# DAIRY PRODUCTION CHALLENGES, HYGIENIC MILK PRODUCTION PRACTICES AND QUALITY ASPECT AMONG DAIRY PRODUCERS IN HULA DISTRICT, SIDAMA REGION, ETHIOPIA

**MSc.THESIS**

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**APPROVAL SHEET-I**

This is to certify that the thesis entitled *"***Dairy production challenge, Hygienic milk production practices and Quality aspect among Dairy producer in Hula district sidama Region, Ethiopia''**Submitted to partial fulfillment of the requirements for the degree of Master of Science in Agriculture with a specialization in (**Dairy science and Technology**) of the Graduate Program of the School of Animal and Range Sciences, Hawassa University.

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I declare that this thesis is my original work and all information and sources of materials used for this thesis have been duly acknowledged. I solemnly declare that this thesis is not done in my study area about dairy production for the award of any academic levels of institution.

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## LIST OF ABBREVIATION

| | |
|---|---|
| ADMY | Average daily milk yield |
| AGP | Agricultural Growth Project |
| AI | Artificial Insemination |
| ARC | Agricultural Research Center |
| LFO | Livestock and fisher Organization |
| CC | Coliform Count |
| CFU | Colony Forming Unit |
| GDP | Gross of Domestic Product |
| ILRI | International Livestock Research Institute |
| MOA | Ministry of Agriculture |
| SPSS | Statistical Package for Social Science |
| TBC | Total bacterial count |

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# DAIRY PRODUCTION CHALLENGES, HYGIENIC MILK PRODUCTION PRACTICE AND QUALITY ASPECT AMONG DAIRY PRODUCERS IN HULA DISTRICT, SIDAMA REGION, ETHIOPIA

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## ABSTRACT

*The objective of the study was to assess dairy production challenges, hygienic milk production practices and quality aspect of milk among dairy producers in Hula district, Sidama Region, Ethiopia. A total of 185 dairy producers from rural and urban/peri-urban area were selected for survey. Primary data was collected from households, key informants and through focus group discussion. Secondary data was collected from Hula district livestock and fisher office. Purposive sampling techniques were used to select district and kebele. Households were selected through simple random sampling technique. For milk microbial quality analysis 40 raw fresh milk samples (24 from rural and 16 urban/pri-urban households) were taken directly from the udder and milking bucket/plastic materials to analysis microbial quality. The results showed that majority (83.3%) of interviewed households were males. Most of the respondents (92.5%) reared local dairy cattle breed while small proportion (7.5%) rearing crossbred. Most of the respondent (93.7%) improved their dairy cattle by using local bull while 2.1% and 4.2% used crossed bull and AI service respectively. The major challenges of dairy production in the study area were shortage of feed (36.5%), lack of improved dairy cattle breed (28.35%), animal health problem (23.03%) and shortage of clean water at dry season (12.3%). Challenges related with milk quality were milk adulteration, lack of milk quality based controlling system, lack of quality marketing system and lack of cooling facility. Majority (90.5%) of the households under the current hand wash their hands before milking while the rest (9.5%) don't. Udder washing before milk is not practiced by higher proportion (88.3%) of the households while the rest (11.7%) do wash. In the study area households use different types of plants for cleaning milk container including Tenadame (Ruta chalepensi, 48.9%), Datata (Lamium amplexicaule, 25.6%) and Bowanyamo (Pedicularis groenlandica, 25.5%). For smoking they used "tid" (Juniperous procera, 64.5%), weyra zaf (Olea africana stem, 12.9%) and were old bamboo (22.6%). There was significant difference (P<0.05%) in TBC and CC between rural and urban/peri-urban. The overall average total bacterial count (TBC) in rural and urban/peri-urban area were 6.0±0.05 and 5.06±0.03 log10 Cfu/ml respectively while coliform count (CC) were 5.1±0.08 and 4.6 ±0.05 log10 Cfu/ml respectively. In generally, milk from rural area had high total bacterial and coliform load as compared to the sample taken from the urban/peri-urban area. The reason for this could be the unhygienic activities such as unclean milking house and equipment, poor personal hygiene, contamination of milk due to infection of udder and teat with mastitis, urine and fecal material predispose the milk for contamination with high microbial load and makes it difficult to ensure production of milk with low microbial load. From this study it is been concluded the milk prhygenic production and microbial quality of milk from the urban/peri-urban area is better and therefore extension work should focus in creating awareness and training dairy producers in about good milk production practice.*

***Key word: Dairy production, Hula, Hygienic practice, Bacterial***

# 1. INTRODUCTION

Livestock perform multiple functions in the Ethiopian household economy by providing food, input for crop production and soil fertility management, cash income as well as in promoting savings, fuel, social functions, and employments (CSA, 2008).Ethiopia has the highest cattle populations in Africa estimated at about 59.5 million out of which about 98.2 % of the total cattle in the country are local breeds. The remaining are hybrid and exotic breeds that accounted for about 1.62% and 0.18%, respectively (CSA, 2017). Dairy farming is one of the livestock sub sectors that can provide income and employment for the economic sustainability of smallholder farmers (FAO, 2010). However, the productivity of dairy cows is in a lowest stand due to various technical and non-technical constraints (Asrat*et al.,* 2016). Milk is nature's most complete food which contains (energy, protein, fat, vitamin and mineral type) that contributes for the nutritional improvement of the people (Habtamu, 2018). Milk production in Ethiopia is mainly dependent on indigenous breeds; more specifically on cattle, goats, camels and sheep. Cattle have the largest contribution (81.2%) of the total national annual milk output, followed by goats (7.9%), camels (6.3%) and sheep (4.6%) (CSA, 2014).

The estimate of total cow milk production for the rural sedentary areas of Ethiopia is about 3.06 billion liters/year (CSA, 2017). The average daily milk yield (ADMY) performances of indigenous cows is1.85 liters/day and ranges from 1.24 liters in rural lowland agro-pastoral system of Mieso to 2.31 liters in rural highland dairy production system of Fogera (Azage*et al.,* 2013). For hybrid cows, milk production per day is 8 to 10 liters (Tadesse*et al.,* 2015). Currently, in Ethiopia per capital consumption is very low, estimated at about 19 liters per person, but urbanization is driving up consumption in Addis Ababa about 52 liters per person per year (Azage, 2016).

The challenges of dairy production in Ethiopia have highly influenced annual milk production per cow which is generally low due to reduced lactation length, extended calving interval, late age at first calving and poor genetic makeup. Another major challenge to such low milk production is shortage of livestock feed both in quantity and quality, especially during the dry season. Moreover, progressive decline of average farm sizes in response to rising human populations, encroachment of cropping land onto grazing areas and expansion of degraded lands, which can no longer support either annual crops and pastures contributed to shortage of feed resources. Further poor grazing management (e.g. continuous overgrazing) contributed to shortage of feed resources as a result of replacement of productive and nutritious flora by unpalatable species (Ahmed, 2006).

The challenges of feed supply from natural pasture fluctuate following seasonal dynamics of rainfall and quality of native pasture is very low especially in dry season due to their low content of digestible energy and protein and high amount of fiber content. This is much worse for crop residues owing to their lower content of essential nutrients (protein, energy, minerals and vitamins) and lower digestibility and intake (Solomon *et al*., 2006). Milk is a complex biological fluid with dense nutrients that provides suitable environment for the rapid multiplication of bacteria that result in milk spoilage. Therefore the microbial load of milk is a major feature in determining its quality. Hygienic control of milk and milk production is not usually conducted on routine bases. Apart from this, door-to-door raw milk delivery in the urban and peri/urban areas is commonly practiced with virtually no quality control at all levels. Although, properly operational formal marketing and grading system targeted towards relating quality of products to market price is not well established, provision of milk and milk products of good hygienic quality is desirable from consumer's health point of view. Quality milk implies to milk which is

free from pathogenic bacteria and harmful toxic substances, free from sediment and extraneous substances, of good flavor, with normal composition, adequate in keeping quality and low in bacterial counts (Zelalem, 2012).

Consumers need clean, wholesome and nutritious food that is produced and processed in a sound sanitary manner and free from pathogens. Hence, quality milk production is necessary for fulfilling consumers' demand. As a result, hygienic milk handling practices should take into account such as the sanitation of milking environment, the hygiene of the milker and utensils used to collect and store milk. Dairy animals may carry human pathogens which may increase the risk of causing food borne illness. Moreover, the milking procedure, subsequent cooling and storage of milk carry the risks of further contamination from man or the environment or growth of inherent pathogens (CAC**,** 2016). In Ethiopia, milk hygiene handling practice is below the standard due to insufficient pre-milking handling practices like washing udder with clean water, cleaning milking barn, drying the udder with individual towel, washing of milkers' hands and milking utensils, using of poor quality and non-boiled water for cleaning of udder and insufficient post handling practice like poor hygiene of milk equipment and storage containers, prolonged storage, transportation and retailing practices predispose the milk to microbial contamination (Tsedey and Asrat, 2015; Fufa*et al.*, 2019).

## 1.1. Statement of the Problem

Dairy constitutes an important part of the Ethiopian smallholder crop/livestock mixed farming system. In Ethiopia, dairy production is mainly of subsistent type largely based on indigenous breeds of cattle. Milk production from this system (based on indigenous cattle) is low to support the demand for the continuously increasing human population, particularly in urban centres (Azage and Alemu, 2016). Hence increase of the sector's production and productivity can be achieved through introducing improved methods of fodder production for dairy cattle, supplying of crossbred heifer, establishing of farmer based bull stations, delivering of crossbred Friesian and Jersey breeding bulls to villages, providing of animal health service in the villages and assisting in marketing. The safety of dairy products with respect to food-borne diseases is a great concern around the world. This is especially true in developing countries where production of milk and various dairy products take place under rather unsanitary conditions and poor production practices (Zelalem and Faye, 2012). Milk production is important practices for consumption as well as cash income source for small householder in Hula district of Sidama region. However there are challenges that affect the potential of dairy cattle production, hygienic milk production practices and microbial quality aspect of smallholder dairy producers. So far, no enough research and extension system has been done at district levels on challenges of dairy cattle production and hygienic milk production practices. Therefore, this study was designed to provide information on the gap of dairy production and forward possible intervention strategies.

## 1.2. Objectives of the Study

### 1.2.1. General objective

- Dairy production challenges, hygienic milk production-practices and quality aspect among dairy producer in Hula district Sidama region, Ethiopia**.**

### 1.2.2. Specific Objectives

- ✓ To assess major challenges of dairy production among rural and urban/peri-uban small-holder dairy producers.
- ✓ To investigate – hygienic milk production practices among rural and urban/peri-urban small-holder dairy producers.
- ✓ To evaluate microbial quality of raw milk among rural and urban/peri-uban small- holder dairy producers.

# 2. LITERATURE REVIEW

## 2.1. Historical events of dairy development in Ethiopia

According to Ahmed et al. (2006), in the first half of the 20th century, dairying in Ethiopia was mostly traditional. Modern dairying started in the early 1950s when Ethiopia received the first batch of dairy cattle from United Nations Relief and Rehabilitation Administration (UNRRA). With the introduction of these cattle in the country, commercial liquid milk production started on large farms in Addis Ababa and Asmara (Ketema 2013). Government intervened through the introduction of high-yielding dairy cattle in the highlands in and around major urban areas. The government also established modern milk processing and marketing facilities to complement this input-oriented production effort. In 1960, UNICEF established a public sector pilot processing plant at Shola on the outskirt of Addis Ababa in order to enhance growth of the dairy sector. The plant started by processing milk produced by large farms. The plant significantly expanded in a short period and started collecting milk from smallholder producers in addition to large farms. This led to further expansion of large dairy farms. During the second half of the 1960s, dairy production in the Addis Ababa area began to develop rapidly as a result of the expansion in large private dairy farms and the participation of smallholder producers with indigenous cattle facilitated by establishment of milk collection centers (Ahmed et al. 2006).

Subsequently, different dairy development projects were launched in different parts of the country. The distribution of exotic dairy cattle, particularly the Holstein Friesian, in different parts of the country, especially around the major urban areas, also contributed to the further development of dairying in Ethiopia**.** Dairy production is an important component of livestock in Ethiopia. It is an important source of food, income and creates job opportunities for many people in rural and urban areas. However, despite its huge number, the performance of sub-sector in

general is low compared to its potential and the direct contribution it makes to the national economy is limited (Sintayehu *et al.*, 2008).

### 2.2. Dairy Production System in Ethiopia

Dairying in Ethiopia is practiced almost all over the country with the intensity of small or medium or large-sized, subsistence or market-oriented farms. The dairy system of the country is categorized based on agro-ecology characterization of the area or climate, socio-economic structures of the population, holdings, type of breed and species used for milk production and the integration with crop production as criterion (Getachew*et al.*, 2014). There are different classifications of dairy production systems in Ethiopia given by different scholars, but according to the dairy development and polices inventory, dairy systems in Ethiopia can be categorized under five systems of operation; pastoral (traditional pastoral livestock farming), Agro-pastoral (traditional low land mixed livestock farming), mixed crop livestock system (traditional highland mixed farming), urban and peri-urban (the emerging smallholder dairy farming) and commercial (specialized commercial intensive dairy farming) (Getachew et al., 2014).

#### 2.2.1. Rural dairy production system

Rural dairy production is system mainly concerned with pastoral, agro pastoral systems and mixed crop production system. Pastoral systems are mainly found in the lowlands where livestock production is the dominant form of production to sustain the livelihood of pastoral society with no cropping (Tegegne*et al.*, 2015). About 30% of the livestock population in Ethiopia is found in the pastoral areas; which comprise 50% of the total land area of the country. Pastoralism is the major dairy production system in the lowland area. Livestock doesn't provide inputs for crop production but they are the very backbone of their owners providing all of the consumable and saleable outputs, like for example milk, and regarded as insurance against

adversity. Milk production is dependent on season due to the rainfall pattern that influences feed availability (Hiwot, 2013).

Agro pastorals system has similar but gradual to sedentary ecological characteristics and cattle type to the pastoral area. Its specific identification is livestock dependent but growing of crop and its further expansion in crop farming gradually allocating the pasture land to crop production. The crop residue and aftermath of crop farming is used as a feed source for animals in the area in addition to communal pasture grazing. As compared to the above system, the system has better consideration for milk market and its access for additional inputs such as animal health services and supplementary feed from industrial by products and development of forage to calves and milking cows near to the newly started farm land to some extent (Getachew*et al.,* 2014). Mixed crop livestock production system 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 (Sintayehu*et al*., 2008). Milk-production is an integral part of the production system of small-scale, non-commercial subsistence-farms which represent among the 83.9% of the population and are responsible for the major part of 98% of the total milk produced and 75% of commercial, liquid milk production (Getachew*et al.,* 2014).

### 2.2.2. Urban and peri-urban dairy production

This system is developed in and around major cities and towns located mainly in the highlands of Ethiopia. The main feed resources are agro-industrial byproducts and purchased roughage. The system comprises small and medium sized dairy farmers that own crossbred dairy cows. Farmers

use all or part of their land for forage production. The primary objective of milk production is to generate additional cash income to the household (Hiwot, 2013).

### 2.3. Milk yield and lactation length of cows in Ethiopia

Indigenous breed of cows are generally considered low milk producers. Annual milk production per cow is generally low due to reduced lactation length, extended calving interval, late age at first calving and poor genetic makeup. However, they are the major source of milk in Ethiopia that account for 97% of the total milk production (CSA, 2016). Milk yield has remained extremely low with average of 1.4 liter/day/cow in Oromiya Regional State (Workneh and Rowland, 2011). 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, 2013).

### 2.4. Traditional Milk handling and processing practices in Ethiopia

In Ethiopia the smallholder farmers produce fermented milk by traditional methods. The major fermented milk products produced by smallholder farmers by traditional methods include “Ergo” (fermented sour milk), “Kibe” (traditional butter), “Neterkibe” (ghee or clarified butter), “Ayib” (cottage cheese), “Arerra” (sour defatted milk), and “Aguat” (whey) (Hiwot, 2013). Dairy processing in the country is basically limited to smallholder level and hygienic qualities of products are generally poor (Sintayehu et al., 2008). In areas where the climate is hot and humid, the raw milk gets easily fermented and spoiled during storage unless it is refrigerated or preserved. However, such storage facilities are not readily available in rural areas and cooling systems are not feasible due to lack of the required dairy infrastructure and when available high

cost of facilities such as refrigerator for resource poor smallholder producers (Bereda*et al*., 2013).

### 2.5. Dairy production challenges in Ethiopia

In smallholder dairy farmers there are different factors affecting dairy value chain. Among these factors reduction in volume of milk production, high cost of different inputs (animal feeds, improved breeds), high barging power of trader, weak relationship of dairy cooperative with its members, long fasting period of Ethiopia Orthodox Church are identified as the major factors affecting milk value chain in smallholder dairy farmer (Girma and Marco, 2014). Dairy production is constrained by multifaceted factors, though the nature and magnitude of the problems. Challenges and problems for dairying vary from one production system to another and/or from one location to another (Tegegne*et al.,* 2015). The major challenges are explained below:-

#### 2.5.1. Shortage and availability of feed

In terms of quality, quantity and seasonality of feed and water supply which leads to reduction of volume of milk produced by small holder dairy farmers is one of the major factors which affect milk value chain in Ethiopia. Roughage and concentrate feeds are either too expensive or unavailable in sufficient quantity and quality to improve dairy production (Tegegne*et al*., 2015 and Girma and Marco, 2014).

#### 2.5.2. Shortage of cultivated land for green fodder production

The main feeding problem in traditional systems of cattle rearing is the lack of quality forage available in the dry season. Therefore, pastoralists must find alternative sustainable ways of feeding as the grazing land is gradually plummeting. Fodder deficit is a major impediment for

dairy development due to pressure of increasing human population (Sinishaw, 2012).For dairy farming and green fodder production is a major problem in urban area, as comparing with the rural highlands of dairy production system of Ethiopia because increasing urbanization. Dairy farms under this system have great pressure to expand dairying mainly due to rapid urbanization and population growth. (Sintayehu *et al.*, 2008).

### 2.5.3. Shortage of improved genetically cattle breed

In Ethiopia, local breeds are the main source of milk and milk products. The number of crossbred cows is very low and is mainly concentrated in and around major urban and peri-urban centers. Indigenous cattle breeds are generally characterized as multi-purpose animals and managed in low input production system and they are inherently low milk producers (Sintayehu*et al.*, 2008).

### 2.5.4. Prevalence of diseases and parasites

Diseases in dairy animals affect reproduction, milk production, milk quality and cause mortality and morbidity in rural lowland dairy production system. Mastitis is the one, which causes high economic loss, as a system is market oriented dairy system (Ulfina*et al.*, 2013). The prevalence of diseases such as Blackleg, FMD, Anthrax, Bovine tuberculosis, Lump skin disease, Tick-borne disease and Lice infestation are which hinders the realization of increased milk production. Those problems related to access to veterinary service, medication supply, and cost of medication aggravated milk productivity in particular and dairy farm production in general (Ulfina*et al.*, 2013).

### 2.5.5. Poor Access to Inputs and Services

Access to inputs and services includes extension, animal health, credit, market information, AI and dairy inputs. The inefficient AI service reported is associated with lack of sufficient facilities and trained AI technicians in the country. The problem of AI service provision seems to be a critical issue at national level. AI service in Ethiopia has not been successful to improve reproductive performance of the country's dairy industry (Lipismita ,Pattanaik, 2014).

### 2.5.6. Poor Socio-economic Status of Dairy Farmers

More than half of all cattle and almost all sheep and goats in Ethiopia belong to smallholders, who keep livestock mostly in traditional systems with livestock contributing substantially to their livelihoods and food security. These prime stakeholders of the entire value chain of milk are deprived of minimum resources of land, labour and capital etc (CSA (2017).

### 2.5.7. Seasonality of milk supply

Marketing constraints include fluctuation in demand and supply of dairy products (as a result of feed shortage and different socio cultural reasons), poor infrastructure (Lack of cooling facilities, simple processing equipment and quality testing skills and equipment) and the long time fasting of the members of the Ethiopian Orthodox church (Ulfina*et al*., 2013). Many people of Ethiopia are Orthodox Church believers and they have a great role in milk marketing during the long fasting period. There is also mismatching in the supply and demand price difference of milk products during long fasting and after fasting period. That the calendar of Orthodox Christian church involves three prolong fasting period per year (before Easter, in demand marketing of milk and milk product(Girma and Marco, 2014)

## 2.6. Hygienic milk production practice

Unhygienic milking procedures don't give hygienic milk .Primary production occurs on the farm, and livestock management can have a significant impact on the productivity of the herd (Buncic, 2006). Because of the important influence of primary production activities on the safety of milk products, potential microbiological contamination from all sources should be minimized to the greatest extent practicable at this phase of production (primary). It is recognized that microbiological hazards can be introduced both from the farm environment and from the milking animals themselves. Appropriate animal husbandry practices should be respected and care should be taken to assure that proper health of the milking animals is maintained. Further, lack of good agricultural, animal feeding and veterinary practices and inadequate general hygiene of milking personnel and equipment and inappropriate milking methods may lead to unacceptable levels of contamination with chemical residues and other contaminants during primary production.In order to achieve hygienic and safe milk:-Clean and health cow, Clean milking parlor and barn, Clean and healthy personnel andClean milking equipment.

## 2.7. Factor affect raw milk quality in Ethiopia

Milk quality is defined both by its composition and free from pathogenic bacteria and harmful toxic substances, free from sediment and extraneous substances, of good flavor, with normal composition, adequate in keeping quality and low in bacterial counts (Belloque, 2009).The concept of total quality management:-quality from milk point of view, quality from the process point of view, quality from supply chain management point of view.

### 2.7.1. Chemical factor affecting raw milk quality composition

A very important aspect of raw milk quality is its composition. For smallholder dairy cows, the typical ranges of milk constituents are: Water: 87%; Milk solids: 10.5%; Milk fat: 3%; Milk lactose: 4.8%; Milk protein: 2.6–4.4%; and Minerals: 1.0 %. The major factor affecting quality of milk composition are: species of animals, breed, age, feed and water shortage, stage of lactation, seasonal vibration , disease, pregnancy, long dry period and stress (Belloque, 2009).

### 2.7.2. Physical factor affecting raw milk quality

#### 2.7.2.1. Milk flavor and odor

Consumer acceptance of milk is greatly affected by its flavor. There are several factors which may produce off-flavors and/or odors in milk (Clare *et al.*, 2013). Some of the more common causes of flavor and odor problems are:

- Feed and weed flavors
- Strong smelling plants, like wild onion or garlic
- Strong flavored feedstuffs such as poor quality silage
- Cow-barn flavors from dung, etc. These are found when milk is obtained from a dirty or poorly ventilated environment or from improperly cleaned milking equipment.
- Drug resides after injection
- Oxidized flavors, from contact with copper or exposure to sunlight

### 2.7.3. Microbial factor affecting of raw milk quality

The most commonly used microbial quality tests for milk and milk products include determination of total bacteria count (TBC) or standard plate count (SPC) and coliform count (CC).

#### 2.7.3.1. Total Bacterial Count (TBC)

The total bacterial count (TBC) of a producer raw milk samples gives an indication of the total number of aerobic bacteria present in the milk at the time of pickup. Milk samples are plated in a semi-solid nutrient media and then incubated for 24 hours at 32°C (90°F) to encourage bacterial growth. Single bacteria or tight clusters (e.g. chains or clumps) grow to become visible colonies that are then counted. All bacterial plate counts are expressed as the number of colony forming units (Cfu) per millilitre (ml). One of the most frequent causes of high SPCs is poor cleaning of the milking system. Milk residues on equipment surfaces provide nutrients for growth and multiplication of bacteria that can then contaminate the milk of subsequent milking. Other practices that might contribute to increased bulk-tank SPCs are milking soiled cows, maintaining an unclean milking and housing environment, and failing to rapidly cool the milk to or maintain it at less than 4.4°C (40°F). On rare occasions, mastitis cows that shed infectious bacteria can also contribute to or cause high SPCs (USDA, 2010).

#### 2.7.3.2. Total Coliform count (CC)

The CC is a test that estimates the number of bacteria that originate from manure or a contaminated environment. Milk samples are plated on Violet Red Bile agar and incubated for 48 hours at 32°C, after which typical coliform colonies are counted. Coliform counts reflect hygiene and sanitation practices followed on the farm. Coliforms enter the milk supply as a

consequence of milking dirty cows or dropping the milking claw into manure during milking. Coliform counts >100 Cfu/ml suggest poor milking practices, dirty equipment, contaminated water, dirty milking facilities, and/or cows with subclinical or clinical mastitis (USDA, 2010).

**Table 1: Ethiopian standard requirements on microbial quality of raw Milk**

| **Aerobic Mesophilic Bacteria count** | |
|---|---|
| **Quality** | **Counts/ml** |
| Very good | 0-200,000 |
| Good | 200,000-1,000,000 |
| Bad | 1,000,000-2,000,000 |
| Very bad | >2,000,000 |
| **Coliform count** | |
| **Quality** | **Counts/ml** |
| Very good | 0-1,000 |
| Good | 1,000-50,000 |
| Bad | 50,000-500,000 |
| Very bad | >500,000 |

Source: (Alganesh, 2017)

### 2.7.4. Source of microbial contamination

#### 2.7.4.1. Internal and external infected udders

Mastitis is an inflammation of the mammary glands in the udder caused by infection with disease-causing bacteria. These bacteria can also end up in the milk and result in illness if the milk is consumed. In case of mastitis counts of *Streptococci*, *Staphylococci* or coliforms will be as high as the total plate count and can be very high up to 107 Cfu/ml. Bulk milk count may even increase to 105cfu/ml under certain circumstances (Alehegne, 2012). The exterior of the udder can be an important source of contamination. But the exterior of the udder is influenced by the environment of the cows, in which cows are housed and milked (Alehegne, 2012). The bacteria

which are naturally present on the skin of animal enter into milk from the surface of the udder and teats; these also include the bacteria which are present in milking and housing places of animals (Ali *et al*., 2011).

#### 2.7.4.2. Contamination of teat

The exterior of the cows' udder and teats can contribute microorganisms that are naturally associated with the skin of the animal as well as microorganisms that are derived from the environment in which the cow is housed and milked (Nangamso, 2016). The groups of microorganisms isolated from teats are mainly Microcoocci and aerobic spore formers. This can be a problem in producing milk in that the spores may survive pasteurization temperatures and spoil the milk and milk products during storage (Bacillus spores) and semi-hard cheese during ripening (clostridia spores). Teat surfaces are also sources of clostridia spores in milk. Sources of these spores are feed stuff, silage and bedding. The number declines markedly when cows go out to pasture because the pasture environment is cleaner than housing conditions (Alehegne, 2012).

#### 2.7.4.3. Contamination of milking and storage equipment

Contamination of milk via the milking equipment occurs when (a) microorganisms adhere to surfaces of the milking equipment and (b) milk residues that remain in the equipment after the cleaning cycle. Under these conditions, growth of adhered microorganisms may occur, especially in cracked and decayed rubber parts that are sensitive to accumulation of microorganisms. During the next milking, adhered microorganisms can be released into the milk (Vissers and Driehuis, 2008). Thorough cleaning of dairy utensils and equipment is essential. Anyone handling milk must also pay great attention to hygiene. Lack of hygiene can contaminate milk with other types of bacteria, which turn it sour and reduce its storage life (Pauline and Karin, 2006). The utensils and equipment used during milking should be made of non-absorbent,

corrosion-resistant material. The surface should be smooth, have minimal joints or open seams and should be free from bending (Pandey and Voskuil, 2011).

#### 2.7.4.4. Cleaning and disinfections of milk equipment

Detergents are necessary to clean milking equipment effectively before disinfection. The effectiveness is increased when warm water is used. This helps to displace milk deposits and to remove dirt, dissolve milk protein and emulsify the fat. Disinfectants are required to destroy the bacteria remaining after washing and to prevent these subsequently from multiplying on the cleaned surfaces. Also their effectiveness is increased with temperature. Sufficient contact time should be allowed with the surfaces to be cleaned and disinfected (Pandey and Voskuil, 2011).

#### 2.7.4.5. Storage time and temperature

The multiplication of bacteria in milk is dependent on both the temperature and time of storage. After production, milk can be stored in cans and in bulk tanks before collection. The storage temperature influences the types of bacteria which grow and their spoilage characteristics. Spoilage of raw milk is due to streptococci and coliforms, resulting in souring of milk. During storage in bulk tanks and transport, the micro flora of the milk changes from micrococcus to psychotropic gram-negative rods. There are many different microorganisms (mainly bacteria), which can find access to milk, and there are three broad temperature ranges classifying their optimum growth rates. Organisms with an optimum growth rate at low temperatures (0-15°C) are psychrophiles, at medium temperatures (20-40°C) are called the mesophiles and at high temperatures (45-55°C) the thermopiles (Nangamso, 2016).

## 2.8. Public Health Impact of raw milk consumption

The economic and nutritional value of milk and dairy products in developing countries is evident. However, as the industry grows and becomes more market oriented, focus needs to be placed on the potential risks associated with dairy production and consumption. In developed countries, up to 30% of the population is affected by a food-borne illness per year causing great strain on public health and the economy. The American food supply system is among the safest in the world, but there are still an estimated 76 million cases of food-borne illness a year causing 5,000 deaths and 325,000 hospitalizations (WHO, 2011). The major pathogens alone are responsible for $35 billion a year in medical costs and loss of productivity. Information on the impact of food-borne illness in developing countries is limited due to lack of reporting systems and poor health care infrastructure.

## 2.9. Control -Measures of Microbial Contamination in Raw Milk

### 2.9.1. Cooling: -

To prevent or retard growth of bacteria in milk and to maintain its quality for domestic consumption or during transport to the processing plant, it is essential to cool the fresh milk as quickly as possible (O'Connor, 1995). Prompt cooling or chilling of milk at a temperature of 5°C or below is necessary to minimize microbial growth and prevent milk quality deterioration during handling, storing and transporting before the raw milk being processed. In order to facilitate bulking of raw milk supply and transport the incoming milk, refrigeration facilities are provided at points of collection and transport means to maintain the temperature as much as possible (Getachew*et al.,* 2008). In the tropical countries of Africa with high ambient temperatures, lack of refrigeration facilities at the farm and household level imply that raw milk will acidify very fast (Godefay and Molla, 2000). Therefore the collection systems must be

designed to move the milk to the cooling and/or processing center in shortest possible time. In addition every effort should be made to use available systems such as water cooling, air circulation or shaded areas to reduce milk temperature (Dello Castillo, 1990).

**2.9.2. Boiling:-**

It is the easiest and most practicable method of making milk safe in every home. As soon as raw milk is produced or delivered, it should be boiled. Boiling involves raising the temperature to the boiling point and maintaining at this temperature for a few minutes. Then the milk should be cooled immediately. The temperature should be maintained below 10ºc.Since this may be impracticable at home, preferably the milk must be consumed as soon as possible after cooling and not an extended period of time after it has been boiled and cooled(Gebra-Emanuel, 1997, Linton, 1982).

**2.9.3. Pasteurization**: -

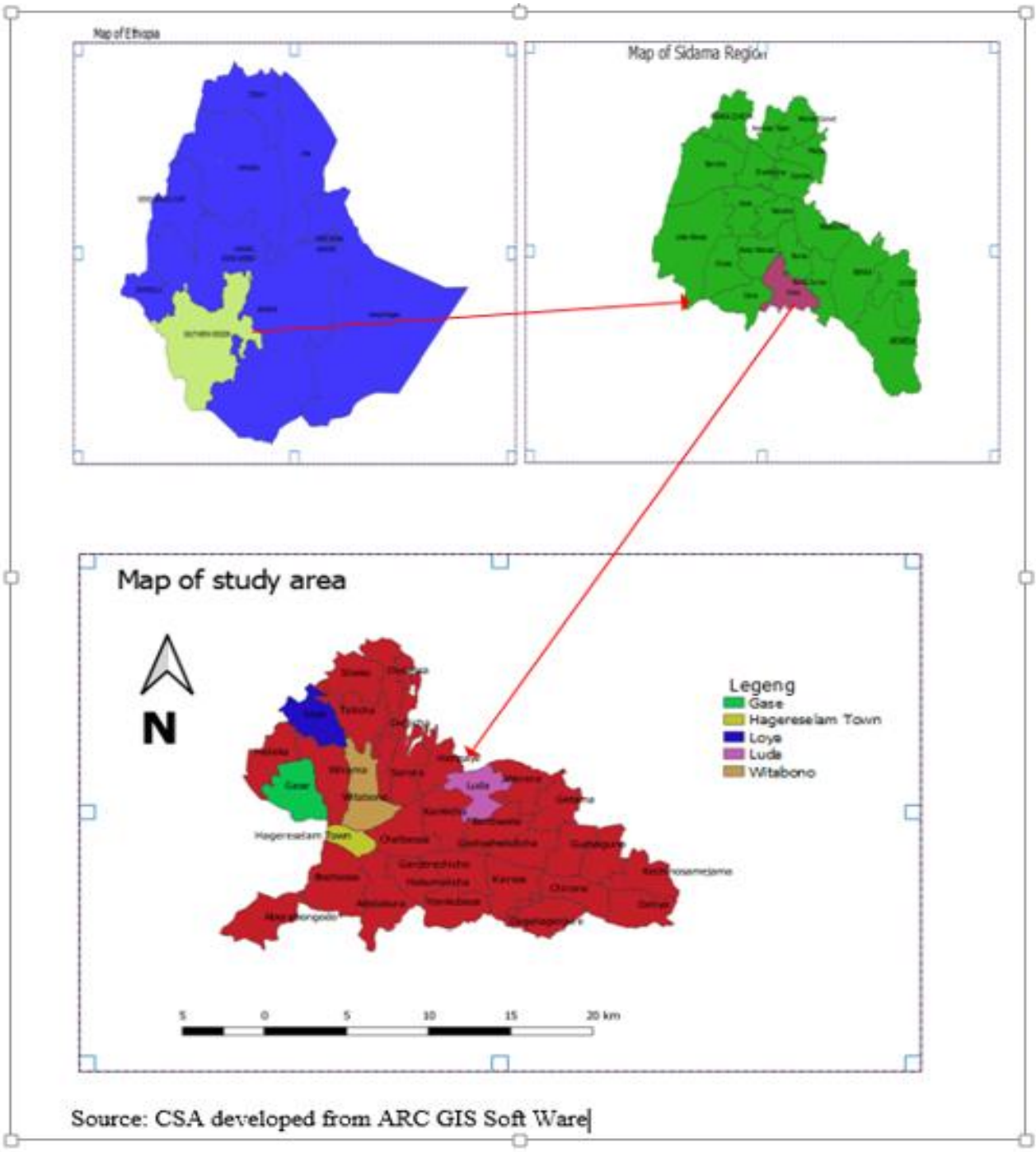
It is the main safeguard against pathogenic organisms in milk. The combination of pasteurization, care in production and processing, and improved storage has resulted in relatively safe milk supply. Milk borne diseases like tuberculosis, diphtheria, and scarlet fever have been practically eradicated. Also, the shelf-life of milk has been increased from a few days to a few weeks (Vasavaoa and Smith, 1987).

# 3. MATERIAL AND METHOD

## 3.1. Description of the study area

This study was carried out in the highland of Sidama regional state. The specific district of the study site was Hula woreda which is located at distance of 369 Km from Addis Ababa which is the capital city in Ethiopia and 85 km from the regional capital city of Hawassa. Its latitude and longitude is $6^{o}$30'N $38^{o}$31'E respectively. It is situated at an altitude of 1900 meters above sea level. It received an annual rainfall of 700-1200 mm with average annual temperature of 11-18$^{o}$C. The woreda comprises 17 kebele administrations of which two (01 and 02) kebeles are urban while the remaining 15 kebeles are rural. The total population in the study wored is 80,464 (Hula woreda administration office, 2015).

According to Central Statistics Agency, the livestock populations of the Sidama region are 2,096,120 Cattles; 430,490 Sheep; 236,416 Goats; 68,388 Horses; 54,093, Donkeys; 1,189 Mules; 84, Poultry;323,589 (CSA, 2013). In Hula district total livestock population cattle; 15,456, sheep; 2,215, goats; 1,056; horse; 769, donkey; 456 and poultry; 3422(Hula woreda livestock and fisher office, 2019).Among woreda level dairy cattle population: - crossbred; 425, local bred; 3,788 (Hula woreda livestock and fisher office, 2019).




*Source: CSA developed from Arc GIS soft ware (2015)*

*Figure1: Administrative map of the Hula district*

### 3.2. Sampling Technique and Sampling size

This study has two parts. The first part of the study was to assess dairy production challenges and hygienic milk production practices while the second part of the study was to analysis microbial quality of raw fresh milk from the study area.

#### 3.2.1. Sampling Technique

Multi stage sampling technique was used to study this part. In the first stage, Hula district was selected purposively due to its accessibility and convenience. In the second stage, four (4) rural and one (02) urban/peri-urban kebele were selected using stratified sampling technique out of 17 kebeles in the woreda levels due to lower potential of dairy cattle production. Households having at least one dairy cow were identified. From that, a total of 185, 113 and 72 from rural and urban/peri-urban area of smallholder dairy producer households respectively were selected randomly. Sample size determination was done according to Yamane (1967) formula with 95% confidence levels and 0.07% level of precision as shown blow.

Where: n is the sample size

$n=N\backslash 1+N\,(e)^{2}$ N is the population size

Sample proportion $=\frac{n}{N}=\frac{185}{2000}=0.0925$ e is the level of precision.

$n=2000\backslash 1+2000(0.07)2=185$

**Table 2: Sample size distribution in the study area (N=185)**

| Variable | Dairy household | Sampling size |
|---|---|---|
| **Rural** | | |
| 1. Gase | 300 | 28 |
| 2. Witta bono | 400 | 37 |
| 3. Loya | 300 | 28 |
| 4. Luda | 217 | 20 |
| **Urban/peri-urban** | 783 | 72 |
| Total | 2000 | 185 |

### 3.3. Data collection

#### 3.3.1. Type and source of data

This study used both qualitative and quantitative data collected from primary and secondary sources. Primary data was collected through household survey, focus group discussions and key informant interview among rural and urban/peri-urban dairy cattle producers were as secondary data was collected from published document from Hula woreda Fisher and Livestock office such as, the total livestock population and the numbers of local and crossbred type of dairy cattle and challenges related to dairy cattle production in the dry season.

##### 3.3.1.1. Household Survey

The questionnaire was used to collect primary data from each selected respondents. The questionnaires were pre-tested. The information collected through household survey include:- challenges (feed, water, grazing land, breed type, disease problem, challenges related with milk quality) and hygienic milk production practice (such as house cleaning, personal hygiene and whole management's aspect around the study area)

### 3.3.1.2. Focus group discussion

Focus group discussion was undertaken in each of the selected kebele. The total 20 FGD were taken from selected five (5) kebele (4 from each kebele) to know the challenges of dairy production and characteristics of the hygienic milking production practices.

### 3.3.1.3 Key informant interview

Key informant interview were conducted to gather important information from those who were knowledgeable and have better experience on dairy cattle production. Member of key informant are kebele resident, model dairy farmer, processor and trader who discussed on about dairy production challenges and hygienic practices and the main factor influencing milk quality.

## 3.4. Milk sampling technique

Totally 40 raw fresh milk samples (24 from rural and 16 urban/peri-urban households) were taken directly from the udder and milking bucket/plastic materials in order to analysis microbial quality such as total bacterial count (TBC) and coliform count (CC) in the raw fresh milk. Form each selected rural and urban/peri-urban kebele 100ml of raw fresh milk was taken in the morning and immediately aseptically using sterile sampling bottles labeled and stored in an ice packed cool box and transported toHawassa University College of Agriculture, dairy science and technology laboratory and kept in refrigerator until the time of analysis. The bacterial count was performed within 24 hours after sampling (Alganesh*et al*., 2016).

**Table3: Sampling of raw milk from the study area (N=40)**

| Hula district | Udder (N=24) | Milking bucket/ plastic | Total |
|---|---|---|---|
| **Rural** | | | |
| Gase | 4 | 3 | 7 |
| Witabono | 4 | 3 | 7 |
| Loya | 4 | 3 | 7 |
| Luda | 4 | 3 | 7 |
| Total | 16 | 12 | **28** |
| **Urban/peri-urban** | **6** | 6 | **12** |

N =Total respondent of sampling

### 3.5. Micro-organism analysis of raw milk

#### 3.5.1. Total bacteria count (TBC)

For total bacteria count analysis one ml of milk sample was addedinto sterile test tube containing nine ml peptone water up to serial dilution of $10^{-5}$ and mix thoroughly. Then one ml of diluted milk sample was dropped on petri dish and 15 -20ml standard plate count agar which have been autoclaved at 121º C for 15 minutes was added. The sample and the agar were gently mixed in clock and anti-clockwise rotations. The mixtures were allowed to stand for 10 minute until solidified. Then the plates were inverted and incubated at 37°C for 24hrs and dilutions wereselect so that the total number of colonies on a plate were between 30 and 300 (Richardson, 1985). Finally, colony count was madeby using colony counter expressed as colony forming units per ml (CFU/ml) using the following mathematical formula as recommended by IDF (1987).

$$CFU/ml = \sum C /(1*n_1 + 0.1*n_2)\, d$$

Where : $\sum C$ = sum of all colonies on all plates counted,

n1 = number of plates in first dilution counted,

n2 = number of plates in second dilution counted,

d = dilution factor of the lowest dilution used

### 3.5.2. Coliform count (CC)

For coliform bacteria Analysisone ml of milk sample was added into sterile test tube containing nine ml peptone water up to serial dilution of $10^{-5}$ and duplicate samples (1ml) are pour plated using 15-20 ml Violet Red Bile Agar solution (VRBA). After thoroughly mixing, the plated samples were allowed to solidify and then incubated at 37ºC for 24 hours. Finally, colony counts are made using colony counter .Typical dark red colonies were considered as coliform colonies.

### 3.6. Data Analysis

Data collected from survey questionnaire and microbial quality analyses were analysed using SPSS version 20. Microbial counts were transformed in to log10, using Microsoft office excel 2007, and counts of microbes were expressed as colony forming units per ml (CFU/ml) using the following mathematical formula as recommended by IDF (1987).

$$CFU/ml = \sum C /(1*n1 + 0.1*n2)\, d$$

Where:$\sum C$ = sum of all colonies on all plates counted,

n1 = number of plates in first dilution counted,

n2 = number of plates in second dilution counted,

d = dilution factor of the lowest dilution used

Using General Linear Model (GLM) of SPSS Version 20 Descriptive statistics such as frequency, percentages and average were computed to describe variables and the results were summarized in tables and graphs. The Least Significant Difference (LSD) value was used for means differences for significance at $P<0.05$

$Y_{ij} = \mu + \beta_j + e_{ij}$ Where,

$Y_{ij}$=individual observation of Rural and Urban/peri-urban for each test

$\mu$=the overall mean

$\beta j$= the $i^{the}$Raw milk producers (Rural and Urban/peri-urban)

$e_{ij}$=the error term

# 4. RESULT AND DISCUSSION

## 4.1. Households characteristics of the dairy cattle producer

The gender, age and educational levels variation between rural and urban/peri-urban household respondents were different ($P<0.05$). Out of the total interviewed dairy producer farm households in the study area 83.3% were male-headed households and the remaining 16.7% were female headed (Table4).This finding is similar to the finding of Tegegne et al., (2013) who reported that most of the households sampled in rural highlands of dairy production system of Fogera and Bure were male headed households (77.5–97.4%). Contrary to this is the report by Bereda *et al.* (2012) report, that dairying offers more opportunities for females to be closely involved in the daily management than males.

The highest proportions of the respondents (48.5%) are aged between 31-45 years while the rest were blow 30 (20%) and above 45 (31.5%). This is one of the household characteristics that is describing the working age (productive age). This study is similar to - a review report by Tegegne *et al.* (2013), who indicated the average age of the household heads in the Ethiopian smallholder farmers ranged from( 39.7 to 51.9)years, which was within the range of the productive age. Education is an important entry point for empowerment of rural communities and an instrument to sustain dairy development. In this context, educational level of the farming households may have significant importance in identifying and determining the type of development and extension service approaches. The role of education is clear in affecting household income, adopting technologies, demography, health as well as a whole socio-economic status of the family (Kerealem, 2005). The respondents in the study area had different educational status, (26%, 47.9%, 17.6 % and 8.5%) were illiterate, primary, secondary and high school respectively. This shows the expansion of educational coverage which provides better

opportunity to increase dairy production system in the study area. This is also in agreement with report from Illu Aba Bora Zone, Southwest Ethiopia (Bereda *et al.,* 2013), where the educational level attained by the majority of the household heads falls between illiterate and primary school.

**Table 4: Household characteristics of dairy producer in the study area (N=185)**

| Variable | Rural (n=113) | Urban/Peri-urban (n=72) | Average | *P -value* |
|---|---|---|---|---|
| **Gender** (%) | | | | 0.247(ns) |
| Male | 78.4 | 88.2 | 83.3 | |
| Female | 21.6 | 11.8 | 16.7 | |
| **Age of households**(%) | | | | 0.005(ns) |
| 18-30 | 16.8 | 23.3 | 20 | |
| 31-45 | 49 | 47.9 | 48.5 | |
| >45 | 34 .2 | 28.8 | 31.5 | |
| **Educational level** (%) | | | | 0.000(s) |
| Illiterate | 31.4 | 20.7 | 26 | |
| Primary (<5) | 45.6 | 50.2 | 47.9 | |
| Secondary(5-8) | 15 | 20.1 | 17.6 | |
| High school(10-12) | 8 | 9 | 8.5 | |

*n=sample from population, s=significance, ns=not significance*

### 4.2. Dairy cattle breed and its improvement in the study area

Dairy cattle kept in the study area are local breed and crossbreds. Local dairy cattle were the dominant type in rural part of the study area as compare to urban area (Table 5). From the total respondents in the study area 92.5%, kept local breed and 7.5% kept crossbreds. These showed that there is lack of enough extension system about how to maximize dairy production through improving genetic performance in the study area. The total dairy cattle improvement system in the study area such as using locale bull, crossbred bull and AI service were 93.7%, 2.1%, and

4.2% respectively. The number of dairy herd and breed improvement observed in the present study were significantly different (P<0.05) between rural and urban /peri-urban smallholder household.

**Table 5: Types of dairy cattle breed and its improvement system in the study area (N=185)**

| Variable | Rural(113) | Urban/Peri-urban(72) | Average | *P-value* |
|---|---|---|---|---|
| **Dairy cattle type** (%) | | | | 0.000 |
| Having local cattle | 97.1 | 87.9 | 92.5 | |
| Crossbred | 2.9 | 12.1 | 7.5 | |
| **Dairy cattle improvement**(%) | | | | 0.000 |
| Using Local bull | 96.2 | 91.1 | 93.7 | |
| Crossed bull | 1.1 | 3.1 | 2.1 | |
| AI service | 2.7 | 5.8 | 4.2 | |

*Significance difference (P<5%)*

### 4.3. Land holding per household in the study area (ha)

The overall average crop land, forage land, grazing land holding per households in rural and urban area of the study were 0.38ha, 0.29ha, 0.99ha respectively (Table 6). Low land holding have negative implications on household income and livestock production. Land holding size influences dairy production by limiting the expansion of dairy farm in the study area. Total land holding per households in rural (1.65ha) and urban (0.13ha) production systems were significantly different (P<0.05). This is lower than the national average land holding size of 1.77ha (CSA, 2013). It is also less than land holdings of 2.0 to 5 ha for 32.6% and 16.2% of the smaller farmers in the country and SNNPRS, respectively (CAC 2016) and greater than 1.1 ha in Shashemene-Dilla area (Sintayhu et al., 2008)

**Table6: Land holding per household in the study area (N=185)**

| Variable | Means±SE Rural(113) | Mean±SE Urban(72) | Mean±SE Overall | *P-value* |
|---|---|---|---|---|
| Crop cultivated land | 0.5±0.04 | 0.25±0.07 | 0.38±0.06 | 0.003 |
| Forage land | 0.04±0.01 | 0.09±0.02 | 0.29±0.02 | 0.000 |
| Grazing land | 1.08 ±0.02 | 0.01 ±0.02 | 0.55±0.02 | 0.245 |
| Total land holding | 1.62±0.07 | 0.35±0.11 | 0.99±0.09 | |

*S.E=Standard error; significantly different (P<0.05*).

### 4.4. Milk yield and lactation length of dairy cow in the study area

Under the current study, milk yield and lactation length between rural and urban areas were found to be significantly different (*P<0.05*).The overall average amount of milk produced by local cow in the rural and urban area is 1 litter /day while crossbred cows produced 2.1 litters /day (Table7). This showed that there is low amount of the milk production in the study area due to management and different environmental factors such as feed shortage, lack of enough grazing land, animal health problem, lack of enough genetically improved cattle breed in the study area. The current result is contrary to Getu *et al* (2012) who reported local and crossbred dairy cows produced 2.5 and 11.9 litter/day respectively in the Wolmera district.

In term of lactation length of local and crossbred in the study area averagely 184 and 212 days or 6.1 and 7.1month in the per a year respectively. These results were also lower than the overall average lactation lengths of local and crossbred cows which were 9.8 and 10.1months, respectively in Burie district (Adebabay, 2014).

**Table 7: Milk yield and lactation length of dairy cow in the study area (N=185)**

| | Rural | | Urban/Peri-urban | | | *P-value* |
|---|---|---|---|---|---|---|
| Variable | Min | Max | Min | Max | Average | |
| **Milk yield**(L/day) | | | | | | 0.000 |
| Local cattle | 0.5 | 1 | 1 | 1.5 | 1 | |
| Cross breed | 1.5 | 2.5 | 2 | 2.5 | 2.1 | |
| **Lactation length(**d/y) | | | | | | 0.001 |
| Local cattle | 180 | 190 | 180 | 185 | 184 | |
| Cross breed | 200 | 210 | 200 | 240 | 212 | |

*Min=Minimum, Max=Maximum*

### 4.5. Purpose of dairy cattle keeping in the study area

The purposes of dairy cattle keeping in the study area were for home consumption purpose, milk selling, and both consumption and selling which were 77%, 6.1% and 16.9% respectively (Table 8). There was significant difference (*P<0.05*) in the study area

**Table8: Purpose of dairy cattle keeping in the study area (N=185)**

| Variable | Rural (113) | Urban/Peri-urban (72) | Average |
|---|---|---|---|
| **Purpose of keeping dairy cattle** (%) | | | |
| Home consumption only | 78.8 | 75.3 | 77 |
| Milk selling only | 2.6 | 9.6 | 6.1 |
| Consumption and selling | 18.6 | 15.1 | 16.9 |

### 4.6. Major challenges of dairy cattle production system in the study area

The major challenges for dairy production in both rural and urban/peri-urban areas were feed shortage, lack of improved dairy cattle breed, animal health problem, shortage of clean water given in proportion as 33.2% & 39.6%, 29 & 27.7%, 25.7 & 20.2%, 12.1 & 12.5% respectively.

Among these, the most basic challenges which are faced in the study area were feed shortage and lack of improved dairy cattle breed, which reduce milk production and productivity.

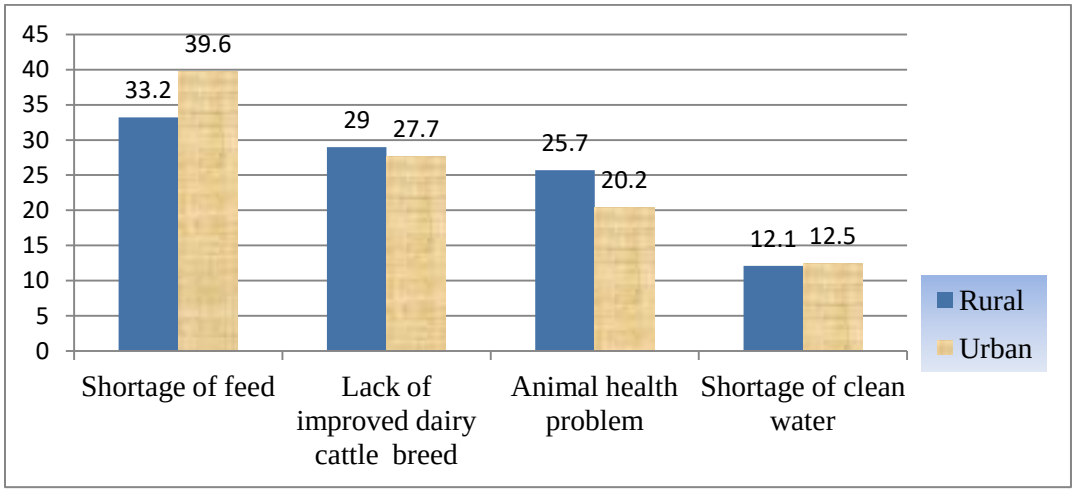



*Figure 2. Major Challenges of dairy cattle production in the study area (N=185)*

### 4.6.1. Challenges related to feed availability in the study area

The overall main challenges related to improved forage availability in the rural and urban/peri-urban areas were, lack of forage cultivated land and lack of forage seedling with 33.5%, 47%, and 19.5% proportion respectively (Table 9). Feeding source of dairy cattle, grazing land, Enset leaf, crop residue, concentrate feed with percentage of 38.2%, 22.6%, 11.7and 27.5% respectively.

**Table 9: Challenges related to feed availability in the study area**

| Variable | Rural(113) | Urban/Peri-urban(72) | Average | *P-value* |
|---|---|---|---|---|
| **Challenges of forage feed** (%) | | | | 0.000 |
| Lack of awareness | 56 | 11 | 33.5 | |
| Lack of forage land | 15 | 79 | 47 | |
| Lack of forage seedling | 29 | 10 | 19.5 | |
| **Feeding system (**%) | | | | 0.121 |
| Grazing land | 50.4 | 26 | 38.2 | |
| Inset leaf | 27.2 | 18 | 22.6 | |
| Crop | 14.4 | 91 | 1.7 | |
| Concentrated feed | 8 | 47 | 27.5 | |

*Significance difference (P<0.05%)*

### 4.6.2. Challenge related to animal health in the study area

The main animal health problem reported in the study area include lack of inadequate veterinary drugs (41.1%), lack of timely vaccination of animals (39.5%) and lack of skilled human technicians (19.4%) which was significantly different (P<5%) in the study area (Table10). This finding is in line with the finding of Asaminew (2011) at Mecha and Bahir Dar zuria district. The sources of veterinary services in the study area were government (63.3%), private (21.6%) and both government and private (15.1%).

**Table10: The animal health problems in the study area (N=185)**

| Variable | Rural (113) | Urban/Peri-urban (72) | Average | *P-value* |
|---|---|---|---|---|
| **Animal health problem**(%) | | | | 0.000 |
| Inadequate of veterinary drug | 40 | 42.2 | 41.1 | |
| Lack of timely vaccination | 40 | 39 | 39.5 | |
| Lack of skilled human technician | 20 | 18.8 | 19.4 | |
| **Source of veterinary services**(%) | | | | 0.546 |
| Government | 69.1 | 57.5 | 63.3 | |
| Private | 21.2 | 22 | 21.6 | |
| Both government and private | 9.7 | 20.5 | 15.1 | |

*Significance difference (P<0.05%)*

### 4.6.3. Challenges related to milk quality in the study area

The major challenges related to milk in the study areas prioritized by the respondents during group discussions were milk adulteration: 20.5 and 23.5%, lack of cooling facility: 40.5% & 30.5%, lack of effective quality control system: 21% & 28% and absence of quality based marketing system: 18 % & 18% in rural and urban\pri-urban areas respectively.

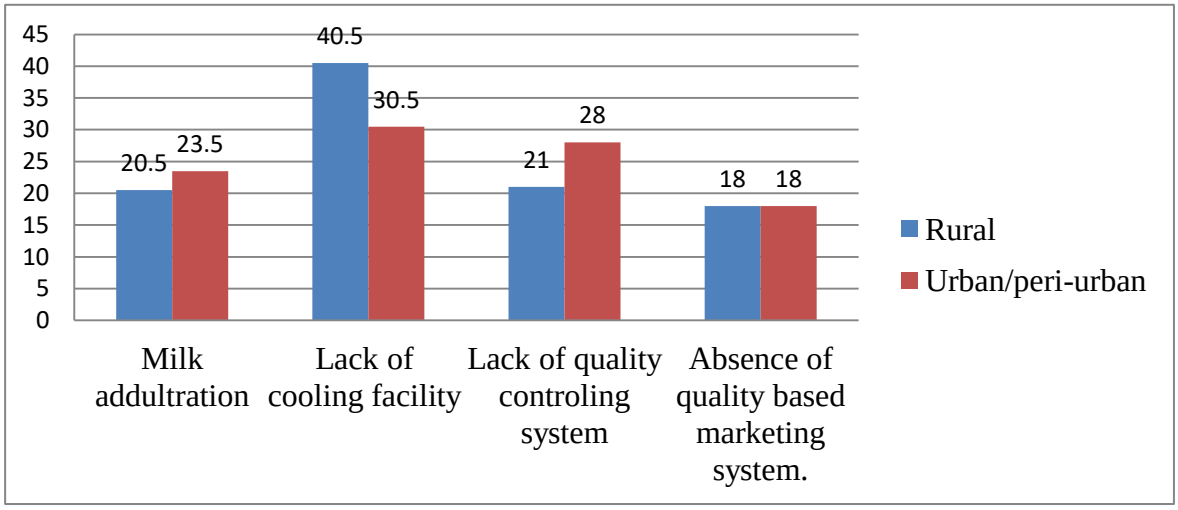



*Figure 3.Challenges related to milk quality in the study area.*

### 4.6.4. Challenges related to marketing system in the study area

Low volume of milk production was the first most important factor of marketing in the study area (Table 11). As a result of low feed availability, farmers reduce their herd size. This reduction in herd size in the study area leads to an overall reduction in the volume of milk produced. In the present study the overall challenges related to marketing system are low volume of milk, distance to the market, during fasting period and lacks of access to credit with proportion of 78%, 12.2% and 9.9% respectively which is significance difference (*P<0.05*).

**Table 11: Marketing related challenges in the study area (N=185)**

| Variable | Rural(113) | Urban/Peri-urban(72) | Average | *P-value* |
|---|---|---|---|---|
| **Marketing challenge** (%) | | | | |
| Low volume of milk | 77.9 | 33 | 55.5 | 0.000 |
| During fasting period | 13.3 | 56 | 34.6 | 0.000 |
| Lack of access to credit | 8.7 | 11 | 9.9 | 0.211 |

## 4.7. Hygienic milk production practices

### 4.7.1. Housing system and cleaning practices

All of the farmers in the study areas used housed type of barn for their cows and milking in the study area (Table12). Zelalem (2010) reported similar result where 80.4% of the respondents used house type barn in central highland of Ethiopia. Godferey (2013) reported farmers milking in open air expose milk to contaminants that enter from the environment. Mbabazi (2005) also who reported farmers milked their animals from undesignated poorly maintained milking shades/parlors predisposing milk to contamination and spoilage. Maintaining the sanitary condition of milking area is important prerequisite for clean milk production (Zelalem, 2010).

The housing types of floor in the study area were wooden bedded (80%), natural earth (7.5% while the remaining (12.5%) was concrete type. Most of the respondents (94.1%) removed manure daily while remaining (5.9%) removed three times a week. This result is contrary to result reported indicating about 47% of the respondents clean their barn three times a week in Gurage Zone, Ezha district Abebe *et al.* (2012).

**Table 12: Housing system and cleaning practices in the study area (N=185)**

| Variable | Rural(113) | Urban/Peri-urban(72) | Average |
|---|---|---|---|
| **Housing type** (%) | | | |
| Housed | 100 | 100 | 100 |
| No house | - | - | - |
| **Housing floor type** (%) | | | |
| Wooden bedded | 89.4 | 70.7 | 80 |
| Natural earth | 10.6 | 4.3 | 7.5 |
| Concrete | - | 25 | 12.5 |
| **House cleaning** (%) | | | |
| Daily | 89.4 | 98.9 | 94.1 |
| Three time a week | 10.6 | 1.1 | 5.9 |
| Two time a week | - | - | - |

### 4.7.2. Hygienic condition of cows and milker in the study area

The milker can be an important source of milk contamination. Therefore, keeping good personal hygiene being in good health during milking operation is very important (Zelalem, 2010). Most of the interviewed dairy producers (90.5%) washed their hands before milking while the rest 9.5% did not wash their hands (Table 13). Milker in the study areas did not cover their hair and dressing gown during milking. Cleaning of the udder of cows before milking is one of the most important hygienic practices required to ensure clean milk production. This is important since the udder of the milking cows could have direct contact with the ground, urine, dung and feed refusals (Zelalem, 2010). As observed in this study, 11.7% of the dairy producers washed their cow's udder before milking and 88.3% were not washing and simply allowed their calves to

suckle before milking. The current result was different than Haile *et al.* (2012) who reported 82.5% of the small size farm owning households in Hawassa city practice pre milking udder washing. The use of individual towel and following essential cleaning practices during milking is important for the production of quality milk (Zelalem, 2010). However, about 97.9% of the smallholder households did not use towels for udder drying while 2.1% were practiced towels for udder drying (Table13). Milking in dry condition significantly reduces bacterial count. It is because no surplus water remains in the surface of the udder to drip into the milk and due to less chance of leaching dirt and bacteria from udder, teats and hands into milk. Cleaning of the udder followed by drying with a clean cloth was effective adhering in reducing the number of bacteria in milk contributed from soiled teats which was significance difference (P<0.05)

**Table13: Hygienic condition of cows and milker in the study area (N=185)**

| Variable | Rural (113) | Urban/Peri-urban (72) | Average | *P.value* |
|---|---|---|---|---|
| **Hand washing**(%) | | | | 1.111 |
| Before milking | 87 | 94 | 90.5 | |
| No washing | 13 | 6 | 9.5 | |
| **Udder washing** (%) | | | | 0.000 |
| Before milking | 3.6 | 19.8 | 11.7 | |
| No washing | 96.4 | 80.2 | 88.3 | |
| **Towel used for**(%) | | | | 0.000 |
| Yes | - | 4.1 | 2.1 | |
| No | 100 | 95.9 | 97.9 | |

*Significance difference (p<0.05%)*

### 4.7.3. Milking equipment, sanitary and milking practices in the study area

Milk containers such as clay pot, plastic material and jerry cans are not recommended for the production of clean milk (Kurwijila, 2006). Aluminum containers are recommended because

they don't have adhesive properties and therefore easy to clean when compared with clay pot and plastic container (Karuga, 2009). Milking and milk storage utensils are properly cleaned and maintained. Therefore, cleaning and disinfections of equipment after each milking is important for reduction of milk contamination from the equipment. Most of the interviewed respondent used milking container such as clay pot, plastic containers and aluminum container; 47.2%, 42.5% and 10.3% respectively (Table14). Abebe *et al*. (2012) reported similar result in Ezha district of Gurage Zone where almost all farmers used plastic jars as milking utensil. This result also agreed with the result of Sintayehu *et al.* (2008) whose report agrees with the current findings. The frequency of washing milk equipment before every use, after every use and no before and after use were 59.1%, 35.9% and 5% respectively in the study area. In Ejerie district 3.3% of smallholder dairy producers cleaned their milking utensil before and after usage. Milking after suckling and milking before suckling were 73.3% and 26.7% respectively in the study area. There was significant difference (*P<0.05)* between the rural and Urban areas in milking equipments used, warm water, and practice of washing.

**Table14: Milk equipment, sanitary and milking practices in the study area (N=185)**

| Variable | Rural(113) | Urban/Peri-urban(72) | Average | *P-value* |
|---|---|---|---|---|
| **Milking equipment** (%) | | | | 0.000 |
| Clay pot | 64.3 | 304 | 7.2 | |
| Plastic/bucket | 34 | 51 | 42.5 | |
| Aluminum container | 1.7 | 19 | 10.3 | |
| **Washing milk equipment** (%) | | | | 0.032 |
| Before every use | 59 | 59.2 | 59.1 | |
| After every use | 31 | 40.8 | 35.9 | |
| No before and after use | 10 | - | 5 | |
| **Types of milking practice** (%) | | | | 0.005 |
| Milking after sucking | 79.5 | 67 | 73.3 | |
| Milking before milking | 20.5 | 33 | 26.7 | |

*Significance difference levels (P<0.05%)*

### 4.7.4. Traditional plants used for cleaning and smoking milk containers

The current result indicated that dairy producers practice washing of milk handling equipment's with plants. Overall (48.9%) of the producers used "Tenadame (*Ruta chalepensi),* (25.6%) used "Datata" (*Lamium amplexicaule) and (25.5*%) bowanyamo (*Pedicularis groenlandica*) to washing and smoking milk equipment (Table15). Smoking of milk handling equipment is a common practice in many parts of Ethiopia and milk vessels are usually smoked using wood splinters of "tid" (*Juniperous procera)* to bring desirable aroma to the milk. This result also agreed with the result of Sintayehu et al (2008) who reported that milking utensils were smoked with different aroma producing plants. This study was also in agreement with study of (Tsedeyand Asrat, 2015) who reported that *Olea africana* was the most frequently used plant for smoking milk vessels followed by *Juniperus procera*. Interviewed respondents mentioned that smoking is used to develop desirable flavour in the milk and increased shelf life of the milk products. About 64.5% of respondents in current study area use "tid" (*Juniperous procera) while* (12.9%) weyra zaf *(Olea africana) and* (22.6%) old bamboo tree to smoke milk handling equipment.

**Table 15: Traditional plants used cleaning and smoking milk containers**

| Variable | Rural(113) | Urban/Peri-urban(72) | Average |
|---|---|---|---|
| **Washing of milk equipment (%** ***)*** | | | |
| Tenadam (*Rutachalepensis)* | 21 | 76.7 | 48.9 |
| Datata (*lamiumamplexicaule*) | 38.1 | 13 .2 | 25.6 |
| Bowanyamo (*pedicularisgroenlandica)* | 40.9 | 10.1 | 25.5 |
| **Smoking of milk equipment** (%) | | | |
| Tid (*Juniperousprocera*) | 54.2 | 74.8 | 64.5 |
| Weyrazaf (*Oleaafricana*stem) | 10.8 | 15 | 12.9 |
| Old bamboo tree | 35 | 10.2 | 22.6 |

### 4.7.5. Types of water used for washing and farming activity in the study area

Smallholder dairy producers in rural and urban area used different water sources for cleaning purpose. In the study area some of dairy Producers washing milk equipment by using soap (47.4%) and most of them did not practiced (53.6%) (Table 16). On average, water sources for cleaning purpose were river/stream (47.7%), tap water (22.5%), and underground water (20.9%) while the remaining used hand well pump (6.9%). Water from non-tap sources used for different purposes can definitely contribute to poor quality milk and milk products. Therefore, it is important that producers should at least filter and heat treat it before use (Zelalem, 2010). The proportion of households that used river/stream and tap water was significantly different ($P<0.05$) among the rural households than urban.

**Table 16:Source of water for udder washing and milking equipment in the study area**

| Variable | Rural(113) | Urban/Peri-urban(72) | Average | *P-Value* |
|---|---|---|---|---|
| **Washing milk handling equipment** | | | | 0.000 |
| Using soap | 12.6 | 82.2 | 47.4 | |
| No using soap | 87.4 | 17.8 | 52.6 | |
| **Farm activity** | | | | 0.000 |
| River/ stream | 78.8 | 20.6 | 49.7 | |
| Tape water | - | 45 | 22.5 | |
| Under ground water | 11.3 | 30.4 | 20.9 | |
| Hand well pump | 9.9 | 4 | 6.9 | |

*Significance difference (P<0.05%)*

### 4.7.6. Public health associated with raw Milk consumption

Most of dairy producer in the study area mixed fresh milk with milk left over from previous milking of different cows of the same farm is together before consumption. On average 49.4% of the interviewed producers consume raw milk while the remaining 50.6% boil raw milk before consumption (Table 17). Among these some of them had suffered from food borne infections of unknown origin.

**Table17: Public health associated with raw milk consumption (N=186)**

| Variable | Rural(113) | Urban/Pri-uban(73) | Average | *P.value* |
|---|---|---|---|---|
| **Milk Consumption**(%) | | | | 0.005 |
| Boil | 20.4 | 80.8 | 50.6 | |
| Not boil(raw) | 79.6 | 19.2 | 49.4 | |
| **Suffered from food born infection** (%) | | | | 0.112 |
| Yes | 55 | 20.6 | 37.8 | |
| No | 45 | 79.4 | 62.2 | |

*Significance difference (P<0.05)*

### 4.8. Microbial analysis of raw milk in the study area

According to Ethiopian Standard Agency (ESA, 2009), the bacteriological quality of raw cow milk is to be less than 2x105 and 2x105-1x106Cfu/ml for very good and good quality while 1x106-2x106 and above 2x106Cfu/ml for bad and very bad milk quality, respectively.

### 4.8.1. Total Bacteria Count

The overall average TBC in rural and urban/peri-urban area was 5.9 and 5.1log10Cfu/ml for milk samples collected directly from the udder and milking bucket/plastic material respectively (Table 18). There were an increased number of total bacterial counts as compare rural with urban/peri-

urban in the study area. In the rural area there is  less management practice due to lack of enough awareness of hygienic milking practices of milker including  milking without cleaning of udder and using dirty water, poor personal hygiene and milking equipment were major factor which was significantly different ($P<0.05$) in the study are. These finding were contrary with Mekonine and Mengistu (2017) who reported the mean total aerobic bacterial count of raw milk collected from farmers and dairy cooperatives were 6.99 log10 Cfu/ml and 6.87 log10 Cfu/ml, respectively and Habtamu *et al.* (2018) also reported that the overall mean total bacterial count of 7.32 log10Cfu/ml, 6.83 log10Cfu/ml and 6.75 log10Cfu/ml for household, dairy farm, and pasteurized milk samples.

### 4.8.2. Coliform Count

Coliforms are other bacterial group which affects milk quality which is associated with the level of hygiene during and subsequent handling (Tollessa, 2016). The overall average CC in rural and urban/peri-urban area were 5.6 and 4.6 log10 Cfu/ml for milk samples collected directly from the udder and milking bucket/plastic material respectively (Table 18). There were also an increased number of coliform counts in rural area compered urban/pri-urban area. This showed that in rural area milk is more contaminated with fecal material, soil, urine from udder and teat as result increase microorganism accesses enter during milking. The current result was similar with the reported of Abebe (2012) 4.03 log Cfu/ml in Southern Ethiopia and Zelalem (2010) 4.58 log Cfu/ml in the central Highland Ethiopia. According to the European Union standards, CC of raw milk should be less than 100Cfu/ml are considered acceptable for milk intended to be pasteurized before consumption (Fernandez, 2009).

**Table18: Mean (±SD) microbial counts (log10Cfu/ml) of raw milk samples**

| | Rural Overall | | | Urban/Peri-Urban Overall | | |
|---|---|---|---|---|---|---|
| | Udder | Bucket | Mean(±SD) | Udder | Bucket | Mean(±SD) |
| TBC | 5.81±0.08 | 6. 0 ±0.01 | 5.9 ± 0.05 | 5.1±0.07 | 5.09±0.08 | 5.1± 0.08 |
| CC | 5. 1 ±0.01 | 6.04±0.02 | 5.6± 0.03 | 3.07±0.03 | 6.2±0.06 | 4.6±0.05 |

*SD=standard deviation, TBC=Total Bacteria Count, CC=Coliform Count*

## 4. CONCLUSION AND RECOMMENDATION

The study was carried out to assessing challenges of dairy production, hygienic milk production practices and quality aspect in Hula district rural and urban/peri-urban dairy producer's small

holder households. In the study area, majority of householder who were participating in dairy production were male and the hygienic milk production practices were female. The majority of dairy cattle producer in the study area were local cattle and remaining few of them were cross breed. The major challenges faced by dairy cattle producer in the study area were: -shortage/poor feed quality, lacks of clean water, animal health problem during dry season and lack of genetically improved bull and shortage of AI service. The challenges related with milk quality were:-milk adulteration, lack of cooling facility, lack of effective quality controlling system and absences of quality based marketing system are also major challenges to affect income. The presence of poor milk handling practices and absence of hygienic milk production system was a common problem observed in the study area. Unhygienic conditions of milking and milker, unclean milk handling equipment, poor washing of udder during milking among the important determinant factors of milk contamination in the study area.

The overall average total bacterial count (TBC) in the milk collected from the rural and urban/ peri-urban area were 6.0±0.05Cfu/ml and 5.1±0.03Cfu/ml respectively and Coliform count (CC) were 5.1±0.08Cfu/ml and 4.6±0.05Cfu/ml in rural and urban/peri-urban area . Generally, milk collected from the rural area contained high amount of total bacterial count and coliform count as compared to milk sample collecting from the urban/peri-urban area. This is due to milk has been contaminated with milking materials, poor personal hygiene, and contamination of the udder and teats with fecal material before milking.

**From this study the following recommendations could be forwarded**:

- Hula district should employee's dairy expert in each kebele level who sharing the knowledge of dairy production system to the smallholder dairy producer.

- Should give training of smallholder dairy producer for using crossbred to improve genetic make- up of dairy cattle.
- Government should create semen collection center to maximize improved dairy cattle production
- Hula district should teach all dairy producer of hay making system and conservation during the dry season.
- Hula district should provide veterinary service at all kebele level to control animal disease and health milk production for the community.
- Awareness creations needed of milk producer, milker and milk collector to be creating hygienic milk production.

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## Annex.1

**QUESTIONNAIRE USED**

These questionnaires are prepared for smallholder raw milk producers who traditionally produce raw milk. The objective of the questions is study on challenges of dairy production, hygienic milk practice and quality aspects among Rural and Peri-urban raw Milk producer small holder Households. Dear respondent first I appreciate your politeness to participate on this study questionnaires. All the required information fulfilled by yourself through interview and group discussion system; and you requested to give truly information without any restriction.

**Thanks to your all Assistance!**!

Date_____

Region_____

Zone _____

Woreda_____

Kebele_____

**1. Characteristics of household respondent in the study area**

1 Sex of household head 1. Male 2. Female

2 Age of household respondent 1. 18-35 2.36 -50 3. Above 51

3 Educational levels 1.Illiterate 2. Read and Write (<5) 3. Elementary (5-8) 4. High school (10-12 grades complete

**2. Characteristics of Dairy production System in the study area**

1. Do you have any dairy cattle? 1. Yes 2. No

1.1 If yes, how many dairy cattle do you have? 1. One 2. Two 3. Above two

1.2 If no, why? _____

2. How much total land holding per house hold (ha)?

2.1 Crop cultivation_____ (ha)

2.2 Forage land _____ (ha)

2.3 Grazing land_____ (ha)

2.4 Total land holding _____(ha)

3. Which types of the dairy cattle breed do you kept? 1. Local dairy cattle 2. Cross breed

3. Both local and cross breed.

4. Which dairy cattle improvement system do you use? 1. Synchronization 2. Bull service,

3. AI service 4. Both bull and AI service

5. What is dairy cattle production system you practices in the area?

| | | Rural area | Pri-urban area |
|---|---|---|---|
| 1 | Pastoral or agro pastoral dairy production system | | |
| 2 | Mixed crop dairy production system | | |
| 3 | Commercial dairy production | | |

6. What are the major feed resources you use for dairy cattle in your area? 1. Green pasture

2) Crop residue 3).Inset steam and leaf 4. Concentrated feed

7. What are main purposes of the keeping dairy cattle in your area? 1. Home consumption

2. Income generation 3. Meat production.

7.1 If you use other purpose specify _____

8. What is milk yield of your local and cross breed dairy cow in your area?

| Milk yield | | Rural area | | Pri- urban area | |
|---|---|---|---|---|---|
| | | Minimum L/day | Maximum L/day | Minimum L/day | Maximum L/day |
| 1 | Local dairy cow | | | | |
| 2 | Cross breed dairy cow | | | | |
| | | | | | |

9. What is a lactation length of local and cross breed dairy cow in your area?

| Lactation length | | Rural area | | Pri- urban area | |
|---|---|---|---|---|---|
| | | Minimum day/year | Maximum day/year | Minimum day/year | Maximum day/year |
| 1 | Local dairy cow | | | | |
| 2 | Cross breed dairy cow | | | | |

**3. The major challenges of dairy production in the study area**

1. Do you have any challenges of dairy production in your area? 1. Yes 2. No

1.1 If yes, what are major challenges do you have in your area?

| Nos | Challenges of dairy production | Rural area | Pri-urban area | Ranked |
|---|---|---|---|---|
| 1 | Feed shortage high cost of feed | | | |

| | | | | |
|---|---|---|---|---|
| 2 | Shortage of water | | | |
| 3 | Lack of improved cattle breed | | | |
| 4 | Animal health problem | | | |
| 5 | Both feed shortage and lack of improved cattle breed | | | |
| 6 | Housing problem | | | |

2. What are the major challenge of poor feed availability in your area (List and rank them)

1 Lack of awareness_____

2 Lack of feeding_____

3. Shortage of cultivated forage_____

4. Poor feed availability_____

3. What are major problem concentrated feed availability in the area?

1. Lack of awareness 2. High cost of price 3. Shortage of supply

4. Do you have any animal health problem in your area 1. Yes 2. No

4.1. If yes, what are those problems which affected dairy production in your area? (Ranked)

1. Inadequate veterinary drug _____

2. Lack of laboratory _____

3. Lack of timely vaccination_____

4. Lack of skilled human technician_____

5. Where is source of veterinary service in your area? 1. Government 2. Private 3. Both government and private 4. NGOS

**4. Hygienic milk practice in the study area**

1. Do you have dairy house 1. Yes 2. No

1.1 If yes, what type of flooring housing you constructed**?**

_____

1.2. If no housed, why? _____

**2**. Do you have frequently clean your dairy house? 1. Yes 2. No

2.1 If yes how often? 1. Daily _____

2. Two time a week_____

3. Three time week _____

3. Do you wash your hand during milking? 1. Yes 2. No

3.1 if yes, how often wash 1. Before milking 2. After milking 3. No washing

3.2 If no what is reason_____

4. Do you wash udder during milking? 1. Yes 2. No

4.1 if yes how often. 1. Before milking 2. After milking

4.2 if no justified you're reason? _____

5. Do you use towel during milking? 1. Yes 2. No

6. Which milking container do you use during milking? 1. Clay pot 2. Plastic material

3. Aluminum container 4. Both clay pot and plastic material

7. Do you wash milking handling equipment frequently? 1. Yes 2. No

7.1 if yes how often? 1. Before every use 2. After every use 4. Both before and after every use

8. What type of milking practices do you use at time of milking?

1. Milking without sucking 2. Suckling before milking **3.** Suckling before and after milking

9. What kind of water used for washing milk equipment? 1. Cold water 2. Warm water 3. Use soap with cold water.

10. Where are sources of water for farm activity? 1. River/ stream 2. Tap water 3 Underground water 4. Under ground water 5. Hand well pump

11. What are the plants used for smoking milking equipment?_____

12. What are marketing related challenges in your area? _____

1. Low volume of milk production _____

**2.** Distance to market _____

3. Low market demand of the product _____

4 Access to credit_____

13. What are major milk quality related challenges in your area?

| Nos | Challenge related with milk quality | Rural area | Pri-urban area | Rank |
|---|---|---|---|---|
| 1 | Limited awareness the hygienic quality of milk | | | |

| | | | | |
|---|---|---|---|---|
| 2 | Shortage of clean water | | | |
| 3 | Lack of cooling facility | | | |
| 4 | Lack of effective quality control system | | | |
| 5 | Absence of quality based payment system | | | |

15. How do you consume your milk and its product in your area? 1. Boiling (pasteurized)

2. Souring 3. Raw milk

16. What are the purposes of using butter in your area? 1. Human consumption 2. Sale

3. Cosmetic purposes

## BIOGRAPHICAL SKETCH

The Author of this thesis was born from his father ToshеTucha and his mother IdayaLagide in Sidama Region Hula woreda in Hula Keble (01) in May, 1985 E.C. He attended his primary

school in Hula woreda (1-8) at Hula elementary school (1993-2001 E.C). He attended his secondary school in Aletawond high school (2002-2005 E.C). After completing his high school education level, he followed his bachelor of degree in Gondar University College of Veterinary medicine and he followed his Bachelor Degree in Animal production and extension (2006-2008 E.C). After completing higher education level, he employed in Hula woreda livestock and fisher Office and he joined graduate studies in Hawassa University College of agriculture to follow his Master of Science in Dairy science and Technology

Appendix2: survey household on hygienic milk production though group discussion.

Appendix 2: Materials and equipment used for samples

Iceboxes

Appendix 3: Different Medias used for bacteria count

Appendix 4: Labe activity