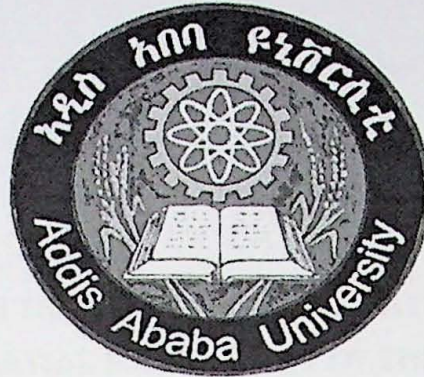


ADDIS ABABA UNIVERSITY
COLLEGE OF VETERINARY MEDICINE AND AGRICULTURE



HANDLING, PROCESSING AND UTILIZATION PRACTICES OF MILK PRODUCTS IN
THE HIGHLANDS OF SOUTHERN TIGRAY, ETHIOPIA

MSc THESIS

BY

ABRAHA NEGASH GEBREHIWOT

JUNE 2012

DEBREZEIT-ETHIOPIA

HANDLING, PROCESSING AND UTILIZATION PRACTICES OF MILK PRODUCTS
IN THE HIGHLANDS OF SOUTHERN TIGRAY, ETHIOPIA

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THE MASTER OF SCIENCE DEGREE IN TROPICAL ANIMAL PRODUCTION AND
HEALTH

BY
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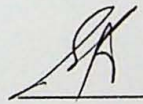
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DEDICATION

I dedicate this thesis manuscript to my beloved brother Mehari Negash for his precious contribution to the successful completion of the study from Alpha and omega.

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ABSTRACT

Cross-sectional study was carried out with the aim of assessing milk products handling, processing and characterize the utilization practices in dairy farmers of Ofla, Enda-Mekoni and Emba-Alaje Weredas in highlands of Southern Tigray, Ethiopia. A total of 156 households possessing a dairy farm, of which 47 urban, 20 periurban and 89 rural were studied using Probability proportional to size approach sample determination. Peculiarity of the area was that butter hair ointment and custom of dying white close in to greyish was different to the utilization of milk products in Ethiopia. Out of the total respondents, 42.31% of them sell fresh milk, 1.92% buttermilk and yoghurt, 98.08% butter to consumers of which 93.26% of them were rural respondents. Milk products handling and processing were using local vessels treated with different plant materials by cleaning and smoking. Milking vessels that are in use for the purposes include 'gibar' (9.62%), plastic materials (55.13%) and 'karfo' (35.26%). Farmers use different utensils for souring milk which included 'qurae' made of clay pot (16%), plastic vessels (54.5%) or gourd (29.5%) whereas for storing ghee 66.03% of the respondents use in plastic, followed by 30.13% who used 'qurae' and 3.21% of them use stainless steel vessels. There was significant ($p < 0.05$) difference in the use of churning vessels in the study area where 93.6% of respondents use 'laga' while the others use water tight plastic vessel. Butter handling practice is generally using 'qorie' that could vary in size and type made from glass (2.6%), stainless steel (6.5%), log (7.1%), 14.2% 'gibar', plastic (17.4%) and gourd (52.3%). The log 'qorie' was best butter handling material, but not easily accessible. Butter milk termed as 'awuso' and spiced butter milk 'hazo' are stored in clay pot, plastic and stainless steel. For improving the shelf life of the different milk products, farmers use various species of plants which are used for cleaning and smoking of utensils used for storing the products. These included: *Olea europaea*, *Dodoneae angustifolia* and *Anethum graveolens* were dominant plants exploited for smoking milk vessels while *Cucumis prophertarum*, *Zehneria scabra* (L. fil) sonder and *Achyranthes aspera* were all rough in nature to clean the grooves of the clay pot and churner. Identification of the active ingredients contained in these plants would help their commercial use for improving the shelf life of milk and milk products at a smallholder level as well as at a larger scale with the aim of increasing the income generation capacity of dairy enterprises.

Keywords: milk handling and processing, milk physico-chemical properties, plants

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ABBREVIATIONS

AI	Artificial Insemination
BoARD	Bureau of Agriculture and Rural Development
CSA	Central Statistical Agency of Ethiopia
FAO	Food and Agriculture Organization of the United Nations
ha	Hectare
IGAD	Intergovernmental Authority for development
ILRI	International Livestock Research Institute
IPMS	Improved Productivity and Market Success of Ethiopian farmer project
Kg	Kilogram
Km	Kilometre
LPI	Livestock Policy Initiative
m.a.s.l.	Meter above sea level
MoA	Ministry of Agriculture
PP	Pages
RCBP	Rural Capacity building Program
SNV	The Netherlands Development Organization
TVET	Technical and Vocational Educational Training

TERMINOLOGY

<i>Afme'ar</i>	also <i>anashe/echelam</i> for foot and mouth disease
<i>Awuso</i>	buttermilk
<i>Beyene</i>	also <i>degehabe/gulehay</i> for rindepest disease
<i>Gibar</i>	grass woven used as milking and butter storage vessel
<i>Goita ger</i>	also <i>shidon ger/ werchi</i> for black leg disease
<i>Hazo</i>	buttermilk mixed with spices to ferment and extend shelf life.
<i>Karfo</i>	milking vessel also termed as <i>kordo, guagid</i>
<i>Laga</i>	milk churning vessel (gourd)
<i>Maetena</i>	smoking tradition of vessels of milk products
<i>Megerem</i>	also <i>tafia/hibet/halafien</i> for Anthrax disease
<i>Qorie</i>	butter handling vessels of different types
<i>Qurae</i>	<i>Mewahlelito</i> vessel to store (sour) milk
<i>sambue</i>	also <i>tirfe</i> for CBPP/Contagious Bovine Pleuropneumonia disease
<i>Shifed</i>	circling disease/bacterial case
<i>Sihum</i>	also <i>niter kibe</i> meant for ghee
<i>Tsimbahlela</i>	yoghurt served as tradition of medication during emergency

1. INTRODUCTION

Domestication of ruminant animals and their use to produce milk, meat, wool, and hides represents one of the cornerstone achievements in the history of agriculture. The essential feature of the ruminant animal that has fostered its utility as a dairy animal is the presence of a large pre-gastric chamber where microbial digestion of feed particularly fibrous feeds not directly digestible by human, provides various fermentation products that serve as precursors for efficient and voluminous synthesis of milk. Without this symbiosis between animal and microbe, the dairy industry would not have developed, and indeed human culture would be vastly different in its food-gathering methods (Weimer and James, 2001).

In Ethiopia, the traditional milk production system, which is dominated by indigenous breeds of low genetic potential for milk production, accounts for about 98% of the country's total annual milk production. The low productivity of the country's livestock production system in general and the traditional sector in particular is mainly attributed to shortage of crossbred dairy cows; lack of capital by dairy producers, inadequate animal feed resources both in terms of quality and quantity; unimproved animal husbandry system; inefficient and inadequate milk processing materials and methods; low milk production and supply to milk processing centers; and poor marketing system. Making improvement interventions to the traditional sector is, therefore, crucial if development of the livestock sector of the country is targeted. Its large livestock population; the favorable climate for improved, high-yielding animal breeds; and the relatively disease-free environment for livestock make Ethiopia to hold a substantial potential for dairy development. Considering the substantial potential for smallholder income and employment generation from high-value dairy products, development of the dairy sector can contribute significantly to poverty alleviation and nutrition in the country. With the present trend characterized by transition towards market-oriented economy, the dairy sector appears to be moving towards a takeoff stage (Zelalem, 2010).

Dairy enterprises are the "white gold" of many developing countries, creating pathways out of poverty while boosting better human nutrition and health, regular income generation, employment, crop farming, and natural resource management. The context for smallholder dairy development in Ethiopia has been changing rapidly, creating both new opportunities and

challenges (Tesfaye *et al.*, 2010). Milk contributes about 20-25% to the agricultural sector and more than 75% of the produce is absorbed locally for consumption (SNV, 2008). In order to sustain milk production to satisfy the increasing demand, efforts to increase milk production should go hand in hand with efforts and knowledge to dispose milk surpluses above local requirement in the milk producing villages. The manufacture of stable marketable products including butter, low moisture cheese and fermented milk will provide smallholder producers with additional source of cash, facilitate investment in the milk production, yield by products for home consumption and enable the conservation of milk solids for future sale or consumption (Belete *et al.*, 2010).

Milking is the defining activity of dairy farming. Consumers demand high standards of milk quality, so milking management aims to minimize microbial, chemical and physical contamination. Milking management covers all aspects of the process of obtaining milk from animals quickly and effectively, while assuring the health of the animals and the quality of the milk (FAO and IDF, 2011). The importance of milk in the Ethiopian diet differs according to the farming system and the socio-cultural set-ups. Generally, in the lowlands especially where livestock keeping is the main occupation, milk is consumed by all groups of the society. In the highlands, the rural people are sedentary farmers raising both livestock and crops. The main part of their diet consists of cereals and legumes. Milk is used for rearing calves and children, and the surplus is soured for making different fermented milk products.

According to Lemma *et al.* (2005ab), storage stability problems of dairy products exacerbated by high ambient temperatures and distances that producers have to travel to bring the products to market places make it necessary for smallholders to seek products with a better shelf-life or to modify the processing methods of existing ones to get products of better shelf-life. The first step that the producers or product handlers can take to ensure a high quality product is to make sure that the production and the manufacturing process are hygienic. These will result in fewer spoilage organisms in the dairy products and thus better quality with longer shelf life in the final products. Another option to ensure good quality is to take maximum care in handling and storage of the products during transport and marketing. The fact that milk is relatively perishable and a high percentage of it is consumed in a relatively natural state, handling of milk and its products to preserve its natural and desired characteristics is very important. The less perishable the products, the longer the smallholders can retain it to obtain good price and surplus made during the production season can be stored for consumption during the season in

which the products are in short supply. Smallholders add different spices to butter as a preservative and /or to enhance its flavour for cooking (O'Connor, 1993; Lemma *et al.*, 2005ab; Asaminew, 2007), buttermilk is also spiced to ferment for better shelf life in the study area.

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. But these preservatives are not readily available in rural areas and cooling systems are not feasible because of lack of facilities (O'Connor, 1993). In these areas, the farmers have to rely on traditional technology to increase the storage stability of milk products either by converting the milk to its stable products like butter or by treating with traditional preservatives (Ashenafi, 2002). Identification and characterization of these traditional herbs and determination of the active ingredients and methods of utilization could be very crucial in developing appropriate technologies for milk handling and preservation in the country (Lemma *et al.*, 2005ab).

According to Mburu *et al.* (2007) characterization of smallholder dairy production systems in highlands is critical in understanding the constraints and opportunities that exist within the farming systems. It allows better targeting of dairy improvement research and development. Therefore, information obtained can be valuable for detailed analysis of constraints and opportunities found in smallholder dairy systems and to design policies and strategies to support smallholder dairy development programs in variable intensification that one has to be aware of the challenges of dairy which, is one of the greatest successes stories of developing country agriculture and one of the most unsung, especially in the disadvantaged marginalized areas. The contribution of milk products to the gross value of livestock production is not exactly quantified (Getachew and Gashaw, 2001). The bulk of Ethiopian livestock's provision to the economy is not properly identified in conventional national accounts as coming from livestock. These distortions are particularly acute for highland livestock production systems in which animal energy for transport and dung for fuel are as important as conventional milk and meat production (IGAD, 2008) that confirmed less attention was given to the sector despite its indispensable contribution to the economy of the majority of dairy farmers and the nation.

Milk production in Ethiopia is constrained by a multitude of technical, financial, institutional and socio-economic factors (MoARD, 2007). Coordinating inputs (knowledge, finance, social and political capital) of various actors and their expectations in a way to create best practices

and innovations could contribute better exploitation of the resource (Tesfaye *et al.*, 2010). The factors driving the continued importance of the informal market are traditional preferences for fresh raw milk, which is boiled before consumption, because of its natural flavour (high fat content), lower price and unwillingness to pay the costs of processing and packaging. By avoiding pasteurizing and packaging costs, raw milk markets offer both higher prices to producers and lower prices to consumers (Thorpe *et al.*, 2000; SNV 2008). Specific upper income market segments prefer and can afford packaged processed milk. Packaging costs alone may add up to 25% of the cost of processed milk depending on the type of packaging used. Polythene sachets of processed milk are cheaper alternatives (SNV, 2008). 'When there is no bridge, there is always other means!' (Zelalem *et al.*, 2009). The marginalized disadvantaged dairy farmers did not have exposure and access to affordable improved technological products to handle and process their milk products; consequently they do act according to their local resources and custom which demand due focus and research.

Unlike the 'Green Revolution' in crop production, which was primarily supply- driven, the 'White Revolution' in developing economies would be demand-driven (Delgado *et al.*, 2002), triggered with the population and income growth, globalization and privatization are also among the forces that are acting towards change (Kelay, 2002; Zelalem *et al.*, 2009). In Ethiopia, particularly in the highlands of Southern Tigray where previous research is very meagre (MoARD, 2007), the dairy products, mainly milk, butter and cheese are very known and peculiarly exploited products than any other areas since long period of time but the doubt is their extent of production in comparison to their demand, nutritional needs and economic values, that is why the objective of this paper has targeted on the main dairy products exploitation degree in relation to the livestock resource potential. Thus this work was initiated with the following objectives:-

- To identify milk production practices and constraints in the study area, and
- To assess milk products handling, processing and utilization practices and methods.

2. LITERATURE REVIEW

2.1. Dairy production Systems in Ethiopia

Based on climate, land holdings and integration with crop production as criterion, four major systems of dairy production can be distinguished in Ethiopia. These are: lowland pastoral dairy production systems, rural highland small-holder dairy production system, urban and periurban small scale dairy production system and large scale dairy production system (Getachew and Gashaw, 2001; Kelay, 2002; Sintayehu *et al.*, 2008; Belete *et al.*, 2010). There are two types of systems in the highland. The traditional system that is based on indigenous breeds and the improved production system which is market oriented and destined on crossbred dairy cattle (Getachew and Gashaw, 2001; Kelay, 2002). The Ethiopian highlands hold about 88% of the country's total population, over 95% of its regularly cropped lands, about 67% of its livestock population, and over 90% of the country's economic activities. Generally speaking, the highlands are favored by good soils and suitable climatic conditions for farming, allowing higher productivity and/or higher population densities than elsewhere (MoARD, 2007). Milk is being produced in all agro-ecological zones of the country. Cattle, camels, and goats are the main livestock species in Ethiopia that supply both milk and dairy products. Eighty three percent of the milk produced is from cattle and the remainder from goats and camels (MoARD, 2007).

Table 1. Milk production contribution of Ethiopian dairy production systems.

Production system	contribution (millions)	% Contribution
Smallholder dairy producers	900	63.3%
Urban/periurban dairy producers	205	14.3%
Pastoral/agro-pastoral dairy producers	320	22.4%
Large private & state dairy producers	5	≤ 0.03%
Grand total	1430	

Source: - Getachew and Gashaw (2001).

2.1.1. Traditional production systems

According to Kelay (2002) and SNV (2008) the traditional smallholder system corresponds to the rural milk production system. Both the pastoralists and smallholder farmers produce 98%

of the national milk production and 75% of the commercial milk production. The majority of milking cows are indigenous Zebu breeds with low production performance. The average lactation yield for indigenous cows is 524 liters for 239 days, the average age at first calving is 53 months and the average calving interval is 25 months. Cows had three to four calves before leaving the herd at 11-13 years of age and the average lactation yield is 524 liters/ cow for 239 days (of which 45% is off take for human use while 55% is suckled by the calf). The highland traditional production system is characterized by communal grazing during autumn and crop residue feed exploiting the integration of crop livestock interaction and hardy indigenous breeds. By doing so the highland mixed farming is believed better to be in yearly household income for there is an extra alternative activity including sale of animal products, crop and crop residues and human labour. The rural system is non-market oriented where milk produced is retained for home consumption, transferred to neighbours as gift (Sintayehu *et al.*, 2008; Belete *et al.*, 2010) and low levels of inputs and outputs (Staal *et al.*, 2008).

2.1.2. Improved production system

Commercial Systems are known for the adoption of modern technology and production of different types of dairy products including cheese, cream, yoghurt and butter. Most of them are staffed with qualified personnel. Some of them are running both dairy farm and processing and some of them are focusing either on farming or on milk processing (Staal *et al.*, 2008). According to Moti *et al.* (2009), commercializing smallholder agriculture is an indispensable pathway towards economic growth and development for most developing countries relying on the agricultural sector. In the long run, subsistence agriculture may not be a viable activity to ensure sustainable household food security and welfare. The welfare gains from market oriented production arise from specialization that builds on and creates comparative advantages, potential for large-scale production, and from dynamic technological, organizational and institutional change effects that arise via flow of ideas due to exchange based interactions.

The periurban and urban production systems are grouped and characterized by high inputs for market-oriented and farmers adopted improved technology to optimize productivity. Producers usually own less than 10 cows and about 2-4 ha of land with intensive crop - livestock production. The system comprises small and medium sized dairy farms that own crossbreed dairy cows (Sintayehu *et al.*, 2008; Belete *et al.*, 2010; Zelalem, 2010).

2.2 Dairy production challenges in Ethiopia

2.2.1 Dairy breed effects

According to SNV (2008) report, about 98% of the cattle population in Ethiopia are indigenous that are adapted to feed and water shortages, disease challenges and harsh climates. Despite the large livestock population and adaptability, livestock productivity in Ethiopia is believed to be poor. For instance, the annual growth rate of cow milk was 1.4% for Ethiopia compared to 2.9% for eastern Africa and 2.4 % for sub-Saharan Africa while population growth of the nation launches by 3% a bright future for dairy market. Ethiopians consume less dairy products than other African countries and far less than the world consumption. The most recent estimate of national average per capita consumption of milk is 19kg/year as compared to 27kg for other African countries and 100kg to the world per capita consumption (FAO, 2003). SNV (2008) stated the World Health Organization (WHO) recommended per capita milk consumption is 200 liters/year/person.

Table 2. Milk yield and lactation length of different breeds in Ethiopia.

Breeds	Locations			Yield (kg/day/ cow)	Lactation length/day	Sources
HFX Borana	high	lands	of	7.3	342	Demeke <i>et.al.</i> (2000)
	Ethiopia	urban/periurban \		8.9	296	Yoseph <i>et.al.</i> (2003)
	Addis Ababa	North	western	7.8	336	Yitay (2008)
Zebu	Arusi area			1	285	Lemma <i>et.al.</i> (2005a)
Sheko				2.1	264	Stein <i>et.al.</i> (2006)
Boran				2.2	249	A dugna and Aster (2007)

Source:- Zelalem (2010).

Cross-breeding with European dairy genes has enhanced dairy development in Kenya but has not been widespread elsewhere (Thorpe *et al.*, 2000). The milk production potential of indigenous cattle is very low. In addition, milk production potential of temperate breeds in the tropical environments is higher than the indigenous breeds; this yield is still far below the genetic potential. Smallholder milk producers, however, face numerous problems, from identifying the types of animal to use, through how to manage them, and producing enough feed to achieve their potential for milk production. Approaches to solve these problems are numerous and closely linked to the production systems (Zelalem, 2010).

The milk yield of crossbred cows ranges between 9-21 litres per day while that of local cows is 1-5 litres/day (BoARD, 2009). The poor productivity of cattle is expressed by low daily average milk yield, short lactation, wider inter-calving interval period and late age at first calving. The typical characters of indigenous breeds of cattle despite their good merit to adapt to the local environment of poor feeding, health hazard and low management due to inadequate feed availability, occurrence of many diseases and poor health control and unavailability of appropriate technology, production is reduced (Getachew and Gashaw, 2001; Kelay, 2002; SNV, 2008) that was also compared in table 2 and 3. This is basically due to the fact that these animals have been selected primarily for survival trait and possess well established adaptive traits to the environment in which they are expected to survive and produce.

Table 3. Mean ($\pm$ SD) for production and reproduction, measurement in four indigenous breeds

Trait	Raya	Arado	Medenes	Begait
Milk yield/day (kg)	3 $\pm$ 1	1.8 $\pm$ 0.4	2.5 $\pm$ 1	5 $\pm$ 0.5
Lactation length (days)	210 $\pm$ 17	242 $\pm$ 20	162 $\pm$ 29	205 $\pm$ 32
Age at 1st calving (months)	41 $\pm$ 10	50 $\pm$ 7	42 $\pm$ 8	38 $\pm$ 5
Calving interval (months)	15 $\pm$ 3	22 $\pm$ 3	19 $\pm$ 5	16 $\pm$ 2

Source:-Dawit (2009).

2.2.2. Feed resources

The quantity and quality of the feed and water provided largely determines the dairy animal’s health and productivity, and quality and safety of its milk (FAO and IDF, 2011). Inability to feed animals adequately year round is the most widespread phenomenon. Dry- season feed supply is the paramount problem. The feed shortages and nutrient deficiencies are more acute in dry seasons. In highlands, population growth and density are causing the shortage of grazing land on which livestock production by small holders relied on. The quality of feed also deteriorates during the dry season. Feed (availability, costs and shortage of forage farm land to cultivate), usually based on fodder and grass, are either not available in sufficient quantities due to fluctuating weather conditions or when available are of poor nutritional quality. These constraints result in low milk and meat yields, high mortality of young stock, longer parturition intervals, and low animal weights as listed in Sintayehu *et al.*(2008).

2.2.3. Disease problems

According to FAO (1995) and IGAD (2008) poor animal health service provision combined with an environment in which diseases flourish conspire to wreak a significant disease burden on poor livestock keepers. Poor service provision can mean that services are simply not available (or reliably available); are inappropriate; are difficult to access because of distance; or that they are prohibitively expensive. Livestock disease reduces yields and causes mortality impacting on savings, reducing herd sizes and increasing risks for poor households. Mortality rates usually equal or exceed off-take through livestock sales, highlighting its devastating effects on households. Even during drought periods, it is disease rather than pure starvation which is the greatest contributor to mortality, a situation which is exacerbated by the fact that livestock often accumulate around areas of scarce pasture and water during droughts, providing ideal conditions for the spread of disease; and which accounts for the higher mortality rates of livestock as a drought breaks and the rain brings disease outbreaks. Animal health and the improved management are also the major constraints for dairy development in Ethiopia which cause poor performance across all production systems.



Figure 1. Farmers carrying a sick animal to a veterinary clinic.

Source: Belete et al.(2010). IPMS Working paper No. 19, pp 43

2.2.4 Milk quality and marketing constraints

The major milk quality related constrains reported by Zelalem (2010) include:

1. limited awareness on hygienic handling of milk and milk products, which could mainly be attributed to inefficient extension services;
2. Shortage of capital to purchase recommended equipment (milk containers, processing and packaging materials);
3. Lack of clean water for sanitation purpose and poor condition of barn or milking area.

4. Lack of market-oriented production, lack of adequate information on livestock resources, inadequate permanent trade routes and other facilities like feeds, water, holding grounds, lack or non-provision of transport, ineffectiveness and inadequate infrastructural and institutional set-ups, prevalence of diseases, illegal trade and inadequate market information (internal and external) are generally mentioned as some of the major reasons for the poor performance of this sector.
5. The dairy commodities are determined by different factors such as season, access to market/distance from towns, fasting and non-fasting days, festivals and holidays, level of supply versus purchasing ability of the urban dwellers, and quality and sources of dairy products (Sintayehu *et al.*, 2008). SNV (2008) pointed out fasting 51% of a year.

Milk is often sold for less than its full value due to lack of access to markets, poor road infrastructure, lack of co-operatives, inability to transport long distances due to spoilage concerns, and unscrupulous traders who add water or other fillers (PPLPI, 2001). Market refers to a set of buyers and sellers who interact and influence price. However, the existence of the market by itself does not ensure an exchange to take place. There should be a channel. Market challenges and problems for dairying vary from one production system to another and/or from one location to another. The structure and performance of livestock and its products marketing both for domestic consumption and export is generally perceived poor in Ethiopia (Zelalem, 2010). Milk as it is perishable and high in demand for urban consumption, needs efficiency in collection and transportation from widely scattered rural sources, requires a well-defined method of preservation and distribution. This would affect the amount that would be available for consumption through losses in quality (Asaminew, 2007).

According to reports of SNV (2008) the dairy marketing system in Ethiopia can be classified in two subsystems : (a) formal dairy marketing subsystem; (b) an informal dairy marketing subsystem. Sale through the informal marketing subsystem may be effected through (i) inter-household sales, or farm-to-house arrangements, and (ii) trading at local centres in dairy products. The farm-to-house arrangement for milk marketing usually involves a contractual type of arrangement in which individual producers may offer to deliver raw milk directly to the consumers at their homes or at some convenient location. Rural areas which are distant to big cities have limited or little, if any, markets for liquid milk and milk surplus in such areas will be converted into butter and/or ghee, and sold in local markets. Such sales in local markets are usually made through established local traders, who may buy directly from

producers at farm-gate. Milk production based on smallholders can be sustained only if marketing facilities are provided to market milk both in the morning and in the evening. Azage *et al.* (2010) stated that when market access is difficult, because of either distance to market or lack of competitive environment, farm gate prices are reduced, returns to labour and capital are low, and input costs rise, thus reducing the incentive to participate in economic transaction that discourage growing entrepreneurs breaking the cultural taboos.

SNV (2008) remarked that the informal system is characterized by no licensing requirement to operate, low cost of operations, high producer price compared to formal market and no regulation of operations. In Ethiopia, 95% of the national milk is marketed through informal channels and is unprocessed. The traditional processing and marketing of dairy products, especially traditional soured butter, dominate the Ethiopian dairy sector. Only 5% of the milk produced is marketed as liquid milk due to underdevelopment of infrastructures in rural areas. Hence, the informal (traditional) market has remained dominant in Ethiopia. Production is non-market oriented and most of the milk produced is retained for home consumption.

2.3. Milk products handling, processing and utilization practices in Ethiopia

The clean milk is defined “ as the milk that is drawn from the mammary gland of lactating animal such as cow, buffalo, goat, sheep, camel, etc., and is collected in a clean dry utensil which is free from dust, dirt, dung, manure, hair, flies, etc. The cow’s milk has a pH from 6.4 to 6.8; and yields about 65 kilo calories per 100 gram. The raw milk may contain very few harmless microbes when it is obtained from the clean udder of a healthy dairy cow. However, milk gets contaminated from various sources including the animal, environment, utensils and handlers (Pal, 2012). In Ethiopia the vast majority of milk used for commercial production and consumption is from cows. The demand for milk depends on many factors including consumer preference, consumer’s income, population size, price of the product, price of substitutes and other factors (Getachew and Gashaw, 2001).

2.3.1 Milk products handling

Milking is the defining activity of dairy farming. Milking management covers all aspects of the process of obtaining milk from animals quickly and effectively, while assuring the health

of the animals and the quality of the milk. Consistency in the day-to-day implementation of milking procedures is an important part of good dairy farming practice for milking (FAO and IDF, 2011). Milk flavour results mainly from proteins, lipids, and carbohydrates, and small amounts of other components. Depending on the way milk is handled, processed, and stored, its quality and flavour can deteriorate. This decline may be due to bacterial growth, enzymatic activity, and environmental factors such as oxygen and temperature. Additionally, milk is susceptible to the development of light-activated or light-induced off-flavours and vitamin A degradation (Fuquay *et al.*, 2011).

Although milking equipment is generally fabricated from stainless steel, which is readily cleaned and sanitized, some parts made of rubber or other non-metallic materials are difficult to sanitize, since only moderate use results in the formation of microscopic pores or cracks. Bacteria attached to these parts are difficult to inactivate by chemical sanitization. Milk-handling equipment, utensils and storage tanks are major sources of the gram-negative psychotropic spoilage bacteria. Contributory factors include poorly designed and constructed pipeline systems, and inadequate cleaning and sanitization between milking. Milk residues on unclean equipment provide a growth medium for psychotropic bacteria which can subsequently contaminate milk (Tamime, 2009). Milking utensils and equipment are the most important sources of bacteria in milk. Utensils should be seamless and preferably made from stainless steel. Bacteria will multiply quickly on poorly cleaned surfaces and in cracks and seams where cleaning is difficult and milk solids build up souring the next batch of milk. In many developing countries, any available container is used to collect and hold milk. Cooking pots, clay-ware bowls, kerosene tins, goat and sheepskin bags, dried ruminant stomachs, wooden containers and gourds are all used, frequently with an old block of wood or a bundle of straw on top to prevent the milk slopping out in transit. The methods have been used for generations, are difficult to change and the farmers are often unable to afford new and more suitable containers (FAO and IDF, 2011).

Payne (1990) remarked that after each milking, all utensils and equipment should be washed and cleaned to remove milk solids, sterilized to remove any microorganisms, then dried out to prevent any more organisms growing on the surface. Washing and rinsing well will suffice if the equipment can be completely dried out. A thin film of moisture on the surface allows bacteria to survive and multiply in warm climates. Proper sanitation is difficult and expensive for most tropical farmers. Detergents and sanitizers are not available or too expensive for

many to buy. Water, often poor in quality and limited in supply, from wells, streams and small dams must be hygienic enough that does not pose health hazards.

2.3.2 Milk products processing

The need of milk products processing as justified by Ebing and Karin (2006), many dairy products can be kept longer than fresh milk; therefore the milk does not have to be consumed immediately, the demand for fresh milk may be limited, and there may be more interest in dairy products, if the daily amount of fresh milk for sale is limited, it may be more economical to process the milk into less perishable products, store them, and sell them later in greater quantities. There may be no market for fresh milk close by, and only preserved products can be sold at markets at a greater distance, greater financial gain may be obtained and lactose intolerance implies that the body is almost or entirely unable to digest the milk sugar, lactose, which is found in milk. Dairy products in which a proportion of the milk sugar is converted during production, such as cheese, curd, yoghurt and sour milk or buttermilk, do not cause many problems in this respect. Processing milk into such stable and marketable products could generate cash income for smallholder producers in rural areas, and enable them to conserve milk solids for sale and consumption in times of scarcity (Asaminew, 2007). The traditional technologies of milk processing are generally considered to be time consuming and inefficient in terms of milk fat recovery as butter per unit of milk. Moreover, besides low diversity of milk products, the quality of the products is poor and resulting in comparatively short shelf life and a lower price for the milk producer.

Churning

Traditional butter making involves churning of sour milk in a variety of vessels, the most important being gourd, clay pots, and wooden vessels carved out of some tree trunks. Churning is usually done by women and consists of rocking the vessel (gourds), or clay pots, which are suspended from a wooden post, or tripod, or placed on the ground or the woman's lap back and forth until butter granules form (Ashenafi, 2002; Asaminew, 2007; Zelalem, 2010) as displayed in figures 2 and 3.



Figure 2. Rural women traditionally processing the sour milk

Sources: Belete *et al.* (2010); Tesfay (2007).

Buttermilk is drained off by pouring it through a rough filter of specially treated fibres of tree bark or washed grass and is usually consumed by the household. According to reports the efficiency of fat recovery in the traditional churning of fermented milk in Ethiopia was about 50–67% in most of households although under cooler temperatures in the Ethiopian highlands fat recoveries of 75–77% were recorded. Assuming that 50% of the milk available for traditional processing is fermented and churned to butter with a minimal 50% fat recovery and that zebu milk contains about 5% butterfat, the amount of ghee containing 99.5% butterfat (O’Conner, 1994; Alganesh, 2002). Prior to churning, the milk had a temperature of $20.0 \pm 0.42^{\circ}\text{C}$ and an acidity of $1.06 \pm 0.03\%$. The milk was churned for 40.0 ± 2.5 minutes and afterwards temperature of the buttermilk was $23.7 \pm 0.32^{\circ}\text{C}$. The sour milk contained about 46.8 g of fat, compared with 7 g of fat in the buttermilk after churning. Thus some 85% of the butterfat was extracted by churning. Butter yield was 66.9 ± 5.6 g (Sintayehu *et al.*, 2008).

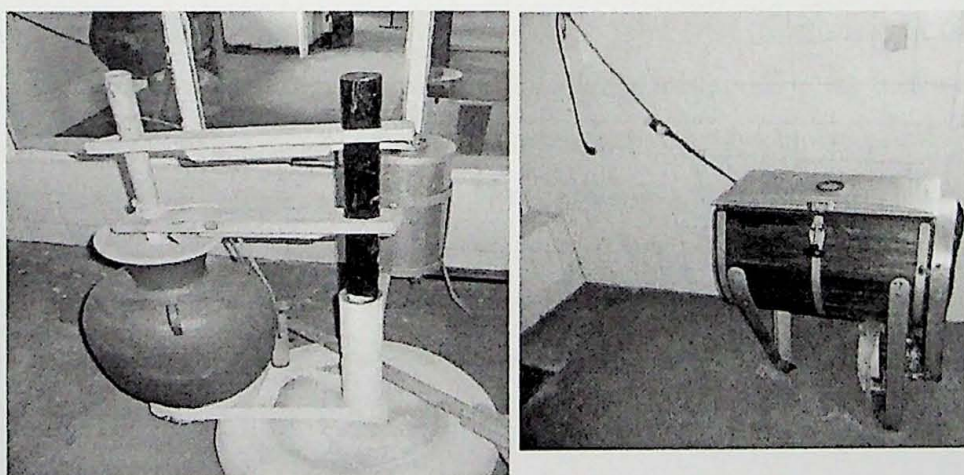


Figure 3. Improved manual and electrical churners in the Ethiopian meat and dairy technology institute.

Sour milk ('Ergo')

The dairy processing in Ethiopia is generally based on '*Ergo*' where the fermentation is natural, with no known starter cultures addition to initiate it. Raw milk is left either at ambient temperatures or kept in a warm place to ferment. Souring is brought through the proliferation of the initial milk flora. The traditional dairy products such as butter, cottage type cheese and other local varieties of milk products are manufactured from soured milk (Asaminew, 2007; Tesfaye, 2007; Sintayehu *et al.*, 2008).

Buttermilk

Buttermilk is a by-product of the butter making process. The taste can be more or less sour depending on the sourness of the cream or the milk which is used for butter making, or the degree to which it sours after churning. In Ethiopia, buttermilk ('*Arera*') is obtained after churning of fermented milk. As buttermilk is rich in protein, lactose, minerals and vitamins, it makes a nourishing beverage either plain or flavoured in the same way as '*Ergo*' (traditional sour milk). Alternatively it may be converted into local cheese (Asaminew, 2007; Kedija *et al.*, 2008; Zelalem, 2010).

Butter

While the majority of dairy milk is consumed raw, there are non-liquid dairy value added markets. Two such examples are the butter market in Ethiopia and the Wagashi cheese market in West Africa (PPLPI, 2001). Butter is traditionally made from sour (ripened) milk (*Ergo*). Milk for churning is accumulated over several days by adding fresh milk to the milk already accumulated by using different types of storage equipment such as clay pot and gourd. Butter is made by agitating the milk until butter grains form. The butter thus formed is taken from the churn and kneaded in cold water. Almost all systems are manually operated through different ways of agitation (Asaminew, 2007; Kedija *et al.*, 2008). Salted water if added to butter could retard bacterial spoilage, minimize moisture and flavoured.

Ghee

Ghee also known as clarified or ripened butter oil can be prepared from butter or cream by direct heating to 110-120°C and its main use is for frying of food and advantageous over butter for its superior keeping quality derived from the almost complete removal of water during the process. The boiling process drives off moisture and reduces the water content to well below one percent so effectively preventing microbial growth. At the same time the boiling process destroys spoilage bacteria, all pathogens and inactivates some of the enzymes resulting from bacterial growth in the milk and butter (FAO, 1995). When butter is melted, powdered spices are added either directly or enclosed in a small cloth bag and this can provide aroma, flavour and prolong the shelf life of the ghee up to 3.3 years if kept clean (Asaminew, 2007; Tesfaye, 2007; Kedija *et al.*, 2008).

2.3.3 Milk products preservation methods

Milk quality is very dependent firstly, on the preparation for the process and milk harvesting, and secondly, on the post harvest handling of raw milk. Milk is the most perishable of all farm produce. Unlike other animal products such as meat, milk is frequently harvested in very unhygienic conditions where, all too frequently, the current practices of cleaning and sterilizing the containers used for its collection and transportation leave much to be desired. Not only is bacterial contamination in buckets and milk cans a major problem, but because the tropical environment encourages rapid growth of these bacteria, the prolonged time delays in cooling the milk to 4°C, reduce its quality even further (Pal, 2012). The government legislation controlling milk harvesting systems in countries with developed dairy industries ensure a consistently superior milk quality that is just not currently possible in most of the dairy smallholdings.

Belete *et al.* (2010) suggested under normal storage conditions in the tropics, milk sours within 4-5 hours that retard growth of undesirable organisms and makes separation of fat easier. Milk processing activities follow limited sanitary procedure before and after milking and utilizing the vessel. Asaminew (2007); Kedija *et al.* (2008); Hailemariam and Lemma (2010); Welearegay *et al.*, (2012) reported that there are different types of plants used for smoking and cleaning of milking, storing, processing and marketing vessels in different parts

of the country. Plant barks used for smoking and washing milk vessels. Such smoking process believed to add flavour to the product and kill micro organisms.

There is a strong preference for traditional products due to taste, aroma and flavour. *Ayib*, a traditional cheese is popular and used as a condiment with many foods. '*Hazo*' fermented buttermilk with spices is a special occasion food ingredient that let producers extend product shelf life and enrich nutritional content is peculiar in the study area, but no recorded. Consumers add spices and herbs to this product at home before serving. The herbs are used for smoking and cleaning milk utensils, as condiment for food, to minimize odour butter ointment ('*shito*' herbs).

2.3.4 Milk products utilization practices

Milk consumption varies considerably between, and within, countries in the tropics. While wealth consumers in poor countries ranged milk as a basic food product, poor people in poor countries regard milk as a supplement to the traditional diet. Within countries, consumption varies widely between and within social groups, highland of the southern Tigray, among who do relatively practice peculiar milk products utilization. Milk has long been recognized as the most complete single food available in nature for health and as medicine, preventive as well as curative (Mahindru, 2009). Ethiopian farmers use their own milk for different purposes. These include: home consumption in fresh form and fermented (*Irgo*); processing long shelf life products such as butter, ghee and ayib; selling in liquid form; and calf feeding. The level of utilization pattern, however, varies depending upon the production systems, proximity to urban centres/towns, availability of market outlets, seasons and economic factors (price). Out of the total annual milk production, 82.9% was used for household consumption, 6.61% was sold; only 0.43% used for wages in kind and the rest 10% was used for other purposes (for the production of butter, cheese and the likes). With respect to the utilization of butter, 60.69% of the product was used for household consumption although considerable portion (36.23%) was sold. Most of the cheese produced was used for household consumption that is about 85.76%, and the rest 2.94% was used for other purposes (CSA, 2010). In the highlands of northern Ethiopia milk is utilized as raw, heated or soured food or processed in to different products after churning the soured milk (*Ergo*) in to butter and butter milk having simple traditional house holding and processing utensils. Consumption of processed dairy products was observed even less frequently among the rural low-income households, indicating that the

majority of the populations do not consume processed products (butter) to any substantial degree. The limited consumption of butter may be due to the higher price associated with it and the need for cash income to buy some necessities. Butter is often consumed on holydays and special occasions in rural low-income households because it fetches routine cash income (Kedija *et al.*, 2008). Butter fetches a higher price compared to other milk products. Besides to income generation, butter is consumed in many forms as food, medicine and lotion.

The reason for lower per capita consumption of milk and milk products in Ethiopia is mainly due to economic and cultural constraints. The habit of consuming milk and milk products is also yet to be developed, even among middle income urban households with a better purchasing power. The result in lower prices for smallholder unorganized producers, is due to their small quantity of milk produced coupled with high transaction cost that causes high product price for poor urban consumers leading to low demand. In recent years, demand for milk and products appears to be rising. The demand, supply and price trends for milk and milk products (butter) have been consistently increasing over the last five years and the additional contributing factors like increased urbanization and population growth, establishment of new processing plants and increased number of dairy enterprises (Tesfaye, 2007; Belete *et al.*, 2010; Tesfaye *et al.*, 2010). Apart from income, consumer preferences and dietary customs also help to explain the relatively low demand for dairy products. Orthodox Christians, comprising about 40% of the Ethiopian population, abstain from consuming dairy and other animal products for about 200 days a year. Low demand for dairy products in Ethiopia compared to demand in other low-income countries in sub-Saharan Africa appears to be a major reason for the slow growth of the dairy sector. Many factors other than demand, however, have contributed to the stagnant nature of the overall economy and the poor performance of the dairy sector. Dairy sector growth and marketing and the potential for income and employment opportunities in dairy production, processing and marketing, was undermined (Tesfaye *et al.*, 2010).

3. MATERIALS AND METHODS

3.1. Description of the study area

The research was conducted in Emba-Alaje Enda-Mekoni and Ofla Wereda of Southern Tigray, from December 01, 2011 to February 30 2012, which are featured by mountain chains, where Maichew of Enda-Mekoni is located at $12^{\circ} 47' N$ latitude $39^{\circ} 32' E$ longitude and an altitude of 2450 m.a.s.l. It has a rainfall ranging from 600-800 mm , temperature ranging $12-24^{\circ}C$, and relative humidity of 80% , which is highly variable from year to year and erratic in nature. The district is located on about 90 -180km south of Mekelle city and 600-690Km north of the capital city Addis Ababa. The study area is also categorized as one of the populated highland areas of the country where land per household is 0.8h. Korem of Ofla lay on $12^{\circ} 29' N$ latitude, $39^{\circ} 32' E$ longitude and that of Adishehu of Emba-Alaje is located on $12^{\circ} 56' N$ latitude and $39^{\circ} 29' E$ longitude (CSA,2007; BoARD, 2009).



Figure 4. Map of the Study area.

Source :- CSA (2007).



Figure 5. Study area landscape: a, steep gorge in Enda Mekoni; b and c, researcher in Lake Hashenge along with grazing animals; d-f, researcher in group discussion with farmers and analysing milk samples.

3.2. Study population and sampling procedures

Single household respondent was used as sampling unit in the study and sample size determination was applied according to the formula recommended by Kothari (2004) and Arsham (2005) for survey studies:

$$SE = \frac{\text{Confidence Interval}}{\text{Confidence level}} = \frac{0.10}{2.58} = 0.04,$$

Where, confidence interval=10% and confidence level=99%

$$n = 0.25/SE^2 = 0.25 / (0.04)^2 = 156$$

Where: N- is number of sample size

SE= Standard error, that SE is at a maximum when $p = q = 0.5$,

with the assumption of 4% standard error and 99% confidence level.

The total sample size was determined to be 156 for the household level interview. There were a total of nine participatory appraisal discussion groups (one per sub-district) and each group had 7-9 members consisting of male and female farmers who were purposively selected based on their good knowledge of husbandry system and milk products exploitation methods.

Development agents (DAs) were involved in the identification of farmers for the group discussion. Proportional Probability to Size (PPS) approach for uniformity matters as (Kedija *et al.*, 2008; Genzebu *et al.*, 2012). In addition to the administration of the formal survey, several informal interviews were conducted with key informants (DAs, Agricultural officers, Development Corridor office, Cultural and Tourism office, Butter merchants and elders) in the zone so as to obtain supplementary information. Three approaches namely, participatory rural appraisal (PRA) for base line information and formal (diagnostic) survey using well-structured questionnaire, farm visit and group discussions of the entire system were used to generate qualitative and quantitative data.

3.3. Data collection

A translated pretested semi-structured questionnaire (Annex 3 and 4) was used to collect information on quantitative and qualitative data: -demographic situations, level of education, type of dairy breed, production performance, production objectives, variety of products, husbandry system (feeding, breeding, housing, disease control), milking practices, types and amount of milk products, handling, processing, utilization systems and materials used. Types and quantity of milk products being produced; milk products marketing system; major production constraints, livestock disease incidences; opportunities for improvement and other related issues by well-trained enumerators under close supervision and assistance of the researcher. For the field survey, the method of data collection used was single- visit-multiple-subject survey.

3.4. Data Analysis

Data collected were analyzed using Microsoft Excel (2007) and Statistical Package for Social Sciences (SPSS, 2007 version 16) computer software program. Survey results were summarized using descriptive statistics like mean, standard deviation, and percents; mean differences were tested using student's t.

4. RESULT

4.1. Household characteristics of dairy farmers

The results obtained on household characteristics are presented in Tables 4 and 5. As shown, 25.6% of the respondents were less than 40 years of age, 51.3% of them aged 41-60 years while those with the age of more than 60 were only 23.1 %. Of the total households interviewed, 73.5% were headed by males the rest being female-headed. When the issue comes to literacy level, the educational status of the household members was diverse that was composed of 12.8% educated while 41% of the household members were illiterate (i.e., do not read and write). Average family size was 4.6 ± 1.84 that ranged from 1 to 14 (annex 1).

The proportion of the households who participated in the dairy technology package was 28.8%. In terms of labour use, 83.33 % of the interviewed households used own family labour, where as the other proportion of them use hired labour in addition for dairy farming. Feeding, watering, barn cleaning, animal keeping, monitoring animal health, cow milking, churning milk, milk selling and selling dung cake were performed mainly by wives and children, while feed purchase, buying and selling animals were responsibilities of the husband. Rural dairy farms are characterized by roofless fenced enclosures to keep cattle during night times; calves being separated from adults and housed in the same shelter with households. Those households involved in the dairy technology packages do practice zero grazing and modified shelter for the hybrid Holstein Frisian cows. Crop residues and hay from natural pasture are important feed resources being used in the area. During feeding, priority is given to working oxen and then to milking cows in addition to grazing on communal grazing lands. Cows were also provided with salt, especially in wet season. Unlike to the nearby lowland Raya areas, highland dairy animals do have access to water one to two times per day sourced from nearby streams/ perennial rivers of the mountains or Lake Hashenge to the Ofla Wereda.

Table 4. Family size, age and sex of respondents based on their educational background.

Study Wereda	Age of the respondent			Education status											
	<40	41- 60	>61	Illiterate			Reading/writing		Elementary		Junior secondary		high school		
	Years	years	Years	HHH Sex			HHH Sex		HHH Sex		HHH Sex		HHH Sex		
	N=40	N=80	N=36												
				M	F	Union	M	F	M	F	M	F	M	F	
Emba-Alaje	40%	26.25%	30.56%	18	7	0	8	2	3	3	2	0	3	2	
Enda-Mekoni	30%	33.75%	30.56%	17	2	1	9	2	5	1	3	3	5	2	
Ofla	30%	40.00%	38.88%	7	12	0	22	3	4	0	2	0	7	1	
Sum	40	80	36	42	21	1	39	7	12	4	7	3	15	5	
Proportion (%)	25.64	51.28	23.08	26.92	13.46	0.64	25	4.49	7.69	2.56	4.49	1.92	9.62	3.21	
Mean	13.33	26.67	12	14	7	0.33	13	2.33	4	1.33	2.33	1	5	1.67	
Std deviation	2.31	5.51	1.73	6.08	5	0.58	7.81	0.58	1	1.53	0.58	1.73	2	0.58	

HHH= Head of household; F= Female and M stands for Male.

Table 5. Dairy farm labourer used in the study Wereda site categories.

Labourer used	Wereda of the study area									Sum	Proportion (%)	Standard deviation
	Emba-Alaje(N=48)			Enda-Mekoni (N=50)			Ofla (N=58)					
	Urban	Periurban	Rural	Urban	Periurban	Rural	Urban	Periurban	Rural			
Family labour	11	6	28	12	5	20	11	5	32	130	83.33	10.01
Hired labourer	0	0	0	2	0	0	4	0	1	7	4.48	1.39
Partly labour hired	2	1	0	3	2	6	2	1	2	19	12.18	1.69
Sum	13	7	28	17	7	26	17	6	35			
Mean	4.33	2.33	9.33	5.67	2.33	8.67	5.67	2	11.67			
Proportion (%)	27.08	14.58	58.33	35.4	14.58	54.167	35.42	12.5	72.92			
Standard deviation	5.86	3.22	16.17	5.51	2.52	10.26	4.73	2.65	17.62			

4.2. Smallholder dairy farmers husbandry practices in highlands of Southern Tigray

4.2.1. Milking procedure practiced

Milking twice per day (morning and evening) was the tradition followed by all households. Among the respondent dairy farmers, 25% of both urban and periurban dairy farmers practice zero grazing and milk their animals at a regular time of the day to supply the product according to their customers demand. Whereas the rest of the proportion do not follow regular time of milking apart from maintaining the frequency. The housing systems, the cleaning processes and the procedures followed by the household are predominantly traditional. Udder washing was practiced by 10.89% respondents, of which 23.10% were from Emba-Alaje, 35.3% from Enda-Mekoni, 29.4% were from Ofla urban and 8.6% were Ofla rural areas who introduced cross breed cows (figure 11a and 13b).

4.2.2. Feeding practice

Crop residues from teff, pulses, barley, wheat and maize and sorghum plus hay and natural pasture are the major feed resources the study area. Coping mechanisms practiced in the study areas during feed scarcity were moving to areas with available feed termed as '*urna*', providing grass harvested from sloppy hills. The other important feed resources include spineless and thorny Cactus while some do practice forage development minimally. The crop residue conservation practices followed by the farmers are subject to nutritional losses. In the urban dairy farming, use of concentrate feeds is a potential alternative through which productivity of cows can be improved; however, the high cost was a limiting factor. Majority of the dairy farmers use leftover house hold feeds such as hull of grain after milling. *Hatela* (slurry from local brew) was another form of concentrate feed available (figure 6-8).

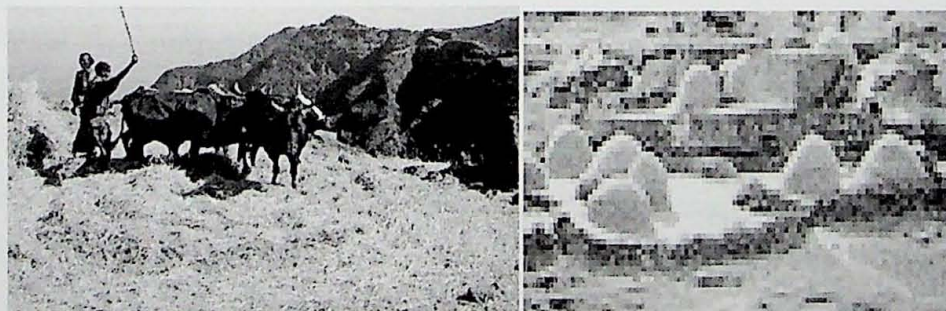


Figure 6. Traditional crop residue storage practices and crop livestock interaction in the highland mixed farming.

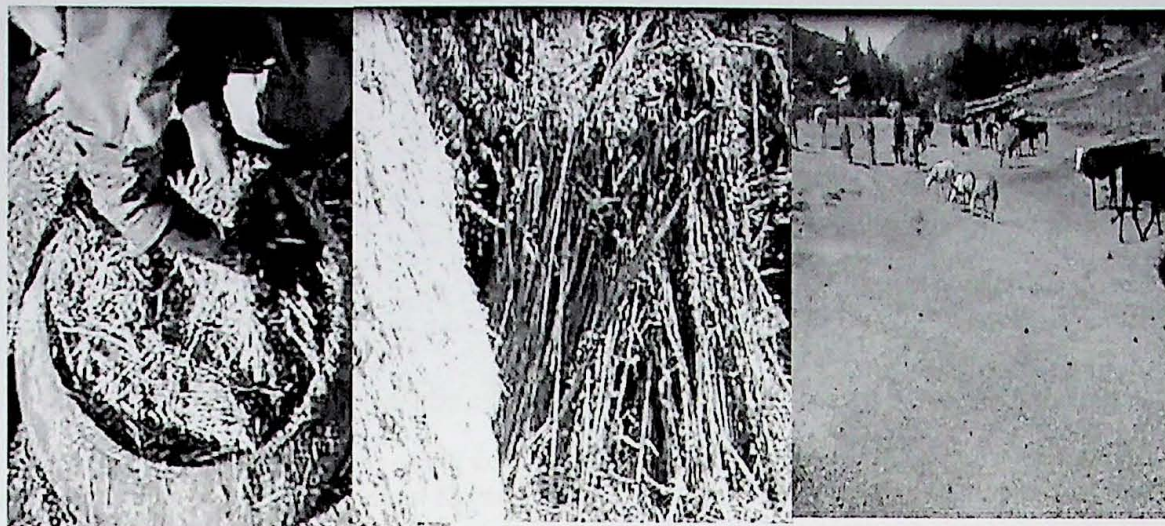


Figure 7. Feed resources of straw hatela mix, straw and stover as well as grazing natural pasture (Adishehu).



Figure 8. Alternative feed resource: a cow supplemented with *hatela* (Korem) and thorny cactus treated by flame before chopping (Maichew).

4.2.3. Housing systems

Housing system of the study areas were featured backyard compound in 62.18% of the respondents, partial shelter in 17.95% of the respondents and improved barn in 19.87% of the dairy farmer respondents. In Urban Emba-Alaje, 76.92% of the respondents practiced improved housing but not hygienic for they do not clean the barn because they deemed crucial bedding to absorb heat for the animals (figure 9).



Figure 9. Housing systems of the study area: a, A night enclosure in Hashenge; b, A modified house with partition for calf pen in Korem; c, a modified house with plastic roof in Maichew model dairy farmer, and d, an improved barn in Maichew dairy union

4.2.4. Calf Rearing

Cattle are kept in barns under normal circumstances and calves are kept in houses until they are strong enough to bear the extreme climatic phenomena. Young animals are managed in a traditional way. Suckling calves are kept separate from their dams, except when calves are used to stimulate milk letdown. Traditionally, calf suckling practice is believed to stimulate milk letdown, prevent teat blockage and softened the teat for ease of hand milking. If the calf dies, the hide is stuffed with cereal straw or grass with four legs made of sticks, rubbed by salt so that the dam would lick it to simulate the presence of the calf and stimulate milk letdown. Young children and females in general do mostly attend calves near encampments. Herders are well aware of colostrum feeding for the new born animals and understand the beneficial effect on health of the young. In all the rural and periurban areas calves are herded in group by child and/or widowed of misery part of the community and encouraged by providing milk of every Wednesday termed as '*tseba rebue*', while urban areas do practice tethering in backyards. Overnight, calves do spent in calf pen (urban and periurban) or in the normal household home (rural areas) isolated from their dams or herd. In local cows majority of the dairy farmers responded until the cow become dry of that rejects her calf from suckling was related with end of lactation period. But those owners of exotic do practice 4- 6 months suckling before weaning. Traditionally, the herders use different types of weaning methods. Weaning is performed by piercing the nose of the calf with thorns, twisting up the nose skin of the calves to prevent suckling (as this causes pain when the wounded nose touches the teat) and smearing of teats with animal dung (figure 10 and 11).

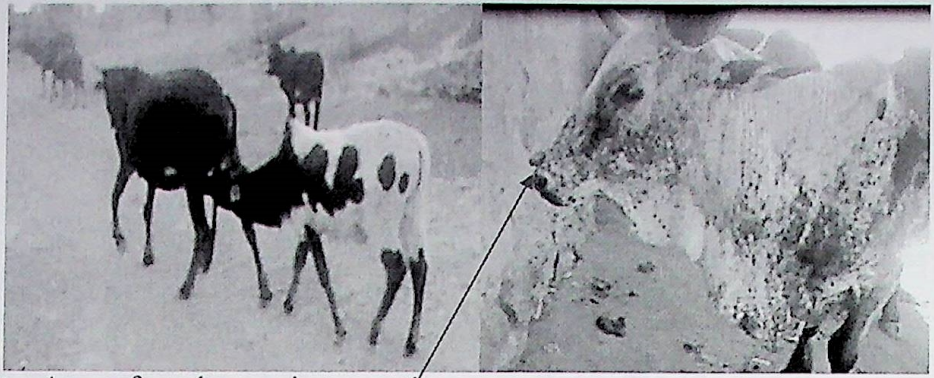


Figure 10. An enforced weaning practice, where calf's nose pierced with thorns and twisted up the skin to prevent suckling.



Figure 11. Calf rearing practice: a, A calf tied nearby to his dam a means of milk let down (Maichew); b, Calf tethered in shaded hay in Korem.

4.2.5. Record keeping

The most important record kept in the dairy farms was birth date that was considered in 44.9% respondents followed by 29.49% respondents to record amount of milk sold, 27.56% respondents used breeding record and 27.56% respondents used feed expenditure record, while 53.20% of the respondents do follow random husbandry practice.

Majority of the milk business was in the urban where 25.64% of the respondents in comparatively do consider cost benefit analysis of their farm productivity and keep records on amount of milk sold/day or month, breeding record, birth date and feed cost are recorded. Wereda level 72% of respondents from Enda-Mekoni, 33.33% respondents from Emba-Alaje and 32.76% of respondents from Ofla had record keeping trials.

Table 6. Number of sampled respondents practiced record keeping.

Record keeping			Milk sold	Birth date	Milk selling amount, breeding record, birth date and feed cost are recorded	random husbandry practice	sum	Standard deviation
Wereda of the study area	Emba-Alaje	Urban	2	0	11	0	13	5.25
		Periurban	0	0	0	7	7	3.5
		Rural	1	0	2	25	28	12.03
	Enda-Mekon	Urban	0	0	16	1	17	7.85
		Periurban	0	7	0	0	7	3.5
		Rural	0	15	0	11	26	13
	Ofa	Urban	0	2	13	2	17	5.91
		Periurban	0	3	0	3	6	1.73
		Rural	0	0	1	34	35	16.84
	Total		3	27	43	83	156	
Standard deviation		0.71	5.07	6.57	12.25			

4.2.6. Milk products marketing

It was noticed that milk marketing was limited to urban and periurban areas but not in the rural districts. The major milk marketing challenges the respondents complained were 52.56% claimed cultural taboos and distance from market areas while 26.92% of the respondent dairy farmers blamed the discouraging market due to lower understanding of consumers to milk nutrition, poor talents of entrepreneurship of milk producers, and lack of road to transport milk from remote areas. Majority of the studied households reported that the demand for the milk products was high during dry season and low during wet season, besides to the fasting periods.

Organoleptic quality determination practiced on the freshness (scent), colour, physical appearance (texture), and free of adulteration (flour, fat, and banana) cleanness of the products during transaction. According to the respondents, butter with an even and yellowish colour, clean flavour and uniformly textured is considered as quality butter that is preferred for ghee, while that of butter with white colour and buttermilk smell and fresh is commonly preferred for ointment. Butter that fails to fulfil these requirements did not fetch them a good price. Therefore producing good quality butter is very important to earn better income and to promote the living standard of the rural producers. There was a fluctuation of butter cost

depending on seasons, holidays and wedding. For there is no uniform unit, butter transaction was commonly using small circular or larger cylindrical shapes, while marketing of fresh milk, yoghurt and buttermilk based on litre unit.

4.3. Dairy farming Function

In the study area, the smallholders rear livestock for draught power, milk production, beef production and generate income through live animal sale, especially as a guarantee in case of risk. Also respondents indicated that cattle were used as manure for fertilizing the homestead farmland and compaction of seedbeds. Hide and skin of the animal was used either as source of cash income or used as household furniture such as grain storage, mat and to carry a baby on back of mothers locally termed as “*delebo*” Others: include manure, dung to smear floors and walls and also for fuel (for cooking purpose or to fire alternative thorny cactus feed). Concerning to dung utilization, 5% of Ofla Wereda respondents do practice biogas, while the rural Enda-Mekoni in vicinity to Ofla have exposure and were in infant stage unlike to Emba-Alaje Wereda where there was no dream of biogas. The interesting thing is dairy farmers exchange dung cake for hatela concentrate feed contacts in majority of urban dairy farms or else cover some part of household earning by selling particularly females of the household.

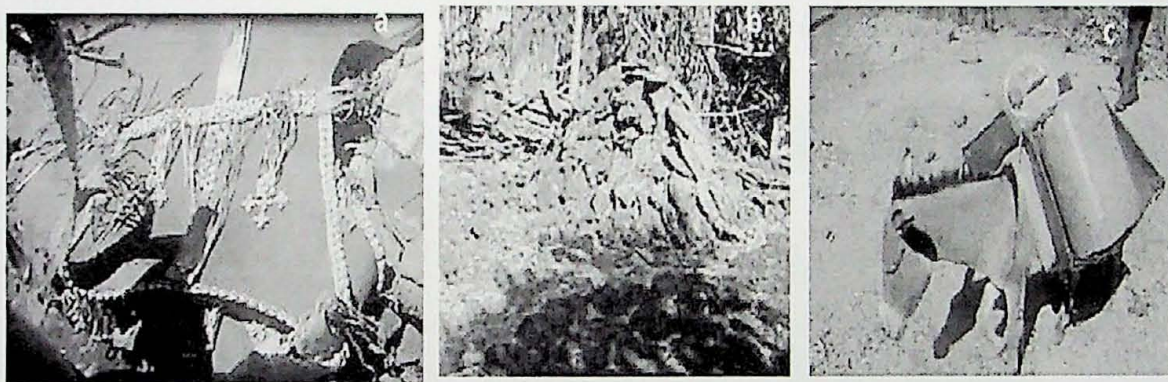


Figure 12. a, Hide locally used for mat and child bearing' *delebo*'; b, dung cake fuel a means of livestock by products exploitation , and c, Beast of animal -dairy farmers means of transport.

4.4. Dairy farming performance

Age at first calving was 3.5 years for local while 2.5years for exotic breeds and calving interval was similar 1.5 year. The average milk yield was 2 ± 1 litres for Arado, 5 ± 1 litres for jersey and 10 ± 2 litres for Holstein Frisians. The average cattle herd size were 3 ± 1 in urban, 4.67 ± 4.93 in periurban and 3.75 ± 2.12 in rural farms. The population of Holstein Frisian decreased from urban to rural while that of the Arado breed increased, indicating that dairy

farming in rural destined on Arado while urban destined on Holstein Frisian breeds. Milking cows of the study areas were 23.1% out of 845 cattle owned by the respondents, which were composed of 631 local including Arado, Raya and Begait breeds and 214 crossbred of Holstein Frisian and Jersey upgraded cattle (Table 7).

Table 7. Breed wise milking cows’ population in the study area.

Cattle Breeds type	Total number	Proportion (%)	Milking Cows	Milking cows in the herd (%)
Arado	589	69.70	114	19.36
Begait	5	0.59	2	40
Raya	37	4.38	11	29.73
Jersey	2	0.24	1	50
Holstein Frisian	212	25.09	67	31.6
Total	845	100	195	23.08

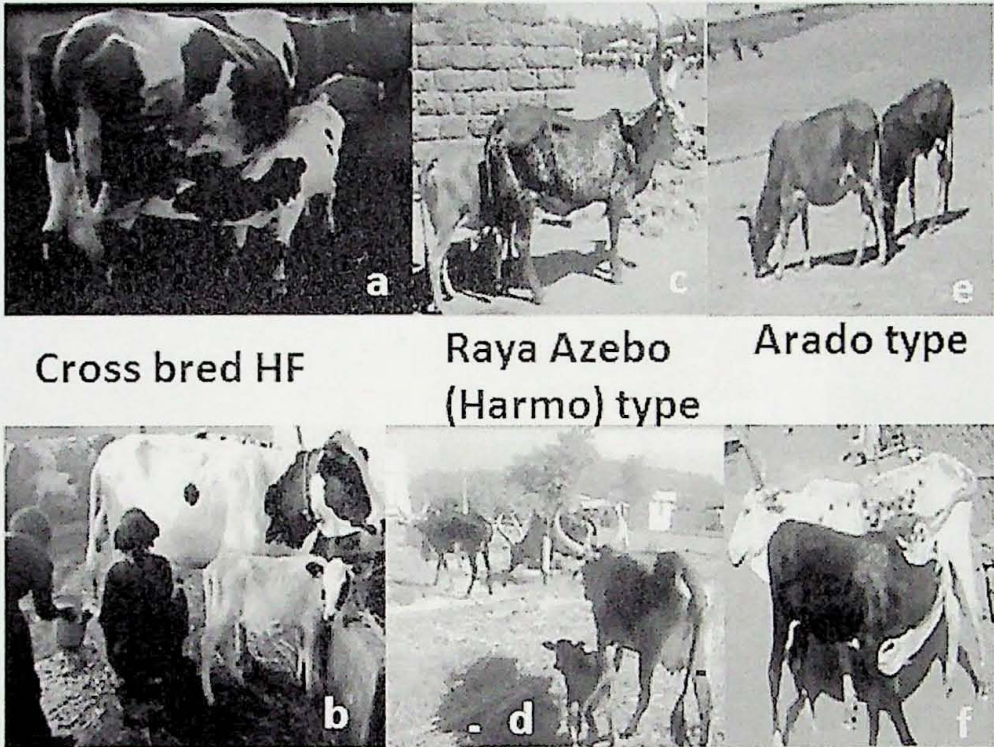


Figure 13.Dairy animals of the study area

4.5. Milk processing and utilization practices in highlands of Southern Tigray

The basic patterns of milk processing such as churning soured milk to make butter, dehydrating butter to make ghee and removing whey to better regulate milk fermentation are common traditional practices. Cottage cheese, known in Ethiopia as *Ayib*, is made by heating skimmed milk to precipitate casein and some of the remaining fat after churning fermented milk to produce butter. Gee provides high-energy food with long shelf life of a year. The

storage stability and its varied use provide butter in distinct advantage over other dairy products in terms of more temporal flexible household use and marketing.

4.5.1. Churning

The dairy farmers practiced traditional milk processing to increase the shelf life and diversify the products as soured milk, buttermilk, *hazo*, whey, butter and ghee that have significant nutritional, socio-cultural and economical values. As the respondents experience, naturally fresh milk is hot and let to stay alone for about 30 minutes before mixed with the yoghurt, not to disturb the previous one.

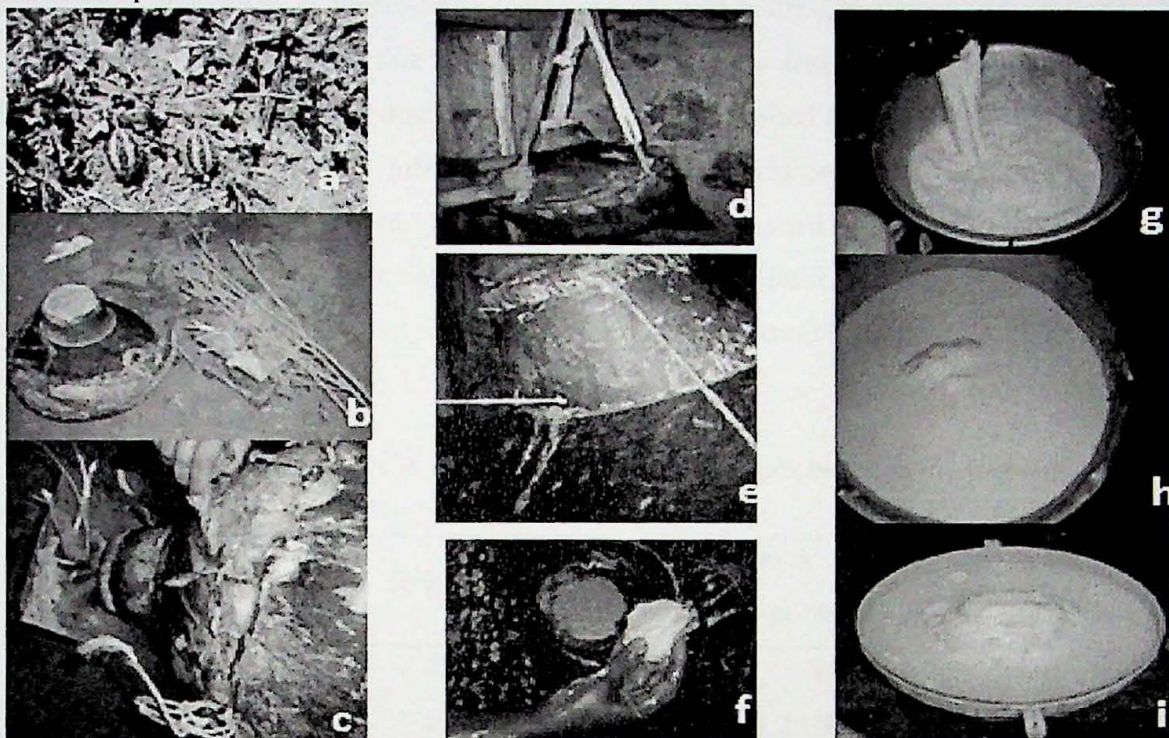


Figure 14. Act of milk processing (a, *Cucumis prophetarum* milk vessel scrubbing; b and c, churner smoking using *Anethum graveolens*; d, act of churning ;e, A grass inserted in to churner ('laga ') to determine ripeness of butter; f,g and h, butter separation and i, butter bathing in water)

Duration of milk fermentation and frequency of churning

There was no significant milk souring varies in different agro-ecological areas. 'Laga' *hamaham* (*Cucurbita pepo*) gourd was used in 93.6% of respondents of the study areas to churn, that could hold about 10-15 litres of accumulated milk, from one or many cows. *Laga* types vary in their internal levelling, the first was rough with number of grooves termed as 'tinkish' for its ease of churning and, the other was smooth that was less preferable.

Procedurally *laga* is washed and smoked, the yoghurt allowed to get heat to speed up butter fat globule formation, pouring yoghurt in to the churner, churning and letting air from the churner with 15 minutes interval rest, after the fourth interval, inserting a grass to check up for its ripeness, then pouring into widen vessel to squeeze out the fat globules formed from butter milk. There was no significant ($p>0.05$) difference in the number of day's milk to sour, however, there was remarked ($p<0.05$) variation among the Wereda in churning times per week. The average durations of milk fermentation prior to processing in the study areas were presented in table 8. Longest duration was observed in Ofla (4.72 ± 0.91 days) followed by Emba-Alaje (4.56 ± 0.50 days) and 4.04 ± 0.82 days in Enda-Mekoni Wereda while churning practiced once in a week in Emba-Alaje, 1 ± 0.09 in Ofla and 1.20 ± 0.46 times/week in Enda-Mekoni Wereda. Churning time fate is determined in the study areas on souring time of the milk since milk accumulated for further processing is very limited and just for better butter extraction. This tradition is also influenced by altitude, temperature of the area and house type. Rural houses made mud and grass where cooking conducted is believed to speed up fermentation unlike the urban corrugated roofed houses. Household with a larger milk yield could churn their sour milk on daily basis particularly urban farmers in the absence of milk market.

Table 8. Mean ($\pm$ SD) days to sour milk and churning times /week in the highlands of Southern Tigray, Ethiopia.

Wereda	N	Souring days	SEM	Churning interval /week	SEM
Emba-Alaje	47	4.53 ± 0.50	0.07	1 ± 0.0	0.000
Enda-Mekoni	49	4.04 ± 0.82	0.12	1.20 ± 0.46	0.07
Ofla	58	4.72 ± 0.91	0.12	1.09 ± 0.34	0.05
Total	154	4.45	0.07		0.27

SEM= Standard Error Mean

4.5.2. Fermented milk

Fermented milk or yogurt "Ergo", a traditional naturally fermented milk product, semi solid with a cool pleasant, aroma and flavour, used as unique medicine "tsimbahlela" during emergence and revive a person from shock and dehydration that's why a cow is respected and considered as common resource of the surrounding in the study areas. Acid is produced in milk by the growth of certain types of harmless bacteria called 'lactic acid bacteria'. They are

normally present in milk and are also used as starter cultures in the production of yoghurt/soured milk. Lactic acid bacteria convert milk sugar (lactose) into lactic acid, which increases the acidity of the milk and prevents the growth of harmful bacteria. The removal of lactose means that these products can be eaten by people who suffer from lactose intolerance. The shelf life is extended by several days and the changes in flavour and texture make this a popular product.

4.5.3. Buttermilk

Buttermilk (*'awuso* or *hugan'*) is a by-product of butter making from fermented milk. Buttermilk is either directly consumed within the family or heated to get whey/*'mencheba/ aguat'* for children and calf consumption and cottage cheese known as *'ajibo/ayib'* for family consumption only in the study areas unlike to the research results in Shoa where ayib rarely marketed informally. The fat compositions do vary from household to household according to the efficiency of extracting and churning ways. Further research is advised to consider the average composition (figure 14h).

4.5.4. Hazo

Dedicately buttermilk allowed fermenting with spices *'hazo'* to extend shelf life and to provide special aroma and flavour for special occasions like socio-cultural festivals. In holidays, 96%of dairy owners practice *hazo* gifts to their neighbours about a litre to each household. Even a widowed who engaged in calves herding do practice *hazo* holiday gifts to neighbours with no milking cows for she possessed weekly *'rebue;* milk.

4.5.5. Butter

Extra milk from home consumption or not marketed is accumulated be it in plastic or gourds or clay pots locally termed as *'qurae'* to be traditionally churned in a gourd (*'laga'*) in all dairy farmers. The alternative coping mechanism, indigenous knowledge practice, use of herbal preservatives, sanitizing and smoking of milk utensils enabled the community to preserve and diversified uses from food, medicine, ointment for hair, leather processing , white cultural clothes dying that was peculiar distinguishing character of the Raya people. Children particularly new born were prioritized to rub their delicate whole body followed by

suckling mothers, engaged girls who particularly practice traditional smoke bath (*'maetena'*) and teenagers (Figure 15).

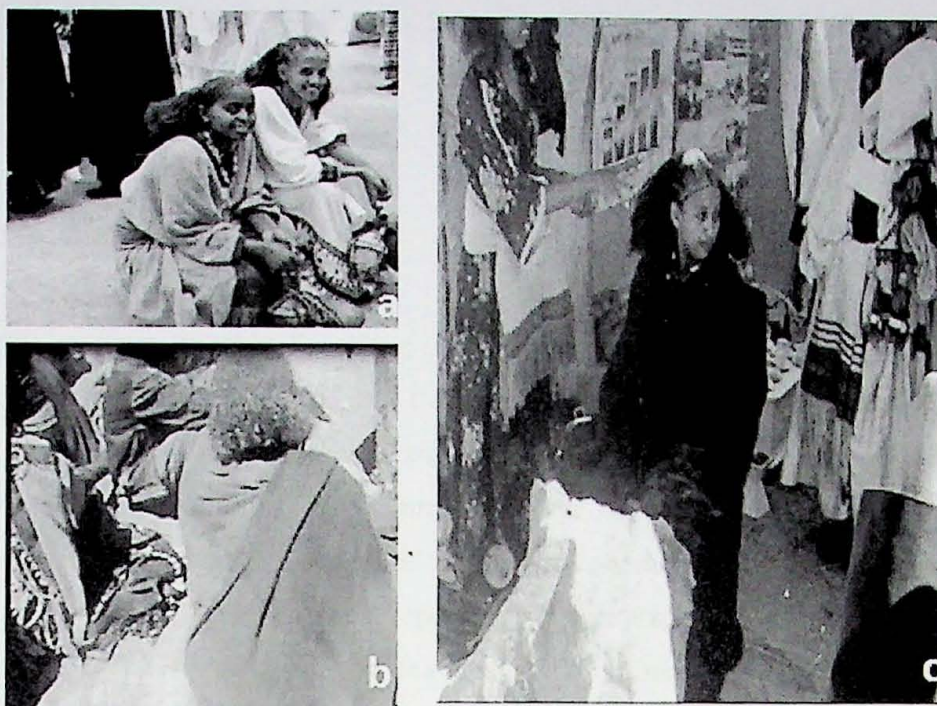


Figure 15. a and b cultural clothes with different colours due to butter dyeing; c, A girl in butter hair ointment and practice of traditional smoke bath (*'maetena'*).

Source: Enda-Mekoni Zone Bureau of culture and Tourism (2011).

Butter sample was analysed for moisture content that provided an average of 21.23% that could be more than recommended to minimize spoilage and extend its shelf life, however, the dairy farmers, do have their own coping mechanism and utilization practices. Besides the moisture content will evaporate in time with room temperature. Moreover, butter could be extracted via heat in to ghee of healthy food for better shelf life or else, non edible butter could be used for hair ointment, to dye their traditional white clothes in to greyish coloured for ease sanitation and cultural matters, and to process leather mat and other usable hide and skin products

4.5.6. Ghee

Ghee (*'Sihum'*) or butter oil prepared from cows or goats milk was a special ingredient of holiday dish in majority of the dairy farmer respondents. Butter oil is used to enrich the taste and nutritional quality of various foods either in cooking or as a spread on the finished food.

Besides to its nutritional, ease of storage make ghee more preferred asset that it could have about a year shelf life, the longest possible age to stay with minimum spoilage followed by butter (6 months) and *hazo* (2 weeks). Its low moisture content and the various spices added in various proportions from household to household, served as preservative and provided immense aroma and flavour.

4.5.7. Milk utilization practices

Fresh milk, yoghurt, buttermilk, whey, cottage cheese('Ajibo'), *hazo* (butter milk that fermented with spices), butter and ghee ('*Sihum*') were among the common dairy products produced and consumed in the area with varying degree, that of fresh milk and yoghurt, were reserved for further processing, while *hazo* and ghee were consumed occasionally during holidays. The milk consumption system of the area was characterized by considerable product diversity. Among the many reasons reported by farmers, insufficient amount of milk production and cultural restriction were the most common hindering factors. Because of low milk production in the traditional sector, little or no milk is usually available for sale. Besides, difficulty is often experienced in finding a market. In some households, advanced pregnant, lactating mothers, children and elders were prioritized to drink milk though it depends on the number of milking cows they have.

A farmer remarked as "honey is for a day while milk is for a year!" indicating the nutritional significance to invest for beloved family. Majority of the dairy owners were intimated with their neighbours for they do have social ties and they share animal products like the priceless life saving '*tsimbahlela*'- yoghurt during emergencies and it was also disgust to drink milk products alone, particularly after long fasting periods, for that matter every dairy owner do distribute about 10 to 15 liters of milk for his neighbour as gift just in every holidays like Easter, *Ashenda*, New-year, Christmas and/or Epiphany. Besides ploughing oxen was shared to neighbours in the rural and periurban areas that kept strong social bond. Beside misery family like widowed were encouraged to engage in keeping group of calves for a Wednesday or Friday milk in the rural while urban do tether their calves around their backyards.

Concerning to milk utilization, the rural household dairy farmers dominantly used the available milk for family food consumption that varied from Wereda to Wereda as shown in figure 10, where 32% of the milk was used Ofla Wereda, followed by 29% in Enda-Mekoni

and 23% in Emba-Alaje. There was no much variation in periurban and urban sites since liquid milk sold to consumers. Dairy farmers were categorized based on marketable milk products that 98.08% of them sell butter, 77.56% of them sell fresh milk, 4.49% of them sell buttermilk and 1.92% of the respondents sell yoghurt .where as none of the respondents sell ghee, cheese, whey and *hazo* milk products.

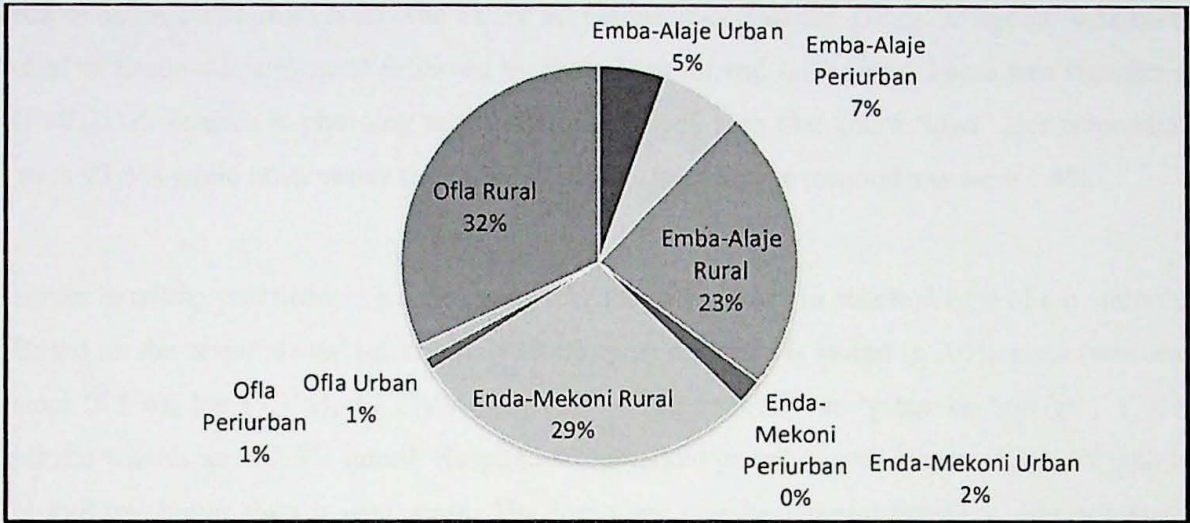


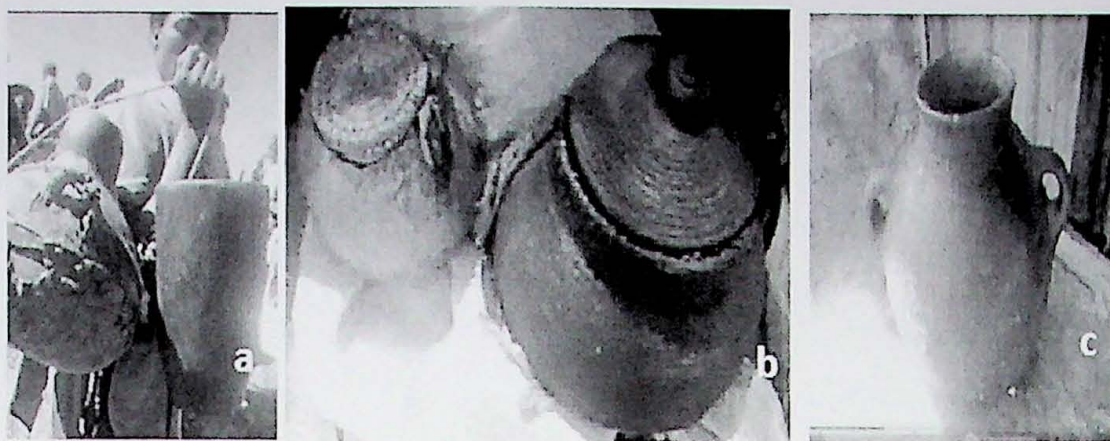
Figure 16. Proportion of the available milk consumed by the family (%).

4.6 .Milk products handling and processing vessels

Equipment used for milking, processing and storage determine the quality of milk and milk products. Therefore, producers should pay particular attention for the type as well as cleanliness of milk equipment. As to the handling manners many including the urban dwellers don't have access to use technological storage facilities to minimize spoilage of milk and milk products. Thus, clay pot, gourds, some unreliable sourced iron and plastic containers are used for liquid milk while broad leaves like castor oil and grass weaved could serve as butter handling materials, which have sanitation problems because of grooved and irregular shapes. However, dairy farmers adapted and appreciate the rough nature of the gourds (*qorie* for butter storage, *qurae* for souring, *laga* for churning and *karfo* for milking) and clay pots as souring and heating vessels for it absorb smoke (the disinfectant and preservative) as shown in figure 17 and 18.

Milking vessels used in the study area were *gibar* (woven grass smeared by *Euphorbia tirucelli* sabs) in 9.62% respondents, plastic jogs (pails) in 55.13% respondents and log 'karfo' in 35.26% respondents. Among the respondents 16% used clay pot, 54.5% used plastic, and 29.5% used gourd made of *Cucurbita pepo* (hamham) as souring vessel. Ghee storage practice of the respondents was also 66.03% in plastic/ glass vessels, followed by 30.13% in clay pot termed as '*qurae* or *tenqi*' and 3.21% in stainless steel vessels. The data in table 9 revealed that the traditional vessels were replaced by plastic in majority of the respondents, since the vessel was easily accessible and cheaper. *Gibar* or *agelgil* was more used in Emba-Alaje Wereda followed by Enda-Mekoni and Ofla areas. There was significant ($P<0.05$) difference in churning vessel use in the study area that gourd '*laga*' user respondent were 93.6% while other water tight plastic vessel churning user respondents were 6.4%.

Butter handling practiced in general in '*qorie*' that could vary in size and type of the material. Based on the respondents' information where to store butter is stored in 2.6% glass (stainless steel (6.5%), log (7.1%), 14.2% woven grass termed locally as '*gibar* or '*agelgil*', 17.4% plastic vessels and 52.3% gourd. Respondent remarked gourd as well insulated but difficult to in and out butter than woven grass. The log *qorie* was best butter handling, but not easily accessible these days because of deforestation problems that some do get from Afar region. Butter milk termed as '*Awuso* or *huqan*' and spiced butter milk '*Hazo*' vessel practiced in clay pot, plastic and stainless steel. Fresh milk and butter milk boiled in stainless steel (71%) or clay pot (29%) while butter extracted in to ghee using clay pot.



Milking vessel made of plastic
Gourd churner 'laga'



Butter storage vessels termed as 'qorie'

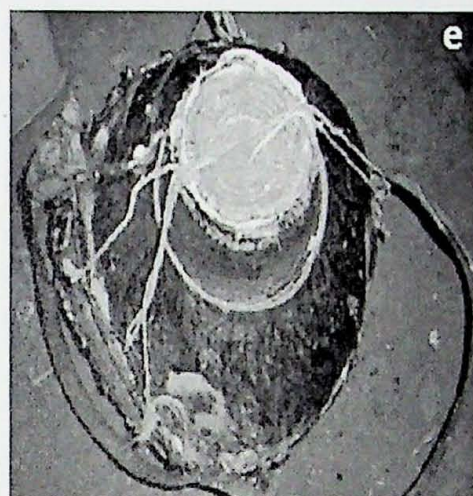


Figure 17. A set of traditional milk products vessels: a, Dairy farmer with a local churner 'laga' and local milking vessel 'karfo'; b, Local butter storage vessels termed as 'gibar'; c, Souring vessel termed as 'qurae' or 'tenqi'; d, A set of milk products handling tradition in a dairy farming household, and e, Local milk churner termed as 'laga'.



Figure 18. A set of alternative milk products handling vessels of customers in Maichew dairy union

Table 9.Comparative respondents' number in the study areas based on milk handling utensils.

Vessels	Milking (' <i>Karfo/kordo</i> or <i>gibar</i> or <i>guagid</i> ')	souring (' <i>qurae</i> ')	churning (' <i>laga</i> ')	butter (<i>qorie</i>)	Ghee (' <i>mesehami</i> or <i>meqersemito</i> ')	buttermilk	Hazo	Heating
clay pot	-	25(16%)			47(30.3%)	13(8.33%)	13(8.33%)	110(71%)
glass Vessels	-	-	-	4(2.6%)	1	4(2.6%)	4(2.6%)	-
Log Vessels	55(35.3%)	-	-	11(7.1%)	-	-	-	-
Stainless steel	-	-	-	10(6.5%)	5(3.2%)	10(6.5%)	10(6.5%)	45(29%)
woven Vessels	15(9.6%)	-	-	22(14.2%)	-	-	-	-
plastic Vessels	86((55.1%)	85(54.5%)	10(6.4%)	27(17.4%)	103(66.5%)	58(37.18%)	58(37.18%)	-
Gourd Vessels	-	46(29.5%)	146(93.6%)	81(52.3%)	-	15(9.62%)	15(9.62%)	-

- data in bracket indicate proportion of respondents who used the milk product vessels.

4.7. Plants used to clean (scrub) vessels of milk products

The dominant milk vessel washing herbs used in all the study areas were *Cucumis prophertarum* ('ramborambo') that prevent defragmentation of yoghurt from rarely souring problems and multi-medicinal value of their livestock, *Zehneria scabra* (*L. fil*) *sonder* ('hafafelos or hareg rasha') and *Achyranthes aspera* ('mechalo') were all rough in nature to clean the grooves of the clay pot ('qurae') and churner ('laga') besides to their disinfectant nature. *Rumex nervosus* ('hehot'), *Rhus glutinosa* ('tetalo'), and *Asystasia gangetica* *L.* ('grbi'ya') were alternatively used. *Sida schimperiana* ('tiffraria') was blamed to wash clay pot which used for local brewery vessels alone, but very rare respondent argued as alternatively scrubbing vessels of milk products.

Table 10. Plants used to clean milk product vessels in highlands of Southern Tigray.

Scientific Name	Local Name	Emba-Alaje N=48	Enda-Mekoni N=50	Ofla N=58
<i>Achyranthes aspera</i>	<i>Mechalo</i>	97.92%	97.92%	97.92%
<i>Asystasia gangetica</i> <i>L.</i>	<i>Grbi'ya</i>	52.08%	52.08%	52.08%
<i>Cucumis prophertarum</i>	<i>Rambo Rambo</i>	100%	100%	100%
<i>Olea europaea</i> (<i>cuspidate</i>)	<i>Awulie</i>	25%	14%	31.03%
<i>Rhus glutinosa</i>	<i>Tetalo</i>	18.75%	18.75%	18.75%
<i>Rumex nervosus</i>	<i>Heho't/imbach'o</i>	39.58%	39.58%	39.58%
<i>Sida schimperiana</i>	<i>Tiffraria</i>	10.42%	10.42%	10.42%
<i>Zehneria scabra</i> (<i>L. sonder</i>)	<i>Hafaflos</i> (<i>hareg rasha</i>)	100%	100%	100%

N= Number of respondent used to practice.

Many respondent prefer *Cucumis prophertarum* ('rambo rambo') to speed up fermentation and prevent from irregularity of yoghurt "mibititas riguo/ergo" *Zehneria scabra* (*L. fil*) *sonder*, a multifunctional herb used by many people, women in particular exploited for its medicinal value, could act as disinfectant. Cleaning plants differ from place to place and even from household to household based upon preferences indicating the variety of materials that need to be exhaustively studied. *Olea europaea* was a multifunctional tree that its leaf alternatively served to clean milk vessels that rural dairy farmers in particular 31.03% of respondents from Ofla followed by 25% respondents of Emba-Alaje, dominantly used it for

scrubbing while the urban dairy respondents do have access of the dry wood to smoke. The usage of such plants along with the locally available vessels led the tradition of milk utilization practices, preferable more than technological innovation, for the immense natural aroma and flavour of milk products. For instance, use of detergent was practiced in urban dairy farmers to wash but must be supplemented via the herbs, otherwise either it would be odorous or delay to sour or milk fat globules defragmented. As reported by respondents, these plants were used to give good flavour for the milk and milk products. As per the respondents, the plants were also used to increase the shelf life of milk products. In general, as indicated in table 12, the uses of such preservative plants differ from place to place and even from household to household.

4.8. Plants used for smoking the milk vessels

Plants used to smoke vessels of milk products in the study sites are summarized in table 11.

Table 11. Plants used to smoke milk product vessels in highlands of Southern Tigray.

Scientific Name	Local Name	Emba-Alaje N=48	Enda -Mekoni N=50	Ofla N=58
<i>Accacia etbaica</i>	<i>Seraw</i>	10.42%	6.25%	13.79%
<i>Anethum graveolens</i>	<i>Shile'an</i>	60.42%	80.00%	39.58%
<i>Asystasia gangetica L.</i>	<i>G'rbi'ya</i>	56.25%	38.00%	46.55%
<i>Cassia arereh</i>	<i>Hambohambo</i>	10.42%	6.25%	13.7%
<i>Dodoneae angustifolia</i>	<i>Tah'ses/ kitkita</i>	100.00%	95.00%	94.8%
<i>Jasminum abyssinicum</i>	<i>Habi-tselim</i>	29.16%	-	-
<i>Olea europaea(cuspidate)</i>	<i>Awuli'e/ weira</i>	100.00%	100.00%	100.00%
<i>Terminalia brownie</i>	<i>Qerent</i>	-	-	25%
<i>Zehneria scabra (L) sonder</i>	<i>Hafafelo/Hareg rasha</i>	43.75%		
<i>Lippia adoensis</i>	<i>Qusne(Kessie)</i>	18.75%	-	-
Unidentified	<i>Hazti</i>	58.33%	28.00%	-

Cells with “-” mark indicate that the plant species in the same raw is not mentioned/cited by the respondents of the study area shown on the corresponding column

Three dominant plants exploited for smoking milk vessels were *Olea europaea*, *Dodoneae angustifolia* and *Anethum graveolens* in decreasing order in the study areas, just for

fumigation, extend shelf-life and milk products aroma and flavour due to scent scenario of the plants. Household preference and agro-ecology difference could contribute to the variety plant usage that Emba-Alaje Wereda respondents alternatively used smoke of *Jasminum abyssinicum* ('habi-tselim'), 'hazti' and 'qusne' that were distinctive to the peak highlands of Tsibet and Alaje mountain chains. *Accacia etbica* ('seraw'), *Asystasia gangetica* L ('qrbiya') and *Cassia arereh* ('hambo-hambo') were also another resource to all study sites. Optionally *Terminalia brownie* ('qerenet') was typical to Oflla Wereda.

4.9. Plant species used in ghee ('Sihum') making

In the study area, ghee was exclusively made for home consumption, not for market. The amount of spice ingredients used in ghee preparation varies from household to household according to experience and access. Table 12 briefs the detail spices used to prepare ghee based on mean $\pm$ standard deviation. Out of 1611 citations for ghee preparation spices used according to number of respondents preference, the spices were: *Ocimum basilicum*/O. *Urticu* (156), *Curcuma longa* (155), *Allium cepa* (147), *Allium sativum* (141), *Aframomum korarimao* (140), *Brassica napus* (127), *Coriandrum sativum* (126), *Trigonaella foenum-graecum* (114), *Brassica hirta*/*Sinapis alba* (112), *Zingiber officinale* Roscoe (105), *Cinnamomum verum* (95), *Trachyspermum ammi* (88), *Rumex abyssinicus* (87) and *Thymus schimperii* Ron (18). *Curcuma longa* ('erdi') served as colouring agent of ghee that majority of respondents deemed yellowish ghee colour is attractive. The ghee spices add value in terms of shelf-life, scene (aroma and flavour) and nutritional combinations of special ingredients.

4.10. Spices used in hazo preparation

Out of 1088 citation for hazo preparation spices (table 13) recorded according to priority were: *Allium sativum* (14.34%), *Brassica hirta*/*Sinapis alba* (14.34%), *Trigonaella foenum-graecum* (14.34%), *Ruta chalepensis* (13.6%), *Carthamus tinctorius* (9.01%), *Ruta chalepensis* (8.9%), *Hordium vulgar* (7.26%), *Capsicum annum* (6.99%), *Allium cepa* (5.52%), *Guizotia abyssinica* (3.49%) and *Piper nigrum* (33). Besides to ingredient value, the spices added in hazo enhance shelf-life through fermentation of buttermilk. The composition also varies according to household wealth and experience. Further investigation on its nutritional value and shelf-life with relation to spice type is recommended.

Table 12. Plant spices used in ghee ('*Sihum*') making in the study areas.

Scientific Name	Common name	Local Name	Emba- Alaje (N=48)	Enda- Mekoni (N=50)	Ofla (N=58)	Sum N=1611
<i>Aframomum angustifolium</i>	Cardamom	<i>Korerima</i>	2.79±2.89	3.10±2.89	2.79±2.89	8.69
<i>Allium cepa</i>	Onion	<i>Keyh shinkurti</i>	2.98±1	3.10±1	3.04±1	9.13
<i>Allium sativum</i>	Garlic	<i>Tsaeda shinkurti</i>	2.98±3.61	2.67±3.61	3.10±3.61	8.75%
<i>Brassica napus</i>	Mustard	<i>Timziz</i>	2.55±3.22	2.48±3.22	2.86±3.22	7.88%
<i>Brassica hirta/Sinapis alba</i>	White mustard	<i>Tsa'eda q'mem</i>	2.24±9.07	2.92±9.07	1.80±9.07	6.95%
<i>Cinnamomum verum</i>	Cinnamon	<i>Kerefa</i>	1.8±8.33	2.55±8.33	1.55±8.33	5.9%
<i>Coriandrum sativum</i>	Coriander	<i>Dimblal</i>	2.92±5	2.61±5	2.30±5	7.82%
<i>Curcuma longa</i>	Turmeric	<i>Erdi</i>	2.98±5.51	3.04±5.51	3.60±5.51	9.62%
<i>Ocimum basilicum/O. urticu</i>	Sweet basil	<i>Seseg/beso bila</i>	2.98±5.29	3.10±5.29	3.60±5.29	9.68%
<i>Thymus schimperi</i> Ron.	Carissa	<i>Tossine</i>	0.31±2.65	0.56±2.65	0.25±2.65	1.12%
Unidentified	Unidentified	<i>Meq'meqo</i>	1.49±5	2.11±5	1.80±5	5.40%
<i>Trachyspermum ammi</i>	Camun	<i>Azmud</i>	1.68±6.8	2.30±6.8	1.49±6.8	5.46%
<i>Trigonaella foenum-graecum</i>	Fenugreek	<i>Aba'eke</i>	2.67±8.66	1.74±8.66	2.67±8.66	7.08%
<i>Zingiber officinale</i> Roscoe.	Ginger	<i>Zingibil</i>	2.36±3.55	1.92±3.55	2.24±3.55	6.52%

Table 13. Plant species used in fermented buttermilk ('hazo') making in the study areas.

Scientific Name	Common Name	Local Name	Emba-Alaje (N=48)	Enda-Mekoni (N=50)	Ofla (N=58)
<i>Allium cepa</i>	Onion	<i>Keyh shinkurti</i>	93.75%	18%	10.35%
<i>Allium sativum</i>	Garlic	<i>Tsaeda shinkurti</i>	100%	100%	100%
<i>Brassica hirta/Sinapis alba</i>	White mustard	<i>Tsa'eda q'mem</i>	100%	100%	100%
<i>Capsicum annum</i>	green pepper	<i>Qaria</i>	64.58%	52%	32.76%
<i>Carthamus tinctorius</i>	Safflower	<i>Suf</i>	72.91%	10%	100%
<i>Guizotia abyssinica</i>	niger seed	<i>Nihug</i>	60.42%	8%	8.62%
<i>Piper nigrum</i>	Black pepper	<i>Kundoberberie</i>	29.17%	14%	20.69%
<i>Ruta chalepensis</i>	fringed rue	<i>Cenafiche</i>	94%	90%	100%
<i>Ruta chalepensis</i>	herb of grace	<i>Chena adam</i>	100%	38%	36.21%
<i>Hordium vulgare</i>	roasted barley	<i>Tihini (Besu)</i>	81%	81%	22.41%
<i>Trigonaella foenum-graecum</i>	Fenugreek	<i>Aba'eke</i>	100%	100%	100%

4.11. Butter packaging practices

Based on respondents preference of butter packaging leaves 62.18% of the respondents used *Racinus communis* ('gulei'), 1.92% used *Cassia arereh* ('hambohambo') and 1.28% used *Cordia africana* (awuhi') plant leaf used as butter packaging material in the study areas. 34.62% of the respondents from urban and periurban prefer plastic package than leaves. According to some respondents the leaves were used culturally and practically for no effect over all butter property, being smooth and larger size uniformly, no butter wastage remains there, moreover, the leaf provide protection from heat. Concerning to utensil 'qorie-log or hamham- gourd or gibar- grass woven' was mentioned according to their preferences based on heat protection for the butter. However, butter traders do prefer to hold on larger sized plastic pail or other stainless vessels. The effect of the packaging leaf on the quality and characteristics of butter deserves further investigation. Some butter sellers do use plastic cover inside the grass woven 'gibar' as alternative to minimize loss but blame for odour (figures 17, 18 and 19).



Figure 19. Butter packaging in Emba-Alaje and Enda-Mekoni markets.

4.12. Group discussion results

Based on Annex 4, in the group discussion production constraints like feed scarcity, disease problems and alternative coping mechanisms were issued for that matter the diseases identified are listed in Table 14 and figure 18.

4.12.1. Animal health challenges

Anthrax, Foot and Mouth Disease, and Blackleg were dominantly livestock diseases that were rampant in the area in their order of importance. Ticks, lice, Lungworm, Mites, and fascioliasis are also livestock parasites of frequent problems in communal grazing lands. There was outbreak of FMD regional level, in particular, Emba-Alaje area but controlled due to regional vaccination campaign. In steep gorges of mountain area and less infrastructure, efficiency of the veterinary services or the veterinary personnel highly depends on the availability of facilities such as transportation, veterinary equipment, drugs. Besides, the farmers practice folklore medicine, to save their animals by bleeding, branding and use of herbal medicines. Urban dairy farmers do have better access to veterinary service that could be affordable in comparative to their income from milk. There was limited access of veterinary service in rural and periurban cases where poor understanding and capital constraints were reflected. The steep gorges of the study area are part of animal and human hazard losses that enforced some farmers to stick on zero grazing. The author has also experienced to see severely broken or death of animals through falling in the steep gorges.

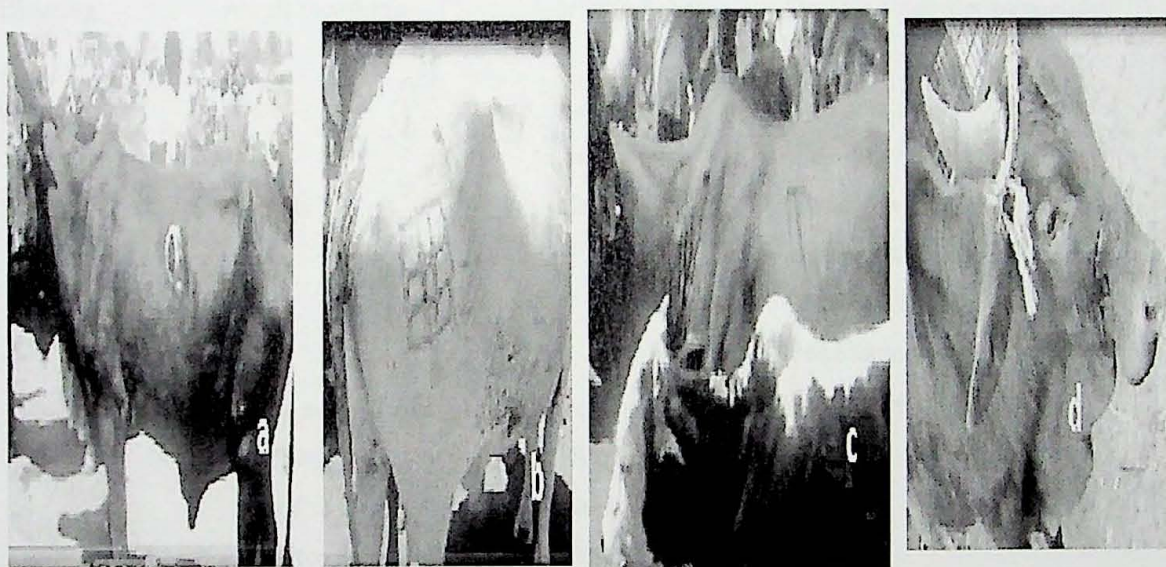


Figure 20. Traditional Medication:-a, branding for inflammation; b, hot branding for broken animals; c, for *tafia*(*Anthrax*), and d, bleeding means of relief to extend life or act of Jewish slaughtering.

Table 14. Disease challenges and measures taken in the highlands of southern Tigray.

Diseases	Symptoms	Local names	Traditional remedy
Anthrax	Anorexia, emaciating	<i>Megerem, tafi'ya,</i> <i>halafen, hibet</i>	Hot branding “ <i>Mitukas</i> ”
Black leg		<i>Werchi,</i> <i>go'ytager, shidon</i> <i>ger</i>	
Foot and mouth disease		<i>Afme'ar, anashe,</i> <i>echelam</i>	Honey topical application
Cataract		<i>Atsmi a'yni</i>	<i>Achyranthes aspera</i> root+ butter
CBPP	Coughing	<i>Sambu'e , tirfe</i>	<i>Solanum incanum</i> +goat milk/nasally
Mastitis	Udder inflammation	<i>Himam gule</i>	River stones heated by birds nest then milked over for udder steam
Cataract	opaque condition	<i>Atsmi ayni</i>	Surgical removal of bone traditionally
Rinderpest		<i>Gulehay,</i> <i>degehabe, beyene</i>	Unknowingly that it is disappeared from Ethiopia
Bloating	rough breathing	<i>M'nfah kebdi</i>	Drain oil/petroleum/yoghurt/ buq'li
Parasite	Lice	<i>qumal derhu</i>	<i>Calpurnia aurea</i> /“Hatsawits”
	Ticks	<i>qurdid</i>	Pick up(“Miqintab”
	Leech	<i>aleqti</i>	Butter+ peper nasal drainage <i>Croton macrostachyus Hochst</i> (‘ <i>Tunbako</i> ’) Petroleum between horns
	Tooth ache+ constipation	<i>Dorera</i>	Hot branding on back
	Circling	<i>Shifed</i>	
	liver fluke	<i>Haseka kebdi</i>	
Other challenges	predator (tiger/hyena)	<i>Mitsdaf,</i>	
	theft	<i>mewqa'eti,</i>	

CBPP= Contagious Bovine Pleuro Pneumonia

5. DISCUSSION

The mean value of family size in the study areas 4.6 ± 1.84 persons was comparable to CSA (2007) report which was 4.5 for Enda-Mekoni, 4.29 for Ofla and 4.36 persons to a household for Emba-Alaje. This slight difference might be the reflection of the steady growth of the population. The proportion of the households who participated in the dairy technology package was 28.8%. In terms of labour use, 83.33 % of the interviewed households used own family labour, where as the other proportion of them use hired labour in addition for dairy farming. Feeding, watering, barn cleaning, animal keeping, regulating animal health, cow milking, churning milk, milk selling and selling dung cake were more of performed by wife and children, while feed purchase, buying and selling animals as well as medication activities (bleeding and branding), were responsibility of the husband. Sell and purchase of dairy animals belong to the spouses more of men while women discharge feeding, milking and dairy products processing and selling. Herding to adolescents or hired in free grazing on communal natural pastures that constituted almost the only feed resource for all rural dairy farmers. Similar work by Girma *et al.* (2011) characterized that children are the primary care takers of cattle at day time. Rural dairy farms are characterized by roofless fenced enclosures to keep cattle during night times; calves being separated from adults and housed in the same shelter with households, however, dairy farming packaged households do abide by zero grazing and modified shelter for the hybrid Holstein Frisian cows.

Milking cows of the study areas were 23.1% out of 845 cattle owned by the respondents, which were composed of 631 local including Arado, Raya and Begait breeds and 214 crossbred of Holstein Frisian and upgraded Jersey cattle. The result is indifferent from MoA (2004) report in Ethiopia that 11.82% of 2990 cattle population in 1998 was milking cows. That could be due to time difference and business mindedness of dairy farmers in urban agriculture now than draught oxen focus by the then time. The population of Holstein Frisian decreased from urban to rural while that of the Arado breed increased, indicating that dairy farming in rural destined on Arado while urban destined on Holstein Frisian breeds.

Milking twice a day is similar to the milking frequency practiced in many parts of the country. Time of milking is normally early morning and late evening that is consistent with Sintayehu *et al.* (2008). But time of the day particularly morning hours could vary that milking is delayed during cool seasons. Similar to the study findings, Pal (2012) reported in

the Ethiopian Herald, that most of the milk produced is marketed to the consumers without being pasteurized or subjected to any microbiological quality control. The milk animals are kept with the rest of the stock in a shade or/ and enclosed during night. Milking is done in shade, grazing field or under a tree. These areas are usually not kept clean. The lactating cows are often soiled with dung and urine. Moreover, proper cleaning of the udder and hindquarters of the cow is not commonly practiced. This coupled with the unhygienic cleaning and handling of milk containers could result in the contamination of the milk. In contradict to Tamime (2009) and FAO and IDF (2011) who stated measures to reduce contamination by spoilage and pathogenic organisms from the farm, the cow's teats and surrounding udder area, and all vessels used during milking and processing should be properly cleaned, however, 89% of the dairy farmers of the study area do not wash cow udder and where access to improved technologies to store or transport their milk to market areas are challenges. With the poor access of technological preservatives and processing utensils, milk products could have been perished, but many thanks to the indigenous knowledge practices of plant uses to speed up fermentation, to prevent milk spoilage and to enhance butter colour, milk products aroma and flavour supported with reports of Lemma *et al.*(2005ab); Asaminew (2007) and Hailemariam and Lemma (2010). Based on the keen observation, dauntless courage and optimism of the dairy farmers' information, some plant such as *Asystasia gangetica* L. 'giribia' used in smoking milk utensils, just to give reddish colour of the butter, was blamed for milk bitterness that should be further investigated.

Three dominant plants exploited for smoking milk vessels were *Olea europaea*, *Dodoneae angustifolia* and *Anethum graveolens* and the dominant milk vessel washing herbs used were *Cucumis prophetarum* that prevent yoghurt from defragmentation in rarely souring problems and multi-medicinal value of their livestock, *Zehneria scabra* (L. fil) sonder and *Achyranthes aspera* were all rough in nature to clean the grooves of the clay pot and churner besides to their disinfectant nature. This agrees with the finding of Amare (1976); Ashenafi (2002); Lemma *et al.*(2005ab); Asaminew (2007); Hailemariam and Lemma (2010); Welcaregay *et al.*,(2012) that smoking reduced the undesirable microbial contamination and enhances the rate of fermentation. The study is also similar in souring case as stated by Ashenafi (2002) that dairy processing, in Ethiopia, is generally based on soured milk, where the fermentation is natural, with no defined starter cultures used to initiate it. Raw milk is left either at ambient temperatures or kept in a warm place to ferment. The souring is brought through the proliferation of the initial milk flora, with microbial succession determined by chemical

changes in the fermenting milk. In many parts of Ethiopia, milk vessels are usually smoked using wood splinters of *Olea europaea* to impart desirable aroma to the milk. Smoking of milk containers is also reported to lower the microbial load of milk. According to Ashenafi (2002); Lemma *et al.* (2005b) and Welearegay *et al.*, (2012), milk in smoked containers had a lower rate of pH drop and the fermented product had good flavour for a longer time after coagulation. They have also indicated that the total count of non-lactic acid bacteria in milk in unsmoked containers reached a high count within 12 h, whereas milk in smoked containers required more than 24 h to reach this level. They have also reported slower growth of coliforms and lactic acid bacteria in milk in smoked containers (Biruk *et al.*, 2009). However, Welearegay *et al.*, (2012) in Hawassa city reported that smoking practice to milk vessels is declining due to complaints of customers not familiar with the flavor mainly by large restaurants and hotels.

Plant leaves of *Racinus communis* ('gulei') followed by *Cassia arereh* ('hambohambo') and *Cordia africana* ('awuhi') used as butter packaging material dominantly. The present study shows that *Racinus communis* and *Cassia arereh* are typical plant leaves to the study areas unlike *Cordia africana* that was reported in Hailemariam and Lemma (2010) in East Shoa. Spices used in 'hazo' preparation were *Allium cepa*, *Allium sativum*, *Brassica hirta*/Sinapis alba, *Capsicum annum*, *Carthamus tinctorius*, *Guizotia abyssinica*, *Piper nigrum*, *Ruta chalepensis*, *Sativium vulgar*, and *Trigonaella foenum-graecum*. Asaminew (2007) reported about 'metata ayib' in Bahir-Dar that could be of relevant utilization practice of milk products.

Storage materials preference was based on their ability to retain flavour of fumigants and herbs used. Gourd 'laga' or rarely water tight plastics were churning vessels of the study area unlike to clay pot churner reported by Alganesh (2002) for East Welega and Asaminew (2007) in Bahir-Dar. Alganesh reported that gourds were used commonly for storage and even for milking purpose. This indicates that the utensils used for milking, processing and storage were different from place to place and even from household to household. Efficient churning materials could contribute to lesser time and energy requirement besides to the economic return of higher butter yield for small holder dairy who do suffer from discouraging market during fasting of lent. Inefficient churner use contributed to less butter exploitation as stated by researchers (O'Conner, 1994; Alganesh, 2002; Zelalem, 2010).

Fresh milk, yoghurt, buttermilk, whey(*mencheba* or *arera*), cottage cheese('Ajibo or *ayib*'), butter milk that fermented with spices ('*hazo*'), butter and ghee('Sihum') were among the common dairy products produced and consumed in the area with varying degree, that of fresh milk and yoghurt, were reserved for further processing, while *hazo* and ghee were consumed occasionally during holidays. The result is consistent with many of the research findings (Lemma *et al.*, 2005ab; Fayo, 2006; Asaminew, 2007 and Zelealem, 2009). Overlapping to the fact that studies remarked, consumption of processed dairy products was observed even less frequently among the rural low income households, indicating that the majority of the population do not consume processed product (butter) to any substantial degree. The limited consumption of butter may be due to the higher price associated with it and the need for cash income to buy some necessities. Butter can fetch them a good price compared to other milk products. Butter was consumed only during holidays and special occasions in rural low-income households because it fetches routine cash income (Asaminew, 2007; Kedija *et al.*, 2008; Hailemariam and Lemma, 2010). Peculiarity of the area was that butter hair ointment of dominantly women but also usual habit of men particularly teenagers, considered as sign of wealthy family. There was also custom of dying white close to give greyish coloured that help to hide dirtiness of the close though recently is changing not only sky up cost of butter but also there is alternative close similar to the greyish dyed close. However, women still do apply on their dress and do prefer to ointment their hair using butter for long lasting than the fabricated lotions, but cost wise they might be enforced not to use butter.

According to the smallholder farmers the intended use of butter will determine the kind of preservatives to be used. Black coloured spices that commonly added in '*shiro*' cook, powdered pulse were not ingredient of ghee, due to the fears that could blackened the ghee. Ghee can be preserved for about long period of time as compare to other milk products, if kept properly and clean. Different spices of plant were used in ghee making. These findings were consistent with the reports of Alganesh (2002) in East Wellega, Lemma *et al.*(2005b) and Hailemariam and Lemma (2010) in East Shoa. Ghee was not marketed in all the areas surveyed. This might be due to consumers' preference to make their own ghee depending on their test and preference for different spices that the finding has close affinities with Hailemariam and Lemma (2010). Compatibly with Asaminew (2007), consumers or traders consider the colour, flavour, texture and cleanness of the products during transaction, that butter quality requirements fetch a good price. During the dry seasons butter price increase, this is related to abridged milk yield of cows due to the insufficient feed supply. Higher price

was also paid for yellow coloured and hard textured butter that deemed to be higher in dry matter or solid non fat for extraction consistent with reports (Asaminew, 2007).

In the districts those smallholders who do not sell fresh milk had different reasons. These were small daily production of fresh milk, cultural barrier, lack of demand to buy fresh whole milk and preference to process the milk into other products. Similar reports were made by Alganesh (2002) and Lemma *et al.* (2005ab). Besides, difficulty is often experienced in finding a market. Typical to the research observation on milk marketing problems, the Ethiopian highland smallholder produces a small surplus of milk for sale. the informal system where the smallholder sells his surplus supplies to neighbours or in the local market, either as liquid milk or in the form of butter but contradict in cottage-type cheese called *ayib* (Sintayehu *et al.*, 2008) selling that was unusual including buttermilk, 'hazo', whey, cottage cheese and ghee. In the vicinity of larger towns the milk producer has a ready outlet for his liquid milk. However, in rural areas outlets for liquid milk are limited due to the fact that most smallholders have their own milk supplies and the nearest market is beyond the limit of product durability like to many of the studies done (Getachew and Gashaw 2001; Sintayehu *et al.*, 2008; SNV, 2008; Tesfaye *et al.*, 2010) besides to cultural traditions and lower talents entrepreneurship of the farmers.

Average age at first calving was 3.5 years for local, while 2.5 years for exotic breeds and calving interval was similar 1.5 year. The lactation length was averaged 6 ± 1 months for local cows while 8 ± 1 months for exotic breeds that matched with Dawit (2009) report in Eastern Tigray who also summarized, milk yield of local breeds from 1.8 ± 0.4 in Arado to 5 ± 0.5 of Begait breeds. The average milk yield was 2 ± 1 litres for local breeds, 5 ± 1.5 litres for hybrid jersey and 10 ± 2 litres for hybrid Holstein Frisians. There was significant ($P < 0.05$) difference for cattle breed in lactation length and milk yield but no remarked ($p > 0.05$) difference in Wereda level. Highest lactation length recorded in Maichew Holstein Frisian was 2 years, contrary to the universal record of 10 months exotic breeds, actually the cows displayed no observed heat. The study result disagreed with Mulugeta *et al.* (2009) who reported average daily milk off take from local cows 1.09 litres and crossbred cow 5.97 litres, with overall lactation length of both local and crossbred cows was 7.52 ± 1.64 months as per farmer's statements. Adebabay *et al.* (2009) recorded local cow's milk yield of 1.46kg/cow/day.

Genzebu *et al.* (2012) in northern Tigray also added that Arado cows give an average milk yield of 1 to 2 l per day for an average lactation period of 7.3 months.

In close affinity to Asfaw *et al.* (2010) work in Arsi zone, generally more number of services per conception was reported using AI as compared to natural mating, attributed to inefficient AI services that included poor quality semen, poor heat detection techniques and inaccurate AI services. The same is true in feeding system that dairy producers practiced inadequate crop residue storage that hinders productivity of the animals. Similar to the reports of FAO and IDF(2011) and Thapa (2000) dairy production was influenced by feed problem, poor animal health services and shortage of drugs, dissemination of poor genetic material, poor government attention to dairying, unreliable AI service, working land shortage to expand and/or forage development, market problems for dairy products, financial problem (absence of credit), waste disposal, lack of recording system (poor information flow), lack/poor extension service & training, lower understanding of the respondent, poor hospitality of AI/veterinary renders. Traditional medication practice such as bleeding and hot branding that damage hide economy of the nation for unreliable remedy could be minimized as remarked PPLPI (2009) by pen side diagnostics for common diseases.

Many research findings similarly stated that there were several constraints to the dairy in particular to milk marketing development, e.g. lack of infrastructure and finance, seasonality of supplies and lack of market structure and facilities(O'Connor, 1993; Asaminew, 2007; kedija *et al.*, 2008). Because of the lack of cooling facilities or even suitable equipment or utensils for milking and storing milk, milk deteriorates rapidly (O'Connor, 1994). Milk is often sold for less than its full value due to lack of access to markets, poor road infrastructure, lack of co-operatives, inability to transport long distances due to spoilage concerns, and unscrupulous traders who add water or other fillers the study was consistent with PPLPI (2009) and cultural taboos and discouraging market (Asaminew, 2007; Fayo, 2006). Contrary to perceived public health concerns, the marketing of raw milk does not pose public health risks as most consumers boil milk that consistent was Kurwijila (2006) and exploit the surrounding herbal resources to smoke and clean the milk products vessels that served as disinfectant, preservative, tasteful with natural aroma and flavour (Asaminew, 2007; Ayenew, 2009; Desalegn, 2009 and Zelalem, 2010) before drinking it.

6. CONCLUSION AND RECOMMENDATIONS

Livestock production plays an important role in the socio-economic and cultural life of the people inhabiting in the mountainous chains of the area. The cows fulfil an indispensable role for the dairy farmers serving as sources drought ox, milk food, income from sale of butter, the only determinant women hair lotion, source of dunk cake for family fuel and served as prestige and confidence to avert risks. The respondent remarked “*Wedi Lahimika* -for own bull and no one could cheer you what a cow could do indeed” to mean reliable resource and do have special dignity for the cow. Milk products served as food, medicine, and means of socio- cultural use for the dairy farmers.

Establishment of dairy shades in the urban areas enabled to strengthen women economy who could not have initial capital and land access, to create employment opportunity and access of protein feeds to the other part of society. The marginalized disadvantaged dairy farmers do not have exposure and access to affordable improved technological products to handle and process their milk products where balanced scenarios are implemented by avoiding pasteurizing and packaging costs, raw milk markets offer both higher prices to producers and lower prices to consumers. Constraints of dairy farming involve higher cost of dairy cows, disease problems, fasting leads to poor milk demand, low productivity of the cows, technology to improve shelf life of milk products, fear of hazards, thefts and predators, and land scarcity particularly in the case of mountain area where fragmentation of land is distributed ‘*gebo meqolo*’ for landless youths. Steep cliff of the area has its own agro-ecological advantage, but featured by cattle falling hazards.

The amount of milk collected for a single churn varies with the number of milking cows and their productivity. Milk produced every day was collected in the collection clay pot , plastic vessels or ‘*laga*’ smoked with woods called *Olea europaea*, *Dodoneae angustifolia*, *Anethum graveolens* *Acacia etbaica*, *Terminalia brownie*, and in some cases *Cassia arereh* and the dominant milk vessel washing herbs used were *Cucumis prophertarum* that prevent yoghurt from defragmentation during rarely souring problems and multi-medicinal value of their livestock, *Zehneria scabra* (*L. fil*) *sonder* and *Achyranthes aspera* were all rough in nature to clean the grooves of the clay pot and churner besides to their disinfectant nature. As reported by respondents, the purpose of smoking was to minimize products spoilage during

storage and to give good aroma and flavor. The dried stem part of the plant is, generally, used for smoking, and it was done either by turning upside down the utensil on a burning dried chips of the plants or by putting the burning chips inside the utensils until the smoke dies out. Keeping milk or milk product for longer period without spoilage and flavor was indicated as main reasons for using plants in washing (scrubbing) dairy utensils. The plant parts commonly used for scrubbing purposes were fresh leaves and whole plant (in case of herbaceous plants).

Milk handling and processing tradition accompanied by indigenous knowledge, local vessels and meant for local consumption of cheaper supplies, harming farmers' and national economy. Materials commonly used for milk collection storage and processing included clay pot, glass container, wooden container, plastic container, woven materials, plastic container and gourd. Interventions in input supply system, production technologies, processing, and marketing practice including the crossbred heifer supply, AI and bull services, vaccination, emerging infectious animal diseases prevention and treatment, development of feed sources, access to dairy production technologies, access to market and market information and supportive infrastructure development, and capacity development on skills of dairy cows management are all in infant stage in the Wereda that demand integrated implementation.

- To recommend possible interventions for the betterment of existing conditions
- The emerging markets of buttermilk and yoghurt in farm gates should be expanded to other means of marketing systems via integrated awareness creation
- Traditionally used plant species should be further investigated to determine active ingredients, effectiveness and safety to consumers.
- The effect of these materials on the shelf- life of stored or preserved butter deserves further investigation. The active ingredients of these preservatives, their effectiveness to keep butter for longer periods without deterioration and the amount and methods of utilization deserve further investigation.
- The impact of spices on human health arising from their uses as butter preservatives also requires further study.
- Facilities for cleaning and overnight storage, milk churns and dairy utensils are rudimentary, requiring intervention,

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ANNEX

Annex 1:Table1. Family size of respondents based on their respective study Wereda.

		N	Mean persons /house hold	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini mum	Maxi mum
						Lower Bound	Upper Bound		
Family Size	Emba-Alaje	48	4.52	1.458	.211	4.10	4.94	1	8
	Enda-Mekoni	50	5.08	2.448	.346	4.38	5.78	1	14
	Ofla	58	4.26	1.371	.180	3.90	4.62	1	7
	Total	156	4.60	1.830	.147	4.31	4.89	1	14
	Model Fixed Effects			1.809	.145	4.32	4.89		
	Random Effects				.245	3.55	5.66		

Annex 2. Table 2. Respondent dairy farmers background.

		Sum of Squares	df	Mean Square	F	Sig.
Age of the respondent	Between Groups	.507	2	.254	.515	.599
	Within Groups	75.390	153	.493		
	Total	75.897	155			
Sex of house hold head	Between Groups	.069	2	.035	.163	.850
	Within Groups	32.623	153	.213		
	Total	32.692	155			
Family Size	Between Groups	18.579	2	9.290	2.838	.062
	Within Groups	500.780	153	3.273		
	Total	519.359	155			
Labourer used	Between Groups	3.169	2	1.584	3.626	.029
	Within Groups	66.851	153	.437		
	Total	70.019	155			
Education status	Between Groups	3.570	2	1.785	.942	.392
	Within Groups	289.866	153	1.895		
	Total	293.436	155			

Annex 3. Questionnaire Survey for the study

Notice: Please explain objectives of the interview to the respondent dairy farmer first.

District's name.....

- I. Peasant Association.....
- II. Household head
- III. Sex -----
- IV. Age -----
- V. Family size ----- Female -----Male
 - s Level of education of respondent a, Illiterate
 - b. Read &write
 - c. Elementary school
 - d. Junior Secondary School
 - e. Secondary School
 - f. greater than12th grade

- 1. Earning means
 - 1st _____ 2nd _____ 3rd _____
- 2. The main crops produced in the area (high to low level of production in terms of area coverage) 1st _____ 2nd _____ 3rd _____
- 3. Why do you rear animals?
- 4. What are the uses (function) of dairy products and by products in different seasons?

Table1- Livestock data of the family

	Livestock population		
	local	hybrid	exotic
Cow			
Calf			
Heifer			
Bull			
Sheep			
Goat			
Equines			

Table 2.relative cattle breed productivity

	Breed		
	indigenous	Hybrid	Exotic
Age at first calving			
Average daily milk yield/ cow			
milking frequency			
lactation length			
calving interval			

Table 3: Daily productivity

	fresh milk	yoghurt	butter	Ghee	Butter milk	cheese	whey	Hazo
total milk yield								
Household consumption								
Sold								
Stored for further processing								
gift for neighbours								

Table 4. Labour division related with dairy farming

list of duties	husband	wife	children	hired	Others
Feeding					
Watering					
barn cleaning					
animal keeping					
buying & selling animals					
cow milking					
churning milk					
/milk selling					
selling dung cake					
regulating animal health					
Others					

5. Milking procedure followed in the farm
 - I. barn cleaning, washing udder, milking
 - II. barn cleaning, suckling ,milking
 - III. suckling, milking barn cleaning
6. Number of days to ferment your milk? -----
7. Why do you process milk & milk products?
8. Number of days required to process your milk products?.....
9. Method of milk processing?
10. Justify the season milk products get perished differently -----
11. Which product is better in shelf life? List according to rank?
 - a. Fresh milk b. Butter c. Butter milk d. whey
 - e. cottage cheese f. Yoghurt g. Soured butter milk
12. Sort of materials and substances used to handle, preserve and process milk products?

Table 6. Milking, processing & storage vessels

Vessels	Milking (‘Karfo/kordo or gibar or guagid’)	souring (“qurae”)	churning (“laga”)	butter (qorie)	Ghee (‘mesehami or meqersemito’)	buttermilk	Hazo	Heating
clay pot								
glass Vessels								
Log Vessels								
Stainless steel								
woven Vessels								
plastic Vessels								
Gourd Vessels								

13. Milk products vessel washing (scrubbing) plants used.....
14. Milk products vessel smoking plants
15. Why do you use such plants?.....

Table 7: Constraints to dairy cattle production

cost of dairy cows								
discouraging cost of Products								
Distance of market								
feed scarcity								
Herder scarcity								
land scarcity								
water shortage								
poor productivity of the cows								
Health problems								

Table 8. Spesfic constraints to milk products						
fresh milk	Yoghurt	butter	Hazo	Cottage cheese	Whey	ghee

16. Feeding methods

- a. Free grazing b. Partial grazing c. Zero grazing

17. What sort of feed do you supply your animals?

- a. Straw
- b. Hay
- c. Grazing area

18. How do you store your straws?

- a. Openly hoarded b in modified shades c . In houses

19. Do you face feed shortages? a, yes b, no

20. If so how do you cope up with feed shortages? -----

Table 9. Relative barn type

	Fenceless	backyard /barn	Improved barn	Normal house
Calves				
dairy cows				

21. How frequently do you provide the cattle with water per day?

Once / Twice /Thrice/ Through out the day

22. How far is the source of water from the home stead?

23. . Source of water for your dairy cattle?

- a. river b. lake c. well d. stream e. tape
24. Do you wash cows' udder? a, yes b, no
25. Why do you wash cow udder?
26. Are you engaged in dairy technology package? a, yes b, no
27. Do you attend cows in heat? a, yes b, no
28. Do you practice breed selection? What are your criteria's to select?
29. Where do get hybrid cows/ replacement heifers?
30. Breeding methods used? a, bull service b, AI c,
31. Why do you prefer so?
32. If problems faced with AI? a, yes b, no
33. Do you practice pregnancy checkups? a, yes b, no
34. What indicators do you use to know late pregnancy? a. Enlarged abdomen
b. reject her calf to suckle c. reduced milk yield d. Data record
35. Do you practice culling? Why so.....
36. Season more diseases appear? Why?
37. Do you practice record keeping? A, yes b, no
38. What sort of record do you keep?.....
39. Who did assist you in record keeping?-----
40. What do you perceive use of record keeping? -----
41. For how long do you separate calves?
42. How do you practice milk feeding to calves?
43. Weaning age-----
44. Do you castrate male calves? A, yes b, no
45. Calves housing -----
46. Means of waste removal -----

Table 11□ what common methods do you practice for respective diseases?

Animals	1 st disease	remedy	2 nd disease	remedy	3 rd disease	remedy
Calves						
Cow						
Heifer						
Bull						
Ox						

Dairy barn inspection

47. Type of barn -----
48. Relative distance from home -----
49. general condition of barn(good□ fair□ bad)
50. Barn condition:-
- a. floor -----
 - b. Aeration -----
 - c. space -----
 - d. sanitation
 - e. access for movement-----

Annex 4. Questionnaires for group discussion

Date[] - ----- Group..... Location..... No. of participants.....

1. The main crops produced in the area (high to low level of production in terms of area coverage)

1st _____ 2nd _____ 3rd _____
4th _____ 5th _____ 6th _____

2. Why do you rear animals?

3. How do you use milk products in different occasions and/ or seasons? Why?

4. Have you ever noticed a change in milk yield? Justify why so?

5. What are the constraints of livestock production particularly dairy farming?

6. Common dairy cattle diseases

S/No	diseases	Animal type	measures taken	remarks
A				
B				
C				

7. Do you practice supplementation a. yes b. no

8. If yes, list

supplement types	supplement Source		
	HH left over	Own products	commercial

9. Is there special time to supplement? Why?

10. Justify why you do not supplement?

11. When do you commonly face shortage feed?

a. ----- b. ----- c. -----

12. Which animals do you commonly give priority to supplement? Why so?

CURRICULUM VITAE

I. Personal data

Name:-Abraha Negash G/hiwot

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- June 29-30/2010:- 3rd & 4th MSP's Meeting on honey & other bee products value chain and livestock market flow. USAID /CARE/ Save the Children /REST/CRS/SNV and Tufts , Mekelle -Ethiopia
- March 11_20/ 2009. Development of Agricultural Occupational Standard, MoA/RCBP, Furra Development Studies, Yirgalem-Ethiopia.

V. Computer skills

► PC diploma from Dynamic information technology, Maichew -Tigray, Ethiopia (Feb10 - July 30, 2004).

VI. Study Papers Produced

► Handling, processing and utilization practices of milk products in the highlands of southern Tigray, Ethiopia (DebreZeit MSc Thesis (2012))

VII. Professional Association

► I am a member of Ethiopian Beekeepers Association and Ethiopian Society of Animal Production (ESAP).

VIII. References

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II. Educational background

- Primary education: 1st-4th and 7th- 8th in Ellala Elementary and Junior School , Mekelle-Tigray.
5th -6th in Kersa Elementary School, Bati-Wollo.
- High School: 9th-12th in Atse Yohannes Comprehensive Secondary School, Mekelle- Tigray.
- Higher Education:
 - ❖ B.Sc Degree in Animal Science from Mekelle University Faculty of Dry Land Agriculture and Natural Resources (1997- 2003).
 - ❖ MSc in Tropical Animal Production and Health from Addis Ababa University, DebreZeit College of Veterinary Medicine and Agriculture (July 2009 _ July 2012)

III. Professional (Work) Experience:

- March 01, 2009 –Oct 30, 2011:- outcome based training coordinator of Maichew Agricultural TVET College, Maichew -Tigray, Ethiopia.
- June 07,2007 – Feb 30, 2009, Research, Extension & Publication Officer
- Nov. 16, 2003 – Present :-Graduate Assistant I & II and Assistant Lecture in Maichew Agricultural College, Maichew -Tigray, Ethiopia

IV. Trainings & Workshops

SIGNED DECLARATION SHEET

I declare that this thesis is my bonafide work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc degree at Addis Ababa University College of Veterinary medicine and Agriculture. I declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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Place: Addis Ababa University DebreZeit College of Veterinary medicine and Agriculture

Date of Submission: June 2012

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Ashenafi Mengistu/PhD/

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Signature: