	30	66.7	62	59.0	92	61.3
	Jerican/plastic material	15	33.3	43	41.0	58	38.7
BHU:	Total	45		105		150	
	Kucho/clay source	12	26.7	14	13.3	26	17.3
	Hamham/plant source	12	26.7	32	30.5	44	29.3
	Plastic material	8	17.8	30	28.6	38	25.3
	Kordo/plant source	13	28.9	29	27.6	42	28.0
GHU:	Total	45		105		150	
	Kucho/clay source	28	62.8	56	53.3	84	56.0
	Plastic material	17	37.8	49	46.7	66	44.0
Churner	Total	45		105		150	
	Laga/plant source	29	64.4	81	77.14	110	73.3
	Jerican/plastic material	16	35.56	24	22.86	39	26

N= Number of respondents, MHU= Milk handling utensil, YHU= Yoghurt handling utensil, BHU= Butter handling utensil, GHU= Ghee handling utensil

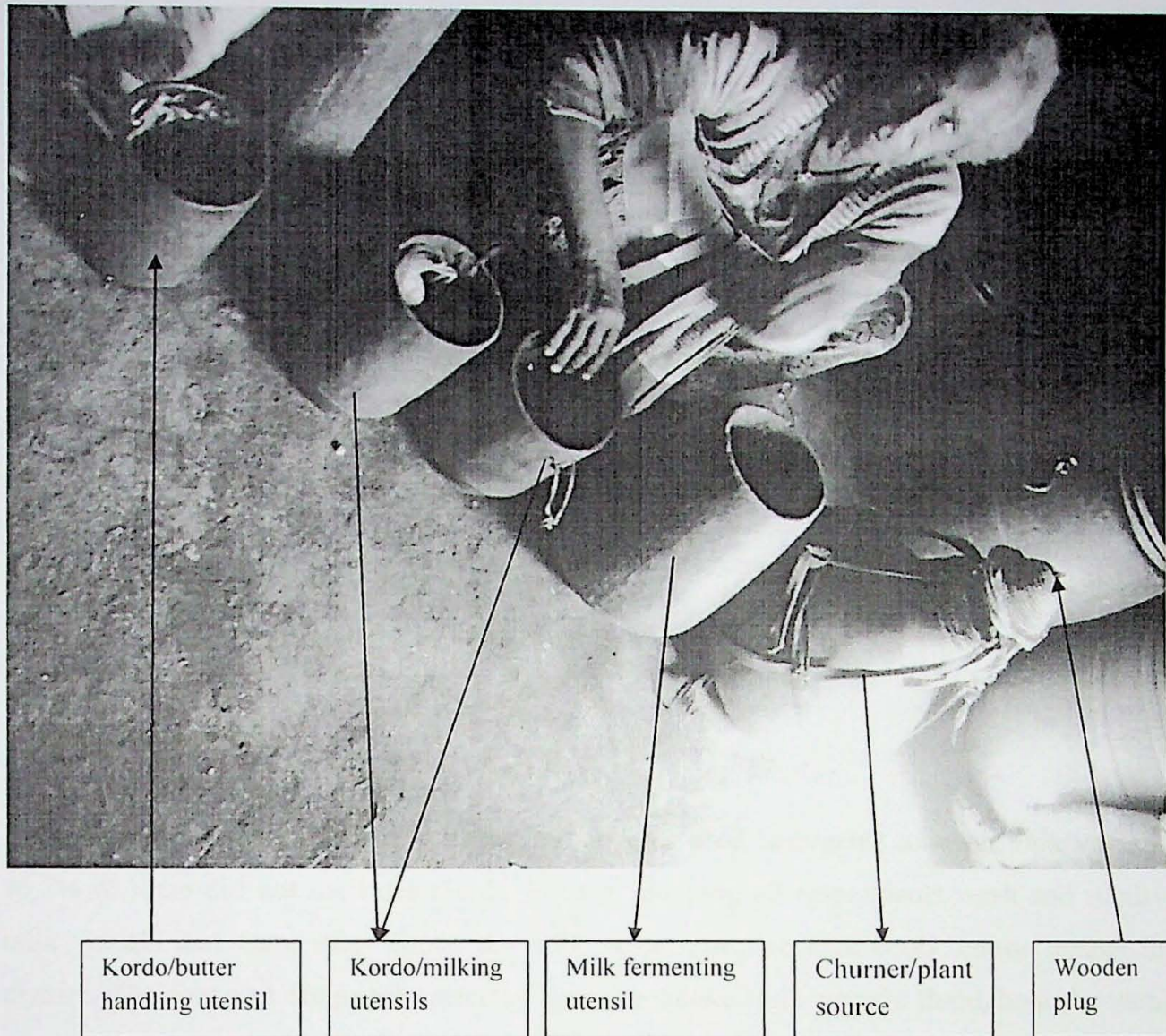


Figure 6: Milk and milk products handling equipments

4.6.2. Smoking of milk and milk products utensils

All (100%) of the surveyed respondents in both production systems applied smoking of milk utensils for different purposes. The major reasons of smoking milk vessels reported by the respondents were for good flavor (53.3%) and for longer shelf life of the products (32%) (Table 26).

Table 26. Experience of smoking and reasons forwarded by the respondents for smoking milk vessels

Variables	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
Smoking milk vessels	Total	45		105		150	
	Yes	45	100	105	100	150	100
	No	0	0	0	0	0	0
Reason for smoking milk vessels	Total	45		105		150	
	For good flavor of the product	15	33.3	65	61.9	80	53.3
	For longer shelf life of the products	14	31.1	34	32.4	48	32.0
	To have reddish color butter	7	15.6	5	4.8	12	8.0
	To have attractive odor butter	9	20.0	1	1.0	10	6.7

N= number of respondents

As presented in Table 27, 53.3% of the respondents used detergents to wash milk vessels and 46.7% of them did not used detergents. Prior to smoking all respondents wash and sundry the milk vessels and then, they smoke the milk vessels by two commonly known plants in the district. The first and frequently selected plant to smoke milk vessels throughout the sampled respondents was *Acacia etbaica* locally called ‘Seraw’. At the time if this plant is not available, all the respondents put their second choice to be the plant called *Olean Africana* locally called ‘Awlie’

Table 27. Proportion of respondents using detergents to wash milk vessels and plants to smoke milk vessels

Variables	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
FCMU*	Total	45		105		150	
	Once per day	4	8.9	2	1.9	6	4.0
	Twice per day	41	91.1	103	98.1	144	96.0
Using sanitizer:	Total	45		105		150	
	Yes	24	53.3	56	53.3	80	53.3
	No	21	46.7	49	46.6	70	46.7
WSWMV*:	Total	45		105		150	
	Pump water	39	86.7	105	100	150	100
	River	6	13.3	0	0	6	4
Smoking plants:	Total	45		105		150	
	1st (<i>Acacia etbaica</i>)	45	100	105	100	150	100
	2nd (<i>Olean Africana</i>)	45	100	105	100	150	100

N= Number of respondents, FCMU*= Frequency of cleaning milk vessel, WSWMV*= Water source for washing milk vessels

4.7. Utilization pattern of milk and milk products

4.7.1. Milk and butter production

The average milk off take, in transhumance livestock production system was 7.26 ± 1.34 liters per day per household. And in sedentary livestock production system, the total average milk production was 6.61 ± 0.65 liters per farm per day. This result was not significantly different ($p > 0.05$) between the two production systems. The overall average milk produced per household per day was 6.81 ± 0.57 liters.

The average butter production per week per household in transhumance livestock production system was 1.21 ± 0.085 kilo grams whereas in sedentary livestock production system it was 1.27 ± 0.06 kilo gram per household per week. This result was not significantly different ($p > 0.05$) between the two production systems. The overall butter production per week in the surveyed respondents in the district was 1.25 ± 0.05 kilo grams per individual per week (Table 28).

Table 28. Mean milk and butter produced per day of the surveyed households in the two production systems of Enderta district

Variables	Transhumance	Sedentary	<i>Over all</i>	P-value
Average milk off take per day:	N=45	N=105	N=150	
Mean $\pm$ SE	7.26 ± 1.34	6.61 ± 0.65	6.81 ± 0.57	0.603
Average butter off take per week:	N=45	N=105	N=150	
Mean $\pm$ SE	1.21 ± 0.085	1.27 ± 0.06	1.25 ± 0.05	0.641

N= number of observation

4.7.2. Milk and butter utilization

In the study area milk and butter were the most common dairy products that had different utilization patterns. Accordingly milk was allocated to household consumption, calf feed, stored for fermentation and allocated to sell whereas butter was allocated to household consumption as food, allocated to household cosmetic purpose and allocated to sell. Other milk derivatives such as butter milk, whey and cottage cheese were (100 %) used for home consumption.

As represented in Table 29, milk and butter utilization were not as such different in both production systems. Overall out of the daily produced milk, the overall daily allocation of milk for household consumption, stored for fermentation, calf feed and allocated for sell were 9.80%, 62.94%, 13.62% and 13.55% were respectively in overall basis. And the overall weekly allocation of butter for household consumption, for cosmetic and for sell was 3.85%, 15.97% and 80.2% respectively.

Table 29. Milk and butter allocation for different purpose

Variables	Transhumance N=45		Sedentary N=105		Over all N=150	
	Sum (liter)	%	Sum (liter)	%	Sum (liter)	%
Total milk	326.62		694.25		1020.88	
HH consumption	41	12.55	59	8.45	100	9.80
For fermentation	205	62.76	437.5	63.02	642.5	62.94
Calf feed	41	12.55	98	14.12	139	13.62
Marketed	38.62	11.82	99.75	14.37	138.37	13.55
Total butter	54		127.95		181.60	
Consumed	2	3.71	5	3.91	7	3.85
As cosmetic	8	14.82	21	16.41	29	15.97
marketed	44	81.48	101.95	79.68	145.60	80.2

N= Number of observations, HH= Household

4.8. Milk processing practices

The report of interviewed farmers (100%) showed that, dairy products frequently processed at household level were whole milk to fermented milk, fermented milk to butter and butter milk and boiling of butter milk to whey and cheese. Majority of the respondents (46%) processed fermented milk to butter three times per week, (37.3%) two times per week and (16.7%) four times per week.

The other and less commonly practiced in the area was further processing of butter to ghee. As all (100%) of the respondents in the studied area said this was occasionally practiced at the time of holidays for the sake of flavoring traditional dishes. During processing of this product spices such as *Aframomum corrorima* "Corarima", *Ocimum basilicum* "Seseg", *Zingiber officinalis* "gingbire", *Allium sativum* "Tsaeda shgurti" were added when boiling the butter then after formation of bubbles ceased, it rested to few minutes until all residue of the spices settled to the base of cooking material then oiled butter was carefully stirred down to its storing utensil leaving the residuals in the cooking material.

During group discussion with farmers in both production systems, farmers forwarded two reasons for processing milk. At first they said that since butter is the first desirable and appreciable product in the area, without processing whole milk it is impossible to get it. They farther explained the reason why they require butter was because, they need butter for its cosmetic value. They said butter has multifunctional values; Along with the cosmetic value of butter, they said a person dressed his/her head with butter as a hair food, can have a bright eye, smooth skin and saved from headache. They also said that if a pregnant woman does not get enough butter in the form of hair dressing during her pregnancy time, she may get difficulty in birth. The second reason forwarded during the discussion for processing whole milk was lack of market for whole milk.

4.8.1. Procedure of churning

During the farm visit and group discussion with farmers in both production systems, respondents said that before churning, they always store the milk collected from local cows and crossbred cows in a different container and churn in different containers purposively. They reasoned out why they did that was because, after the milk is processed to butter, the market preference by consumers is higher for butter processed from local cow than that of the crossbred cows. So they said that they are primarily interested to process milk from local cows than the milk from crossbred cows.

Fermented milk to butter and butter milk is processed through traditional churning method shown in Figure 7 (some of the churning methods).



Figure 7: Traditional methods of churning fermented milk in Enderta district

According to the report of farmers there was no difference in efficiency of butter recovery or time taken to churn between the two churning methods shown in Figure 7, they both take around one and half up to two hours depending on the volume of milk in the churning pot. It was based on the preference of the person whether he or she needs to churn on stand or sat.

Prior to start of churning, the churning pot (Figure 7) was filled with fermented milk to three fourth of its size; then in case of A the churning material locally called “Laga” was hanged with a rope to the roof of the family house near the door then a person stand and shake the pot with a maximum force to back and forth alternatively. But in case of B, the pot was hanged to three standing woods, and then people sat and shake the churner back and forth. When start churning, the wooden plug (Figure 6) at the top of the churner opened every few munities interval until the gases formed in the pot removed.

While churning, the milk inside the pot is monitored to see whether butter granules are formed or no by opening the wooden plug and then inserting a thin - rough wood prepared for this purpose and taking out few butter granules and observing the size of the granules whether butter is formed completely or not. After butter was formed completely, the churning pot was put to the ground and then the pot slowly shaken back and forth. This purpose as the respondents said, would help to collect or to come across each other (the butter granules distributed throughout the butter milk in the pot). Then after four to five minutes, the butter was taken out and inserted in to cold water and repeatedly washed by changing the water to remove completely the residuals of butter milk from the butter. After that the butter was stayed inserted in cold water for further 20 minutes and then after the water was completely drained the butter was stored to its own utensil which was previously washed, dried and smoked container for this purpose.

During farm visit farmers said the frequency of churning can be determined by the volume of milk and the stage of fermentation. As they said, this stage of fermentation can be checked by monitoring the size of the yoghurt granules and the color of the yoghurt by visiting the milk fermenting pot. Accordingly, if the sizes of the granules become large and slightly yellowish color than fresh milk is observed then they understood it is ready to churn.

4.8.2. Shelf life of dairy products at farm level

During processing milk and milk products to the next derivatives, farmers in both production systems use different methods to increase the shelf life of the products. All the surveyed respondents apply boiling to increase the shelf life of whole milk, smoking of butter handling utensils to increase shelf life of butter, proper washing and smoking of yoghurt utensils to increase the shelf life of yoghurt. They also use spicing together with boiling to increase the shelf life of butter in the form of ghee.

Table 30. Shelf life of some dairy products in Enderta district during dry and wet season

Production system	Shelf life of products at dry season			Shelf life of products at wet season			Shelf life of ghee in years
	in days			in days			
	Milk	Butter	Yoghourt	Milk	Butter	Yoghourt	
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
Transhumance	0.81 $\pm$ 0.1	6.73 $\pm$ 0.2	2.22 $\pm$ 0.08	1.27 $\pm$ 0.06	13.24 $\pm$ 0.5	3.08 $\pm$ 0.06	1.37 $\pm$ 0.06
Sedentary	0.88 $\pm$ 0.03	7.54 $\pm$ 0.21	1.72 $\pm$ 0.05	1.27 $\pm$ 0.03	15.86 $\pm$ 0.3	2.68 $\pm$ 0.06	1.18 $\pm$ 0.02
Over all	0.86 $\pm$ 0.02	7.30 $\pm$ 0.16	1.87 $\pm$ 0.05	1.27 $\pm$ 0.03	15.07 $\pm$ 0.3	2.80 $\pm$ 0.05	1.2 $\pm$ 0.03

N= Number of respondents

4.9. Milk and milk products marketing

Milk and Butter marketing in Enderta district was entirely informal. Producers and buyers together decide the selling price of the product. After little debate about the product and the price, they agree up on and then exchange.

In both production systems of the study area, only whole milk and butter are the marketable dairy products. Butter was the most important milk derivative which was produced and marketed by all respondents in both production systems. As farmers especially, farmers that have only local milk cow said they do not bother even not interested to sell whole milk from local cows, rather they are interested to sell butter and to use the other milk derivatives like butter milk and whey –cheese for household consumption. The most important reason respondents pointed out was because fresh butter has the highest demand for cosmetics by all the rural and urban consumers.

As indicated in Table 31, all (100%) of the interviewed respondents were participating in selling of butter, but only 15.6% of respondents from transhumance production system and 28.6% of respondents from sedentary production system involved in whole milk selling.

Table 31. Sellable dairy products in Enderta district

Variables	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
Selling whole milk:	Total	45		105		150	
	Yes	7	15.6	30	28.6	37	24.7
	No	38	84.4	75	71.4	113	75.3
Selling butter:		45		105		150	
	Yes	45	100	105	100	150	100
	No	0	0	0	0	0	0

N= Number of respondents

As represented in Table32, all (100%) in transhumance used the money earned from milk and milk products for household demand meeting only while in the sedentary livestock production system 6.7% of the respondents used the money for farm input and the rest (93.3%) used it for household demand meeting. Expenditure of the money to farm inputs along with the farms who had crossbred milking stock (22.6%) was proportionally higher ($p<0.05$) to those farms who own local milking stock only.

Table 32. Expenditure of money gained from milk and butter sells across farming system and farm types in Enderta district

Variable	Group	Expenditure			
		Farm input		Household demand meeting	
		N	%	N	%
	<i>overall</i>	7	4.7	143	95.3
Farming system	Transhumance	0	0	45	100
	Sedentary	7	6.7	98	93.3
	X ² p-value		0.076		
Farm type	Local farm	0	0	119	100
	Local-crossbred	7	22.6	24	77.4
	X ² p-value		0.001		

N= Number of respondents, Farm input includes: expanding of farm with inputs like feeders and drinkers, housing, increase number of improved breeds and household demand meeting includes: purchasing coffee, salt, pen and exercise book for children.

4.9.1. Whole milk and butter sells outlet

Sells out let, buyer type and mode of payment for whole milk and butter are displayed in Table 33. The only whole milk sells outlet in all the interviewed respondents participating in whole milk sell was farm gate (100%) and the buyer types were all consumers (100%).

Table 33. Milk and butter sells out let, buyer types and modes of payment in the two production systems in Enderta district

Variables	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
Sells outlet for milk:	Total	7		30		37	
	Farm gate	7	100	30	100	37	100
Sells outlet for butter:	Total	45		105		150	
	Farm gate	19	42.2	50	47.6	69	46.0
	Market place	26	57.8	55	52.4	81	54.0
Buyer type for milk:	Total	45		105		150	
	Consumers	7	100	30	100	37	100
Butter buyer at farm gate:	Total	45		105		150	
	Consumer	29	64.4	79	75.2	108	72.0
	Trader	16	35.6	26	24.8	42	28
Butter buyers at market place:	Total	45		105		150	
	Consumer	26	57.8	73	69.5	99	66.0
	Trader	19	42.2	32	30.5	51	34.0
Made of payment for whole milk:	Total	7		30		37	
	Cash	4	57.1	21	70.0	25	67.6
	contract	3	42.9	9	30.0	12	32.4
Mode of payment butter:	Total	45		105		150	
	Cash	45	100	105	100	150	100

N= Number of respondent

4.9.2. Determinants of whole milk and butter prices

As the farmers explained during the group discussion, there is price increment every year for whole milk from fasting periods to non fasting periods and holydays. And for butter was also the same but in addition to the factors above, price of butter was increased from outlet one to out let two (from farm gate to market place). They added that always price of milk and butter declined

during fasting times and the months from September to end of December. They reasoned out that, during this time cows given plenty of feed unrestrictedly in terms of crop residue and crop aftermath and so there is increased in milk and butter production. As a result, farmers increase supplying of milk and butter and so price decreased. And also the price to these products highly raise up during festivals and holydays as the demand for whole milk and butter increases rapidly during these times.

As indicated in Table 34, mean price of whole milk was 6.43 birr/liter and the mean price of butter was 126.10 birr and 138.07birr/kg at farm gate and market place respectively during the study period. Price of butter at farm gate was significantly higher ($P<0.05$) in sedentary livestock production system than transhumance.

Table 34. Price of whole milk and butter in Enderta district during the study period (October 2011- January 2010)

Farming systems		Price of milk at farm gate in birr	Price of butter at farm gate in birr	Price of butter at market place in birr
Transhumance	N	7	45	45
	Mean $\pm$ SE	6.67 $\pm$ 0.21	123.22 $\pm$ 0.80	138.22 $\pm$ 0.98
Sedentary	N	30	105	105
	Mean $\pm$ SE	6.39 $\pm$ 0.11	127.33 $\pm$ 0.85	138.62
<i>Overall</i>	N	37	150	150
	Mean $\pm$ SE	6.43 $\pm$ 0.10	126.10 $\pm$ 0.66	138.07 $\pm$ 0.52
P- value		0.305	0.004	0.845

N= Number of respondents

4.9.3. Whole milk and butter marketing channels

For whole milk, the only participants were producers and consumers. As can be observed from Table 33 the only buyers of whole milk in both production systems of the study area were direct consumers. Therefore, the marketing channel of whole milk in the surveyed respondents of the study area was producer $\rightarrow$ consumer.

For butter, the market participants were:

- Producers
- Consumers
- Rural assemblers: collect butter from producers at the farm gates then sell at market place
- Local traders in local market of the study areas: collect butter from rural assemblers or producers then sell it at the same market
- Big traders from Mekelle market: collect butter from producers or rural assembler or local traders during the market days of the study area then sell it at Mekelle market outside the study area.

Therefore, the marketing channels for butter were:

Producers→ Consumers

Producers→ Rural assemblers →Consumers

Producers→ Rural assemblers → Local traders → Consumers

Producers→ Local traders → Consumers

Producers→ Big traders → Consumers

Producers → Local traders → Big traders→ Consumers

Producers→ Rural assemblers → Big traders from Mekelle market→ Consumers

Producers→ Rural assemblers→ Local traders → Big traders from Mekelle market →Consumers

As the information gathered from different market agents and the survey result presented in Table 33, most buyers of butter at both outlets were consumers, so the most common channel for butter in Enderta district was producers→ consumers. And the second was producers →Rural assemblers → local traders → Consumers channel.

4.10. Constraints of milk production and marketing in Enderta district

4.10.1. Constraints of milk production

Table 35 represents the major constraints of milk production in Enderta district. Majority of the interviewed respondents in both production systems reported no problem of housing cattle, but 24.7% of the respondents reported shortage of space as a problem in housing animals.

High cost was the major problem of feeding animals as reported by all respondents in both production systems in the district. 52.7% of the respondents said feed shortage was mainly faced at dry season and 47.3% of them said the shortage was mainly happened at wet season.

Distance (51.1%) was the main water related problem reported by the respondents in transhumance production system, but in sedentary livestock production system impurity (37.1%) was the main problem. The problems related to breed and breeding and animal health service were delay of AI service (83.9%) and distance to services centers (54%) were the major problems respectively.

Conflict with neighbors was reported by 68.9% of the respondents in transhumance production system. But this report was not common in sedentary livestock production system (7.6%). During the group discussion with farmers in transhumance livestock production system, the respondents forwarded the reason for the conflict was communal grazing land and water sources at the border areas of Afar and Enderta district.

Table 35. Constraints of milk production

Variables	Groups	Transhumance		Sedentary		<i>Overall</i>	
		N	%	N	%	N	%
Housing problem:	Total	45		105		150	
	Shortage of space	10	22.2	27	25.7	37	24.7
	No problem	35	77.8	78	74.3	113	75.3
Feed problem:	Total	45		105		150	
	Cost	45	100	105		100	
Feed shortage faced in:	Total	45		105		150	
	Dry season	19	42.2	60	57.1	79	52.7
	Wet season	26	57.8	45	42.9	71	47.3
Water problem:	Total	45		105		150	
	Scarcity	15	33.3	37	35.2	52	34.7
	Impurity	7	15.2	39	37.1	46	30.7
	Distance	23	51.1	29	27.6	52	34.7
Breed and breeding problem:	Total	8		23		31	
	cost of crossbred heifers:	0	0	5	21.7	5	16.1
	Delay of AI service:	8	100	18	78.3	26	83.9
Animal health service problem:	Total	45		105		150	
	Shortage	15	33.3	54	51.4	69	46.0
	Distance	30	66.7	51	48.6	81	54.0
Conflict with neighbors :	Total	45		105		150	
	Yes	31	68.9	8	7.6	39	26.0
	No	14	31.1	97	92.4	111	74.0

N= Number of respondents,

4.10.2. Constraints of milk and butter marketing

During group discussion across each production systems, lack of whole milk market was indicated as a serious problem, especially to those farmers owning cross bred cows. Seasonal fluctuation of price, low price during lean demand periods (fasting periods) and peak production (September to December) were also reported as a constraint for milk and butter marketing in both production systems. According to the information gathered from milk and butter buyers, the other problem of whole milk and butter marketing in the district was adulteration of other things to milk and butter by some traders.

As presented in Table 36, the survey result also showed that shortage of milk and butter market was significantly different ($p < 0.05$) for respondents that own crossbred milk stock (74.2%) and the respondents that own only local milk cows (44.5%).

Table 36. Shortage of milk and butter market by farm type and farming system

Variables	Group	Shortage of milk and butter market				
		Yes	%	No	%	Total
	<i>Over all</i>	76	50.7	74	49.3	150
Farming system	Transhumance	17	37.8	28	56.2	45
	Sedentary	59	62.2	46	43.8	105
	X ² p-value		0.039			
Farm type	Local farm	53	44.5	66	74.2	119
	Local-crossbred	23	74.2	8	25.8	31
	X ² p-value		0.003			

N= Number of respondents

As represented in Table 37, respondents in transhumance livestock production system indicated that shortage of milk and butter marketing occurs only during fasting times, but in sedentary livestock production system the problem of milk and butter marketing was also faced even in non fasting times in any moth of the year.

When comparison of milk and milk products shortage made between local and local plus cross bred farms, the shortage was significantly higher ($p < 0.05$) in local plus cross bred farms than local bred farms only.

Table 37. Market shortage at fasting times and any other moths of the year by farming system and farm type

Variables	Group	Fasting time		In any month of the year		Total
		N	%	N	%	
	Over all	64	84.2	12	15.8	76
Farming system:	Transhumance	17	100	0	0	17
	Sedentary	47	79.7	12	20.3	59
	X ² p-value				0.037	
Farm type	Local farm	53	100	0	0	53
	Local-crossbred farm	11	47.8	12	52.2	23
	X ² p-value				0.001	

N=Number of respondents

5. DISCUSSION

The overall average family size of target respondents in the present study was higher in male headed households than female headed households. This could be related to the wealth status as most of the time male headed households in the rural areas are relatively in better economic status than female headed households. And this difference could also bring difference in labor inputs for milk production and as a result better labor source for milk production in the district could be expected from male headed households. Family size was also higher in transhumance production system than sedentary livestock production. This difference might also be raised due to the difference in production system, as transhumance herd movement production system, may incorporate hired labors for herding, and this may increase the family size. The overall family size in the present study was less than the report by Asaminew (2007) in Mecha and Bahir Dar Zuria district (7.71 persons per household) and it was higher than the average family for Tigray region (5 persons per household) (CSA, 2003) where the study district located in .

In the present study, 69.3% of the household heads was. This study showed higher literacy level than the finding by Kedija (2007) in Mesio district of Oromia region (80% illiterate). But it was lower than the literacy level reported by Negussie (2006) who found that the educational level of milk producers in Mekelle zone was (19.2 % illiterate, 7.3 % read and write and 73.5 % literate).

Land for crop production is a critical issue in the study area. Not only it is important to the livelihood of the people but also determines the survival of cattle in both production systems. This is because of cereals like wheat and barley are the major crops grown in the area and the residue from these crops are important to supplement for work oxen during land preparation and to supplement all cattle herd during periods of critical feed shortage. Land holding per household in the present study was higher in male headed than female headed households. This may be related to the family size as male headed households had bigger family size than female headed households. Similar result of higher land holding by male headed households than female headed households was reported by Kedija (2007) in Meiso district. The overall average landholding of target households in the present study was slightly higher than the finding by Adebabay (2009) for Bure district (1.33 ha per household), but lower than the report by Tesfaye (2007) in Metema

district (5.28 ± 0.22 ha) and also lower than the national average land holding size (2.5 ha). This shows the presence of critical land shortage in the present study area, which might have a discouraging effect in milk production and in overall livestock production.

The composition of cattle in transhumance livestock production system was slightly lower than the composition in sedentary livestock production system. This may be due to the incorporation of other ruminants such as goat in a higher proportion in transhumance than sedentary livestock production system. The overall percentage of cattle in the present study was 34.04% is slightly lower than the composition of cattle (42%) in Meiso district reported by Kedija (2007) and the composition of cattle (56.6%) in Metema district reported by Tesfay (2007).

The average cattle holding per household in transhumance livestock production system was higher than the sedentary livestock production system. This difference could be due to the different nature of the production systems. As farmers in transhumance production system moves their herds seasonally for search of feed and water, this may encourage them to have large herd size. But in sedentary livestock production system farmers do not have alternatives to the shortage of feed, which means they do not have other alternative grazing areas that can move their herds for search of feed and water, so this may limit them to have small herd size. Overall the average cattle holding per household of target respondents in the district was 9.87 ± 0.35 heads per household incorporating 2.85 ± 0.12 heads of local cows. This result was in agreement with the findings of Adebabay (2009) for Bure district (average local cow of 2.57 heads per household). But the finding of the present study is lower than the average cattle holding per household reported by Tesfaye (2007) who reported that, cattle holding in Metema district (15.53 heads per household) and the average holding of cow (4.8 ± 0.23 heads per household). The average local lactating cow holding per household in transhumance production system was higher than sedentary livestock production system. But the average crossbred lactating cow holding was not different in the two production systems. This was because the transhumant people had high number of local cattle per individual because of the movable nature of local cattle from place to place in the transhumance production system. But in case of crossbred cattle both production systems follow similar management system (both follow stale feeding without grazing). So this could make them to have similar number of crossbred lactating cows.

The purpose of local cattle keeping reported in the present study is in line with the finding of Adebabay (2009) who report that milk producers of Bure district keep their livestock for draught power in the first importance and consumption /meat and milk/ as a second importance. But this result was in contrast to the finding of Tesfaye (2007) who report that the major objective of cattle keeping in Metema district was for milk and milk products (48.9%) and for draught power (24.3%). Yigezu (2003) also reported that, the rural farmers in highland areas incorporate small-scale dairy production with crop farming with the objective of producing animal power (oxen) for tilling the land.

The feed resources and feeding practices reported in the present study is similar to the report of livestock feed resource reported by Alemayehu (2005) and the finding of Adebabay (2009) in Bure district reported two practices of cattle feeding (grazing and stale feeding) and the major sources of feed for cattle as natural pasture, hay, crop-residues, crop-aftermaths and non-conventional feedstuffs such as 'attella'/brewery and concentrates are rarely used with the exception of those milk producers who keep crossbred cows. Kedja (2007) also reported the practice of stall feeding in Meiso district during the cropping season and during cultivation. Negussie (2006) also found grazing practice for local cattle and stall feeding for crossbred cattle in Mekelle zone. However, the result of the present study was totally diverted to the recommendation of Albright (1993) who forwarded that except as necessary for a particular research or teaching protocol, dairy cattle should be fed diets that have been formulated to meet their needs for maintenance, growth, production, and reproduction.

To keep the health and productivity, feeding of dairy cows should be based on reproductive status and lactation stage of the milk cows. But in this study feeding was based on the availability of feeds rather than considering production level and reproduction stage. Farmers in the present study entirely use group feeding based on sex and age during supplementing of crop residues for local cattle. And individual feeding and group feeding based on sex and age for crossbred cattle. Negussie (2006) found only group feeding practice by small farmers in Mekelle zone.

Mitigation for feed shortage was different in the two production systems in the present study. In transhumance livestock production system, only the farmers who own crossbred cows purchase

feed at the time of feed shortage. But in sedentary livestock production system, all the producers who had crossbred cows and some of the farmers who had only local cattle purchase feed at the time of feed shortage. This difference might be resulted, because the farmers in the transhumance production system copped the feed shortage by moving their herds to other areas, whereas the farmers in the sedentary livestock production system did not practice such activity, so they purchased feed during shortage of feed.

In this finding watering management of local and crossbred cattle was different with giving better attention in the quality of water and watering frequent for crossbred cows. This result is in contrast to the finding by Adebabay (2009) who report insignificant difference in watering management of local and crossbred cattle in Bure district. This difference might be due to the presence of better understanding of handling of crossbred cattle in the present study area. Better frequency of watering for crossbred cows in dry than in wet season was observed. This finding due to the fact that cows will drink up to twice as much water in hot weather as in cold winter weather (Puck *et al.*, 2004). Water source from pump was provided for crossbred cattle the whole year in both production systems in Enderta district, and the watering frequency for this breed was majority twice in dry season and once in rainy season. Whereas water from river, dam and wells were used as water source for local cattle in both seasons. But difference in watering frequency of local cattle was observed in the two production systems. Watering frequency of local cattle in sedentary livestock production system was higher than the watering frequency of local cattle in transhumance production system during dry season. This difference might be due to the longest distance to watering point in transhumance production system, since the survey result indicated nearly half of the farmers in this production system trek 5-10 kilo meters to arrive the watering point unlike to the majority of producers in sedentary production system that travel < 5 kilometers. Overall this result indicated that once per day watering of local cattle was a common phenomenon in the district (57.3%) in dry season and rainy season (98.7%). This finding is in line with the finding of Tesfaye (2007) who indicated that once watering of local cattle (90.5%) in wet season and twice watering (69.2%) in dry season in Metema district. This less frequency of watering cattle in dry season indicates scarcity of water in dry season in the present study (in Enderta district).

Housing system of local cattle was similar in the two production systems (with wall constructed from stone and mud, but absence of roof cover) only during the time between September to the beginning of January before the movement of herds in transhumance production system to other places, but after the movement of herds from farm gate, the housing system of cattle in transhumance production system was open fenced paddock with woody fences. In the present study, farmers gave attention to house calves than large cattle because they believe calves are less resistant to extreme climatic conditions. So majority of the respondents housed calves with in family house. Kedja (2009) reported similar finding in Meiso district that farmers housed calves in well protected enclosures. Providing of closed barns with roof cover for calves was also practiced in Metema district as noted by Tesfaye (2007). Albright (1987) also reported fenced pastures as housing practices in the warm humid climate areas.

The source of animal health service in the district was entirely dependent in government service. All the activities including AI services, vaccinations and treating diseased animals were given by government employed experts. In both production systems there was no private sector involved in animal health related services such as clinics, shops or pharmacies participating in providing animal services or drugs. Similar situation was reported by Umali *et al* (1992) who indicated that livestock services like livestock health are still remained a government responsibility, in most developing nations. Negussie (2006) also reported that majority (95 %) of the producers in Mekelle zone were solely depended on governmental clinic to vaccinate and treat animals. However, the result of the present study was different to the finding for Metema district described by Tesfaye (2007) where most of the households (71.4%) in Metema district of Amhara region were supplied veterinary medicine from private sources, while lower proportion of households (28.6%) were supplied from government sources. This difference shows animal health services is remained a governmental task in Tigray region. So this indicates that the regional government in Tigray, have to create favorable conditions and encouragements to attract private institutions to participate in animal health services in order to alleviate the shortage of animal health services in the region.

Two means of cattle breeding systems were identified in the area, the use of bull service and AI; where majority of the farmers used natural mating to reproduce their cattle and some of them that had crossbred cows were also totally depended on AI. During natural mating, majority of the farmers use their own selected bull for breeding, but some of them used neighbor's bull by selecting the superior one putting the criteria such as body size, body conformation, color and history of milk yield of his dam. But very few respondents still applied uncontrolled mating in the field without considering bull selection to mate their cows. This finding was similar to the finding by Belete (2006) for Fogera district who found two types of cattle breeding system, natural (controlled or hand mating and uncontrolled) and Artificial mating.

In the present finding milking was entirely practiced by hand. Majority of the respondents milked both local and crossbred cows twice per day and insignificant proportion of respondents practiced once milking of local cows and three times milking for crossbred cows. For crossbred cows milking was practiced without suckling, but for local cows milking was practiced incorporated with partial suckling as the farmers believe allowing the calve to suckle during milking helps the cow to let down milk. This idea of the farmers in the present study was in agreement to the finding of Gebre-Egziabher *et al* (2000), who reported that calf suckling results in higher milk yield and long lactation length of the dam as well as higher weaning weight and pre weaning gain of the calf. Sintayehu *et al.* (2008) also reported majority of the producers in Shashemene- Dilla area milked cows twice per day.

Washing udder of local cows was not practiced in the district for the reason calves provided suckling prior to milking farmers ignored the importance of washing udder. On the other hand washing udder of crossbred cows was a common practice. In contrast, Asaminnew and Eyassu (2009) reported that farmers do not practice washing udder during milking in Bahir Dar Zuria and Mecha Woredas.

Majority of the respondents in the present study cleaned the animal barn once per day and very few of them that had crossbred cows clean the barn twice and trice per day. Dung was used as fuel by majority of the respondents and it was used for soil fertilization by some of them and very few households were also used it as a source of income by selling. This practice of dung

utilization was similar to the finding of Belete (2006) in Fogera area where majority of the respondents used it as fuel. But this result was different to the practice of dung utilization in Metema district reported by Tesfye (2007) where majority of the respondents used cattle dung for soil fertilization but insignificant proportion used as fuel (1.3%).

Labor is one of the important inputs in dairy farming. In the present study, gender has different contribution in different activities of dairy husbandry. In majority of the households milking was done by husbands whereas milk processing, barn cleaning and sell of milk and milk products were performed by wife. And also herding was done by male children followed by female children. This result was similar to the finding reported by Belete (2006) in Fogera area and by Tesfaye (2007) in Metema district. But Sintayhu *et al* (2008) reported milking is majority done by wife in Shashemene -Dilla area (79.3%).

The overall AFC, AFM and AFC for local cows in Enderta district were (42.97 ± 0.37 , 53.97 ± 0.49 and 17.97 ± 0.25 months) respectively, whereas for crossbred cows AFM, AFC and CI were (29.77 ± 0.65 , 41.00 ± 0.55 and 13.81 ± 0.23 months) respectively. The AFS indicated in the present study is in line with the report by Gidey (2001) for Fogera heifers (44 ± 0.8 months) and crossbred cows (35.7 ± 0.4 months) in Andassa livestock research center. Lower result of AFS for local heifers (32.82 ± 1.06 months) and crossbred cows (25.05 ± 1.26 months) was reported by Negussie (2006) in Mekelle zone. This difference might be due to the difference in management because urban dairy production is expected to be resourceful than the rural dairy production. The AFC for local cows was similar to the finding by Kedja (2007) in Meiso district (52.49 ± 0.91 months). Adebabay (2009) also reported similar result in Bure district (53.52 months and 34.68 months) AFC for local and crossbred cows respectively. The CI found in the present study for local cows was higher than the findings by McDowell (1971) for Horro breed (12.2 months) and the report by Goshu (1981) for Barka breed (11.8 months). But it was similar to the report by Gidey (2001) for Fogera breed (18.6 months).

In the present study, milk yield at early for local cows (1.16 ± 0.75 liter) was much less than the milk yield at early lactation (2.32 ± 0.089 liters per day) reported by Adebabay (2009), but the daily milk yield of local cows at mid (2.34 ± 0.06 liters) and late lactation periods (0.99 ± 0.03

liters) were similarly reported by Adebabay (2009) in Bure district (2.18 liters) and (0.96 liters), respectively. Assamnew (2007) also reported that higher milk yield in early than mid lactation (2.0, 1.2 and 0.6 liters at early, mid and late respectively). This difference might be resulted due to the incomplete milking practice of farmers at early lactation in the present study area, because during the first 30 to 45 days farmers did not practice complete milking of local cows for the reason they leave the milk to calves for suckling. The daily milk yield for crossbred cows was in early (11.27 ± 0.58 liters), mid (7.06 ± 0.52 liters) and late (5.00 ± 0.51 liters) lactations was similar to the report by Adebabay (2009) in Bure district for crossbred cows (10.96, 9.12 ± 1.19 and 5.04 ± 0.74 liters) at early, mid and late ;lactation, respectively.

Lactation length of local and crossbred cows in the resent study was (7.27 ± 0.10 and 9.55 ± 0.23 moths) respectively. The lactation length of local cows in the present study is similar to the report in CSA (2005) lactation length of local (7 months). The lactation length for crossbred cows was in agreement to the report by Adebabay (2009) for crossbred cows (10.1months) in Bure district. But the result found in this study was shorter than the result (11.67 months) for crossbred cows reported by Enyew *et al* (2000) in Asela research station.

In the present the overall average milk of take recorded in the present study were (6.81 ± 0.57 liters per day per house hold. This finding is in line with the report of Tesfaye (2008) for Metema district average milk off take per household (6.3 liters per household per day). But this result was lower than the result recorded (19.7 ± 1.2 liters per day per small farms) by Negussie (2006) in Mekelle zone. This might be related to the number of lactating cows holding differences and breed type of the cows as most of the households in the present study had local cows but in case of Negussie (2006) finding most of the households rear crossbred cows.

As other small holder milk producers in many parts of the country, milk producers of Enderta district were using traditionally prepared and plastic materials bought from the market to handle and store milk and milk products. Kordo for milking, Gefho/clay pot for milk storing for fermentation, Kucho/clay source, Hamham/plant source and Kordo/plant source for butter handling, Kucho/clay source for ghee handling were the common traditional utensils found in the present study. And respective use of plastic materials was also observed in the study area.

Ayenew *et al* (2009) reported that dairy farmers in North western Ethiopian high lands were using different milk utensils for collecting, storing and processing milk where most of the per-urban producers used local materials gourd and clay pot and the producers in urban area more (83%) used plastic utensils and the rest (17%) used aluminium utensils. Tesfaye (2007) and Belete (2006) also found milk producers using traditional materials for milk handling, storing and churning in their respective study areas in Amhara region.

Smoking of milk and milk products utensils was a common practice in the present study area. Milk producers had different reasons for smoking milk handling and storing utensils. The major reasons forwarded were: for good flavor of the product, for longer shelf life of the products, to have reddish color butter and to have attractive odor butter in order of importance. Practices of milk utensils smoking was also reported by (Adebabay, 2009; Kedja, 2009 and Tesfaye, 2007) in Bure, Meiso and Metema districts respectively.

The milk utilization pattern in the present study was (8.45% for household consumption, 63.02% for fermentation, 14.12% for calf feeding and 14.37% marketing). This result was in agreement to the report of Abera (2008) who found that milk allocated for consumption (10%) and for sale (15%) in Kuyu wereda of Oromia regional state. But the proportion of milk allocated for consumption in the present study was quite smaller than the finding by Tesfaye (2009) in Metema district (23.3%). On the other hand milk allocated for fermentation in this finding was similar to Metema district (63.2%), but the milk allocated for sale in the present study is higher than the finding in Metema district (0.4%) in the same study. This difference may show, fresh milk sell is more accustomed in the people or there may be better market access for whole milk in present study area.

In the study area milk derivatives such as butter milk, cheese and whey are used for human consumption only. Whereas study by Adebabay (2009) in Bure and Tesfaye (2007) in Metema reported that part of these milk derivatives was given to animals. This may show the greatest value given to such milk derivatives as human food in the present study area.

Fermentation of fresh milk was the only way used as a starting point for converting milk to other milk products in Enderta district. Frequently processed products were whole milk to fermented milk, fermented milk to butter and butter milk and boiling of butter milk to why and cheese. And processing of butter to ghee was less frequently practiced in the area. Frequently processing of fermented milk to butter and butter milk was reported by Tesfaye (2007) and Ayenew *et al.* (2009) in Metema district and North western Ethiopian high lands respectively. The unfamiliar practice of processing butter to ghee in the present study may be related to the high demand of unprocessed butter (sour butter) for cosmetic purpose in the study area, so farmer sell the butter unprocessed. Milk producers in the study area, forwarded two main reasons for processing milk to other milk derivatives. The first reason was the desire of butter because of its multifunctional value in their community and the second reason was lack of market for fresh milk. Desire of milk derivatives was reported as a reason for processing milk in Metema district. Lemma *et al.* (2005) also reported that farmers in North Showa zone Oromia region rely on traditional technology to increase the storage stability of milk and milk products either by converting the milk to its stable products like butter or by treating with traditional preservatives, as cooling systems are not feasible because of lack of facilities. O'Mahony (1988) also reported high ambient temperature, small daily quantities of milk produced, consumer preference, the improved keeping quality of fermented milk and the type and capacity of the locally available processing materials and methods as reasons for smallholder milk processing to be based on fermented milk.

The procedure of churning identified in the present study was similar to the reported procedures of churning in other parts of the country which were reported by Belete (2006) and Tesfaye (2007) all reported the first step in processing butter was the storage of whole milk in fermenting pot some days letting to ferment depending factors like temperature and milk volume.

In the present study, all milk producers in Enderta district apply boiling to increase the shelf life of whole milk, smoking of butter handling utensils to increase shelf life of butter, proper washing and smoking of yoghurt utensils to increase the shelf life of yoghurt. They also use spicing together with boiling to increase the shelf life of butter in the form of ghee. Adebabay (2009) reported smoking (for milk and yoghurt), spicing (for cheese and ghee), and washing (for butter) in Bure dstrict to increase the shelf life of the products. Ayenew *et al.* (2009) also reported

smoking of the container, and boiling of fresh milk, refrigerator and cooling by putting the container with milk into a cold-water were the methods used to preserve fresh milk and spicing for butter and cottage cheese in North western Ethiopian high lands.

In the present study the sellable dairy products identified during the study period were whole milk and butter that were found to be market through informal way. Butter was the most marketable dairy product in the district. Adebabay (2009) found similar result in Bure district, where milk and butter were marketed mainly through informal marketing systems. Debrah and Antehheh (1991) also reported those rural dairy farmers located within 20 km distance from Addis Ababa sell less milk and more butter and cheese.

The only sells outlet for whole milk found in the present study was farm gate whereas for butter the sells outlet identified were farm gate and market place. For whole milk the modes of payment were cash and cash in contract while was cash the modes of payment for butter. Adebabay (2009) reported farm gate/homestead, market place and door to door delivery were the outlets for whole milk. Tefaye (2007) reported farm gate, market place and delivery to customers as outlet for butter in Metema district. The absence of door to door delivery system in the present study may be related to the custom of the people in the study area. As observed during the data collection door to door delivery system were not practiced for both marketable dairy commodities. This shows milk producers in the study area do not lose money and time by delivering milk and butter to consumers.

The price of butter at farm gate was higher in sedentary livestock production system than transhumance production system. This difference may be due to less demand of butter in transhumance production system, because in transhumance livestock production system, most of the people may have their own milking cows. The market channel of whole milk in the present study was very short unlike the market channels found in other parts of the country. This may show trading of whole milk is not common in the study area. The market chunnel of butter found in the present study is however similar to butter channels found in other parts of the country. For instance Sintayehu *et al* (2008) and Tesfaye (2007) reported similar marketing channel for butter in their respective study areas.

The major constraints of milk production reported in the present study were feed cost, seasonal shortage of feed, distance to watering point, water impurity, and unavailability of AI service on time, distance to health services and conflict with neighbors. Of these problems distance to watering point and conflict with neighbors were the major problems in transhumance production system. This might be due to the cattle movement management in transhumance production system (cattle move to search feeds apart the watering point and move to the border areas with other districts or regions. As a result they are faced to water scarcity and conflict with neighbors. Emebet *et al* (2003) reported that the institutional constraints, Policy-related constraints and technical constraints responsible for such low productivity are revolved around three factors: Such as feed availability and quality: seasonal quantitative and qualitative feed shortages, and Poor Livestock health and Low genetic potential for milk production and unavailability of supply of improved genotype poor veterinary health care and management. Many other literatures indicated feed shortage, and poor veterinary services milk production are constraining in Ethiopia. For instance Sintayehu (2008) reported availability and costs of feeds constrain dairy production in Shashemenne- Dilla area.

The major constraints of milk and butter marketing reported in the present study were shortage of market for whole milk, seasonal fluctuation of price low price during lean demand periods (fasting periods) and peak production (September to December) and adulteration of milk. Shortage of whole milk market was more serious for the households who had crossbred cows than the households who had local milk stock. This is because as the households who had crossbred milk stocks produce milk to extended period of than to those who had only local cows; this may make the households with crossbred stock to be affected with product market shortage than the households with only local milk stock. The other probable reason as some milk producers reported was also the lack of interest to convert milk from crossbred cows because of less market preference to the butter from crossbred cows. Holloway *et al* (2002) reported the reason for low marketable milk products as limitations on the possibilities of exploring distant but rewarding markets due to high transaction costs arising from transportation and high opportunity cost of labor involved, dependable marketing system is not yet developed to market milk and milk products, producers and consumers are spatially separated; most producers are found in the rural areas while consumers or profitable market is found in urban areas. Market

infrastructures and marketing facilities are not well developed in the country. Sintayehu *et al.* (2008) reported discouraging seasonal marketing systems as a constraint in Shashemenne – Dilla area.

6. CONCLUSION AND RECOMMENDATIONS

In both livestock production systems (transhumance and sedentary livestock production systems) local cattle were reared primarily to have draught oxen whereas crossbred cattle were reared for milk production. Local cattle management in the transhumance livestock production system has an impression to hold large heads of cattle per household, livestock system where cattle are trekked to long distance of watering point, watered less frequently, housed in a way the animals exposed to extreme climatic conditions when moved to the lowlands. Milk producers owning crossbred cows moisturize the straw with traditional brewery by-product "Atella" to increase intake; they also forwarded the lack of knowledge to use other crop residue treatment techniques. Farmers' awareness on the use of improved dairy cows is becoming increasing and many of the farmers that own crossbred cows had the objective of expanding their dairy farms. However, dairy production and marketing in the area was constrained mainly by high feed cost especially reported by milk producers with crossbred stock, feed shortage, inadequate and inefficient AI and animal health services and conflicts in use of communal pasture lands (predominantly reported in transhumance livestock production system), price fluctuation, demand fluctuation and adulteration.

In line with the survey result and the above conclusion the following recommendations are forwarded:

- The cattle management practice in transhumance production system had attitudes towards larger herd size and had poor husbandry practice. Thus education/trainings on improved husbandry practices and awareness creation on the importance of quality than holding large heads of cattle should be provided.
- In the study area the feeding practice of local cattle was year round communal free grazing of natural pasture, so this type of feeding could reduce the productivity of the grazing lands and exposed to erosion and soil degradation leading to serious feed shortage in the district. Therefore, the district Agricultural and Rural Development office should have to introduce recommended grazing land management strategies like rotational

grazing, area closure by changing the attitude of the farmers to apply cut and carry feeding system and conserve grasses in the form of hay for the critical feed shortage times.

- Milk producers should be supported with strong extension service by way of introducing improved dairy technologies, improved feeding methods and improving the quality of available crop residues like urea straw treatment. Further research to establish Straw-“Attela” ratio in feeding cattle will also have much help in improving the utilization efficiency of the feed stuffs.
- If dairy production is to be developed in the district, the market outlet for the product has also to be organized. Private sectors should be encouraged to collect milk from the area and bring it to Mekelle zone where the demand for whole milk is very high.
- Milk producers especially those owning crossbred dairy cattle should be trained on sanitary production conditions to minimize the alarmingly increasing disease incidences like mastitis. On the other hand a sort of awareness creation mechanism should be introduced on proper handling of milk and milk products so that producers will be encouraged to adopt hygienic production systems.
- Adulteration of marketable dairy products was pointed out as a problem in the district. The concerned government body should introduce regulatory and control mechanisms to deter such practices.

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8. ANNEXES

Annex 1. Questionnaire survey

Region _____

Study area _____

Tabia _____

Date of interview _____

Name of interviewee _____

Name of the respondent _____

Sex A, male B, male

Age of the respondent _____

Position of the respondent in the family _____

A, Household head B, Family member

1. Household demographic Characteristics

1. Household head

Sex(Tick one box)		Background
Male	Female	

Background: Where A. Farmer B. Merchant C. Government employee D. Other (specify) respectively

2. Age of household head _____

A, <30 B, 31-40 C, 41-50 D, 51-60 E, >60

3. Marital status of the household head _____

A, Married B, Single C, Widow D, Divorced

1.4. Educational level of the Household Head _____

A. Illiterate B. Elementary school C. High school D. diploma and above respectively

E. read and write

4. Family size, age and level of education.

Family members	No.	Level of education.
Children		
Males $\leq$ 15 yrs		
Females $\leq$ 15yrs		
Adults		
Males 15-30		
>31		
Females 15-30		
>31		

Level of education: A. Illiterate B. Elementary school C .High school D. diploma and above respectively E.

Read and write

5. The main source of income (please rank 1-3 in a descending order).

Fresh milk sale	Milk products sale (specify)	Other livestock production	Crop production	Other (specify)
Rank				

6. Landholdings (ha)

Land use	Private(ha)	Communal(ha)	Contracted(ha)	Rented out	Total
Crop production					
Grass land					
Forage land					
Other(specify)					

7. Livestock holding and cattle herd structure

Cattle class	Number and breed type

	Local	Cross	Exotic		
			Friesian	jersey	Other(specify)
Male calves<1 year					
Female calves<1 year					
Heifers					
Bull					
Oxen					
Dry cows					
Lactating cows					
Pregnant cows					
Sheep					
Goats					
Camel					
Mule					
Horse					
Donkey					
. Chicken					
Beehives					

8. Reasons for keeping cattle (rank 1 to 3)

Reasons	Rank	
	Local	Cross
milk production		
meat production		
Draught		
Other (specify)		

2. Experience and household labor distribution in dairying

1. Experience in dairy farming _____ years.

2. Do you receive any help from government or non-government organization on dairying?

A. Yes

B. No

If yes, what type of help? _____

3. How do you get information on dairying most of the time?

A. From Radio

B. From extension agents

C. Other (specify) _____

D. I do not have information

4. Did you get any formal training on dairying?

A. Yes

B. No

If yes, for how long did you take the training? _____

A. for a few days

B. for a few weeks

C. for a month

If you got formal training would you please mention the concern of the training.

A. on breeding of dairy cattle

B. on feed and feeding management of dairy cattle

C. on milking, milk handling and processing

D. on calf rearing and health care of dairy cattle

E. on general management of dairy cattle

F. other (specify) _____

5. Do you think that you have improved your knowledge on dairying from the training?

A, Yes B, No

If no what do you thing is the reason? _____

6. When did you start keeping crossbred milk cattle? _____

7. Source of crossbred heifer(s): A, The use of AI B, Purchase of cross breed bull

C, Purchase of cross breed cow or heifer D, Purchase of pure exotic cow/heifer and then

crossbred with local bull E, Purchase of pure exotic bull and then crossbred with local

cow/heifer F, Other (specify) _____

8. Advantage and disadvantage of keeping crossbred cattle compared with local cattle (rank in decreasing order)

Advantage	Rank	Disadvantage	Rank

9. Would you carry on keeping these crossbred cows in the future? A, yes B, No

If No, why? _____

If Yes, why? _____

3. Cattle husbandry

3.1. Housing

1. How do you house your cattle?

Breed	Class of cattle and housing types in dry and rainy seasons													
	Calves		Heifers		lactating cows		pregnant cows		dry cows		Bull		oxen	
	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS
local														
cross														
Exotic														

Housing type: A. Enclosure without shed B. Enclosure with shed C. Improved barn D. In family house

Where, DS= dry season and RS = rainy season

2. What is the house made from?

Parts of the house	Type	
	Local	Cross
Roof		
Wall		
Floor		

Type: A. represents for Corrugated Iron B. Grass
C. Wood. D Concrete E. Stone F. Mud G. Other

(specify) _____

3. When do you house your cattle?

A, All the time B, Only at night C, other (specify) _____

4. Do you have any conflict with your neighbors because of your cattle? A, Yes B, No

5. If yes, what do you think is the reason? _____

6. Frequency of cleaning the barn and dung utilization? (Tick one or boxes)

Frequency of cleaning		Dung utilization	
Once per day		No use	
Twice per day		As cow dung cake	
Three times per day		For soil fertilization	
More than three times		Other(specify)	

7. If you dispose cattle dung, how do you dispose it? A, Draining system B, labor

C, other (specify) _____

8. Do you sell the animals' dung cake?

A, Yes B, No

9. If yes, where do you usually sell the animals dung cake?

A, At the farm gate B, On the nearby market C, Other (specify) _____

10. What is your labor source for your dairying?

A, Family labor B, Hired labor C, Both D, other (specify) _____

11. When is your high labor demand?

A, during the peak of lactation B, during hay harvest C, during cow dung preparation

D, Other (specify) _____

3.2. Feed and Feeding

1. What is the feeding practice of your cattle?

A. Free grazing (full time) B. stall feeding

C. grazing +stall feeding D, Other (specify) _____

2. If your cattle graze, for how long they stay in grazing (hours per day) in different season? (put gazing hours)

Breed	Class of cattle and grazing hours /day													
	Calves		Heifers		lactating cows		pregnant cows		dry cows		Bull		oxen	
	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS
local														
cross														
Exotic														

Where: DS= dry season RS= Rainy season

3. Do you grow improved feed for your cattle? A. Yes B. No

If yes, what are they?

A. Grass	B. Forage legume	C. Tree legume

If no, what are your major reasons for not growing animal feeds?

A. Insufficient land

B. Insufficient labor

C. Insufficient inputs (seed, fertilizer, and cash)

D. Labor shortage

4. Which crop residue do you feed for your cattle? (Tick one or more boxes)

Crop residue		Rank
Teff straw		
Barley straw		
Wheat straw		
Maize stalk		
Other (specify)		

5. Do you have practice of treating crop residues to improve utilization? A, Yes B, No

If yes, which crop residue do you usually treat and what type of treatment do you use?

1. _____

2. _____

3. _____

If no what is the reason for not treating the crop residue? _____

6. What is the main daily feed given for your cattle? A, Crop residue B, Concentrate C, Other (specify) _____

7. Do you buy any feed for your cattle?

A. Yes

B. No

8. If you buy, would you mention the average price of purchased feeds?

Feeds	(Tick purchased feed)	Birr/qt	Source
1. Hay			
2. Green grass			
3. Noug seed cake			
4. Wheat bran			
5. Salt (Nacl)			
6. Crop residues			

7. Formulated ration			
8. Bone meal			
9. poultry litter			
10. Atela (residue of local bird)			
11. Other (specify)			

Source: A. from private traders B. from the industries C. Other (specify) _____

9. For what class of cattle do you supply with feed supplement most of the time? (for more than one answer tick the boxes)

Classes of cattle	Special attention given for (rank)	Amount of supplement feed offered (kg/day)	Frequency of supplementing	Type of feeding
Local				
1. calves				
2. heifers				
3. lactating cows				
4. pregnant cows				
5. dry cows				
6. bulls				
7. oxen				
Crossbred				
1. Male calves				
2. Female calves				
3. heifers				
4. lactating cows				
5. pregnant cows				
6. dry cows				

7. bulls				
----------	--	--	--	--

Type of feeding: A, individual feeding B, group feeding

Frequency of supplementing: A. once B. twice C. Three times

10. If your feeding is group feeding how do you group the animals?

A. Age group B. Sex group C. Breed group

D. Reproduction status within females (i.e lactating stage, late pregnant and dry)

E. Feeding all classes together F. Other (specify) _____

11. If you feed your cattle through feed trough how do you handle the feeding trough and feed leftovers? (Tick one box)

Frequency of cleaning the feed trough		Use of the leftovers feed	
Once per day		Reoffering to the animal	
Twice per day		Removing and mixing in dung to prepare manure	
Once in two days		Throwing as waste	
Other (specify)		Other (specify)	

3.3. Watering

1. Source of water at different season of the year (Tick in one or more boxes)

Water source	Seasons		
	Dry	Rainy	Year round
pipeline			
nearby river			
Pond			
Wells			
Others			

2. If you use pipeline, what do you provide for your cattle when there is pipeline water cut off?

3. If you use water source from river, pond or well, do you usually transport the water or bringing the animals to the rivers, pond or well?

A. Transport the water

B. Bringing the animals to the river or pond

If you take your dairy cattle for water what is the average distance to the watering point? A, <1

B, 1-4 kg C, 4-10 kg D, >10 kg

4. How frequently do you provide water for your cattle?

Breed	Class of cattle and watering frequency													
	Calves		Heifers		lactating cows		pregnant cows		dry cows		Bull		oxen	
	D	R	D	R	D	R	D	R	D	R	D	R	D	R
local														
cross														
Exotic														

Where: D= dry season R= Rainy season

Frequency of watering: A. free access B. once per day C. twice per day and D. once per two days

5. How do you water your dairy cattle? A, through individual watering trough

B, through common watering trough C, other (specify) _____

6. How frequent you clean the watering trough? A, once per day B, Twice per day

C, Once per two days D, < once per two days

3.4. Breeding

1. Do you have Practice of estrus detection?

A, Yes B, No

2. What is the means of cattle reproduction you use? (Circle on the alternatives you use)

A, AI B, Breeding bulls (natural) C, both D, Other (specify) _____

3. If you use AI, from where do you get the service?

A, Government employed technicians B, NGO's

C, Private D, Others (specify) _____

4. Which method do you prefer and why?

A, Natural (bull service) _____

B, Artificial insemination _____

5. What is your problem in relation to AI?

A, Shortage of the service B, Unwillingness of AI technicians

C, Other (specify) _____

6. Do you have your own breeding bull currently? A. Yes B. No

7. If yes, breed type _____

8. If no, what is your source for the bull? (Tick on the boxes)

Neighbor's bull	
Communal bull	
Unknown bull	
Other (specify)	

9. What is/are your criteria to choose your replacement breeding bull/dairy cow? _____

10. Do you have any plan to improve the reproductive performance of your dairy herd?

A, Yes B, No

11. If yes, how (specify the method you think to improve your dairy herd) _____

12. Have you ever practiced culling your dairy cattle? A, Yes B, No

13. If yes, what is/are the main reason of culling and your priority of culling for cash? (Tick)

Reason of culling		Rank	Priority of culling for cash	Rank
Disease			Milking cow	
Age			Bull	
Infertility			Heifer	
Low milk yield			Male calves	
For cash income			Female calves	
Feed Shortage			Pregnant cow	
Others (specify)				

3.5. Calf Rearing Practices

1. Do you wean your calf? A. Yes B. No

If yes, at what age do you wean the calf (in months)?

Local A. Male _____ B. Female _____

Cross A. Male _____ B. Female _____

Exotic A. Male _____ B. Female _____

If yes, which type of weaning do you exercise?

A. Isolation and herding separately B. Protection from sucking without isolation

C. Other (specify) _____

If yes, explain the reason why you wean?

A, To get more milk B, Prepare the cow for mating C, Give rest time for next calving D, Others (specify) _____

2. Method of milk feeding up to weaning:

A. Bucket feeding B. Partial suckling

C. Unrestricted suckling D, Other (specify) _____

3. Do you provide colostrums for your newborn calf? A. Yes B, No

If no, why _____

4. For how long is the newborn calf supplied with milk (in months)? Male _____ Female _____

5. Do you provide supplementary feed to newborn calf till they start grazing?

A, Yes B, No

If yes, mention the type of feed and form of feeding? _____

6. After weaning, what do you do with male calves?

A. Sell B. fatten them C. as sire D, other (specify) _____

3.6. Milking

1. Milking method: A. hand milking B. machine milking

2. Type of milking practices

A. Milking without suckling B. Few suckle before and after milking

C. Suckling before milking only D. Others (specify) _____

3. Do you wash udder of milking cows? A. Yes B. No

If yes, when do you do it? A. Before milking B. After milking C. Before and after milking

4. Use of towel:

A. Use of individual towel B. Use of collective towel C. Other (specify) _____

3.7. Animal health service

1. Major dairy cattle disease in the area (Rank them)

Local name	Common name	Traditional control measure, if any	Rank

2. How many animals do you lose the last one- year (2010-2011) because of disease?

Class	cattle type			Total
	local	cross	exotic	
1. calves				
2. heifers				
3. lactating cows				
4. pregnant cows				
5. dry cows				
6. bulls				
7. oxen				

3. Do you have access to animal health services? A. Yes B. No

4. If yes, who has been giving health services for your dairy cattle?

A. MoARD B. NGos C. Other (specify) _____

4. Milk production, utilization, handling, processing and marketing

4.1 Milk production and reproduction performance of cows

1. Reproductive performance of cows

Type of cattle	Reproductive Performance		
	AFM (months)	AFC (month)	CI (month)
local			
Cross			
Exotic			

2. Milk yield and number of milking per day for milk cows

Type of cattle	No of milking per day	Lactation performance				
		Daily milk yield(Lt)				Lactation Length (month)
		early	mid	late	average	
local						

4.2. Milk production and utilization at household level

1. Daily milk production of the HH and daily milk allocation for different purposes

Type of milk cows	No of cows	Total milk production per day of the farm (liters)	Amount used for

		Mini mum	Maxi mum	Avera ge	Home consum ption	Calf feeding	Farm process ing	Selling
Local								
Cross								
Exotic								

2. Milk products produced per week (In kg)?

Milk products	Quantity produced/week	Quantity consumed at HH level	Quantity marketed
Butter			
Cheese			
Yogurt			

3. Rank dairy products in order of preference for HH consumption?

(First product in the list being the most preferred one)

4.3. Milk handling

1. What utensils do you use for handling and storage of:

Liquid milk _____

Yogurt: _____

Butter: _____

Cheese: _____

Ghee: _____

2. Do you practice smoking of milk vessels? A. Yes B. No

3. If yes, what is the purpose of smoking? A. For good flavor

B. For longer shelf life of the products C. others (specify) _____

4. What products/plants do you use for smoking milking utensils?

Milking utensils	Product/Plant used for smoking	
	Local name	Scientific name

5. How frequently do you clean your milking equipments? A. Once per day B. Twice per day

C. 3 times per day D. Others (specify) _____

6. Water source used to washing milking equipments? (Tick the alternatives you use)

Water source	season		
	Dry	Rainy	whole year
pipeline			
Rain			
Wells			
Pond			
River			
Others (specify)			

7. Do you use sanitizers for cleaning milking and milk handling equipments? A. Yes B. No

8. If yes, please mention the type of sanitizers you use _____

9. For how long do you keep milk and milk products without spoilage? And what methods do you use to increase the shelf life of the following?

products	Average shelf life in days		method
	Dry season	Wet season	

1. Milk			
2. Yoghourt			
3. Butter			
4. Cheese			
5. Ghee			
6. Butter milk			
7. Why			
6. Others (specify)			

Method: A. smoking milk vessels B. boiling the product C. Salting D. Other (specify)

10. Have you a problem of spoilage of milk and milk products?

A. Yes B. NO

11. If yes what are the reasons?

A. lack of market B. Excess Product C. Poor conditions of handling and storage
D. Others (specify) _____

4.4. Milk processing

1. Do you process milk? A. Yes B. No

2. If yes, what are your reasons to process milk? _____

3. If yes, indicate the products you process.

No	Processed products	Tick	Rank
1	Fresh milk to yoghurt		
2	Whole milk to cheese		
3	Fermented milk to butter and butter milk		
4	Butter milk to cheese and why		
5	Other (specify)		

4. What is the volume of fermented milk churned to produce butter at a time?

Type of cow milk	Amount of milk churned at a time (lt)	Amount of butter produced (kg)
Local		

HF cross		
Jersey cross		
Other(specify)		

5. What type of materials do you use for processing?

Processing	Frequency of processing per week	Materials used
Churning		
Cheese (Ayib)making		
Ghee making		
Others (specify)		

Frequency of processing: A. Once B. Twice C. Three times D. Other (specify) _____

6. Do you practice adding of products/plants to milk and milk products during processing?

A. Yes B. No

7. If yes indicate the following:

Products	Product/plant added		Reason of adding
	Local name	Scientific name	
Milk			
Yoghourt			
Butter			
Cheese			
Ghee			
Butter milk			

4.5. Dairy product marketing

1. Do you sell Fresh milk? A. Yes B. No

2. Do you sell butter? A. Yes B. No

3. If no, Why? _____

4. If yes fill the following table:

Sales of milk and milk products and prices during the study period

No	Description	Wet season		
		Outlet1	outlet 2	Outlet3
1	Raw milk			
	sales outlet			
	Reason for choice of outlet			
	Buyer type			
	Qty/day or week in litter			
	Price/unit (birr/litter)			
	Mode of payment			
2	Butter			
	sales outlet			
	Reason for choice of outlet			
	Buyer type			
	Qty/day or week in Kg			
	Price/unit (birr/Kg)			
	Mode of payment			

Codes for sales outlet: A. Farm gate (homestead) B. Market place C. Delivery to buyer

D. Other (specify) _____

Codes for mode of payment: A. Cash B. Cash in advance C. Credit D. Others (specify) _____

Codes for buyer type: A. Consumer B. Trader C. Catering shop B. Organization

(Hospital/school/hostel) E. Collection point of /private/Cooperative enterprise

F. Others (specify) _____

Reason for choice of outlet: A= Good price B = Short distance C = Reliable customer

D= Mode of payment

5. At which season/months, the price from the sale of milk and milk products tends to increase or decrease? (Rank the type of product you sale frequently)

No	Products	High priced Season and/months	Low season and/months	Rank
1	Milk			
2	Butter			
3	Cheese			
4	Yogurt			
5	Butter milk			
6	Ghee			
7	Why			

Codes for months: A. Sept. B. Oct. C. Nov. D. Dec. E. January F. Feb. G. March H. Apr. I. May L. June M. July N. Aug.

6. For what purpose do you mostly use the money that you get from the sale of milk and milk products A. Farm inputs B. Farm improvement or expansion C. For household demand meeting D. Other (specify) _____
7. Would you mention the distance in Km and the transport cost of milk and milk products sell (for a double trip of a sell)? _____ Km, _____ Birr
8. Is there any period that you have problem of marketing your milk and milk products?
A. Yes B. No
8. If yes, which months? A. Fasting months B. In any month of the year (specify) _____
C. Other (specify) _____
9. Which cow's milk is preferred by the consumers? A. jersey crosses' B. Holstein Friesian cross'
C. jersey. D. Holstein Friesian E. Other specify _____
10. Do you know why they preferred milk from this species? A. Yes B. No
11. If yes, what are the attributes preferred?
A. The color of the milk B. The fat content of the milk C. Other (specify) _____
12. Is there any significant price difference in the milk of cross-breed and local cow? A. Yes
B. No
13. If yes, please indicate from which type of milk you get the highest price
A. From local in general B. From HF crossbreed C. From Jersey crosses
D. Other (specify) _____
14. Is there any milk taste difference between cross bred and local cow?

A. Yes B. No

If yes, which type of cow milk has the best taste?

A. HF crossbreed B. Jersey crosses C. Local D. Other (specify) _____

15. Has any of your milk intended for sale been rejected because of poor quality? A. Yes B. No

If your answer for question number 15 is yes, how frequently?

A. 3/4 of the time B. 1/2 of the time

C. 1/4 of the time D. Others (specify) -----

16. Which milking or milk product is mostly rejected?

Frequently rejected milking	Tick	Reason	Mostly rejected milk products	Tick	Reason
Morning milking			Butter milk		
Mid day milking			Butter		
Evening milking			Cheese		
			Yogurt		
			Ghee		
			Other(specify)		

5. Constraints of dairy cattle husbandry, milk production, handling, processing and marketing at household level

5.1. Major problems in relation to cattle husbandry?

1. What are your major problems in relation to housing and dung disposal? _____

2. What are your core problems in relation to feed and feeding cattle? (Rank them)

No	Feed related problems	Rank	Feed Shortage mainly faced	
1	Availability		Dry season	
2	Cost		Wet season	

3	Quality		Both	
4	Technical knowledge about fodder production, handling and feeding			
5	Any other(specify)			

3. Do you have coping mechanisms for such a problem of feed shortage?

Coping mechanisms for Feed shortage

1. _____

2. _____

3. _____

4. What is your main water related problem?

A. Scarcity

B. Impurity

C. Distance

D. Other (specify) _____

5. What are your major problems in relation to breed and breeding? A. cost of AI service (how much _____) B. Un availability and cost of improved breed (how much _____)

C. Other (specify) _____

6. What are your major problems in relation to calf and calf rearing? A. Mortality B. Slow growth

C. Other (specify) _____

7. What are your major problems in relation to milking? A. labor cost (how much _____) B. sanitary of workers C. Other (specify) _____

8. Is there a problem with animal health services? A, Yes B, No

If yes, please mention the reason _____

5.2. Major constraints in relation to milk production, handling, processing and marketing

1. What are the major problems with respect to milk production? (Prioritize)

Major problems	Prioritize
----------------	------------

2. Do you have a problem of skipping record keeping in milk production? A. Yes B. No

3. What are the major problems with respect to milk and milk products marketing? (Prioritize)

Major problems	Prioritize

Annex 2. **Farm visit**

1. Partitions of house (tick one or more)

Partitions	Cow shed	Bull room	Calving room	Calf room	Culling room	Milking room
Tick						

2. Housing facilities (Tick)

Water trough only (WT) _____

Feeding Trough only (FT) _____

WT + FT _____

No facilities _____

Windows _____

Does the house have drainage facility? A. Yes B. No

3. The area of the barn (m^2) _____

4. Number of animals housed in the area of the barn _____

5. Bedding material _____

6. Mechanisms of feed storage

No	Feed type	Storage mechanism

7. Presence of skin injuries A, Yes B, No

8. Presence of udder injuries A. Yes B. No

9. Presence of teat blindness A. Yes B. No

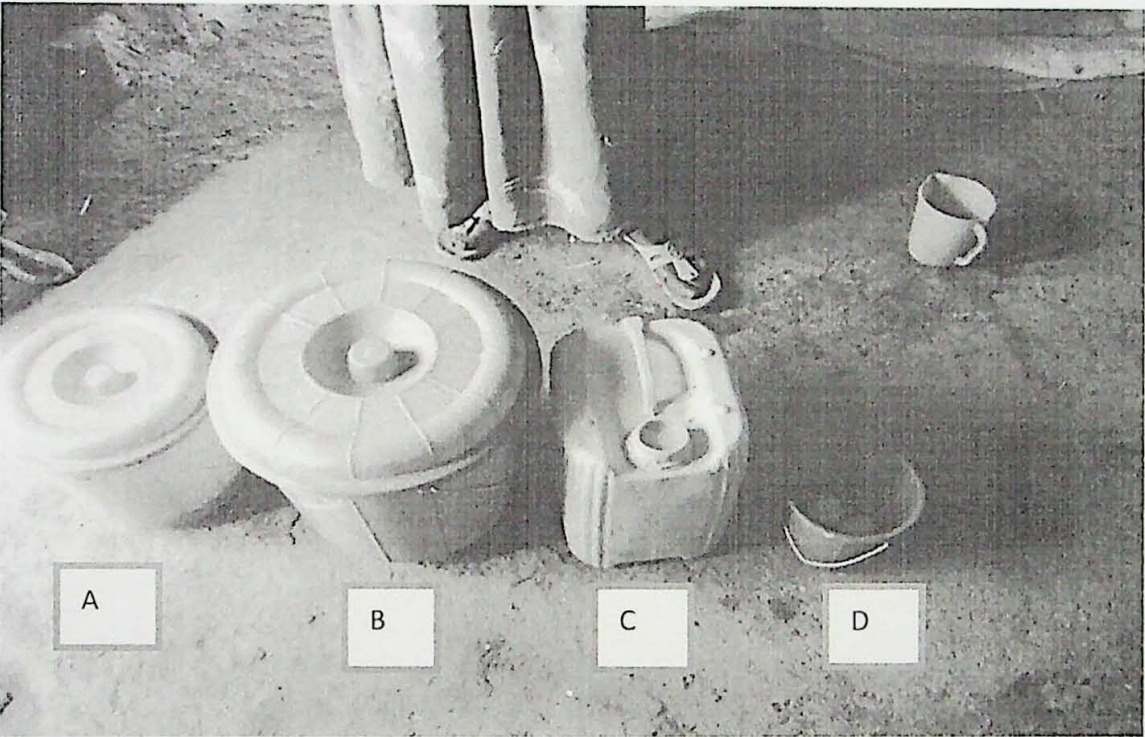
10. Is the body of the animal specialty udder, flank and hind legs neat?

A. Yes B. No

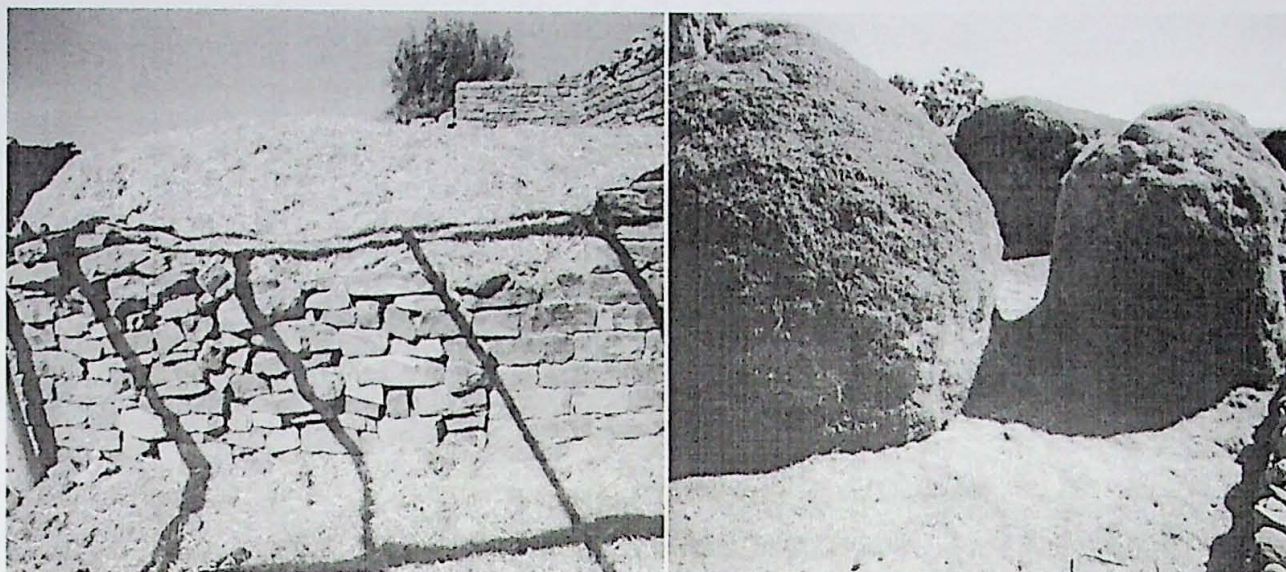
11. Foot and leg condition A. lamed B. Not lamed



Annex 3.3. Open stone fenced local cattle housing system in Enderta district



Annex 3.4. Plastic dairy product handling and storing equipments, A (milking utensil), B (Milk fermenting utensil), C (Fermented milk churning utensil) and D (Sour butter handling utensil)



Annex 3.1. Storage mechanism of wheat and barley straw (the left one, in sedentary livestock production system) and (the right side, in transhumance livestock production system) in Enderta district



Annex 3.2. Cattle grazing crop aftermath in the sedentary livestock production system in Enderta district

9. SIGNED DECLARATION SHEET

“This thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged”.

Name: TSADKAN ZEGEYE KAHSAY

Signature: _____

Date: JUNE 2012

This thesis has been submitted for examination with my approval as a University advisor.

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