ADDIS ABABA UNIVERSITY
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DAIRY PRODUCTION, PROCESSING AND MARKET SYSTEM: A CASE STUDY OF GAMBELLA, SOUTH WEST ETHIOPIA

A thesis submitted to the school of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Science in Tropical Animal Production and Health

BY
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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CSA	Central Statistics Authority
CSG	Conservation Strategy of Gambella
ESAP	Ethiopian Society of Animal Production
FAO	Food and Agricultural Organization
GBOA	Gambella Bureau of Agriculture
GDP	Gross Domestic Product
Ha	Hectares
HH	House holds
IAR	Institute of Agricultural Research
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
IPS	International Project Service
IRC	International Rescue Committee
Kg	Kilogram.
m.a.s.l	Meters above sea level.
MoA	Ministry of Agriculture
N	Sample respondents
PPS	Proportional Probability to Size.
PRA	Participatory Rural Appraisal
RMA	Rapid Market Appraisal
SDDP	Smallholder Dairy Development Project
SE	Standard Error
SNNPRS	Southern Nations Nationalities and Peoples Regional State
USD	United State Dollar

ABSTRACT

A study on characterization of cattle milk production, processing and marketing system was conducted in Gambella region based on data collected between September and December, 2009. A multistage sampling procedure was employed to select representative kebeles and households from Jekow and Gambella town. A total of 156 households were randomly selected using systematic random sampling methods. Questionnaire based formal survey as well as Participatory Rural Appraisal techniques were employed to collect both quantitative and qualitative data on cattle milk production, prioritizing the major production constraints and selection criteria for dairy cows and breeding bulls in the region, while Rapid Market Appraisal techniques were used to characterize the marketing system of dairy products. For verification of the survey based information, 24 households (12 lactating cows in each) were voluntarily selected from the two farming systems and were monitored (one month/ farming system) on related parameters. Two types of livestock production systems were identified in the district, namely crop-livestock mixed farming and urban production system. The current study was concerned entirely on both the production systems. The average cattle herd size of households was 16 heads, but it varied significantly ($P<0.05$) between the two areas. Cows (43%) and heifers (20%) mainly dominate the herd composition. The breeding system was entirely natural mating performed unselectively. Major feed resources used by the households were natural grazing (48%) and crop residues (29.5%). Availability of water throughout the year was also noted by most respondents (88.5%). The major disease of cattle identified in the current studied areas was trypanosomosis (49.4%) followed by brucellosis (25%). Average milk off-take of indigenous cows was 1.62± 0.07 liters /cow/day and on average cows gave a lactation yield of 355.0± 10.274 liters/cow during an average lactation period of about 7.30±0.06 months. Cows in urban gave significantly ($P<0.05$) higher daily milk yield and milked with in a lactation period similar to that of rural areas. These differences were mainly attributed to feeding practice (supplementation; atella) in the urban area. Out of the total milk produced, most of it was consumed (41%), while some quantity was sold out (37%), traditionally processed (13%) and given to neighbor (8%). The dairy marketing system identified was entirely informal. Milk production and marketing system were constrained mostly by diseases, feed scarcity, security problem, distant traveled to sell milk and seasonality in price variation. Government intervention should focus on dairy production and on improving the marketing system of these products.

Key words: Dairy, production system, marketing, processing, utilization.

1. INTRODUCTION

The estimated human population of Ethiopia in 2006 was 79.4 million (The Economic Intelligence Unit, 2007), with an overall density of 67 persons per km^2 (Edmond, 2007). The population is comprised of 61.369 million rural (84%) and 11.675 million urban (16%), and the overall annual population growth is estimated at 2.78% (CSA, 2008). Ethiopia has a diverse population, with more than 70 distinct ethnic and linguistic groups (Edmond, 2007).

The county has the largest livestock population in Africa estimated at about 35 million heads of cattle, 2 million camels, 22.5 million sheep, 17 million goats, 55 million chicken, 2.75 million horses, 5.2 million asses and 0.63 million of mules (ILRI, 2000; FAO, 2002). Despite its huge number, the livestock sub-sector in Ethiopia is less productive in general, and compared to its potential, the direct contribution to the national economy is limited. The poor genetic potential for productive traits, in combination with the sub-standard feeding, health care and management practices that animals are exposed to, are the main contributors to the low productivity (Zegeye, 2003).

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

Regarding dairying, the national milk production remains among the lowest in the world, even by African standard. The total milk production is estimated at about 2.7 million tons per annum (CSA, 2008). The per capita consumption of milk in Ethiopia is about 16 kg/year, which is much lower than the African and world per capita averages of 27 kg/year and 100 kg/year, respectively (Saxena *et al.,* 1997). Hence, about 6 million tones of additional milk are required per annum to feed the population as per the world standard (Saxena *et al.,* 1997). This indicates the existence of a wide gap between potential demands of the growing population of Ethiopia. In order to meet the demand of the growing population of Ethiopia, milk production has to grow at least at a rate of 4 % per annum (Azage, 2003).

The lag in domestic supply of milk relative to demand in the tropics has resulted from several factors, and Ethiopia has no exception. On the demand side, rapid increase in person income; on the animal

side, low animal productivity, inappropriate technologies, inadequate research and extension support, poor infrastructure and unfavorable external conditions have contributed to the poor performance of the livestock sector in general, and of the dairy subsector in particular (Williams *et al.,* 1995). Given the considerable potential for smallholder income and employment generation from high-value dairy products (Staal, 2002), the development of the dairy sector in Ethiopia can contribute significantly to poverty alleviation and nutrition in the country

Dairy production is a biologically efficient system that converts large quantities of roughage, the most abundant feed in the tropics, to milk, the most nutritious food to man (De Leeuw *et al.,* 1999). The dairy industry also occupies a special position among the other livestock sectors due to four interrelated features .The first is related to the specific properties of milk in that it is a bulky and heavy commodity produced on a daily basis. Secondly, the socio-economic position of the majority of the farmers involved is small-scale producers, with a weak and vulnerable position on the market. Thirdly, dairy cooperatives hold a strong position in milk marketing and processing. The fourth and final feature is that milk is valuable but an extremely expensive raw material to make a wide range of products (Perera, 1999).

One of the necessary conditions for increased milk production is the provision of assured marketing outlets that are sufficiently remunerative to producers. Experience from India, Uganda and Kenya reveals marketing outlet as a key initiator of milk production to smallholders. Even in the long run, surplus milk can be processed into different dairy products for export, which brings foreign exchange. Planners should consider the relative efficiency of alternative milk marketing systems in terms of costs and marketing margins, product hygiene and quality, range and stability of services offered and stability of producers and consumer prices. To do so, policy makers, development organizations and private investors are in need of information of different aspects of the production system of the specific area, potentials and constraints of production and marketing conditions/systems (Matthew man, 1993).

So far, most of the characterization studies were limited to state farms located mainly in higher altitudes where the climate is suitable for milk production. As dairy production in Ethiopia is constrained by several factors classified as: (a) technical or biological and (b) socio-economic and institutional factors (Fekadu 1994), some of the major environmental constraints such as low rainfall, high temperature and low forage production, common plant association, livestock and human carrying capacity, incidence of important livestock diseases and parasites, mainly define the lowlands

like Gambella. And because of that there is a need therefore, to differentiate and describe in detail the different types of dairy production and marketing systems that exist within the study area so that research, recommendations and technical assistances are to be tailored to the specific needs of the farmers in each production systems.

In contrary to this, there is limited knowledge of the dairy production, processing and marketing systems in the study area. Therefore, this study is designed to address the following objectives in Gambella town and Jekow woreda.

General objective

- To characterize dairy production, processing and marketing systems in Gambella district.

Specific objectives were to:

- ✓ Characterize dairy production systems and prioritized problems, challenges, and opportunities of milk and milk product produced in the study area.
- ✓ Explore the ways of dairy processing and milk handling practices, and
- ✓ Describe dairy marketing systems and identify constraints and opportunities for dairy marketing in the area

2. LITERATURE REVIEW

2.1. Cattle production systems in sub-Saharan Africa

In the today century, cattle production systems have been intensified in many parts of developed and developing world. Average herd sizes have increased by process of combination of small units and an increase in purchased feed use. The future will bring greater control of cattle production, preserving these systems that benefit society and outlawing those that have detrimental effects on the region in which they are practiced (Philips, 2001). According to Ibrahim and Olaloku (2000), the livestock production systems in Sub-Saharan Africa can be divided into two broad types: traditional and improved production systems.

2.1.1. Traditional production systems

These systems include the pastoral, agro-pastoral and subsistence mixed crop-livestock production systems. In the pastoral system, relatively large herds of cattle are grazed on communal and public land. Because of seasonal scarcity of feed and water, cattle trek over long distances. In this system, cattle owners acquire minimal land holdings at the home base. Pastoralists are unable to settle and take advantage of available production technology. It is estimated that up to 70-80% of Africa's cattle population is within this system (Ibrahim and Olaloku, 2000).

Agro-pastoralists own sizable pieces of land and practice integrated cop-livestock production. In this system, crop residues are utilized when feed is scarce but nutritional inadequacies remain. Transfer of technology is not easy and in spite of this in a few countries farmers in this system adapted improved technologies. For example, addition of urea to crop residues was adapted in West Africa. Productivity, nevertheless, is below potential because animals are fed below the optimum level. Agro-pastoralists and pastoralists‘ production systems produce about 70% of the milk and meat in sub-Saharan Africa. The agro-pastoral system is a considerable improvement over the pastoralists' production systems (Rass, 2006).

Sere and Steinfeld (1996) defined subsistence mixed systems as those systems in which more than 10% of the dry matter fed to livestock comes from crop by-products and/or stubble or more than 10% of the value of production comes from non-livestock farming activities. Globally, mixed farming systems produce the largest share of total meat (54%) and milk (90%) and are the main system for

smallholder farmers in many developing countries (Sere and Steinfeld, 1996). In Ethiopia, especially in subsistence mixed crop-livestock system, livestock play an important role in the provision of food (milk and meat), draft power and dung as a source of fuel and for soil fertility enhancement (Feleke, 2001).

2.1.2. Improved production systems

This category is characterized by high inputs. These are market-oriented production systems in which farmers adopted improved technology to optimize productivity. These systems are increasingly popular in eastern and southern Africa. Producers usually own less than 10 cows and about 2-4 hectares of land with intensive crop-livestock production **(**Ibrahim and Olaloku, 2000**)**. There are also large-scale commercial livestock keeping in per-urban areas targeted to respond to the demand of urban consumers and depends on high level of purchased feeds, including by-products from agro processing industries.

In contrast, small- scale livestock keeping by poorer urban dwellers offers supplementary source of income, as well as source of animal protein, which the families could otherwise not afford to buy. Peri-urban and urban livestock-keeping systems have a potentially important role to play in disposing of organic waste, which otherwise could endanger human health, and converting in into useful products (Ibrahim and Olaloku, 2000**)**. Due to high population densities and animal stocking rates, as well as easy access to markets it posses, the system become attractive to invest in market-oriented dairy production technologies in peri-urban areas (Tangka *et al.*, 2002).

2.2. Milk Production System

Livestock are raised in all of the production systems of Ethiopia by pastoralists, agro pastoralists, and crop/livestock farmers (Ahmed *et al.,* 2003). Dairying is practiced almost all over Ethiopia involving a vast number of small, medium or large-sized subsistence or market-oriented farms. Based on climate, land holdings and integration with crop as criterion, dairy production systems are categorized into rural, peri-urban and urban dairy systems.

2.2.1 Rural dairy production system

Rural dairy system is part of the subsistence farming system that contribute up to 98% of the total milk production of in Ethiopia, and includes pastoralists, agro-pastoralists, and mixed crop–livestock

producers (Ketema, 2000; Tsehay, 2002; Yoseph *et al*., 2003; Zegeye, 2003; Dereje *et al*., 2005). The system is not market oriented and most of the milk produced in this system is retained for home consumption (Ahmed *et al.,* 2003). The level of milk surplus is determined by the demand for milk by the household and its neighbors, the potential to produce milk in terms of herd size and production season, and access to a nearby market. The surplus is mainly processed using traditional technologies and the processed milk products such as butter, ghee, *ayib* and sour milk are usually marketed through the informal market after the households satisfy their needs (Tsehay, 2002).

Pastoral milk production system is one of the major systems of milk production, practiced in the lowland region of Ethiopia where the livelihood of the semi-nomadic transhumance population is dependent on their stock. Milk production in this system is characterized by low yield and seasonal availability (Zegeye, 2003).

The highland mixed farming milk production is the predominant milk production system accounting for the major part of the 97% milk produced from indigenous stock. The highland livestock, as in the lowland, is dominated by cattle constituting 72.4% of the total TLU. From this only 28% are cows of which 40-45% is milked each year (Feleke and Geda, 2001). Oxen comprise 27% of the herd indicating the significance given for oxen as source of power in crop production. The highland smallholder milk production is found in the central part of Ethiopia, where dairying is nearly always part of the subsistence, smallholder mixed crop and livestock farming. Local animals raised in this system generally have low performance with average age at first calving of 53 months, average calving intervals of 25 months and average lactation yield of 524 liters (Zegeye, 2003).

2.2.2 Peri-urban and urban milk production system

Peri-urban milk production is developed in areas where the population density is high and agricultural land is shrinking due to urbanization around big cities like Addis Ababa and other regional towns. It possesses animal types ranging from 50% crosses to high grade Friesian in small to large sized farms, and contributed only 2% of the total milk production of in Ethiopia. This sector owns most of the country‘s improved dairy stock (Tsehay, 2001). The main source of feed is both home produced and purchased hay and the primary objective is to get additional cash income from milk sale. This production system is now expanding in the highlands among mixed crop–livestock farmers, such as those found in Selale and Holetta, and serves as the major milk supplier to the urban market (Gebre Wold *et al*., 2000).

Urban dairy farming is a system involving highly specialized, state or businessmen owned farms, which are mainly concentrated in major cities of the country. There are about 40,000 crossbred and pure exotic cows in urban and peri urban areas of the country. In Addis Ababa alone, there are about 5200 dairy farms with some 58,500 cattle (almost 50 percent crossbred). Total annual milk production from 5200 dairy farms is estimated at 44 million liters in which 83% is marketed, while the difference is used for household consumption (Azage, 2004). In terms of marketing, 71% of the producers sell milk directly to consumers (Tsehay, 2002). Moreover, price is high even when quality is low. No standardize quality control mechanisms or dairy policy exists to safeguard consumers (Tsehay, 2002). They have no access to grazing land. Currently, a number of smallholder and commercial dairy farms are emerging mainly in the urban and peri-urban areas of the capital (Felleke and Geda, 2001; Azage, 2003) and most regional towns and districts (Nigussie, 2006).

2.3. Dairy cattle productivity in Ethiopia

2.3.1. Milk yield and lactation length

Indigenous breed of cows are generally considered low milk producers. However, they are the major source of milk in Ethiopia that account for 97% of the total milk production in the country (CSA, 2008). Milk yield has remained extremely low with average of 1.4 liter/day/cow in Oromiya Regional State (Workneh and Rowland, 2004). Similarly, Lemma (2005) reported that the average milk yield of local Arsi cows was 1.0 liter/head/day. For North Gondar indigenous cattle, the overall average estimate lactation yield was 540 ± 21.05 liters per head, which is very low due to poor genetic makeup, shortage of feed and poor management conditions (Azage, 2004). Kedija (2007) reported that the lactation length of local cow in Mieso district is 7.29 months.

The overall lactation length of local cows in the Gambella region is estimated to be 7 months with average daily milk of 2.07 liters (CSA, 2008). The average milk yield of local cows found in Somali region is less than two liters per day which could reach up to 488 liters over a 249 days lactation period in all pastoral areas elsewhere (IPS, 2000)..

2.3.2 Traditional milk handling and processing practices in Ethiopia

Cows are the main source of milk, and it is cows‘ milk that is the focus of processing in Ethiopia (Layne et al. 1990). Dairy processing in Ethiopia is generally based on *ergo* (fermented milk in

Ethiopia), without any defined starter culture, with natural starter culture. Raw milk is either kept at ambient temperature or kept in a warm place to ferment prior to processing (Mogessie, 2002). Dairy processing in the country\ is basically limited to smallholder level and hygienic qualities of prodcts are generally poor (Zelalem and Faye 2006). According to Zelalem and Faye (2006), about 52% of smallholder producers and 58% of large-scale producers used common towel to clean the udder or they did not at all. Above all they do not use clean water to clean the udder and other milk utensils. Of the interviewed small-scale producers, 45% did not treat milk before consumption, and organoleptic properties of dairy products was the most commonly used quality tests Zelalem and Faye (2006).

In a study conducted in the Borena region of Ethiopia, butter was found to be an important source of energy as food for humans, and is used for cooking and as a cosmetic. The storage stability of butter, while not comparable to ghee, is still in the order of four to six weeks. This gives butter a distinct advantage over fresh milk in terms of more temporal flexibility for household use and marketing (Layne et al., 1990).

2.4 Milk consumption and marketing pattern

Milk and milk products form part of the diet of many Ethiopians and they consume dairy products either as fresh milk or in fermented or soured form. Feleke and Geda (2001) estimated that 68% of the total milk produced is used for human consumption in the form of fresh milk, butter, cheese and yoghurt, while the rest is given to calves and wasted in the process. Butter produced from whole milk is estimated to have 65% fat and is the most widely consumed milk product in Ethiopia. Of the total milk produced, 40% is allocated for butter while only 9% is reserved for cheese. Traditional butter, which ferments slowly at room temperature, can be kept for a year or longer, offering rural consumers a readily storable and durable dairy product (Ahmed, 2003).

The consumption of milk and milk products varies geographically between the highlands and the lowlands and the level of urbanization. In the lowlands, all segments of the population consume dairy products, while in the highlands major consumers primarily include children and some vulnerable groups of women. The limited statistical data available on potential milk demand suggest that demand for milk will increase at least in the urban centers and among the people with high purchasing power (Mohamed *et al*., 2004).

According to the report by Feleke and Geda (2001), the demand for milk depends on many factors including consumers‘ preference and income, population size, price of the product, price of substitutes and other factors. They also indicated that the demand for milk is inelastic with respect to income and price. In general, increasing population growth, rising income and decreasing consumer prices are expected to expand the demand for milk and milk products. The population of Ethiopia is estimated to grow at 2.9% per year, while the urban population increases at a rate of 4.4%. Therefore, growth in population and income are expected to increase fluid milk consumption.

Based on the 1994 national population census of the Central Statistics Authority of Ethiopia, urban dwellers account for 15% of the total population of 63.5 million in 2000. It is estimated that 40% of the urban population (those with average income above Ethiopian Birr (ETB) 350, or less than US$ 50) can afford to buy 20 liters of milk per month. A study by the Ministry of Agriculture in Addis Ababa indicated that effective demand for milk was about 36,240 tons in 1995 and projected to reach 55,440 tons in the year 2005 (MoA, 2000). Similarly, the demand for butter was estimated to be 10,624 and 16,227 tons in the years 1995 and 2005, respectively. The rural population is estimated to be 85% of the total population and its milk consumption largely depends on livestock holding. In the mixed highland region, it is estimated that 50% of households own cattle of which 56% are dairy cattle. Consequently, most households have access to milk. Similarly, 80% of the households in the lowlands own cattle, significant numbers of small ruminants and camels. In this area, it is likely that all households consume milk (Feleke and Geda, 2001).

2.5 Dairy marketing systems in Ethiopia

In the African context, markets for agricultural products would normally refer to marketplaces (open spaces where commodities are traded). Conceptually, however, a market can be visualized as a process in which ownership of goods is transferred from sellers to buyers who may be final consumers or intermediaries. In Ethiopia, dairy products (fresh milk, butter, buttermilk and cottage types of cheese) are distributed through the informal and formal marketing systems. The informal market involves direct delivery of dairy products by producers to consumers in the immediate neighbourhood and sales to itinerant traders or individuals in nearby towns (Siegefreid and Berhan, 1991). Therefore, markets involve sales, locations, sellers, buyers and transactions (Debrah and Berhanu, 1991).

According to Tsehay (2002), a milk-marketing group can be defined as a group of smallholder farmers who individually produce at least one liter of saleable milk and are willing to form a group with the objective of collectively processing and marketing milk. Berhane and Workneh (2003), in their review, indicated the very useful involvement of the government of India at every step of the development for expansion of dairy cooperatives in the country for the successes of dairying and suggested that the Anand pattern of dairy development (India) can be emulated at least around the major milk sheds in Ethiopia, for instance around Nazareth, Dire Dawa, Harar, Bahir Dar, Jimma and Assela.

As reported by many authors, farmers‘ milk marketing groups and dairy Cooperatives play role for milk marketing outlets, which as a result encourages farmers to produce more (Zegeye, 2003).

2.6 Common challenges and constraints of dairy production and marketing in Ethiopia

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 for export is generally perceived poor in Ethiopia. Underdevelopment and 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 (Belachew 1998; Belachew and Jemberu 2003; Ayele et al. 2003).

3. MATERIAL AND METHODS

3.1. Description of the Study Area

This study was conducted in Gambella Region, which is found at 777km distance from Addis Ababa in the Western part of Ethiopia. It extends between 7‘N to 8.17‘N latitude and 33‘E to 35.02‘E longitude (CSG, 2000). The area comprises of diversified topography features with altitude ranges between 300-2300 meters above sea level. The average annual rainfall and temperature range from 800-1200mm and 30.7-37^{o}C, respectively. The Region has wet season (May-October) and dry season (November-April) (GBOA, 1999). The region has an area of 34,063km^{2}and divided into three zones and eleven Woredas. The selected areas for study are Jekow woreda and Gambella town based on accessibility and high cattle population. The human population of the region is estimated to be 228,435 with annual growth rates of 2.23% for rural and 4.11% for urban areas and around 17%of the populations live in Gambella (CSG, 2000). The estimated livestock populations of the region are 212,591 cattle, 48,114 sheep, 54,638 goats, 336 horses, 173,844 poultry and 35,122 beehives (CSA, 2008).

Jekow woreda is one of the four woredas in Nuer zone, which is located 120kms from Gambella town and 897kms from the capital, Addis Ababa. It has an altitude of 320-500 meters above sea level, and an annual average rainfall of 870 mm with mean annual temperature of 30^{o}C (GBOA, 1999). The woreda has wet season (May-October) and dry season (November-April) (GBOA, 1999). The soil types of the woreda are sandy, red loam and black and the major crops grown are Maize and Sorghum. Out of the total human and cattle population found in the region as shown above, the woreda account for about 15 %(38,834) and 25% of the proportion, respectively (CSG, 2000).

Gambella town is the region‘s capital and is found 777 km west of the capital Addis Ababa. It has an altitude of 530 meters above sea level, and with an annual average rainfall of 800 mm with mean annual temperature of 33^{o}C (GBOA, 1999). Major crops grown in the area are maize, sorghum and groundnut. The human and cattle population in the town is 17% and 19% of the proportion, respectively (CSG, 2000).

3.2. Study population and study design

Households owning dairy cattle in the three kebeles of Jekow district and in the three kebeles of Gambella town constituted the study population. This research was prospective and cross-sectional survey based type, focused on the selected area. Generally, information was collected using survey methods and interview with key informants.

3.3. Determination of sample size and sampling procedure

The sampling units were households keeping lactating dairy cattle. The sample size required for the study is determined by the formula recommended by Arsham (2007): $N=0.25/SE^2$ Where: N= Sample size, SE^2= Standard Error square

With the assumption of 4% standard error, a total of 156 households were sampled. Equal number of households were randomly selected both from Jekow (78 households) and Gambella administrative council (78 households). List of households of the selected kebeles were obtained from kebele officers, Agricultural extension officers, and development agents. A systematic random sampling method was employed to select equal number of households (26) from each woredas' selected kebeles.

3.4 Data collection

3.4.1 Milk production and processing related data

Discussion with key informant

Primarily, over view of the area was perceived through discussion held with agricultural extension officers, experts and development agents. Discussions were held with key informants in each farming system with the help of topical guidelines (checklists) for some qualitative data related to production constrains, opportunities and selecting criteria for dairy cows as well as breeding bulls. Six group discussions were held in the study areas; Jekow woreda (3 discussions) and Gambella town (3 discussions). Group discussion members were 10 in number and composed of males and females, which were selected based on their experiences in dairy production.

Questionnaire survey was designed in a way to obtain information on milk production and marketing system from sampled households. The questionnaire was pre-tested and adjusted before its full administration. The content of the structured questionnaire included household characteristics (age, sex, family size, educational background), income sources, labor distribution, landholdings, characteristics and types of livestock owned, experience in dairying, experience and purpose of cattle rearing, productive and reproductive performance of cows, breeding system and types of bulls used, cattle husbandry system (feeds and feeding system, water sources, housing and breeding system, milk handling and calve rearing practices cattle health and disease problems), the amounts of milk produced and how utilized, milk marketing systems and challenges and prospects of dairying. The questionnaire was administered by recruited enumerators (diploma holders in Animal Science; trained before actual data collection commenced).

Farm visit

Visits were made to describe some of the routine dairy activities (cleaning, milk handling and processing system) practiced by producers.

Monitoring

Out of the 156 households from the two study area, 24 households were voluntarily selected (12 households per study area) for monitoring purpose. A total of 72 indigenous milking cows from the selected households were monitored for a period of one month per study area. However, their stage of lactation was not taken into account because of limitation in accessing cows with different lactation stages. The author as well as one member in each of the monitored households, who had at least attended grade 3 or above; trained about taking measurements on each variable and filling the form prepared for data collection were involved in data collection process. Milk yield was recorded both in the morning and in evening milking time every other day. Milk produced during each milking was measured using a one liter holding plastic container locally known as *"Joge"* (holding 1 liter), which are available in every household. The container in each household was graduated at a quarter of a liter interval so that the recorder read the amount of milk to the nearest 0.25 liter.

3.4.2 Description of marketing system

Rapid Market Appraisal

In order to characterize the marketing system of milk and milk products, Rapid Market Appraisal (RMA) techniques was employed (Miles, 2000). Before administering RMA, the number of permanent dairy traders and sellers in the study area were identified. Fifty nine traders (13 and 46 from urban and crop- livestock system, respectively) were interviewed with the help of separate topical guidelines (checklists) at the two main market places in the district, namely, rural open market (at Jekow) and urban market (at Gambella town) as well as at their respective sites. The amount of milk delivered to the market was monitored for 2 weeks per a season and per a marketing gate by assigned enumerators at specified gate.

The checklists were used to collect data on aspects like: the type of business, place of purchase and sale, volume of purchase and sale, time of purchase and sale, types of buyers, prior arrangement, mode of payment, factors affect price as well as constraints in buying and selling the different products.

3.4.3 Milk testing

Milk samples were taken from each milk seller and checked for adulteration. A total of 118 milk samples were tested. Adulteration was checked by measuring the specific gravity, and normal milk is expected to have a specific gravity of 1.026-1.032g/ml which implies a lactometer reading range of 26-32 L0 (O'Connor, 1994). Normal milk is expected to have a specific gravity of 1.026-1.032g/ml, while the reading below (1.026g/ml) and above (1.032g/ml) that mentioned range will be considered as an indication of milk with water and skim milk, respectively. The mmaterials (measuring cylinder of 200-250 ml and lactometer) and procedures used were as follows: First, milk temperature of about 20°C was ensured; milk samples (200ml/sample) were mixed and pour gently into a measuring cylinder (200-250ml); the lactometer was allowed to sink slowly into the milk and then the last Lactometer in degree (ºL) just above the surface of the milk was read, recorded and finally, the milk density was calculated.

3.5 Data analysis

Statistical analysis of the primary data was made using the statistical package for social science version 13. Survey results were reported using descriptive statistics. General linear model was employed to evaluate the relations between dependent and independent variables.

Data related with pricing, collected for the characterization of dairy marketing system were analyzed using descriptive statistics and data collected using Rapid Market Appraisal technique were reported with summarized discussions. Chi-square tests and General Linear Model (GLM) were employed to test different variables in the two locations. Significances were declared at 5 % level.

4. RESULT

4.1. Characteristics and socio-economic profile of respondents

Out of the total interviewed dairy cattle producers (N = 156), 84.62% were male and the rest (15.38%) were female household heads. The overall mean family size (Mean ± SE) as well as average age (Mean ± SE) of respondents in the studied households was 7.72 ± 0.31 persons and 40.74 ± 0.76 years, respectively. The highest mean value for family size was found in mixed crop-livestock (9.28 ±0.51 persons) as compared to that of urban one (6.17 ± 0.25 persons). Similarly, significant variation in respondents‘ age range was also found, higher in mixed crop-livestock (43.51 ± 1.05 years) than that of urban dairy production system (37.96 ± 1.02 years). The overall proportion of illiterate, primary and secondary level of farmers was 72.4%, 18.6% and 9% respectively (Table.1).

Table1. Educational level of the respondents based on production and sex of household head

Production type	HH(N)	Illiterate		Primary school		Joint secondary and above		p-value
		n	%	n	%	n	%	
M.crp-ls	(78)	65	41.7	9	5.8	4	2.6	0.010
Urban	(78)	48	30.8	20	12.8	10	6.4	
HH.head sex								
Female	24	20	83.3	3	12.5	1	4.2	0.02
Male	132	93	70.5	26	19.7	13	9.8	
Over all	156	113	72.4	29	18.6	14	9.0	

HH (N) = Total number of respondents, n=number of the household heads for the indicated attribute, M.crp-ls`= Mixed crop- livestock production, HH. Head sex= Household Head sex

As indicated in the Table 1 above, significant ($P < 0.05$) difference on educational level between production systems was seen. Moreover, differences between household headed by female and male was also significant ($P < 0.05$), and the majorities of the female (83.3 %) and male (70.5 %) headed households were illiterate

4.2. Sources of income

Sampled households in the current study area generate income from different sources, which were found varied significantly by production and among gender of the household heads as presented in Table 2.

Table 2.Variation between production and among gender of household heads income

	Sources for household income (%)							
	Crops sale		Animal sale		Dairy products sale		Off-farm activity	
Types of production	n	%	n	%	n	%	n	%
M.crp-ls (N= 78)	49	62.8	8	10.3	18	23.1	3	3.8
Urban (N= 78)	8	10.3	11	4.1	45	57.7	14	17.9
Household head sex								
Female (N= 24)	4	16.7	5	20.8	14	58.3	1	4.2
Male (N= 132)	53	40.2	14	10.6	49	37.1	16	12.1
Overall	57	40.2	19	12.2	63	40.4	17	10.9

N=Sample respondents, n = number of household heads for the indicated attribute, M.crp-ls= Mixed crop-livestock

4.3. Labor distribution

In crop–livestock and urban households, 79.5% (in both productions) of purchasing activities were done by adult males. Selling and breeding activities were mostly the responsibilities of adult male household members (60.3% for mixed and 66.7% for urban in selling of cattle and 84.6% for mixed and 78.2% for urban in breeding activities). Cattle‘s herding in crop–livestock production was operated mostly by young male children (91.0%). This was done by either male family (14.1%) or hired labor (85.9%) in the urban system.

4.4. Farm land size of dairy producers

The overall average land size in the surveyed areas was 2.59 ha per household, but this varied significantly by production and by gender of house heads (Table 3).

Table 3. Mean (± SE) total farm land size (ha) based on production and sex of household heads

Production type	N	Mean (SE)	p-value
Mixed crop-livestock system	78	2.18(0.15)	0.000
Urban system	78	3.0(0.16)	
Household head sex			
Female	24	1.67(0.20)	0.000
Male	132	2.76(0.12)	
Total	156	2.59(0.12)	

N=Total number of respondents, p-value = Significant value, SE= Standard Error of mean

As indicated in Table 3, the significantly large land sized was observed from mixed crop-livestock producers and male headed households.

4.5. Livestock herd characteristics

4.5.1. Herd size and composition per household

Mean livestock holdings and total cattle herd size per household for the production systems are shown in Table 4.

Table 4. Means (SE) of livestock herd size and composition per household in the study areas

Livestock spices	Mixed crop-livestock (N=78)		Urban (N=78)		Overall (N=156)	
	Mean(SE)	%	Mean(SE)	%	Mean(SE)	%
Cattle	26.67(1.10)	76.68	6.23(0.40)	76.82	16.45(1.00)	76.69
Sheep	3.37(0.31)	9.69	0.94(0.11)	11.59	2.15(1.00)	10.02
Poultry	0.42(0.03)	1.21	0.09(0.04)	1.11	0.26(0.10)	1.21
Donkey	0.06(0.03)	0.17	0.06(0.03)	0.74	0.06(0.02)	0.28
Horse	-	-	0.01(0.01)	0.12	0.01(0.01)	0.05
Goat	4.26(0.25)	12.25	0.78(0.13)	9.62	2.52(0.20)	11.75
Total	34.78(1.72)	100	8.11(0.72)	100	21.45(2.33)	100

N= number of households, SE= standard error

Mixed crop–livestock production system as compared to urban system had significantly larger number of livestock holdings ($p<0.05$). Cattle were the largest in number in both mixed and urban production systems (Table 4).

4.5.2. Herd structure

All the cattle owned by the sampled households were indigenous. In both production systems, cows constitute the highest proportion followed by heifers, while male calves hold least proportion among the herd. However, urban system posses significantly ($p< 0.05$) lesser cows than mixed crop-livestock (Table 5).

Table 5. Means and standard errors of cattle herd size and composition by production systems

Types Of cattle	Mixed crop-livestock (N=78)		Urban (N=78)		Overall (N=156)	
	Mean(SE)	%	Mean(SE)	%	Mean(SE)	%
Lactating	6.15(0.30)	23.10	2.17(0.11)	34.83	4.16(0.22)	25.30
Dry cow	4.90(0.30)	18.40	0.79(0.12)	12.68	2.85(0.24)	17.34
Bull	3.62(0.30)	13.60	0.23(0.10)	3.69	1.92(0.19)	11.68
Heifer	5.81(0.33)	21.81	0.87(0.12)	13.96	3.34(0.26)	20.32
Female calve	3.37(0.20)	12.70	1.17(0.10)	18.78	2.27(0.14)	13.81
Male calves	2.79(0.2)	10.50	1.00(0.10)	16.05	1.90(0.12)	11.56
Total	26.64(1.63)	100	6.23(10.55)	100	16.44(1.17)	100

N= number of households, SE= standard error

4.6 Farming experience in the study area

Dairy farms of the urban production system were established, relatively, more recently (less than 15 years) compared to those of mixed crop-livestock production systems (above 15 years). In the majority (42.9%) of the farms, herd size was said increased through time while 23.7% of the households indicated no change in their herd size. Respondents that indicated decrease in their herd size were 12.8% of the total study participants. Some 20.5% of the respondents did not have any idea about the trend of their herd size. The trend, however, showed significant difference between mixed crop livestock and urban production systems. In urban production system, 60.3% of the respondents indicated increase in their herd size while for the mixed crop livestock system, households with similar response represented only 25.6%. In both production systems, some 12.8% households with

decreased herd size mentioned diseases (63.5%), thieves (17.3%) and predators (12.2%) as major causes for their negative herd trend.

4.7 Purposes of keeping cattle

The objective of keeping cattle varied significantly ($p < 0.05$) between urban and the mixed production systems as presented in Table 6 below.

Table 6. Primary reasons for urban and mixed crop-livestock production systems producers

Purpose of keeping cattle	Mixed crop–livestock (N = 78)		Urban (N = 78)		Overall (N=156)	
	Freq.	%	Freq.	%	Freq.	%
For milk sale	13	16.7	46	58.9	59	37.8
Milk consumption	60	76.9	28	35.9	88	56.5
For asset	2	2.6	4	5.2	6	3.8
Dowry	3	3.8	-	-	3	1.9

N= number of respondents, Freq. = Frequency

In both production systems, milk production was the first objective. However, milk had different functions for cattle keepers in urban and mixed crop–livestock production systems as indicated in the Table 6. For urban producers, milk is primarily destined for market while in mixed crop livestock system it was allotted for household consumption.

4.8 Cattle husbandry practices

4.8.1 Feeds and feeding systems

Commonly used feed resources by cattle keepers in the study areas were natural grazing, , cereal crop residues, plant weeds, and non-conventional feeds like *muone/theng'* (tella) and leaves of other palatable trees and shrubs. However, feeding system applied was varied by production system.

In the mixed crop–livestock system, mostly cereal crop residues and naturally grazing land were the major feed resources and all species of livestock were allowed to graze freely together. Most of the households (87.2%) in the mixed crop–livestock system do not supplement their dairy cows or early

weaned calf with additional feeds. In contrast, 73.1% of the urban producers do supplementation (tella) to their dairy cows and early weaned calf with additional feeds.

4.8.2. Water resources and watering practices

The main sources of water identified in the present study areas were rivers (Baro), pipe water, dams and wells, lakes (makuey), spring water and bore holes. Vast number of the households in the urban (85.9%) and mixed crop–livestock (79.5%) system obtained water from rivers, and the rest of the sources in the case of urban system were from pipe water (7.7%), pond(5.1%) and well(1.3%), whereas in the mixed crop-livestock system, 15.4 and 5.1% of the sources were obtained from pond and well, respectively. Regarding the accessibility of the water, almost all (98.7%) of the interviewed dairy producers in both production systems responded that they had access to water throughout the year, and only (1.3%) reported that during the dry seasons there is a scarcity of drinking water in the area.

Watering frequency to dairy animals varies by seasons (wet and dry), and from one production system to another. During wet season as water is abundant everywhere, the majority (54.5%) of the households leave their animals to look for water by themselves, while the rest 22.4%, 17.9% and 5.1% of the households were watering their dairy cows once a day, twice a day and three times a day, respectively. During dry season, most (57.7%) of the households provides water twice a day, while the rest were watering once a day (32.1%) three times a day (5.8%) and a small proportion(4.5%) allow freely .

Unlike mixed crop-livestock production system, urban producers usually give water in the form of liquid feeds (mixed *atella* with water), free water is not given by some of the households (24.4 and 3.2% for dry and wet seasons, respectively).

4.8.3. Housing systems

Systems of housing as well as types of house used by interviewed household to shelter their cattle were differed significantly between mixed crop-livestock and urban production system. For instance, roofed houses (a close barn locally made from grasses, wood and mud) is the common type of shelter used by majority (59%) of mixed crop–livestock households, while majority of urban households (60.3%) use open ban/shell as a night shelter for their cattle. However, sheltering cattle with the family is quite uncommon practiced in mixed crop- livestock production system (6.4%) as compared to that practiced in the urban one (14.1%).

4.8.4. Breed type, source of herd and selection criteria.

All dairy cattle (100%) in both production systems of the study areas were indigenous zebu breeds and have not been characterized well. The sources of establishment herd for most households were dowry (33.3%), market (47.4%), gift (7.7%) and exchange with small ruminants (11.5%). However, a significant variation exists between urban and mixed production systems as to the sources of establishment herd. For urban households, market represented the major sources (60.3%), which is different from crop-livestock producers (42.3% obtained from dowry). Regarding record keeping, there was no any record keeping practiced in both study areas (urban and mixed production systems) be it of dairy production and/or reproduction parameters.

Selection criteria for dairy cows

According to the information obtained from urban respondents as selection criteria for dairy cows, present and equal teats was the first and most preferable parameter among others, followed by large body size. For mixed crop-livestock production system, large body size was the top criteria followed by teat size. Milk production potential, as criteria for selection, was given 3rd rank in both production systems.

Table 7a below presents criteria used for dairy cow selection by production systems.

Table 7a. Selection criteria for dairy cow by production systems

Selection criteria	Mixed crop-livestock (N=78)	Urban (N=78)	Overall (N=156)
Large body size	10.9	15.4	26.3
Present and equal teats	12.2	12.2	24.4
Large udder and teat	4.5	4.5	9.0
Long and curved neck	5.1	5.8	10.9
Large stomach	2.6	1.9	4.5
Milk production background	7.7	7.7	15.4
Color coat	7.1	2.6	9.6
Total	50	50	100

N= number of observations

The above survey findings on the selection criteria were more or less comparable to what was obtained from PRA method. However, the 3rd choice was differently selected by mixed crop-livestock (large udder) when compared to that of urban one (long neck), Table 7b.

Table 7b. Pair-wise ranking for selection of dairy cows by production

No	Selection criteria	Rank	
		Mixed Crop-livestock	Urban
1	Large body size	1	1
2	Present and equal teats	2	2
3	Large udder and teat	3	-
4	Long and curved neck	-	3
5	Large stomach	5	5
6	Milk production potential background	4	4
7	Color coat	4	-

Bull's selection and mating

Producers used different criteria to select their own bulls as presented in Table 8a.

Table 8a. Selection criteria for breeding bulls by production system

Selection criteria	Mixed crop-livestock (N=78)	Urban (N=78)	Overall (N=156)
Large body size	7.7	17.3	25
Milk production background	1.9	2.6	4.5
Long and large horns	17.9	10.9	28.8
Large neck and dewlap	11.5	5.8	17.3
Color coat	4.5	2.6	7.1
Normality in behavior	5.8	9.0	14.7
Long tail	0.6	1.9	2.6
Total	50	50	100

N= number of observations

As indicated in **figure 1a**, Long and large horns as well as large body size were the dominant criteria used by most of the crop-livestock and urban households, respectively. And castration to unmated is the most common breeding method practiced in the study area.

a) **b)**

Figure 1a & b. The selected local breed bulls running on mating in the field

The results of PRA (Participatory Rural Appraisals) for selection of breeding bull were almost similar with the results of questionnaires survey (Table 8b).

Table 8b. Pair-wise ranking for selection of breeding bull by production systems

No	Selection criteria	Rank	
		Mixed Crop-livestock	Urban
1	Large body size	4	1
2	Milk production potential background	4	5
3	Long and large horns	1	-
4	Large neck and dewlap	2	2
5	Color coat	5	5
6	Normality in behavior	3	3
7	Long tail	5	4

4.8.5 Milking practices

Hand milking is the only type of milking practiced in the surveyed areas. At the time of milking, washing of teats is not practiced by almost all (98.7%) respondents in the crop-livestock and urban (96.2%) producers. Mmajority of the households (95.5%) milked their cows twice a day. Very few farmers milk their cows once (3.2%) a day. None of the mixed crop-livestock producers coped about milking regularity, and about 34.6 and 29.5% of the urban producers complete their morning milking between 06:30 and 07:30 hours, and 07:30 and 08:30 hours, respectively. Regarding evening milking, 15.4% and 17.9% milk their cows between 06:30 and 07:30 hours and 07:30 and 08:30 hours, respectively, and only 2.6% of the households did not have fixed milking time.

4.8.6. Calf rearing practices

In the surveyed areas, most producers (87.2%) exposed newly born calf to colostrums earlier than six hours of birth. However, the extent of time on whole milk feeding was seen varied significantly from production to production. For example, Milk feeding for un weaned calves was allowed for a period of more than nine days after birth by all (100%) interviewed crop-livestock households, while the feeding lasted for 6 to 9 days in the majority of urban producers (64.1%), 28.2% fed milk beyond 9 days and the rest 7.7% terminated within 5 days of birth. Early weaning is uncommon in the surveyed area, especially crop–livestock producers (1.3%) as compared to urban one (7.7%) at average weaning age of 4.58 ± 0.10 versus 4.65 ± 0.10 months and almost all interviewed households (98.7 and 92.3% of crop-livestock and urban, respectively) practiced partial suckling prior to milking. The same variation was also observed for feed supplemented to early weaned calves. Most of the urban

weaners (56.4% vs12.8%) supplement feed early (within 7 to14 days after birth) as compared to crop-livestock weaners, while nearly two third of crop–livestock producers(65.4% vs. 32.1%) supplements feeds lately between 14 and 28 days, and after one month of calving (21.8% vs11.5%) than urban supplemented.

4.8.7 Animal health problem

The major diseases of cattle cited in the study areas were trypanosomosis (49.4%), brucellosis (25%), parasites (15.4%) and FMD (10.3%). Trypanosomosis was cited as the most important disease in both production systems. Out of all respondent interviewed, about half (50.6%) used traditional medicine to treat their animals, while 34% used traditional healer and only 15.4% had access to a costly (private) veterinary service. The majority of the sampled farmers (88.5%) did not practice vaccination of animals and only 11.5% vaccinate their animals.

All the farmers reported that, there is no veterinary service given by the government in the study areas. With an exception of 10.9%, most of the farmers were not aware of zoonotic diseases (89.1%).

4.9. Milk production and utilization

4.9.1 Production Performances

The overall mean lactation length for cows in the studied areas was 7.30 ± 0.06 months, and by productions, no significant variation observed (Table.9).

Table 9. Mean and standard errors of the performance parameters

	Performance (Mean ± SE)	

Variable	Rural (N=78)	Urban (N=78)	Overall (N= 156)	P-value
Lactation length(months)	7.31± 0.08	7.27± 0.08	7.30± 0.06	0.73
Daily milk yield/hd/ltr(wet)	1.66± 0.09	2.10± 0.12	1.88± 0.07	0.023
Daily milk yield/hd/ltr(dry)	1.25± 0.08	1.44± 0.08	1.35± 0.06	0.001
prod./hh/ltr(wet)	6.64± 0.32	5.70± 0.27	6.16± 0.20	0.001
prod/hh/ltr(dry)	4.76± 0.24	3.80± 0.25	4.29± 0.18	0.005

(N) = Total respondents sampled, SE=Standard Error, yield/hd/ltrs (wet) = yield per head in liter, prod/hh/ltr= production per household in liter.

The estimated average milk yield per head per day in the surveyed areas was 1.62± 0.07 liters and the lactation yield was 355 liters over an average lactation period of about seven and half months (7.30± 0.06 months). However, season had a substantial effect on milk yield as well as on production system (Table 9).

4.9.2 Milk and milk products utilization

Tables 10 (survey finding) and 11(monitoring result) illustrate milk production and use categories in urban and mixed production systems. The overall average milk production per household per day in both production systems was seen higher during follow-up period (8.4±0.09 vs. 5.23±0.20 litters). From the survey data (table 10), a comparison of the two systems showed that the proportion of milk sold was significantly ($p<0.001$) higher in the urban system than mixed crop-livestock system (53% *versus* 29%), while the opposite was true for the proportion of milk processed (15% *versus* 22%).

Table 10. Milk production and use categories as indicated by respondents

Variables	Urban farms	Mixed livestock	Overall (N=156)

	(N=78)		(N=78)			
Milk utilization (%):	Mean ±SE	%	Mean ±SE	%	Mean± SE	%
Milk produced in liter/day/HH	4.74±0.20		5.71±0.30		5.23±30.21	
Proportion of milk consumed	1.13 ±0.18	23.8	2.12 ±0.20	37.1	1.63±0.19	31
Proportion of milk sold	2.52±0.2	53.2	1. 64 ±0.16	28.8	2.1±0.18	40
Proportion of milk processed	0.71±0.1	15	1.23±0.11	21.5	1.00±0.11	19
Proportion of milk wasted	0.38±0.05	8	0.72±0.10	12.6	0.55±0.07	10

(N)= Total respondents, SE= Standard Error

The follow-up study showed that significantly ($p<0.001$) more milk was produced by urban households (10.2 litres per day) than by mixed crop-livestock producers (7litres per day) (Table 11), and the reverse is true for survey result (6 and 5 liters/household/day; table 10).

Similar disparities, with even greater difference were obtained between the follow-up data and questionnaire survey for the two production systems (table 11). The amount of milk wasted for various means was significantly higher than in the urban farms (table 10 and 11). The survey data analysis showed that in the mixed crop-livestock system, a significantly ($p<0.05$) higher proportion of milk was consumed at home as compared to urban farms (53 versus 40%).

Table 11. Proportion (%) of milk utilization from 24 dairy farms (Monitoring result)

Variables	Urban farms (N=12)	Mixed livestock (N=12)	Overall (N=24)

Milk produced in liter/day/HH	10.3± 1.4		7.0± 0.9		8.4± 0.9	
Milk utilization (%):	Mean SE	%	Mean SE	%	Mean SE	%
Proportion of milk consumed	2.0±0.18	19.4	3.7± 0.5	52.8	3.4± 1.0	40.6
Proportion of milk sold	7.0±2.0	67.2	1.5± 0.21	21.4	3.1± 0.43	37.9
Proportion of milk processed	0.8±0.23	7.8	1.11± 0.25	15.8	1.1± 0.33	13.2
Proportion of milk wasted	0.6±0.24	6.6	0.7± 0.12	10	0.7± 0.20	8.3

(N)= sample number of the selected farms, SE= Standard Error of mean proportion HH= Household

As shown in table 10 and 11, the proportion of milk wasted for different reasons was slightly different as compared to proportion of milk conserved for processing which differed by double from both the survey and monitoring data analyzed. Unlike the survey information, the monitoring data revealed that the proportion of milk used for the household consumption ranked first, while from survey information home consumption had taken the second lead.

4.9.3 Handling of milk processing equipments

The majority of the crop-livestock producers (60.3%) used gourd and the rest used clay pot (21.8%) and plastic utensils (12.8%). Besides, very few (5.1%) of the total crop-livestock producers had access to the aluminum milk utensils. In urban farms, higher number of households (67.9%) used plastic utensils and the rest (17.9%) used aluminum utensils. Only 6.4 and 7.7% of the urban farmers were using gourd and clay pot utensils. Thus a clear significant variation was observed between mixed and urban producers equipments used for milk handling.

Frequency of cleaning milk utensils was seen varied significantly between production systems of the surveyed areas. Most of the urban producers (52.6%) used twice a day cleaning, while the rest 25.6% did it once a day, 14.1% once every two day and 7.7% above two days. However, 34.6% of mixed crop-livestock producers did it once in two days, while 28.2% once a day, 25.6% above two days and 11.5% twice a day cleaning. The predominant practice (79.5% of farmers) was the use of water and leaves of shrubs (such as *Combretum molle (*Zolmay*)*, *Ocimum suave* (kaye) and *Buddleja polystachia* (Thinnguan)) twice a day, followed by drying and smoking with plants specifically used

for this purpose (e.g. *Olean Africana* (Mathole), *Thymus vulgaris* (Tosgne) and *Juniperous procera (Junifer)*).

The sources of water which the farmers had access to, were significantly differed for the two production systems: while most (88.5%) of the farmers had access to pipe water in the urban areas, water from bore wells (33.3%) and rivers (52.6%) was also used in the mixed crop-livestock locations.

4.9.4 Milk processing

The reasons of processing fresh milk into products as well as equipments used during processing were varied significantly between the two production systems. Out of the interviewed households in mixed crop–livestock production system, 64.8% preferred churning to get butter and use buttermilk for household consumption, while 25.3% had not access for whole milk marketing and 2.3% households were restricted by traditional taboos not to sale whole milk and preferred to churn it. Unlike mixed crop–livestock producers, the majority of urban households (34.1%) did churn during fasting days where there is less demand for dairy products. The rest 20.7, 11.9 and 0.6% did churn because of preference of butter and other by-products, if all milk could not be marketed, and because of taboos against selling whole milk.

The primary dairy product traditionally processed by urban and crop–livestock systems showed some similarity. In the urban system, the primary dairy product was butter for 67.6% of the households, fermented whole milk (*ergo*) for 28.8% of the households and cottage cheese for 3.6% of the households. Similarly, in the mixed crop-livestock production system, butter was the primary product for 93.5% of the households, *ergo* for 5.5% of the households and cottage cheese for the remaining 1.4% of the households. The entire mixed crop–livestock producers (100%) used gourd for churning , and about 45.7% of the urban producers used traditional churning material made from clay pot while the rest 28, 13.5 and 12.6% used gourd, traditional churning material made from clay pot and wooden, respectively

4.10 Dairy marketing system

4.10.1 Contribution of producers in dairy marketing

In the surveyed areas, dairy marketing was recently introduced activity (last 6 years ago) by only 22.5% households of mixed crop-livestock producers, while in the urban system, it was an old business oriented for about 13.1 years by 73.3% households. Out of the interviewed producers in the crop–livestock system, 52.5% of dairy farmers sold whole milk while 26.4% of households produced sour buttermilk for sale and 21.1% of households sold butter. In contrast, the majority of urban dairy farmers (90%) primarily produced whole milk for sale, while 7.7, 1.5 and 0.8% of the households produced *ergo*, butter and sour buttermilk, respectively, as primary dairy products for sale.

The primary selling outlets and criteria for selection of these outlets in the two production systems were almost similar. Individual consumers or traders usually buy milk at specified milk selling points as well as at the farm gates. About 63.5% of dairy producers in the study area sold their dairy product directly to consumers, the rest 17.9 and 18.6% marketed through traders and catering shops. As a result, the majority of producers in both urban (61.5% households) and crop–livestock systems (65.4% households) sold their milk directly to consumers either at the producers or consumer‘s gate, as their selling outlets. Next to consumers, the major recipients of milk from producers are traders (32.1 and 29.5%) in urban and mixed crop–livestock system, respectively.

Most of the households in the urban production system use reliable customers (46.2%) and better price (35.9%) as their primary selection criteria for selling outlets. In contrast, for the mixed crop–livestock producers, short distance is the main criteria (45.5%) for using a given selling outlet while the rest 16.7, 14.1 and 7.7% choose reliable customers, good price and mode of payment, respectively. However, considerable proportions (22.7%) of respondents in the mixed crop–livestock production system said that lack of alternative is the other factor for using the available outlet. Regardless of high seasonality variation for the demand in dairy products in the study areas, the majority of dairy producers (86.5%) said they did not satisfy the demand of their customers.

4.10.2 Dairy product marketed and prices

Marketable dairy products in the study areas include whole milk, traditionally processed butter, ghee, ergo (fermented whole milk), cottage cheese and sour buttermilk. Prices of dairy products varied significantly between productions and by seasons. The price was seen higher in urban production system and during dry season (Table 12).

Table 12. Average prices of milk and milk products

Marketable milk and its derivatives	Urban		Mixed crop-livestock	
	Wet season Price range (in birr)	Dry season Price range (in birr)	Wet season Price range (in birr)	Dry season Price range (in birr)
Whole milk (in liter)	5- 6	5- 7	3- 4	4-6
Ergo(fermented milk in liter)	3-4	3-5	2- 3	4- 5
Butter (kg)	20- 35	25- 45	15- 20	25- 35
Cheese (kg)	7- 12	10- 14	-	-
Ghee (liter)	-	-	10- 15	15- 20

4.11 Constraints, opportunities and prospects of dairy production and marketing

4.11.1 Milk marketing constraints

As indicated in the Table 13, **t**he major constraints for milk marketing as cited by the producers in study areas include small amount of milk produced (38.5 %), long distance to market (30.1 %), cultural beliefs (3.8%), seasonality in price variations (16 %), and spoilage (11.5 %). and were varied significantly ($p<0.05$) between production systems.

Table. 13 Variability of reasons for non participation in the dairy products marketing

Market participation constraints	Production systems					
	Mixed crop livestock (N= 78)		Urban (N= 78)		Total (N= 156)	
	Frequency	%	Frequency	%	Frequency	%
Less milk quantity	14	17.9	46	59	60	38.5
Distant to market	37	47.4	10	12.8	47	30.1
Seasonal price variations	9	12.5	16	20.5	25	16
Cultural taboo	6	7.7	-	-	6	3.8
Spoilage	12	15.4	6	7.7	18	11.5
Total	78	100	78	100	156	100

For example, low milk quantity was very critical problem faced by more than half (59%) of the urban producers. While, this was considered least by mixed crop- livestock producers. Likewise, distance to market (47.4 %) and to some extent cultural restriction (7.7 %) were the constraints faced by mixed crop- livestock producers than by the urban ones. However, seasonality of demand (demand fluctuation) (12.5 and 20.5 %) and spoilage (5.4 and 7.7%) were relatively faced equally by both production (mixed crop- livestock and urban producers, respectively). Cultural taboo was indicated as a limiting factor for milk marketing by only 3.8% of the respondents.

4.11.2 Milk testing

About 118 milk samples from households that supplied milk to Jikawuo and Gambella open markets were sampled to see the percentage of adulterated milk in the district. The result indicated that 48.3%, 30.5%, and 21.2% were adulterated, skimmed and normal, respectively. However, there were significant (P< 0.05) variations between the two market sites in terms of adulteration, skimming as well as normality of milk (Table 14).

Table 14. Milk test results for adulteration at Nyinenyang and Gambella open market sites

Parameters	*Market sites*				*Total*		*p-value*
	Gambella (N= 47)		Nyinenyang(N=71)		(N= 118)		
	N	%	N	%	N	%	
Adulterated	32	27.1	25	21.2	57	48.3	0.002
Skimmed	10	8.5	26	22.0	36	30.5	
Normal	5	4.2	20	16.9	25	21.2	

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

4.11.3 Constraints to dairy Production

According to the respondents, there were different challenges faced in dairy production in the area. These were prevalence of diseases and inadequate access to veterinary drugs and services (32.5%), feed scarcity (20%), security problem and lack of improved dairy animals. Among those problems, disease as well as veterinary services in general, feed scarcity, security problem and poor production level of local dairy cows were the major problems cited by most of the households in all the production areas. However, poor extension services (7.5%) and lack of improved dairy processing technology (5%) were considered least (Table 15).

Table 15. **M**ajor production constraints as cited by respondents from mixed crop-livestock and urban production systems.

Production constraints	Production systems				Total (N= 40)	
	Mixed crop livestock (N= 20)		Urban (N= 20)			
	Frequency	%	Frequency	%	Frequency	%

Diseases/no clinics and services	6	30	7	35	13	32.5
Security problem(thieves)	5	25	-	-	5	12.5
Poor production from dairy	-	-	5	25	5	12.5
Feed shortage	4	20	4	20	8	20
Insufficient market	3	15	1	5	4	10
Lack of improved dairy processing	1	5	1	5	2	5
Poor extension services	1	5	2	10	3	7.5
Total	20	100	20	100	40	100

N= number of observations

All dairy producers (100%) of the survey areas were constrained by unavailability of AI services, which curtailed genetic improvement. The major reproductive problems in the survey areas include abortion, long calving interval, and late age at first mating and were varied significantly from production to production. In the mixed crop–livestock production system; 69.2, 20.5 and 10.3% of the respondents indicated problems related to abortion, long calving interval (above 13 months), and late age at first mating (above 24 months) , respectively. The major reproductive problem in the urban production system was long calving interval (70.5%) and late age at first mating (21.8%).

4.11.4 Opportunities for dairy developments

Based on responses of study participants and personal observation the dairy production related opportunities identified were access to land and availability of water throughout the year; both are important requirements for sustainable dairy farming. Absence of cultural or religious prohibition of dairy products consumption could also be cited as positive factor for future development. All rural and nearly half of the urban dwellers are not Orthodox followers, thus no fasting period against dairy products consumption. Dairy producers also expressed their willingness to continue to work and expand their dairy farming activities. The rapid urbanization of the regional capital town Gambella with that of human population increase is also another opportunity for the positive futurity of the sector.

5 DISCUSSIONS

Out of the total interviewed dairy cattle owners (N = 156), 84.62% were male and the rest (15.38%) were female. Higher proportion of the female headed households was observed in the urban production system (19.2% versus 11.5%). This result is much lower than the 33% female headed smallholder farms reported for Addis Ababa area (Azage, 2004).

Family size may influence the availability of labor in the households for herding and other livestock activities. The overall mean family size (Mean ± SE) in the studied households was 7.72 ± 0.31 persons, which is relatively higher for crop-livestock producers compared to the urban system (9.28±0.51 versus 6.17±0.25). Kedija Hussen (2007) reported family size of 6.62 **±** 0.22 person/household. Total livestock (34.78±1.72/household) and cattle herd sizes (26.64±1.63) observed in the present study agrees with earlier report that large household sizes usually have large herds or flocks (ILCA, 1990; Solomon *et al.*, 1991).

With respect to educational status of the household head, the majority of dairy producers were illiterate. High proportion of illiterate was observed in the crop-livestock production system (41.7% versus 30.8%) and in female headed households (83.3% compared to 70.5% in the urban) sides. This result related to fact that education is considered very less by crop-livestock producers of the current study area, in addition to the belief that female girls are believed as sources of income (dowry) from the family. The results in general indicate that good and applicable practical training extension service about dairying could fit well to the local condition rather than formal training program in order to improve their dairy production and marketing aspects.

Different sources of incomes identified in the surveyed areas included sales of dairy products, crop, live animals sales and off-farm activities. Dairying was a good source of income for urban producers which accounted for 57.7% share of the total income, while the crop–livestock producers generated only little share (23.1%) from dairying. The result agrees with finding that crop-livestock production systems are none market oriented in which most of the milk produced was retained for home consumption (Ahmed, 2003).

Dairy activity like purchasing, selling and breeding activities, which is highly sex and age dependent relays on family labor. Hiring labor was very uncommon in crop–livestock production system,

whereas herding (85.9%) and milking operation (16.7%) in the urban production system were operated by hired labor. This result agrees with previous reports for smallholder dairy production systems of Ethiopia, such as the ones indicated for Addis Ababa milk shed (Yoseph *et al*., 2003).

The overall average farm land size in the surveyed areas was 2.59 ha per household, but this varied considerably between productions and based on sex of household head. Largest land holding observed in the mixed crop-livestock production system (3.00ha/household versus1.67 ha/household of the urban system) is attributed by their living condition that depends not only on livestock but also crop production which requires land to cultivate. Comparatively, the present finding regarding land holdings is highest compared to the farmers in SNNPRS in Oromia that own only 0.1–0.5 ha of farm land (CACC 2002). Therefore, it can be said that land for rearing dairy cattle was/is not a problem in the study area.

The overall trends in dairy development showed that, the majority (42.9%) of the farms were showing a progressive trend, which is a common scenario in different parts of Ethiopia due to the ever increasing demand for milk and milk products as recommended by Sintayehu (2008). while some (12.8%) were discouraged by factors such as diseases, thieves and predators. Cattle was shown dominant (16.45±1.00) over livestock herd followed by goat (2.52±0.20) and sheep (2.15±1.00) in all the surveyed areas. And the average means for cows (3.51±0.23) and heifers (3.34±0.26) were found to be higher from the cattle herd composition. As a result, most of the farmers (56.4%) were keeping cattle for milk production. However, milk had different functions for cattle keepers in the current study area, and the majority of households in the urban (29.5%) and mixed crop–livestock production systems (38.5%) used milk for sale and household consumption, respectively. These characteristics were also noted by other authors for different production systems in some part of the country such as Wollega (Alganesh, 2004), Oromia Regional State (Van Dorland, 2004) and Wollo in Amhara Regional State (Dereje, 2005).

Feed resources identified in the area included grazing land, cereal crop residues, maize Stover, mixed/balanced homemade concentrates, plant weeds, and non conventional feeds like *'atella'* and fruit wastes and other tree parts. The major feed resources are natural pasture and crop residue and these are of poor quality affecting the fertility of cows and milk production. Ranjhan (1999) also reported that feeding systems in smallholder dairying are primarily based on grazing of native pasture of low productivity. This also agrees with the report of Leng (1999) who indicated that feed resources from crop residue (straw and stover) and pastures (both green and mature) are of low digestibility.

Most of the respondents in mixed crop-livestock system (87.2%) do not supplement their dairy cow with additional feeds; only 12.8% used to supplement their dairy cows and early weaned calf with additional feeds. This is mainly due to problems associated with accessibility and affordability of supplemental feeds in the area. With an except for concentrates feeding, feed resources identified in the urban area of the present study are similar to the commonly used feeds in other urban dairy farming systems in the country (Nigussie, 2006).

Rivers, pipe water, dams and wells, lakes, spring water and bore holes were the main sources of water identified in the present study areas. Most of the households in both the urban (85.9%) and mixed crop–livestock (79.5%) system obtained water from rivers and the rest of other sources in a less proportions. Regarding the accessibility of the water, almost all (98.7%) of the interviewed dairy producers in both production systems responded that they had an access to water throughout the year, and the rest (1.3%) reported that during the dry seasons there is a scarcity of drinking water in area during which they used pond and holes as a water sources for their animals. This figure showed the availability of the water in the surveyed areas. However, watering frequency to dairy animals is varies from one production system to another, due to the factors such as season of the year, accessibility of the water sources, feeds and feeding system applied. Based on the seasons,the majority (74.4%) of mixed crop–livestock producers water their cattle once a day during dry season compared to 41% households that water their cattle once a day during wet season.

Contrary to mixed crop-livestock producers, urban producers in the studied areas usually give water in the form of liquid feeds (mixed *atella*, concentrates, and water), free water is not given by some of the households (24.4 and 3.2% for dry and wet seasons, respectively). This result disagreed to a results from trials conducted under ranch conditions at Boran plateau which indicated that cattle were watered once every three days during the dry seasons, and such a restricted watering lose body weight faster than those on a daily watering frequency,and leads to a reduction of milk produced by about 13 % (Coppock,1993). Based on the report of the respondents, the accessibility of water in the current study areas revealed that, water as an input for dairy development is among the opportunities identified in the area.

According to Sitayehu (2008), sheltering cattle, not only protects animals from extreme environmental hazards, but also ease some other husbandry practices. Based on the results from respondents as well as my personal observation, types of shelter used by all the producers in the

surveyed areas were designed in such a way that routine activities like feeding, watering, milking, waste management and other activities cannot be easily and effectively handled, and were found varied significantly by production. Majority of households (59%) in the mixed crop–livestock system kept their cattle within their own residence huts (close typed house made from grasses) as night shelter for cattle, while sheltering in the open ban/shell as a night shelter for cattle was the most common practiced by 60.3% of the households in urban system.

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Provision of genetically potential dairy cattle and/or good breeding services as per the demands of producers is one of the prerequisites for the development of dairying (Wiener 1994). All dairy cattle (100%) in the study areas were indigenous zebu breeds and have not been characterized well. Most of the foundation stocks of both production systems were from dowry (33.3%) and purchased from open markets (47.4%), which revealed that producers were not curious and/or did not have access to the selection of dairy cattle. Local bulls were allowed freely in the herds to run on mating, and this was an indication for existing of uncontrolled mating in the studied areas. Therefore, if urban and mixed crop-livestock dairy production is to flourish, access to improved genetic material through improved AI or breeding service is critical.

Traditional hand milking is the only type of milking practiced in the surveyed areas. Almost all (98.7%) and (92.3%) dairy cattle producers in the crop–livestock and urban systems, respectively practiced partial suckling prior to milking, and there was no proper sanitary procedure followed during milking especially in mixed crop-livestock dairy producers. At the time of milking, washing of teats is not practiced, and the producers believe that during calf suckling for milk let-down, the teat get washed by the saliva of calf. Like most smallholders dairy producers in Ethiopia (Sintayehu, 2008), twice (95.5%) milking was the predominant frequency of milking in both production systems.

Since local/zebu cows are believed not to give milk without partial suckling, local calves from such cows are not weaned early. The average weaning age of calves in the studied areas were 4.58 ± 0.10 and4.65 ± 0.10 months, practiced by 7.7% and only 1.3% weaners in the urban and mixed crop-livestock system, respectively. Similarly, most urban weaners (56.4%) supplement feed early (within 7 to14 days after birth) as compared to only 2.8% of the crop-livestock weaners. The relatively higher proportion of early feed supplementation and early weaning observed in the urban producers‘ sides were associated with the assumption of profit maximizations from sale of milk that was otherwise be used by calves.

Among the major problems, disease was identified as one of major constraints that pose major threat to cattle production in the current study areas of Gambella region. The major diseases of cattle identified in the studied areas were trypanosomosis (49.4%), brucellosis (25%), parasites (15.4%) and FMD (10.3%). Trypanosomosis (locally named as ~~–~~*loke liech*") was identified as the most important disease in both production systems. And since there is no effective treatment, farmers control the fly only by smoking the herds frequently using dried cow dung. The current study result was similar with the work of Belete (2006) in Fogera district, that Trypanosomosis has a serious impact on livestock production and agricultural development over most land of the region especially in forest areas.

Based on the respondents and personal observation in the study area, the loss of animals due to diseases was aggravate by shortage of veterinary professionals, accessibility of veterinary service in the area and lack of adequate transport facility were the major problems. The existing of such a poor performance of veterinary service indicated that regional government give less attention to the livestock sector in general. Similar assumption was reported by Tafesse (2001), in that poor performance of veterinary service in the lowlands is the outcome of the government monopolized service. Livestock keepers therefore, tend to divert to traditional ethno-veterinary practices in the villages and make use of various herbs and/or illegal drugs to treat their animals. Except 15.4%, the majority (50.6%) do not take their animals to modern veterinary services, while 34% used traditional healer to treat their animals. A vast number of households (88.5%) did not practice vaccination services and were not aware of zoonotic diseases (89.1%).

The overall average volume of milk produced/day/head in the present study (1.62± 0.07 liters) is more or less similar to what was reported for Shahsemene-Dilla areas (Sintayehu, 2007) (1.97±0.24 liters), but is lower than that reported in Metema District (Tesfay Mengstu, 2007) (2.54±0.33 liters).The less volume of milk estimated in the current study may be associated to the health problems (lack of veterinary services) and/or genetic makeup of individual cow. However, the higher average milk volume produced/household/day observed in mixed crop-livestock producers (10.0±1.157 liters) may be attributed to higher average holding of milking cows than in urban farming households.

As opposed to the present work, research conducted in East Shoa Zone of Oromia indicated that lactation length of local cows was 9.5 months (Lemma *et al.,* 2005). Other higher values (450 days) for the Friesian-Boran crossbred cows of Cheffa farm (Oromia) was reported (Gebeyehu and Hegde,

2003). According to farmers, the shorter lactation length of cows (7.30± 0.06 months) obtained in the present study could be attributed to the short rainy season (contributing to shortage of feeds), infestation of biting flies and hotter environmental condition prevailing in the study areas.

Seasons as well as inputs (like feeding) seem to have substantial effect on milk yield, and found varied from one production to another. The overall means average milk yield/head/day in wet and dry season was relatively lower (1.66 ± 0.09 and 1.25 ± 0.08 liters, in wet and dry season, respectively) for crop-livestock system as compared to urban system (2.10± 0.12 and 1.44± 0.08 litters). Moreover, an actual measurements were made of the amount of milk produced, sold, wasted, home consumed and processed for the verification of the information about the milk utilization collected during the survey.

Different from survey result, monitoring data revealed that significantly ($p<0.001$) more milk was produced per household day by urban than by mixed crop-livestock producers (10.2 versus 7litres/household/day; table 11) which might in fact be attributed by feeds and water supplementation practiced by some of urban producers and/or by chance in which more genetically riches cows were selected from urban than from mixed crop-livestock producers during monitoring, and the reverse is true for survey result (6 and 5 liters/household/day; table 10) which is mostly due to the presence of a greater number of lactating cows in the mixed crop-livestock dairy production system (6 lactating cows/household) than the urban one (2 lactating cows /a farmer).

Contrary to other finding, daily milk yield per household per day estimated from present study (both the survey and monitoring data results) is lower than daily milk yield (25.1 liters/day/household) reported in Awassa (Ike, 2002), but the latter were crosses of Holestien Freshian. Yitaye (2009) in the North Western Ethiopia reported that 1.14 million litters from 256 farms were produced annually. This suggests that a comprehensive intervention program has to be in place with respect to genetic improvement, feeds and feeding systems, health care and other management aspects in the current study area.

Fresh milk utilization pattern in the current study areas is more or less resembled to that observed in other areas. Both in the monitored and the surveyed farms of the mixed crop-livestock system, the amount of milk wasted for various means was significantly higher than in the urban farms (table 10 and 11). Comparable results (8.2 and 4.9% for rural and urban areas, respectively) were reported by Anthony (2002).The survey data analysis showed that in the mixed crop-livestock farms, a

significantly ($p<0.05$) higher proportion of milk was consumed at home as compared to urban farms (53 versus 40%). The higher consumption of fluid milk in mixed crop-livestock production areas as compared to urban one is most probably due to poor market access for milk by mixed crop-livestock producers. Therefore they use more of the fluid milk for home consumption and process it into butter which has a better shelf-life to sell it on distant markets.

Surveyed dairy farmers were observed using different milk utensils for collecting, storing and processing milk. The majority (60.3%) of the crop-livestock producers used gourd and the rest used clay pot (21.8%) and plastic utensils (12.8%). The use of plastic material (67.9%) is quite dominant over other milk utensils in the urban area. Besides, very few (5.1%) of the total crop-livestock producers had access to the aluminum milk utensils as compared to urban one (17.9%).

One of the major factors affecting the quality of dairy products is related to adequately perform milking procedures and cleanness of the milking utensils (Gonfa et al 2001). In the studied areas, it was found that washing of teats before and after milking is not practiced by almost all (98.7%) respondents in the crop-livestock and urban (96.2%) producers. Urban producers were found relatively better in term of cleaning frequency (52.6% *molle (*Zolmay*)* and *Ocimum suave* (kaye) twice a day, followed by drying and smoking with plants specifically used for this purpose (e.g. *Olean Africana* (Mathole) and *Juniperous procera (*Junifer*)*). versus 11.5% households uses twice a day cleaning) to their milk utensils. And the predominant practice (79.5% of farmers) was the use of water and leaves of shrubs (such as *Combretum*

Procedures of cleaning and disinfection of milking utensils prior to milk collection reported herein, were similar to previous results from Ethiopia (Gonfa et al 2001; Yousuf Kurtu 2003; Sintayehu et al 2008). According to the local understanding, the practice of smoking the vessel by specific trees and shrubs has an advantage of imparting special taste and odour to the product, and to disinfect the vessels, thus reducing the numbers of micro-organisms and thereby extending the shelf life of the product. Ashenafi (1996) supported this assumption, as greater numbers and a faster development of aerobic mesophilic micro organisms occurred in milk kept in non-smoked than smoked containers.

Most of the households in mixed crop–livestock production system preferred churning to get butter and use buttermilk for household consumption, in addition to lack of accessing market for whole milk marketing. And this was not in the case of urban producers where majority of households did churn during fasting days where there is less demand for dairy products and because of preference of

butter and other by-products, if all milk could not be marketed, and because of taboos against selling whole milk.

In regard to the type of product processed, butter was the primary dairy product traditionally processed by most of the urban and crop–livestock system. Among the other churning material, the entire mixed crop–livestock producers (100%) used gourd for churning, and about 45.7% of the urban producers used traditional churning material made from clay pot. This is an indication that traditional churning materials are the dominant over the modern churning material in the study area.

Marketable dairy products in the study areas include whole milk, traditionally processed butter, ghee, ergo (fermented whole milk), cottage cheese, and sour buttermilk and are dependent on many factors, such as production system, seasons of year and the purchasing ability of consumers. Sale of milk in mixed crop-livestock production system (75%) decreases at a highest rate than urban milk sale (18%) during the dry season. Based on the figure, less amount of milk sold by mixed crop-livestock producers during the dry season is related to less quantity of surplus milk obtained and otherwise be used for sale, in addition to the need of money as an income by urban producers.

Similar to finding reported by Coppock (1994) in pastoral areas, as milk production per household increases, there is also an increase in milk sale. Based on personal observation and interview with producers, farmers are major milk suppliers to the market. Consequently, the amount of milk sold per day during wet and dry season in Gambella open market was significantly ($P \leq 0.05$) higher than in Jikawuo local market (Table 12). This is perhaps for the reason that the Gambella open market is more central for more number of rural producers. Gambella market site has more potential to access milk than Jikawuo market.

Since informal dairy marketing was the only means of marketing in the current studied area, there was no fixed price for each dairy product. Prices of dairy products in the current study is relatively lower in crop-livestock producers (i.e. declined during the wet season) as compared to urban one (Table 12).Contrarily, the higher in price (especially fresh milk) observed in mixed crop-livestock production systems (3-4 & 4-6, and 15-25 & 25-35, for whole milk and butter, during wet and dry season respectively) was attributed by the distant to the market place, in addition to less surplus of milk as mention before. This indicated that fresh milk could not be kept for a long time before consumed, and dairy producers living at a distant from market centers could fetch a relatively lower selling price than farmers closer to the centers.

This view is supported by Sintayehu (2008) who stated that the distance from market sites (mainly to urban centers) had a major prohibiting effect on farmers from selling fresh milk to urban consumers. The current finding is also in line with that of Yousuf Kurtu (2003). Furthermore, the amount of milk sold was significantly ($p<0.05$) higher during the wet season when cows produced relatively more milk. Related to this, significantly ($p<0.05$) higher prices were reported for dry as compared to wet season (Table 12). Yousuf Kurtu (2003) and Sintayehu (2008) derived suggestions related to this specific market situation for the Eastern and Southern parts of Ethiopia. Therefore, distant traveled to sell milk and seasonality in price variation were considered as market related constraints in the present study area. Less milk quality (adulteration of milk, Table 14) which related to product maximization from milk seller is also among market constraints.

Furthermore, disease as well as veterinary services in general, feed scarcity, security problem were the major production problems identified by most of the households in the study area (Table 15). In addition, all dairy producers in the study area were constrained on unavailability of AI services, and about 70.5% urban and 69.2% crop-livestock producers commended on long calving interval and abortions as serious reproductive problems affecting performance of dairy herds. This is also true for unavailability of improved genotypes (less milk quantity) and the AI service.

Regarding dairy development related opportunities, the present of access land and availability of water throughout the year, were identified as good prospects for future sustainable dairy development. In addition, the majority of dairy producers‘ willingness to continue and expand dairying in the future, the rapid urbanization of the regional capital town Gambella as well as lack of fasting day (i.e. all rural and nearly half of the urban dwellers are not Orthodox follower that can fast some days against dairy consumption) were also identified as some of the opportunities for dairy development in the future.

6. CONCLUSION AND RECOMENTATION

The traditional cattle production system practiced in Gambella region is composed of crop livestock mixed production system and urban production system. Cattle production in the urban production system in the study area seemed to be in transition to market oriented smallholder system with some level of inputs and some opportunities for market linkage, while mixed crop-livestock system was traditional subsistence type of production system. Mixed crop-livestock households depended entirely on family labor as compared to urban producers.

Milk handling and processing practiced in the study area are entirely based on traditional types, performed unhygienically. Smallholder dairy farmers who have no access to well organized milk storing and processing technologies rely on traditional measures of cleaning their milking and milk processing equipment and the addition of certain plant materials to their products which shall increase the shelf life, and in turn may induces health risks.

Dairy marketing system identified in the study area was entirely informal marketing system, in which the producers sell dairy products directly to consumers and/or traders with no fixed price. In general, milk production and marketing system were constrained by feed scarcity, disease, poor veterinary service, security problem and limited access to markets, less quantity of milk which related to poor breeding services and seasonal price fluctuation. Above all, disease, feed scarcity and security problem were the most constraints hindering dairy development. However, The rapid urbanization of the regional capital town Gambella with that of human population increase, access of water and land for rearing dairy are an opportunity and prospects for the development of dairying in the area.

Therefore, based on the above findings the following points are recommended

- To improve the situation, strong extension service in feed conservation and utilization techniques and animal health management should be sought.
- Provision of training to the farming communities is imperative so as to improve their knowledge and skills on the management of dairy animals, and production of quality milk
- Improving animal health services including paravet training and drug supply system as well as strengthening diseases surveillance and reporting system.
- Smallholders should be provided/supported with credit facility, technologies for processing of milk and market access
- Establishing milk collecting and processing unit through encouraging the dairy producers.
- Give attention to peace and security among the different tribes within and out of the country to minimize loss of cattle due to tribal conflicts

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8. ANNEXES.

Annex-1. Questionnaire used for the formal (diagnostic) survey of the study area.

I. General information of the areas

Region: _____ Zone_____ Woreda _____ Kebele _____

Altitude (m a.s.l.) _____

II. characteristics and socio economic profile of the respondent

1. Sex of Respondents a). Male_____ b). Female_____

2. Family size: _____

3. Age of farm owner: _____

4. Educational status: a) illiterate. b) Primary level. c) Secondary and above

5. Source of income: a) crop sale b) animal sale c) dairy product sale d) off farm activities

6. Labor distribution in dairy production

Responsibility	Types of duty					
	Purchasing cattle	Selling cattle	Breeding activities	Milking	Herding	Others (specify)
Husband/adult						
Wife/adult						
Sons/young						
Daughters/young						
Laborer/hired						

7. Land holdings (ha) _____

8. Characteristics of livestock holding

8.1 Livestock herd size and composition

Livestock species	Herd size	What is the trend in the last ten years (increase or decrease)	Reason for the change in the trend
Cattle			
Sheep			
Poultry			
Donkey			
Horse			
Goats			

8.2. Cattle herd structure

Type of cattle	Status	Number			
		Indigenous	Crossbred	Exotic	Total
Cows	Lactating cow				
	Dry cow				
Bulls					
Heifers					
Male calves					
Female calves					
Total					

9. Purpose of keeping dairy cattle

Milk sale_____ Milk consumption _____ asset _____ Dowry ---------- Other (s): _____

10. When did you start keeping dairy cattle in your farm (in year)?

a). Below 10yrs, b) above 10yrs, c)Below 15yrs d) above 15yrs

11. Cattle husbandry and management

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

13. What type of feeding do you practice for dairy cattle?

a) Based on only grazing

b) Based on only stall feeding (concentrate + hay and/or crop residue+ agro-industrial byproducts + cut and carry) please underline the combinations

c) Based on grazing and stall feeding (concentrate + hay and/or crop residue+ agro-industrial byproducts + cut and carry) please underline the combinations

d) Any other system (specify)

14. If you supplement additional feed for your animals, which group of cattle?

15. What type of water sources you use for dairy animal watering, specify the type of water source, season and frequency of watering?

No	water source	Season of availability	Frequency of watering
1	River		
2	Well/bore holes		
3	Supplied tank, pipe		
4	Spring water		
5	Lake		
6	Pond and holes		

16. How do you house your dairy cattle?

a) Separately in corral b) Mixed in corral c) Mixed in barn

d) Separately in barn c) In the farmer‘s house mixed with people

e) Other (specify)

17. What was your source of establishment herd?

18. What is/are your selection criteria for dairy cow?, prioritize the criteria?

19. Do you keep the performance and service records of your dairy cattle? a) Yes b) No

20. If yes, what are the records you are keeping?

21. Do you select your own bulls? a) Yes b) No

22. Which are the selection criteria you use to select bulls?

23. Do you feed new born calves with colostrums? If yes, for how long after birth?

24. For how long new born calf stay with their mother?

Local _____ Cross _____ Exotic_____

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

a) Yes b) No

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

	Type of feeds	Form of feeding
Local	_____	_____
Cross	_____	_____
Exotic	_____	_____

27. When and why do you wean your calves?

When Why

28. Are you providing your calves with separate housing? If yes, is it protecting the calves from extremes of temperature and humidity?

29. What are the major health problems of cattle that are of economic importance in the area? List in the order of importance

24. How do you manage cattle health problems?

a) Taking to local veterinary clinic

b) Taking to a traditional healer

c) Any other way (specify)

30. Do you give vaccines to your cattle? If yes, against which diseases?

31. Do you have knowledge about zoonotic diseases? a. Yes b. No

If yes, mention some diseases:

32. Do you get veterinary services? a) Yes b) no

33. If yes, what kind of service?

34. If no, explain the reason why no services

III. Milk production and utilization

35. Do you estimate the yield of milk performance by your dairy cattle a day? If yes please fill the table below

No	Parameters	Season of the year		Total
		Wet	Dry	
1	Daily milk yield/head/day (liter)			
2	Daily milk production/hh/day (liter)			
	Total			

36. How long of time from beginning to the end of milking period do your milking cow spent (month)?

37. How do you use the amount of milk produced (in liter)?

a) Consumed at home___, b) selling___, c) processing___, d) others (specified)

38. What are the main constraint out of the following constraints for your dairy production?

a)Feed shortage, b) disease, c) others (specified)

IV. Dairy products marketing

39. For whom do you sell your dairy products?

a) to individuals, b).to traders, c).To others (specified)

40. What type of product you sell?

a) Whole Milk, b) Fermented Milk, c) Butter, d) Butter Milk, e) others (specified)

41. What criterion do you mostly use in selecting your marketing out let?

a). Price, b). Distance, c). Reliability,d). others (specified)

42. What are major constrains related to dairy product marketing?, mention some

.

Annex-2. Checklist for point to be discussed in the PRA approach

- Selection criteria for dairy cows and breeding bulls
- What are the major constraints of dairy production in your locality?
- What are your suggestions to alleviate the above mentioned constraints?
- What are the opportunities of cattle production and breeding practices in your community?

9. CURRICULUM VITAE (CV)

1. **Personal information**

- Full Name: Gatwech Tang Dup
- Sex: Male
- Birth date: 15 January, 1988 G.C
- Birth place: , Gambella region, Ethiopia
- Marital status: Married
- Nationality: Ethiopian
- Address: Gambella Town
- Cell phone: 0917527475
- E-mail: gatwechmantang@gmail.com

2. Education and training

Educational background:

- 1988 (1980 E.C)-1992 (1984 E.C): I completed grade 1-5 in Malual Gahoth primary school.
- 1993 (1985 E.C)-1995 (1987 E.C): I completed grade 6-8 in Dimma Primary and secondary school.
- 1995/6 (1987/8 E.C)-1997 (1989 E.C): I completed grade 9- 10 (Old curriculum) in Mizan senior secondary school.
- 1998(1990 E.C) - 2000(1992 E.C): I did no learning
- 2001(1993 E.C) - 2003(1995 E.C): I completed grade 10- 11 (New curriculum) in Dimma senior secondary school.
- 2004(1996 E.C): I completed preparatory grade 12 (New curriculum) in Gambella senior secondary school.
- 2005 (1997 E.C)-2007 (1999 E.C): I completed my BSc in Animal science from Haramaya University college of agriculture, Ethiopia.

- 2009 (2001 E.C)-Jan 2012 (2004 E.C): I completed my MSc in Tropical animal health and production from Addis Ababa University, Faculty of Veterinary Medicine, Ethiopia.

- **Trainings on:**

  - **S**urvey methods and related software applications (May24-June 1, 2008) organized by the Ethiopian institute of agricultural research (EIAR).

  - Training on general beekeeping management from January 1- 7/2008 at Holeta National Research Center, Holeta, Ethiopia.

  - Training on general animal health care and prevention from February 9-13/2011 at Holeta National Research Center, Holeta, Ethiopia.

  - Business process reengineering (BPR) organizing by Ethiopian civil service College (May 1-5, 2008) at EIAR, HQ.

3. Language skills

- Nuer: Mother tongue.

- English: Excellent in writing, reading, speaking and listening.

- Amharic: Medium in writing, reading, speaking and listening.

4. Work experience

- From 1999- 2002 (G.C): I work as Bar foot social worker for Unaccompanied Minors and Separated Children under Save the Children Sweden in Dimma Refugees Camp.

- July 2007 (1999 E.C) up to now, I am working as researcher for Livestock research activities in Gambella agricultural research institute (GARI) (with telephone: +251475510014, P.O.Box of 62, Gambella, Ethiopia).

- I work also as Ruminant and Fishery Case- team coordinator of GARI from the beginning of 2012.

- Research papers:

1. Study on Traditional milk handling practice in Partial fulfillment of BSc in Animal science, Haramaya University, Ethiopipia.
2. Currently I am working my MSc thesis on Dairy production, processing and marketing system in selected districts (Jekaw district & Gambella town) of Gambella region, Ethiopia.
3. Many others unpublished written research materials.

5. Social skills and competences

I am working as a Ruminant and Fishery Case- team coordinator of GARI where a social, communication and teamwork skill is very important. My fields of studies namely Animal science (BSc) and Tropical animal health and production (MSc) are what make me also to have more such skills in societal/country development and communication processes.

Social and Teamwork skills:

- Working and living together with multicultural people (Nuer, Anuak, Amhara, Oromo, Tigre, and many other Ethiopian tribes) within GARI.
- Working with farmers with different background from Nuer, Anuak, Komo, Opo, majenger and settlers from highland in agricultural research activities.
- Teamwork through farmers research groups and scaling up/out of technologies where multidisciplinary team of researchers and stakeholders work together with farmers.
- Business processing reengineering (BPR) also an opportunity for researchers to work together in a team manner.

Communication skills:

- Advisory communication with researchers, technical assistants, developmental agencies and farmers.
- Knowledge exchange with above groups.
- Interpersonal communications.
- Building coherent innovations.
- Conflict management.

- Supporting organization development and capacity building.
- Persuasive transfer of innovations.
- Raising awareness and consciousness of pre-defined issues.
- Information provision.
- Conducting participatory rural appraisal (PRA), home visit, group discussion, etc.
- Organizing Trainings, workshops, group meetings, demonstrations and field days for stakeholders.
- Preparing communication means such as leaflets, letters, reports, etc.

6. Technical skills and competences

Computer skills:

- Microsoft office programs (word, excel, PowerPoint, etc).
- Data management computer softwares (SPSS, Stata, and ArCview of GIS)

Skills on Audio-visual equipments (video camera, digital camera, overhead projector, etc):

- How to use them.

7. References

No	Name	Title & organization	Phone	e-mail address
1	Kueth Lul	DG of GARI	+251917834668	-
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3	Ruach Chol	Researcher of GARI	+251917488391	ruachuolchay@yahoo.co

		(my colleague)		m
4	Luke Kue	Head of finance in IOM	+251917804791	-
5	Dr. Mekonen H.	Addis Ababa University lecturer (my advisor)	+251911662669	alemu57@yahoo.com

10. SIGNED DECLARATION SHEET

I declare that this thesis is my original 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 and is deposited at the university library to be made available to borrowers under rules of the library. I solemnly declare that this thesis is not presented for a degree in any others university anywhere for the award of any academic degree.

Name**:** Gatwech Tang Dup

Signature: _____

Date of submission: _____

This thesis has been submitted for examinations without approval as university advisor.

Dr. Mekonen Hailamariam (DVM, Associate Prof.) _____