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CHARACTERIZATION OF SMALLHOLDER DAIRY PRODUCTION AND COW MILK QUALITY IN KOMBOLCHA DISTRICT, SOUTH WOLO, ETHIOPIA

MSC Thesis

BY

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MSc Program in Animal Production

August, 2020

Bishoftu, Ethiopia

CHARACTERIZATION OF SMALLHOLDER DAIRY PRODUCTION AND COW MILK QUALITY IN KOMBOLCHA DISTRICT, SOUTH WOLO, ETHIOPIA

A Thesis Submitted to the College of Veterinary Medicine and Agriculture of Addis Ababa University in partial fulfillment of the requirements for the degree of Master of Science in Animal Production

BY

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As members of the examining board of the final MSc open defense we certify that we have read and evaluated the thesis prepared by: **"Merema Seber Yimer, Entitled**: **Characterization of Smallholder Dairy Production and Cow Milk Quality in Kombolcha District South Wollo, Ethiopia"** and recommended that it be accepted as fulfilling the thesis requirement for the degree of masters in animal production

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DEDICATION

This work is dedicated to Mohammed Endris, and my brother Seid Ali for their unfailing encouragement. I hope this work will inspire them to great heights.

STATEMENT OF AUTHOR

Frist of all, this research is my reality and for this thesis I would like to inform you that all of the use full materials are properly understood. This research is for M. Sc. Degree at Addis Ababa university veterinary medicine and the college of agriculture and is deposited at university library to be made available to borrowers under rules and regulations of the library. I sincere this these is for variety of academic degrees or diploma and certificate award of any else.

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BIOGRAPHICAL SKETCH

The author, Merema Seber Yimer, was born in South Wollo of Amhara National Regional State, in August 1989. She began her education at Abyot Primary School in Tenta *Wereda* and completed her elementary and Junior School at Abyot Primary School. She completed Secondary high School in Adjibar Senior Secondary and Preparatory School, Adjibar in 2003/2006. She then joined Wollega University in 2007 to attend her undergraduate study from where she graduated with a Bachelor Degree in Animal Science in July 2009.

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LIST OF ABBREVIATIONS

(^{o}L)	Lactometer in degree
AI	Artificial Insemination
AOAC	Association of official analytical chemists
CC	Coliform count
Cfu	Colony forming units
CSA	Central Statistical Agency
GDP	Gross Domestic Product
HH	Households
MC	Milk Collection
MP	Milk Producer
P^{H}	Hydrogen ion concentration
PMN	Polymorph nuclear cells
SCC	Somatic cell count
SHD	smallholder dairy
SPC	Standard plate count
SPSS	Statistical package for social sciences
TBC	Total bacteria count
TCC	Total coliform count
WBC	White blood cell

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ABSTRACT

A cross-sectional study was conducted in urban and peri-urban area of north eastern Ethiopia from November 2019 to April 2020 with the objectives to characterize smallholder dairy cattle production systems and to assess the quality of milk at farm gate and milk collection centers in Kombolcha *districts. Totally, 158 randomly selected smallholder farmers from urban and peri-urban areas were included in the study. Data were collected through questionnaire, observation and milk quality analysis. Statistical Package for Social Sciences was used to analyze the data. Sixty milk samples were collected and the analysis of microbiological and physical property was analysis. In peri-urban areas, the majority 10 (20.4%) of the respondents keep cattle for milk sale and in urban area the majority 15 (30.6%) keep cattle for asset. About 41.8 % of the farmers use both AI and bull service whereas 30.6 % use natural mating and 27.6 % of them artificial insemination. Mastitis, Blackleg, Bovine-Pasteurellosis, bloat were the prevalent diseases of cattle in the study area. All of the farmers (51.1%) were using separate house type barn for their cows and milking in their house. More of dairy producers (88.8%) washed their hands before milking while the rest 11.2% did not wash their hands. The overall mean microbiological count of log (TBC cfu/ml), log (CC cfu/ml) and log (SCC/ml) of raw milk was 6.88±0.17, 4.85±0.10 and 5.84 ±0.18, respectively. The pH of all the milk samples collected from MP, MC was found to be 6.65±0.04, 6.67±0.05, respectively. The mean specific gravity of raw milk samples collected from milk producers and milk collection center was 1.029±0.002 and 1.028±0.002, respectively. There were significant differences ($P < 0.05$) within the specific gravity of milk collected from milk producer and milk collection center.*

Key words: *Milk quality, Smallholder dairy production, Urban and peri-urban dairy production*

1. INTRODUCTION

Crop and livestock production is the major economy of Ethiopia which contributes 45% of the national Gross Domestic Product (GDP), more than 80% of employment opportunities and over 90% of the foreign exchange earnings of the country (MOA, 2010). The livestock population of the country was estimated at about 60.4 million cattle, 31.3 million sheep, 32.7 million goats, 1.4 million camel, 56.1 million poultry and 6.5 million beehives (CSA, 2018).

Despite the role of cattle to the farming community in particular and to the national economy at large, the sector has remained underdeveloped and underutilized (Melaku *et al.,* 2011). Dairy production is one of the major sustenance factors for the rural economy of Ethiopia.

Dairy production is one of livestock production system practiced throughout the world. In the country different classifications have been used to characterize the dairy production system. Dairy production classified in to three categories based on their locations, namely, urban, peri-urban, rural dairy production system (Ahmed *et al.,* 2003).

The annual milk production status of the country is very low, about 2.59 million ton per annum and growing at a rate of only 1.4 percent (Azage *et al.,* 2002). Per capita milk consumption in Ethiopia has sharply dropped to below 20 liters compared to the global average of 100 liters. For years, Ethiopia ranked first in cattle population in Africa, however, the dairy industry is not as developed as that of East African countries like Kenya, Uganda and Tanzania (Zegeye *et al.,* 2003).

There are a number of factors to the low productivity in the country which are quantitative and qualitative deficiencies in the feed resource base, diseases, poor animal performance level, weak livestock policies with respect to extension services, marketing and infrastructure and insufficient knowledge on the dynamics of the different types of farming systems existing (Swai

et al., 2005). Smallholder dairying is an important role to produce milk for home consumption and for sale, through income generation, source of nutrition, financing emergency cash needs, and to produce manure for crop production (Chinogaramombe *et al.,* 2008). Milk marketing without quality control measures at the smallholder farm. A product is not usually conducted on routine base and its hygienic control of milk. According to Godefay and Molla (2000), in the urban and peri-urban area milk supply is door-to-door operation due to the lack of quality control at all levels.

The standard marketing and grading system for comparing milk supply to market price is not in line with product quality in terms of consumer health, to desirable good hygienic quality milk product (Zelalem, 2012). To sell row milk in the traditional farmers informally due to absence of organizing, marketing network that has produced milk ineffective to reach the consumer. Moreover, high microbial contamination of milk due to unclean storage utensil as a results of quality losses. To construct allocate interventions and subordinate smallholder milk producers requires a clear understanding of the dairy production systems and associated constraints. Little was known about the smallholder dairy production systems, reproductive and metabolic health disorders and major husbandry constraints. In the study area, most of reported studies on the constraints of dairy cattle production were focused on the work performed on research stations and institutional herds. Thus, it is justifiable to generate scientific information on the production system and the major constraints of dairy cattle in the study area. Therefore, the objective of this study was:

- ✓ To characterize smallholder dairy production system in selected districts and
- ✓ To assess the quality of milk at farm gate level and milk collection centers in the study area

2. LITERATURE REVIEW

2.1. Smallholder Dairying

Smallholder farmers represent about 85 % of the population and are responsible for 98 % of the milk production. Different institutions and researchers have tried to classify smallholder farmers in terms of dairy cattle ownership. Smallholder dairy farming involves keeping dairy cows with a herd of less than seven (7) milking cows on less than 1 ha of land (Henk *et al*., 2007).

Smallholder dairy production in low income countries continues to attract substantial development support from national and international agencies as a viable pathway out of poverty. Development support is greater for dairy production in areas with high population pressure on land and high market demand for dairy products where intensification of production is encouraged (Tulachan *et al*., 2000).

Small holder dairy systems are common throughout the developing countries of Asia, Sub-Saharan Africa and Latin America. There are nearly as many types of smallholder dairy systems as there are farms, because most farms are unique in some way. There are many descriptors of individual farms and these could be categorized into three types: physical, farm family/financial and institutional (Moran, 2005).

The bulk of the milk production in Ethiopia comes from smallholder producers located near or in proximity of capital and regional towns to take advantage of the urban markets (Ahmed *et al*, 2004). Considering the important prospective for smallholder income generation and employment opportunities from the high value dairy products, dairy sector is a major contributor to poverty reduction and improved nutrition in the country. With the present trend characterized by transition towards dairy sector moving towards a takeoff stage (Ahmed *et al.*, 2004).

2.2. Constraints of Smallholder Dairy Production

The Constraints is any barrier that prevents livestock keepers from achieving their goal to improve their livelihoods in the context of smallholder livestock production system. In urban and peri-urban dairy production system the main contributing factors could be Seasonal availability and costs of feeds and feeding system (Sintayehu *et al.*, 2008).

The smallholder dairy production system is also constrained by water shortages. As a result of water shortages during the dry season, free water intake of lactating dairy cows is reduced and limits milk production and reduce health status (Guendel, 2006). The major constraints in development of dairy production feed shortage problems in terms of quality, quantity and cost of feed are noted (Sintayehu *et al.,* 2008). Feeds are generally not available in sufficient quantities owning to overgrazing of lands and uncertain weather conditions. One of the important challenges of Ethiopian dairy sector as inadequate animal feed resources was also reported by other worker (Yilma *et al.*, 2011).

Constraints that hinder livestock development can be broadly categorized into environmental, technical, infrastructural, institutional and policy making reported by other worker Aleme and Lemma (2015). Based on the report, the major technical constraints are under nutrition and malnutrition, high prevalence of diseases, poor genetic resource management and poor market infrastructure.

2.3. Dairy Production Systems in Ethiopia

2.3.1. Rural Dairy Production System

Mixed crop-livestock production is to use most part of highlands within subsistence smallholder farming system systems (Belete *et al.*, 2010). Major feed resources, with minimal contribution of

improved forage and local beverage by-products are Natural pasture, cop residues, stubble grazing. Supplemented feeds to lactating cows, fattening animals, ploughing oxen and to donkeys when they are at work are provided Green grass and concentrates such as Nug-cake and wheat bran. Breeding system in rural production system tacks place natural mating practice. In lowland area pastoralism is the main system of milk production. Generally, water availability, low rainfall, shortage of feed, highly influenced by season and milk production is low (Tsehay, 2002).

2.3.2. Peri-Urban Production System

This system is located around major cities and towns. It comprises of small sized to medium dairy farms which are also capable of keeping improved and local dairy stock. In Addis Ababa and other regional towns commercial dairy farmers and smallholder include peri-urban dairy production system (Ahmed *et al.,* 2003). In this system the major feed resources are agro-industrial by-products, purchased roughage and in addition they use crop residue and pasture land. As reported by Belete *et al.,* (2010), to generating additional cash income is primary objective of milk production. At the moment mixed crop-livestock farmers in the highland expanding, such as those found in Holetta and Selale serves as the major milk supplier to the urban market (Gebre Wold *et al.,* 2000).

2.3.3. Urban Dairy Production System

Urban dairy systems in general are located in cities and/or towns and focuses on production and sale of fluid milk, with little or no land resources, they used stall feeding practices (Ayenew *et al*., 2008). Milk production systems are emerging importance components in Ethiopia urban and peri-urban dairy production systems. In this production system type of commonly feed are

purchased concentrates, roughages of conventional, non-conventional sources *atela* and different fruits, wastes and road side grazing were also used. (Asrat *et al.*, 2016).

This system generally focused on fluid milk sale, limited access to grazing land, they are often based on Stall feeding practice (Yitaye *et al.*, 2009). The major feed resources in urban production system which are agro-industrial by-products and purchased roughage. Fekede *et al.* (2013) also stated that urban dairy production is relatively intensive and mainly based on stall-feeding using purchased roughages and concentrates.

2.4. Milk Handling

Throughout the world milk and milk product play importance roles for human nutrition. The quality of the milk is highly dependent on farm management because milk is highly perishable and can easily adulterate. Strict and comprehensive dairy regulations are therefore customary and necessary Banda (2010), around the world food borne disease is a great concern with respect the safety of dairy products. Unsanitary condition and poor production practice takes place under developing countries where production of milk and various dairy products (Zelalem and Faye, 2006). Materials used for milking, processing and storage effect of the quality of milk and milk product. High contamination of milk by bacteria as potential source due to the use of plastic and traditional container, because high accumulation of bacteria on milk to contact surfaces during the interval between milking (Abebe *et al*., 2012).

2.5. Milk Marketing System

Market access is one of the most important factors. Currently farmers are constrained due to, amongst others, information asymmetries, price risk and production risk. The public system is

not functioning in an efficient or coordinated manner to support the smallholder (Spielman, 2006). 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 demand in the market (Gatwech, 2012).

According to (Azage, 2013) study conducted in Shashemene Oromia Region, and Hawassa, Yirgalem/Dale and Dilla in Southern Nations, Nationalities and Peoples, marketing of fluid milk in urban system is arranged through direct contact between producers and consumers, and/or involves wholesalers/processors, cooperatives, and retailers. Ethiopia has no market for dairy, with the exception of few major urban areas. Lack of markets affects the overall dairy production and consumption in the country (SNV, 2008). Generally dairy marketing systems are traditional; during milk marketing, in majority of household whole milk and butter are used for sale (Gatwech, 2012).

2.6. Dairy Cattle Husbandry Practices

2.6.1. Feeding Practice

The major feed resource for ruminants in the tropics and sub tropics encompasses natural pasture, crop residues and agro- industrial by products. Besides forage legumes and concerned forage complement the total ruminant feed in most of the region (Falvey and Chantalakhana, 1999). Urban and peri-urban farms are mostly landless and are located within or close to major towns and cities. The higher demand of milk in urban population has been a driving force for establishment of urban and peri-urban dairy farms (Habib *et al*., 2007).

In Ethiopia dairy feed resources are mainly from crop residues, hay, improved forage, agro industrial byproducts and non-conventional feedstuffs. Hay is the commonly used feed stuff in

central highlands of Ethiopia. However, the composition and nutritive value of hay collected from various agro-ecological generally, crop residues from cereals such as barely, wheat, *teff) straw*, peals straw such as (legume, peas, and lentil) and maize and sorghum Stover form the basal diets of the animals. The majority of urban farms used concentrate as a supplement for dairy cattle which is less practiced in peri-urban farms. However, a by-product local beverage was commonly used as supplement to local cows both in urban and peri-urban areas (Derese, 2008).

2.6.2. Housing

Type of housing provided for dairy animals varied depending upon the classes of dairy animals, agro-ecology, production system and physiological stage (Azage *et al.*, 2013). In urban and peri-urban area the roof is made of iron sheet, but the wall varies depending on economic status of the owner, some of them have built with block and the other built with wood and mud, whereas the floor was constructed in concrete, soil compact with or without beddings. A good quality shed for dairy cattle provides comfort to the animal, decreases wastage of feedstuff and ensures better environmental control. Proper clean housing environment and equipment help to ensure that the animals are taken care of appropriately and that adequate facilities are available to manage the cows effectively (Asaminew, 2007).

Manure from the urban areas is also supplied to a limited extent to the peri-urban areas, particularly to crop producing farms. Therefore, contribution of manure produced as organic fertilizer was, thus, found economically important to both dairy farm owners and even to the surrounding rural farmers dairy farmers in urban and peri-urban, respectively, were using manure as source of their immediate income (Gebrekidan, 2014).

Manure from these animals plays a very important role for farming of their food crops. Waste management is one of the major routine activities in dairy production. So it is a must to properly clean manure and urines from the dairy house/shelter to assure good and hygienic working conditions/environments. Additionally, inadequate manure management can pose potential haphazard and present serious problems to both animals and humans and threat to local water quality through excess runoff with a little planning and ingenuity, however, livestock manure can become an important value-added of byproduct of daring in just about any size operation (Page,2014).

2.6.3. Watering and Water source

A good supply of clean water is essential for the production of quality milk. The utensil used for milking and containers should be clean as the same drinking water (Younan *et al.*, 2007). Unsafe water is a major contributor to poor quality. However, producers should apply it before using filtration heat treatment (Zelalem, 2010).

2.6.4. Breeding and Calf Rearing Practice

The most common cattle breeding system in Ethiopia is natural uncontrolled mating and AI is currently in use in only few areas in Ethiopia. Smallholder dairy farms prefer AI to natural mating, but the unavailability of the AI services regularly, forces them to use natural mating (Mekonnen *et al.*, 2006). The breeding objective in any livestock species is to increase profit by improving production effectiveness. Profit is a function of income and costs generated by each animal category composing the herd (Wolf *et al.*, 2011). Breeding is the first and probably most important step to be taken in dairy cattle farming. Without it, the program could result in genetic change, but in the wrong direction. Improving the wrong traits is corresponding or even worse than no improvement at all (Van der Werf, 2004).

In most tropical countries, livestock service is implemented as artificial insemination and natural breeding techniques (Bebe *et al.,* 2003). Dairy farmers in the highland, midland and the lowland areas of Ethiopia used natural mating by using an indigenous breeding bull (Tesfa, 2009). Along with natural mating, some farmers used AI in highland and midland areas. A study by Solomon *et al.* (2014) also indicated that the most of the farmer in the Metekel zone are based on natural breeding because there is no artificial insemination resource.

After parturition, cows are not milked for about two weeks during which calves are kept with and allowed to suckle their dams freely. Milking commences after two weeks of calving and the calves are allowed to suckle their dams for short time before and after milking for local cattle. Bucket feeding of milk is practiced before weaning mainly by farmers who owned crossbred cows. In Tanga Region, northeast Tanzania restricted suckling (71%) and bucket feeding (29%) were the commonest form of pre-weaning calf rearing systems practiced. Many farmers in the studied area believe that mastitis can be minimized by practicing restricted suckling. The mean weaning age was 130 days and ranges 0 to 360 days (Swai *et al*., 2005).

A study by Ayele (2012) described that in Fogera; Jeldu and Diga districts of the Nile Basin about 25% of the total 207 respondents practice weaning of their calves. In and around Boditti town, South Ethiopia, 25% of households, followed early weaning (after 3 or 4 months) if there is feed availability for the calves, 14.2% wean when the cow becomes pregnant or aggressive for the calf, while the majority (51.7%) of the households wean calves when the dam/cow becomes dry.

2.6.5. Disease

Disease has numerous negative impacts on dairy production in various ways such as premature, death, reduced body weight, fertility, reduced yield of milk and reduced capacity for work and almost all the diseases have severe effects on overall production efficiency of animals (Belayeneh, 2013).

2.7. Physical Properties of Milk

2.7.1. PH value

The pH of milk determines whether it is considered an acid or a base. Milk is slightly acidic or close to neutral pH. The exact value of a sample depends on when the milk was produced by the cow, any processing done to the milk, and how long it has been packaged or opened. Other compounds in milk act as buffering agents, so that mixing milk with other chemicals brings their pH closer to neutral.

The pH of a glass of cow milk ranges from 6.4 to 6.8. Milk fresh from the cow typically has a pH between 6.5 and 6.7. The pH of milk changes over time. As milk goes sour, it becomes more acidic and the pH gets lower. This occurs as bacteria in milk convert the sugar lactose into lactic acid. The first milk produced by a cow contains colostrum, which lowers its pH. If the cow has the medical condition mastitis, the pH of the milk will be higher or more basic. Whole, evaporated milk is slightly more acidic than regular whole or skim milk **(**Walstra *et al.*, 1999**).**

2.7.2. Density

The density is a relationship between the body mass and the volume this body occupies in the space. The density test is performed in order to be used in the detection of adulteration in the milk, since the addition of water only would cause the decrease in density, whereas the skimming (fat removal) would cause an increased density in the milk, besides supplying important information for the determination of the total dry extract.

2.8.Bacteriological Quality Tests

Due to its complex biochemical composition and high-water activity, milk serve as an excellent culture medium for the growth and multiplication of many kinds of microorganisms. Presence and multiplication of saprophytic bacteria in raw milk might change the milk composition and influence the quality of the product (Godefay and Molla, 2000). Sanitary methods of handling milk must be strictly adhered to rigidly in order to provide safe m ilk for human consumption. Furthermore, since milk is a good growth medium, even a small number of non-pathogens can multiply considerably if the milk is not kept refrigerated. Because the consumer has no way of knowing whether or not the m ilk delivered to the home or purchased in the store is contaminated, a number of standard tests are carried out periodically on milk in that area. From the results of these tests, milk is classified into grades designated as A, B, and C Tests commonly employed to determine the quality of milk include Standard plate count and Coliform count (Volk and Wheeler, 1980).The total number of aerobic bacteria present in the milk at the time of pick up the standard plate count of raw milk gives an indications. Obviously, very clean milk 18 will have lower bacterial counts than milk collected or handled under unsanitary conditions. The standard plate count is a basis for grading milk. Kurwijila *et al.*, (1992) reviewed bacterial count

graded in to very good, good, fair and poor when not exceeding 200,000, 200,000-1,000,000, 1,000, 000- 5,000,000 and greater than 5,000,000 respectively.

All plate counts are expressed as the number of colony forming units (cfu) per milliliter. This method is used mainly to estimate the bacterial population of raw milk prior to heat treatment. It has a limited value in that it doesn't indicate the quality of microbial populations in terms of pathogens and non-pathogens. Plate count standards have been developed to ensure satisfactory production hygiene and that the product is safe (Hamann, 2003).

Non-spore forming rods, grams negative, facultative anaerobic and comprises of the coliform group of bacteria. that are able to ferment lactose with production of acid and gas at 300C within 24 hours. Coliforms comprise the genera *Escherichia, Enterobacter, Citrobactor* and *Kelbsiella*. In proportion to the number present, existence of any of these types in dairy products is indicator of unsanitary conditions or practices during production, processing or storage. Dairy hygiene is given less serious attention in Ethiopia.

Somatic cells are composed of white blood cells (WBC) and occasionally sloughed epithelial cells. Cells found in normal cattle milk from uninfected glands include neutrophils (1.1%), macrophages (66.68%), lymphocytes (10-27%) and epithelia l cells (0-7%) (Hamann, 2003).When bacteria invade and colonize the mammary gland, the macrophages respond by initiating the inflammatory response that attracts polymorph nuclear cells (PMN) in to the milk to engulf and destroy bacteria. More than 90% of SCC in infected glands is composed of neutrophils. The cells can be counted by a direct microscopic method on stained milk smears. The most commonly used automated device for rapid determination of SCC in milk samples is the somatic milk cell counter. This instrument stains cells with a fluorescent dye and then counts the number of fluorescing particles (Hamann, 2003).

2.8.1. Sources and Microbial Load of Raw Milk

Milk may contaminate and increment in microbial load along at different critical points of milk marketing from farmer to the consumer level. Raw milk can leads to contamination by poor hygienic practice and dirty breasts and due to operator hygiene (Blowey, 2010). Alganesh *et al.* (2007) reported the overall mean total bacterial count of cows' sampled from a small scale producer in East Wollega Ethiopia was 7.60 log10 cfu/ ml in milk. Worku *et al.* (2012) who reported bacterial count 7.36 -7.88 log10 cfu/ml from raw cows' milk in Borana, Ethiopia; In DebreZeit, Ethiopia 7.07 $\log_{10}$cfu/ml (Mosu et al., 2013) and in Bahir Dar, Assamnew and Eyassu (2011) reported 7.58$\log_{10}$ cfu/ml.

2.8.2. Control of Milk Contamination

Physicochemical and microbiological analyses are an important tool to monitor the quality of dairy products (Hettinga, *et al*., 2008). Microbiological quality control is to provide fluid milk from disease-free udders (physiologically healthy animals) to milk processing plants to manufacture wholesome milk and milk products (Barbuddhe, 2008). Chilling the milk fast ensures a longer shelf life and it tastes better if it is chilled quickly and stays cool. If milk does not stay cool, it will sour and separate (Martin *et al.,* 2007).

Microbial control includes minimization of microbial sources in the farm environment, minimization of microbial transmission, prevention of microbial growth, and infection of animals. Many aspects of farm management (feed management, facility hygiene and milking operations) are involved in the control of the microbial contamination of bulk tank milk. However, the total bacterial count will also be affected by factors that are independent of farm management, such as seasonal variations (Wiley, 2009).

Hygienic milk production, proper handling and storage of milk, and appropriate heat treatment can reduce or eliminate pathogens in milk (Kurwijila, 2006). To ensure a good microbial quality of bulk tank milk, quality assurance systems for dairy farms are being developed and bacteriological schemes are being implemented in payment systems of farm raw bulk milk (IDF, 2006). The most commonly used microbial quality tests for milk and milk products include determination of total bacterial count (TBC) or standard plate count (SPC) and coliform count (CC) (Amistu *et al*., 2015). Provision of microbiological quality parameters of raw milk and milk products plays an important role in quality control. It is necessary to minimize technological and economic losses in milk processing and obtain a longer shelf life (Gurler *et al.,* 2013).

Total bacteria is said to be an importance indicator of hygiene during storage of raw milk (Fatine *et al.*, 2012). To meet increased raw milk quality standards, producers must adopt production practices that reduce mastitis and reduce bacterial contamination of bulk tank milk. Use of effective management strategies to minimize contamination of raw milk and proven mastitis control strategies will help dairy producers achieve these important goals (Oliver, 2010). The use of detergents and good quality water for clean the equipment.

3 MATERIALS AND METHODS

3.1 The study areas

Kombolcha town is an industrial town found in the north eastern part of Ethiopia located in South Wollo Zone of the Amhara Regional State. It is situated at a distance of 377 km from Addis Ababa. The town is located at about 11^0 6′ North latitude and 39^0 45′ East longitude with an elevation between 1842 and 1915 meters above sea level. The town is bounded by Dessie Zuria *Woreda* in the Northeast and Northwest, Kalu *Woreda* in the South and Albuko *Woreda* in the Southwest. The town has 6 urban and 6peri urban *kebeles*. Based on the 2015 national census conducted by the Central Statistical Agency of Ethiopia (CSA), Kombolcha woreda has a total population of 125,367, of whom 50,180 are men and 75.185 women;98,677 or 98.9% are urban inhabitants living in town of Kombolcha, the rest of population is living at rural *kebeles* around Kombolcha. The majority of the inhabitants were Muslim, with 63.9% reporting that as their religion, while 20.2% of the population said they practiced Ethiopian Orthodox Christianity and 15.9% were Protestants.

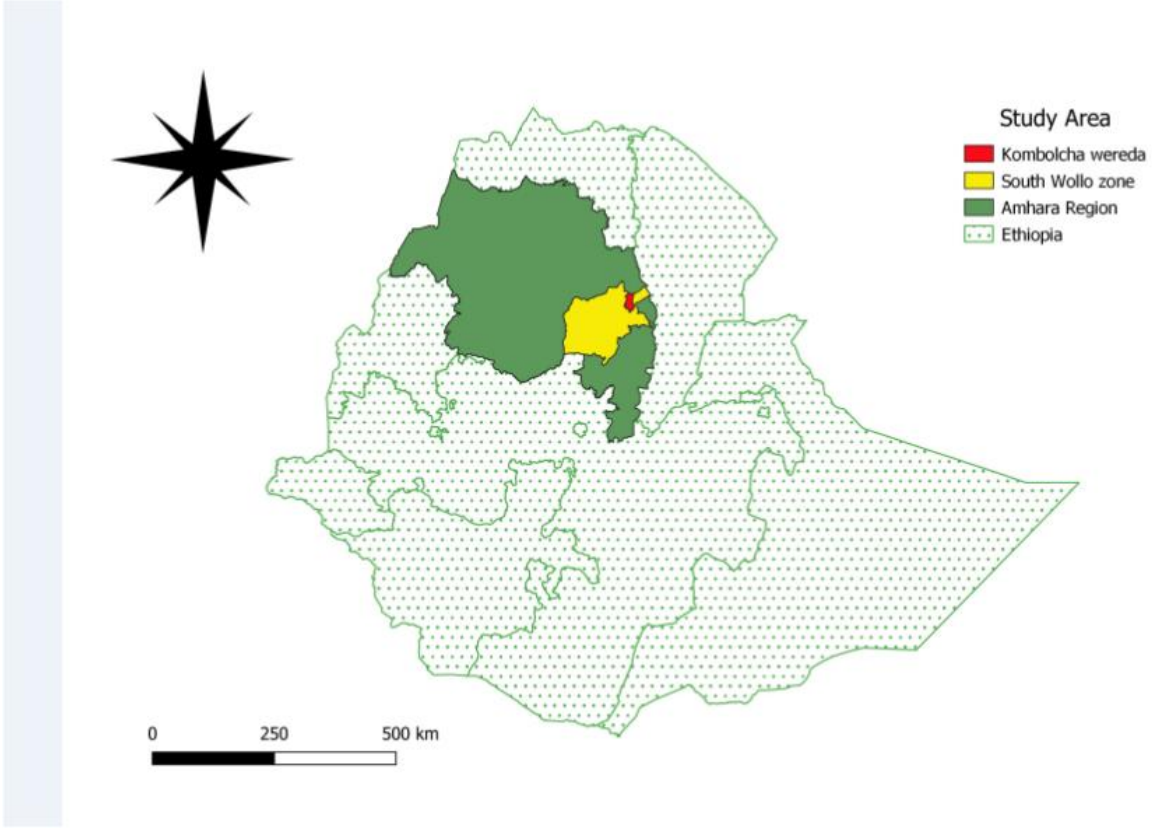

Figure 1: Map of the study areas

3.2 Study population

A total of 98 smallholder dairy farmers who own improved and exotic dairy cows and two cooperative that have milk collection center were used to collect the required data.

3.3 Study Design

A cross sectional study was conducted from November 2019 to May 2020 using questionnaire interview, and personal observation to collect data on characteristics and management practices of smallholder dairy production systems and associated cattle production constraints at two dairy cattle production sites, namely; urban and peri urban dairy cattle production sites. In addition, with questionnaire data, raw milk sample were collected from smallholder farmer and collection

center to analyze for the Physical property of raw milk and the presence of bacteriological agents was assessed; through standard plate count, coliform and somatic cell count tests parameters.

3.4 Sample size and sampling procedure

To select representative samples, the potential of the urban and peri urban area were identified. Urban area has 6*kebeles* of which three have potential in dairy production. From the list of these six *kebeles*, three were selected purposively. These included Abisha Ager (01), Kuteba (04), and Berbera Wonz (05). About 49 households were selected from each kebeles, Abishaager (20), Kuteba (19) and Berbera Wonz (10) with the number in parenthesis indicating sample size. Peri-urban *kebeles* has also six *kebeles*, of which three have potential in dairy production. From the list of these six three namely, Tulu Adama (07), Woyirawu (010), Sheshaber (012) were selected. Forty-nine households owning dairy cattle were selected Tulu Adama (14), Woyirawu (15), and Sheshaber (20) respectively. For the laboratory analysis, milk samples were collected from two milk collection centers (30 samples from each) operated by cooperatives.

The sample size was determined according the formula given by Arsham (2007) for survey studies: N = 0.25/SE2 Where, N = sample size; SE = Standard error of dairy farms. Accordingly, by assuming standard error of 3.98% as follows, N=0.25/ (0.0398)2=157.8 ≈158 approximately

3.5 Data Collection

3.5.1. Questionnaire survey

The data used for this study were collected from primary and secondary sources. Primary data on the dairy production and marketing system were collected from the milk closed type questionnaire format, observations. Secondary data were collected from different documents and

publications. During the survey data collected from smallholder producer based on the, demographic and socio-economic characteristics of households ,dairy management (dairy cattle breeding, milking, milk handling and transporting, calve rearing, major feeds, housing, disease occurrence). Closed type questionnaire format was used to collect data from smallholder produces focused on the hygienic handling practices during milk production (barn type and cleaning practices, and milk utensils), type of storage container, quality testing methods and other related data were collected.

3.5.2. Collection of milk samples

Raw milk sample was collected at farm and milk collections centers, by following strict aseptic procedures. Then milk was thoroughly mixed after which 25 ml of milk was transferred into sterile sampling bottles. The milk sample bottles was capped, labeled with a permanent marker

Put in ice box (4°C) to restrict microbial multiplication and transported to Veterinary Microbiology Department of Kombolcha Regional Animal Health Laboratory for analysis of microbial quality.

3.6 Bacteriological Quality Tests

Tests employed to determine the quality of milk for bacteriological quality test were Standard plate count, Coliform count, and somatic cell count and physical characteristics (density, P^H.). Detailed description of the steps followed in each of the methodologies is presented in the following sections.

3.6.1. Standard plate count (SPC)

The standard plate count of raw milk samples was performed by putting one ml of milk sample into a sterile test tube having 9 ml peptone water. After mixing, the sample was serially diluted

up to 1: 10-7 and duplicate samples of 1 ml of diluted milk samples were streaked on 15-20 ml standard plate count agar media and then incubated for 48 hours at 37^0c to encourage bacterial growth. Finally, colony counts were made using colony counter. Single bacteria species or clusters grow to become visible colonies that were then counted. All plate counts were expressed as the number of colony forming units (cfu) per milliliter. Results from plates, which contained 10 to 300 colonies per plate were recorded.

3.6.2. Coliform count (CC)

The coliform group of bacteria comprises all aerobic and facultative anaerobic, grams negative, non-spore-forming rods that are able to ferment lactose with production of acid and gas at 37^0c within 24 hours. Finally, colony counts were made using colony counter (Marth, 1978). The corresponding total coliform count (TCC) and total bacteria count (TBC) were computed from duplicate plates containing between 25-250 colonies. Plates containing less than 25 colonies were taken as less than 25 estimated counts and plates containing greater than 250 colonies for all dilutions were recorded as too numerous to count (TNTC) (Maturin and Peeler, 2001).

The higher coliform count observed in the current study it might be attributed to the initial contamination of the milk through the milkers, milk containers and milking environment. Since it is not practical to produce milk that is always free of coli forms, even at high level of hygienic condition; their presence in raw milk to a certain extent may be tolerated. Coli form (CC) count less than 100 colony forming Units (CFU)/ml is considered acceptable for milk intended to be pasteurized before consumption. After counting and recording bacterial colonies in each petridish, the number of bacteria in milliliter milk was calculated by the following formula given by American Public Health Association (APHA, 1992).

3.7. Somatic Cell Count

In SCC analysis, direct microscopic counting method was performed. Milk film preparation, staining and counting was done according to the standards set by International Dairy Federation 1995).To obtain a uniform distribution of cells, milk samples were mixed by moving upside down gently 25 times and allowed to stand for 2 minutes to permit air bubbles and foam to disappear. Microscopic slides degreased with alcohol before milk film preparation. A 0.01ml of milk was taken with a 50µl micropipette calibrated at 10 and spread evenly over one cm^2 area on a microscopic slide and allowed to dry at room temperature on a leveled table. One cm^2area was delineated by a template prepared from a cap board. Dried films were dipped in toluidine blue dye for 30 minutes. After 30 minutes, slides were left to dry for a few minutes, washed with tap water then allowed to dry again in a dust free area. Stained slides were stored in slide box until counted. Using oil immersion objective those cell nuclei clearly recognizable and those at the periphery with more than 50% of the cell body in view was counted.

To measure the diameter, first stage micrometer slide was placed on a microscope stage. Then under oil immersion objective the number of divisions in stage micrometer was counted. Each division on a stage micrometer slide represents 0.01mm and hence to calculate the field diameter, the number of divisions counted will be multiplied by 0.01mm.

3.8. Physical Property of Milk Test

3.8.1. P^H-value

The p^H (Hydrogen ion concentration) meter was calibrated with standard buffers 4 and 7before measuring the pH of the mixture. For determination of pH in the products, method of AOAC (2000) was adopted and digital pH meter was used. Sample solution was taken in the beaker and

directly inserted the electrode into the solution. When the first reading was completed, the electrode was wiped with distilled water and dried-up with tissue paper. Similarly, all other samples were determined accordingly.

3.8.2. Density

Milk samples were taken from milk collection center checked for adulteration. A total of 60 milk samples were tested. Adulteration was checked by measuring the specific gravity. 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 was considered as an indication of milk with water and skim milk, respectively. The materials (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 (°L) just above the surface of the milk was read, recorded and finally, the milk density was calculated.

3.9. Data analysis

All the collected data were arranged on Microsoft Excel 2010 before the actual data analysis was conducted. The coded data were analyzed through Statistical Package for Social Science (SPSS version 20) software. The total bacteria and coliform count data was transformed to log values before subjected to statistical analysis.

4 RESULTS

In this section, 98 households were interviewed to capture some issues related to household characteristics, farming activities, dairy management, husbandry practice and milk samples were collected from 60 households and two milk collecting cooperative.

4.1. Characteristics of Households

4.1.1. Demographic Characteristics of Households

In the study areas, over 81.6%, 79.59% of the study participant households were male headed and 18.4%, 20.41% were female headed in urban and peri-urban areas. About 32.65%, 20.42% of the age of the respondents falls in the range of 18-30 years, 18.37% and 30.61% of the age of respondents fall in the range of 31-45years, 22.45% and 30.61% of the age of respondent's fall in the range of 46-55 years, 18.37 % ,10.20% of the age of respondents fall in the range of 56-65years and 8.16 % of the age of respondents above 65 years in urban and peri-urban respectively. The marital status of the sample respondents were married (63.3, 42.9%), divorced (6.1%, 22.4%) and single (30.6%, 34.7%) in urban and peri-urban respectively (Table 1).

Table 1: Percentage of Demographic Characteristics of Households in the study area

		Urban		Pre-urban		Overall	
		N	%	N	%	N	%
Variable category							
Sex	Male	40	81.6	39	79.59	79	80.6
	Female	9	18.4	10	20.41	19	19.4
Age	18-30	16	32.65	10	20.42	26	26.5
	31-45	9	18.37	15	30.61	24	24.5
	46-55	11	22.45	15	30.61	26	26.5
	56-65	9	18.37	5	10.20	14	14.3
	>65	4	8.16	4	8.16	8	8.2
Marital status	Married	31	63.3	21	42.9	52	53.0
	Single	15	30.6	17	34.7	32	32.7
	Divorced	3	6.1	11	22.4	14	14.3

N=number of observations, %= percentage

4.1.2. Educational status in the study areas

The respondents in the study area had different educational status. The proportions of respondents read and write 1-4 grades, 5-8 grades, 9-12 grades were 30.6%, 28.6%, 20.4%, 20.4% in peri-urban and urban study areas as indicated in (Table 2).

Table 2: Educational status in the study areas

Educational status of HH	Production systems		
	Peri-urban=49 (%)	Urban=49 (%)	Overall (%)
Read and writing	30.6	10.2	20 (20.4)
1-4 grade	28.6	30.6	29 (29.6)
5-8 grade	20.4	20.4	20 (20.4)
9-12 grad	20.4	38.8	29 (29.6)

HH: Households,

4.1.3. Source of Income of the Respondents

Majority of the sampled respondents (51.0%, 30.6%) get their household likelihood primarily income from livestock production in urban area and peri-urban areas. Others consider livestock production as the main source of household income with supplementary crop production and other side business activities were (38.8%, 10.2%) and (10.2%, 59.2%) like shop, transport service, hotel in peri-urban and urban areas (Table 3).

Table 3: Percentage of the households' sources of income

Variable	Location					
	Peri-urban=49		Urban=49		Overall (%)	
	N	%	N	%	N	%
Crop production	19	38.8	5	10.2	24	(24.5)
Livestock production	25	51.0	15	30.6	40	(40.8)
livestock production and side business	5	10.2	29	59.2	34	(34.7)

4.2 Husbandry Practices in Study Areas

4.2.1. *Purpose of keeping cattle*

In peri-urban production system 61.2% respondents reported purposes of keeping cattle were for draught power, 20.4% of respondents for milk sales, 10.2 % of respondent's milk for home consumption and 8.2 % respondents were for the purposes of accumulation of asset. In urban production system 61.2% of respondents for milk sales, 8.2% of respondent's milk for home consumption and 30.6% respondents were for the purposes of accumulation of asset (Table 4).

Table 4: Primary purposes for keeping cattle in the study areas

	Location			
Variables	Urban		peri-urban	
	N	%	N	%
Purpose of Keeping cattle				
Milk for home consumption	4	8.2	5	10.2
Milk for sale	30	61.2	10	20.4
For asset	15	30.6	4	8.2
For draught power	*	*	30	61.2

* No Involvement

4.2.2. Breeding system

Different cattle breeding system practices were mentioned by the sampled households in the two locations. More than 30.6 % of the respondents used natural breeding by using bull service. Only 27.6 % of the households were using artificial breeding and majority of them (41.8 %) used both natural and artificial insemination for breeding their cattle. Households who were using natural breeding system get breeding bull from different sources. Majority (35.7 %) of the households were using breeding bull either a selected bull from their own herd and 30.6 % from neighbor bull. The rest of households (26.5 %) were using purchased bull and only7.2 % did not able to locate source of bull (Table 5).

Table 5: Method of dairy cattle mating practices (% of respondents)

Variable	Variable category	Location		
Breeding system		Peri-urban=49	Urban=49	Overall (%)
	Natural breeding	20.4	40.8	30(30.6)
	Artificial insemination	24.5	30.6	27(27.6)
	Both	55.1	28.6	41(41.8)
Source of bull	Selected from herd	30.6	40.8	35(35.7)
	Purchased	22.4	30.6	26(26.5)
	Neighbor bull	40.8	20.4	30(30.6)
	Couldn't identify	6.2	8.2	7(7.2)
Distance to the AI center	1-5km	30.6	32.7	31(31.6)
	6-10km	51.0	20.4	35(35.7)
	>10km	18.4	46.9	32(32.7)

N= number of observations, % percentage

4.2.3. Feed resources and problem associated with feeding in the study areas

The major sources of feed for dairy cows in the study area were industrial by product, improved forage, crop residues, hay and non-conventional feeds (Table 6). Accordingly, crop residues and hay, industrial by products were the major feed resources of the study area. The availability of feed resources in the area depends on seasons. However, crop residues (teff straw, wheat straw and barley straw) and conserved forage (hay), were used both in wet and dry seasons. Few farmers used mineral licks as a supplement for dairy cows.

Table 6: Reported feed resources of smallholder dairy (%)

Variable	Variable category	Location		
Major feeds		Peri-urban=49	Urban=49	Overall (%)
	Crop residue	21	0	21(21.4)
	Hay	0	15	15(15.3)
	Improved forage	15	4	19(19.4)
	Industrial by product	10	20	30(30.6)
	Non-conventional feeds	3	10	13(13.3)
Total		49	49	98(100)
Major feed supply for dairy cattle	Own farm produced	9	0	9(9.2)
	Both produced & purchasing	25	9	34(34.7)
	Purchasing	15	40	55(56.1)
Total		49	49	98(100)

SHD =smallholder dairy, N= Sample of respondents

4.2.4 Cattle housing practices

Table 7 showed the farmers' percentage used housing system and cleaning, types of house and material used for the floor among the study areas. While comparing the farmers in study areas, it was seen that the farmers used the concrete. Due to easy to clean, the concrete floor is preferable over the mud floor. It is difficult to clean the mud floor. The economic ability of the farmers plays a key role whether they use concrete or mud floor. All most all the farmers cleaned the animal house at least once per a day. In the remaining of the farmers, it was done only occasionally, every day, two per week two times per week or three times per week.

Table 7: Dairy cattle housing conditions under smallholder farmers (% of respondents)

Variable	Variable category	Location	
		Peri-urban=49	Urban=49
Type of housing	Separate house	51.1	51.1
	Backyard enclosed	*	*
	Feed trough only	38.8	22.4
	Feed water trough	10.2	26.5
Materials used for the floor	Mud	22.4	22.4
	Concrete	51.1	61.2
	Stone	26,5	16.3
Frequency of removing the material	Every day	69..4	81.6
	Two times per week	16.3	10.2
	Three times per week	14.3	8.2

*No Involvement

4.2.5. Milking management and hygiene practices

The milkier can be an important source of milk contamination. Therefore, more of respondent dairy producer (88.8) washed their hands before milking while the rest 11.2 % did not wash their hands (Table 8). In Urban and peri-urban dairy production systems respondents reported milking frequency were, 25.5 % milked their cattle during morning, 56.1% during morning and evening, 18.4% during evening only, during milking time 61.2 % udder washing before milking12.2% washed after milking only and 26.5% no washing. Nearly 62.2% of the smallholder was the cases collective towels for cleaning udder of milking cows and 23.5% of the smallholder households just with hands for udder drying and 14.2% households do not practice udder drying (Table 8).

Table 8: Milking management and hygiene information (% of the respondents)

		Location					
Variables	Category of variables	Urban		peri-urban		Overall%	
		N	%	N	%	N	%
Milking frequency	Morning only	10	20.4	15	30.6	25	25.5
	Morning and evening	30	61.2	25	51	55	56.1
	Evening only	9	18.4	9	18.4	18	18.4
Washing hand before milking	Yes	44	89.8	43	87.8	87	88.8
	No	5	10.2	6	12.2	11	11.2
Udder washing time	Before milking only	30	61.2	30	61.2	60	61.2
	After milking only	3	6.1	9	18.4	12	12.2
	No washing	16	32.7	10	20.4	26	26.5
Type of towel used	Collective towel	34	69.4	27	55.1	61	62.2
	No washing and drying	5	10.2	9	18.4	14	14.2
	Just with hands	10	20.4	13	26.5	23	23.5

4.2.6. Milking container and sanitary practices

In the present study, milking containers and sanitary practices are shown in Table 11. Majority of milk producer farmers used plastic made milk containers during milking and transportation to milk collection centers and processing plants. About 48.9 % of the respondents washed their milk container with cold water, and 15.3 % of the respondents used hot water 21.4 % used cold water and soap while 14.3 % used hot water and soap.

Table 9: Milking container handling and sanitary practices (%)

Variable	Variable category	Location		
		Periurban=49	Urban=49	Overall(%)
Container used for transportation/delivery	Plastic	38	49	87(88.8)
	stainless steel cane	11	*	11(11.2)
Types of water used for Cleaning the container	cold water	24	24	48(48.9)
	hot water	4	11	15(15.3)
	Cold water and soap	16	5	21(21.4)
	Hot water and soap	5	9	14(14.3)

*No involvement

4.2.7. Calf rearing and weaning practices

Management practices for calves in the study areas are given in Table 10. In the current study, the respondents used bucket feeding, partial suckling and both methods. The result of this study shows 74 (75.5%) of the respondents isolate newly born calves within 2-3 days and use bucket feeding system. But the majority of the sampled households 24 (24.5%) do not isolate the calves from their dams (Table 10). For Bucket fed crossbred calves in kombolcha districts, weaning age ranges from 3-6 months of age depending on the growth rate and body condition of the calf. Since there was no practice of isolating local calves from their dams mainly in the peri urban areas, weaning age ranges from 9-18 months of age (Table 11).

Table 10: Calf rearing practice in the study areas (% respondents)

Variable	Variable category	Location				
		Peri-urban=49		Urban=49		Overall (%)
Newborn calves Isolation		N	%	N	%	N
	Yes	40	81.6	34	69.4	74(75.5)
	No	9	18.4	15	30.6	24(24.5)
Calf milk feeding	bucket feeding	40	81.6	34	69.4	74(75.5)
	Partial suckling	5	10.2	10	20.4	15(15.3)
	Both	4	8.2	5	10.2	9(9.2)

N=number of observations, %=percentage

Table 11: A summary of calf weaning age in the study area (n=98)

	Location		
Weaning age	Peri-urban=49	Urban=49	Overall (%)
3-6	21	47	68 (69.4)
9-12	23	2	25 (25.5)
12-18	5	0	5 (5.1)
Total	49	49	98(100)

N=number of observations, %=percentage

4.3 Major Dairy Cattle Diseases in Study Areas

The farmers faced with different dairy cattle diseases. The major diseases pointed out by the smallholders that affect dairy production and productivity in the study areas include Mastitis, Black leg, Bloat and Bovine-Pasteurellosis, under smallholder management system (Table12).

Table 12: Diseases and frequency of occurrence as reported by farmers (%)

	Location		
Type of disease	Peri-urban=49	Urban=49	Overall (%)
Mastitis	10	15	25 (25.5)
Blackleg	20	20	40 (40.8)
Bloat	4	9	13(13.3)
Bovine-pastuerollosis	15	5	20(20.4)

4.3.1 Sources and distance of water for cattle

Farmers had diverse methods of collecting water to provide their dairy cattle from different sources. The water sources were rivers, borehole, ponds and piped water (Table 16). The distance to water tended to affect the frequency of watering cattle. The majority of the farmers watered at home. The farmers were faced with water related problems such as scarcity, unhygienic/impurity and parasites such as leaches

Table 13: Main water sources and water related problem in the study areas (%)

	Location			
	Urban		peri-urban	
Variable	N	%	N	%
Source of Water				
River	5	10.2	15	30.6
Borehole	5	10.2	9	18.4
Pipe water	39	79.6	25	51.0
Distance for water				
Watered at home	30	61.2	39	79.6
<1km	10	20.4	00	00
1-5 km	9	18.4	10	20.4
Main water related problem				
Scarcity	29	59.2	11	22.4
Parasites such as leaches	10	20.4	23	46.9
Unhygienic / impurity	10	20.4	15	30.6

4.4 Milk production constraints

The main dairy production constraints as perceived by farmers included animal diseases, feed shortage, poor management, Low milk yield; Low milk price **(**Table 14). Animal disease was mentioned as the most important constraint. Feed shortage was the second most important constraint in the study areas.

Table 14: Main constraints of dairy milk production in the study areas

	Location			
	Urban		peri-urban	
Factor	N	%	N	%
Disease	20	40.8	20	40.8
Low milk yield	5	10.2	10	20.4
Feed shortage	13	26.5	11	22.4
Low milk price	2	4.1	2	4.1
Poor management	9	18.4	6	12.2

N=number of observations, %= percentage

4.5 Raw Milk Physical Characteristics

The average pH value was 6.65±0.04 with the raw milk sampled recording readings. The pH of all the milk samples collected from MP, MC was found to be 6.65±0.04, 6.67±0.05, respectively (Table 5). No significant variations were found for the parameter in all the milk samples in the milk producer, milk collection. The mean and standard deviation of the specific gravity of raw milk samples collected from milk producers MP, milk collection MC 1.029±0.002, 1.028+0.002 respectively. Statistically it was found that there were significant differences ($P < 0.05$) within the specific gravity of milk collected from milk producer and milk collection (Table 5).

Table15.Physical parameters of raw milk collected from producers and milk collection center

	Milk source			
Parameters	MP** (46)	MC** (14)	P-Value	Overall
Density	1.029±0.002	1.028±0.002	0.04*	1.028±0.002
PH	6.66±0.04	6.63±0.05	0.03*	6.65±0.04

**MP is milk sample from producers, **MC is milk sample from collector,

*Shows there was a significant difference in PH and density of milk from producers and collectors.

4.6 Microbial quality of raw milk

4.6.1 *Total bacterial count*

The average values of total bacteria count/ml of raw milk samples Collected from milk collectors (MC) and milk producers (MP) were 6.63±0.12 $\log_{10}$cfu/ml and 5.46±0.14$\log_{10}$ cfu/ml. (Table 16). Statistically there was a significant difference ($P<0.05$) in total bacteria count/ml of raw. Milk collected from milk producer and milk collection centers. The overall mean of TBC obtained from raw milk in the present study is 6.88±0.17log10 cfu/ml.

4.6.2 Coli form count (CC)

The average values of coliform counts/ml of raw milk samples Collected from milk collection center and milk producer were 4.36±0.14$\log_{10}$ cfu/ml and 3.83±0.12$\log_{10}$ cfu/ml., respectively (Table 16). Statistical analysis showed that there was no significant difference within the coliform counts/ml from different raw milk sample sources and it was observed that the coliform

counts/ml of milk samples were high. This may be due to poor hygienic milking, improper cleaning of dairy utensils and unhygienic handling during marketing of milk.

4.7 Somatic cell count (SCC)

Average value of somatic cell count somatic cell count collected from milk collection center and milk producers were 5.71±0.13log_{10} cfu/ml and 5.25±0.14log_{10} cfu/ml., respectively. Analysis showed that there was no significant difference ($p>0.05$) in the different milk value chain points and between the two towns. The overall mean of SCC in the two areas was 5.84±0.18 log10 somatic cell/ml.

Table 16.Microbiological quality of milk for producer and milk collection center of study area

Source of milk	Microbial quality of milk (log cfu/ml)			
	Number of samples	TBC	CC	SCC
Farmer	46	5.46±0.14^{e}	3.83±0.12^{f}	5.25 ±0.10^{d}
collection center	14	6.63±0.12^{d}	4.36±0.14d^{e}	5.71 ±0.13^{f}
overall mean	60	6.88±0.17	4.85±0.10	5.84 ±0.18

Means with different superscripts letters are significantly different ($P<0.05$)

4.8 Raw Milk marketing constraints

Results for are summarized in raw milk marketing constraints at specific study area (Table 7). The respondent farmers indicated that, price variations (33.3%), lack of fair market (43.3%), in the collection center price variation (33.3%), lack of faire market (16.7%). There are many constraints encountered by the milk producers in marketing of milk. They indicated that

pricevariation, lack of faire market was the main obstacle hindering them from channeling their milk to costumers, producer either through milk collection centers or selling direct to café and hotels.

Table 17. Descriptions of marketing problems of small holder at the study areas (%)

Variable	Farmers		Collection center	
Market problem	Total	Frequency (%)	Total	Frequency (%)
Lack of fair market	26	43.3	10	16.7
Price variation	20	33.3	4	33.3

%=percentage

5. DISCUSSION

5.1 Household Characteristics

The result of this study indicated that male respondents were higher (80.6%) than female respondents. This result is in line with the (Azage*et al., (*2003) finding reporting that, most of the households sampled for the study were male headed households (77.5–97.4%) and (Assefa *et al.,* 2013), reported that, the majority (85%) of the respondents were male household heads. As it can be observed from the result of this study the majority of sample respondents were married (53%) whereas 33%, 14.2% and 1% of the respondent were single and divorced, respectively. In the present study, most of the respondents' age ranged between 46-55 years, who is working in dairy farms with probable family responsibilities. This finding was contrary with that of Dawit (2010) where it was reported that the age of 15 and 65 years is being for active and productive group Educational level of all interviewed smallholder framers were, 20.4% could write and read and 5-8 grades 10% of them 1-4 grades, 30% of 9-12 grades and14% of them diploma and above. Education is an important factor which if lacking can negatively impact on future improved dairy production and productivity. The advantage of education is clear in affecting adopting technology, health and a whole of socio-economic status of the family, household income, demography (Adebabay, 2009). This shows that the growing educational coverage provided better opportunity to implement improved agricultural practices and wise use of scarce agricultural resources in the study area.

5.2 Source of income

The major source of income for all households in the study area was crop production (64%) followed by livestock production (41%) and other side business activities (35%), like shop,

transport service, hotel and etc. in the urban area, The latter two were mainly the characteristics of urban dairy producers (Table 4). Similar studies by (Yigerem *et al*., 2008) shows urban producers generate substantial (50% of their total income) level of income that dairy producers achieve from dairying. The result of studies in the mid highland and crop–livestock production system of Ethiopia haves own that depending on the distance from urban centers, the level of income share from dairying increases and ranged from 0.07 to 44% of the total income of farmers (Rewe *et al.,* 2006). Contrary to this finding Asaminew (2007) in Hararghe zone found that contribution of cattle and crop production were equally major income sources of households as a whole. This is due to the study area difference in that in Hararghe this is due to the study area difference in that in Hararghe area crop production may not be the larger contributor to up of the area when compared to the present study area. Household income due to ecology and geographical set up of the area when compared to the present study area.

5.3 Dairy Cattle Husbandry Practices

5.3.1 Breeding system

The overall mean of dairy cattle farmers used artificial insemination (AI), natural breeding, both natural and artificial insemination are 31%, 34.1%, 47%, respectively. In urban and peri urban areas of Kombolcha, smallholder dairy farms mostly keep cross breed animals for milk production. Different cattle breeding practices were mentioned by the sampled households in the two locations. The current finding is almost similar with the result of (Emebet *et al.,* 2008) at Haramaya district shows Natural and uncontrolled breeding was the common method of mating animal in the study area and farmers who had no their own breeding bull shares from neighbors. Another scholar (Diriba *et al.,* 2014) found similar result that indicates the majority of dairy

farmers in the area were observed to be more interested to use natural mating compared to AI, which indeed is induced by the widespread inefficiencies of the latter system. Another finding (Radostitis *et al.*,1994) also described the breeding practice similar to the current result. None of the Dairy Producers had breeding bulls mainly due to shortage of space and difficulties of management including shortage of feed. On the other hand all of the dairy Producers in Dire Dawa area had breeding bulls as an alternative to artificial insemination.

5.3.2 Dairy cattle housing and milk hygienic practices

In the current study, almost all dairy owners used separate housing system for their dairy cattle. Similarly, Ayalew (2017) reported that in South Wollo Zone, Dessie town of Ethiopia, all (100%) of the urban and peri-urban respondents used separate houses for their dairy cattle .Where as in urban and peri-urban study area 28.4%, of respondents cattle kept their cattle in separate house. This observation was found to be different from other study areas. Based on feeding and watering facilities this observation in line with previous studies Bekele *et al*., (2015). About 77.78% of the respondents in urban area had both feed trough and water trough while only 35.56% in the peri urban area had both feed and water trough. Most of the respondents' milk producer farmers were during milking and transported milk to collection center used plastic made milk containers (Table 11). Non-food grade plastic cans, buckets and jerry milk containers are not recommended in the production of clean milk. In Ezha district of Gurage Zone where all farmers used plastic jars as milking utensil reported similar result by Abebe *et al.*, (2012). According to Karuga, (2009), aluminum containers are recommended because they don't have adhesive properties, generally easy to clean when compared with plastic containers. Milk storage and milking utensils are properly maintained and cleaned. About 20% of the household washed their milk container with cold water and soap while 14% of respondent used for hot water and

soap (Table 12). The current finding of contradicts with the finding of Haile *et al.*, (2012) who reported about 85.6% of household use wash milk handling equipment by detergent together with warm water while 12.1% of household them cleaned with cold water.

5.3.3 Milking and calf rearing management

The majority of the respondents reported that cows are milked twice a day. About 56 percent of the respondents in study area pointed out that they milk their cows two times a day at morning and evening. All the respondents indicated that for milking to take place calves have to suckle their dam for 2-3 minutes to stimulate milk let down; otherwise it results in low milk yield. The majority of respondents of the study area were washing their hands before milking. Nearly 62.1% of the smallholders were using collective towels for cleaning udder of milking cows in 23.4% collective towels were used while in the rest (14.2%) no towel use practiced. Similar findings were also reported by (Galton *et al*., 1986) that pre-milking udder preparations play an important part in the contamination of milk during milking. Out of the interviewed dairy cattle producers in urban and peri-urban areas of the current study, the majority of the dairy producers experienced calf weaning in their farm. About 77% of the respondents isolate newly born calves within 2-3 days 76% of the respondents used bucket feeding, 20.4% use partial suckling and4% used both methods in calf management practices.

5.3.4 Dairy cattle disease prevalence and health care services

Diseases in dairy animals affect reproduction, milk production, milk quality and cause mortality and morbidity (Azage *et al.*,2013). In the rural lowland dairy production system of Mieso and Metema, disease and parasite were ranked as the major problem by most of the farmers (about 66-86%). The high incidence of pasteurolosis and blackleg disease observed in urban and per-urban area is in agreement with findings of Adebabay (2009) who reported that the major

reported cattle diseases prevailing in Burea study area were pasteurolosis and blackleg. Most of the respondents reported that their sick animals get veterinary services but they didn't have enough services due to lack of drug and distance from services providers. Traditional methods of disease treatment were also practiced in the area. The most common traditional methods of curing sick cattle included cutting and bleeding parts of the animal body and smoking, and drenching of sick cattle with selected herbal extracts.

5.3.5 Feed resources and problem associated with feeding in the study areas

It is the animal feeds that represent the dairy and input. Most of the respondents commonly feed their cattle; hay, industry byproducts, improved forage, non-conventional feed and crop residues. Generally, crop residues from cereals such as barely, wheat, *teff) straw*, peals straw such as (legume, peas, and lentil) and maize and sorghum Stover form the basal diets of the animals. Other important feed resources in the study areas were non-conventional feeds such as *Attela* (the residue of *Tella*). *Atela* is usually used by HHs who own small herd size which is similar with a study by (Girma *et al., 2014).* Some respondents in peri-urban reported these non-conventional feeds. In view of the high costs of concentrate feeds, use of these non-conventional feedstuffs might be a viable alternative. Dairy producers in the urban areas mainly use purchased roughage and concentrate feeds along with non-conventional feeds like attella. There is no hay-making practice for later use during the dry season where feed is less available. Therefore, during the dry season, urban producers rely on purchased animal feeds such as sugar cane and green or dry grass.

5.3.6 Housing Management:

The result of the current study indicates that there are four types of dairy cattle housing system in the area (Separate House, Backyard enclosed, Feed trough only, Feed water trough). In this study areas were difference management system with in production systems. Similarly study by Bekele *et al*., (2015), all the dairy households (100%) in urban area keep their cattle in loose barn while 73.33% of the farmers in the peri-urban areas keep their cattle in separate houses, of DangilaTown, Based on feeding and watering facilities. Moreover, this observation in line with previous studies Bekele *et al*., (2015). About 77.78% of the respondents in urban area had both feed trough and water trough while only 35.56% in the peri urban area had both feed and water trough

5.4 Constraints of dairy production

Animal diseases, feed shortage and poor management as problems were mentioned by respondents as the primary dairy production constraints in the study areas. Similar findings of different research works (Agza *et al.,* 2013 and Teshager *et al.,* 2013) in different parts of Oromia were implicated that milk production in Ethiopia is highly hindered by one or more of the above mentioned factors that affect dairy production. Moreover, other researcher identified similar constraints in smallholder dairy production in different pre-urban and urban areas of Ethiopia (Zemenu *et al.,* 2014). Other concerns reported by participants from all dairy production system included: lack veterinary and artificial insemination services. The demand for crossbred cows in the study area was high but supply is far below the demand. The farmers who own crossbred cows complain about inadequate artificial insemination services. The accomplishment of these constraints affects the overall milk production in the areas. Low milk yield due to poor

genetic potential of local cows, were among the other constraints encountered. Hence, to minimize these constraints, integrated work should be done with close participation of the farmers, the extension personnel and veterinarians from the Zonal and Woreda Offices of Agriculture and the researchers.

5.5 Raw Milk Physical Characteristics

The specific gravity of raw milk was slightly similar with the study of Tekle *et al*., (2015), Zelalem (2012) and Wangdi *et al.,* (2016). The pH value found in the current study was comparable with the findings reported by Tekle *et al*., (2015). A pH value found in the sampled raw milk is in agreement with the findings of Imran *et al.,* (2008).

5.6 Microbial quality of raw whole milk

Total raw milk bacterial population at the site of the study was 6.88logcfu ml. These result compared with (O'Connor, 1994) the total bacteria count high with the acceptable level of 1 x 105 bacteria per ml of raw milk. In the current study the presence of high bacteria count due to improper milking utensils, poor cleaning water and contamination originated from the udder surface. The total bacteria load of raw milk increase due to using unsafe water, without washing our hand when milking and dirty udder (Bukuku, 2013). The current result is also parallel with the finding of Fikrineh, (2012) in mid rift valley of Ethiopia who describe 7.08 log cfu/ml of TBC and lower than the report of Asaminew and Eyassu (2011) in Bahirdar and Mecha district who describe 7.58 log cfu/ml of TBC.

In this study area the overall mean coliform count produced milk was 4.85log cfu/ml which is higher than a study in Bahrdar zuria and Mecha wereda by Asaminew (2011) who reported a coliform count of 4.49logcfu/ml. The current result is lower than the work reported by Zelalem and Bernard (2006) with 6.57logcfu/ml for milk collected from cows of different producers in the central highlands of Ethiopia.

The contamination of milk sample initially is due to either from the cow, un sanitize milk container, poor sanitize hand of the milker and the milk environment. The somatic cell count (SCC) is internationally recognized as a parameter for assessing milk quality and udder health (Degraaf *et al.,* 1997). The overall mean of somatic cell count in log (SCC/ml) of raw milk was 5.84 ±0.18 for milk sample from the milk producer and collection centers.

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusions

In light with this cross-sectional study, two main dairy production systems exist in the study area: market oriented urban and peri urban smallholder dairy production systems. The urban and peri urban production system is characterized by keeping mainly cross bred animals of unknown blood level and constrained by land shortage, feed scarcity, inefficient breeding practice and unimproved milk marketing system. Producers in peri-urban also gave concentrate supplementation. While in urban area, hay, crop residues, non-conventional feeds and agro-industrial-byproducts were the major feed resources. Mastitis, Black leg, Bovine-Pasteurellosis, bloat were prevalent.

Microbial counts were non-reach the international acceptable limit. This may be due to lack of sanitation purpose, improper utensils used for milking, absence of cooling facility during storage and transportation and poor handling practice.

6.2.Recommendation

From the study findings, it is recommended that

- ✓ The rapid urbanization, subsequent increase in human population and standards of living of the urban dwellers especially the regional kombolcha town can be considered as good prospect for the development of dairy in the area. Dairy in the study areas can be improved by solving major problems of small holder dairy producers through services related to feed supply, good marketing systems and through provisions of veterinary artificial insemination.

- ✓ Non-Governmental Organizations and feed supplying companies should collaborate to improve the dairy industries through forage development interventions
- ✓ Awareness creation focused on market oriented dairying should be provided by agricultural extension workers for the milk producers who allocated greater amount of milk for home consumption and who did not participate in milk value addition to enable them participate in milk value addition business activities.
- ✓ Smallholders dairy farmers should be provided/supported with extension and training opportunities for hygienic conditions of milking, storing.
- ✓ The poor milk quality observed in the present study requires further investigation of the status of the farms, milk handling, and transportation delivery of milk from the farm up to consumers.

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8 APPENDIX

Appendix 1: Questionnaire survey

Demographic characteristics of households

1, Gender of household: 1, Male 2, female

2, marital status of households

1, Married

2, Single

3, divorced

4, Widowed

3) What is your Source of income?

A) Crop production

B) Livestock production

C) From livestock production and side business (shop, restaurant, etc)

4) Primary purposes for keeping cattle

1. Produce milk for home

2. Produce Milk for sale

3. for drought power

4. for asset

5) **Dairy cattle husbandry practices**

Breed and breeding system

6) What is your breeding system?

1) Natural breeding…….....

2) Artificial insemination ……

3) Both ……..

7) What is your source of bull

1. Selected from herd

2. Purchased

3. Neighbor bull

4. Couldn't identify

Housing

8) What type of shelter/house do you provide?

1, separate house

2, backyard enclosed

3, to gather with family house

4, feed trough only

5, feed water trough

9) What material do you use for the roof of the cow shed?

1) Mud floor

2) Concert

3) Stones

10) How do you remove manure from the shed?

1) Every day…….....

2) One time/week….....

3) Two times per a week

Milking management and hygiene information

11) How many times do you milk your cow per day?

1) Morning only…….

2) Morning and evening….

3) Three times/ day……

4) Other, Specify_____

12) What material do you wash udder drying?

1 no washing and drying

2 collective towels

3 just with hands

13) What type of a container do you use to deliver the milk?

14) what type of container do you use to delivers the milk

1) Plastic….

2) Stainless steel cane.

Feed resources and feeding strategies

15) What is available feed resource?

1. Crop residue

2. Natural grazing

3. Hay

4. Improved forage

5. Industrial by product

6. Non-conventional feed

16) What is the major source of feed for your dairy cattle?

1) Own farm produced…….

2) Purchased…….

3) Both farm produced and purchase

17) What is major feed resource in the area?

1. Natural pasture

2. Crop residue

3. Hay

4. Fodder trees

5. Crop after math,

6. Industrial by product

Calf rearing practice

18) do you have new calves isolation

1. Yes

2. No

19) At what age do you normally wean your calf?

A. 3-6

B. 9-12

C. 12—18

20) Which method do you use for pre-weaning calf milk feeding?

No.	Breeds	Bucket feeding (1) Partial suckling (2) Both (3)
1	Local	
2	Cross breed	
3	Exotic	

Water provision

21) What is the source of water for dairy cattle?

no	source	dry season	wet season
1	River		
2	Borehole		
3	Pipe water		
4	Pond		
5	Spring water		
6	Other source		

22) What is your main water related problem?

1) Scarcity…….

2) Parasites such as leaches.

3) Unhygienic/impurity…….

4) Other, specify_____

23) How far the water points from your home?

No	Distance	Wet Season	Dry season
1	watered at home		
2	< 1 km		
3	1-5 km		
4	6-10 km		
5	> 10 km		

24) What are the major diseases occur in your dairy farm?

1. Black leg
2. Mastitis
3. Bloat
4. bovine-pastureollosis

25) Distance to veterinary services

1) <1km……...
2) 1-5km……..
3) 6-10km……...….
4) >10km…….

Milk producers/farmers……..

26) do you have constraints during selling your milk? yes no

If yes, what are the difficulties?

1) Poor quality of milk…..
2) No market …….

3) Low price……..

4) Lack of transportation …..

5) Other, please specify

Constraints of dairy cattle production

27) What are the main challenges of dairy production in the study area

1. Disease

2 low milk yields

3 low milk prices

4 poor managements

5. Feed shortage

Milk producers/farmers

28) What are the constraints facing in milk market?

1. Distance of collection centers form my home

2. Lack of access to adequate markets

3. Spoilage of milk during transportation

4. Inadequacy market information

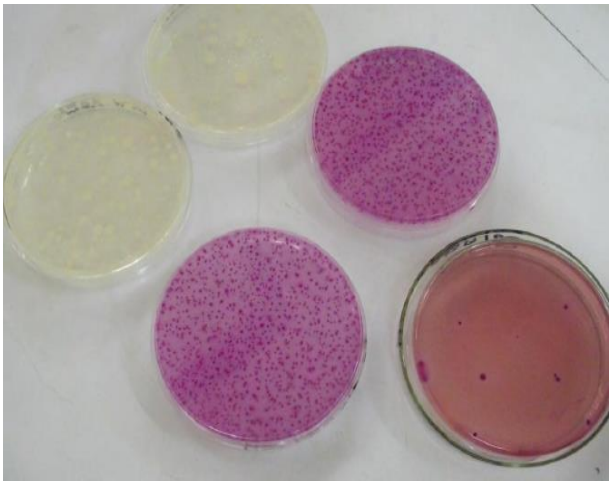
5. Low market price of milk

6. Low quality of milk

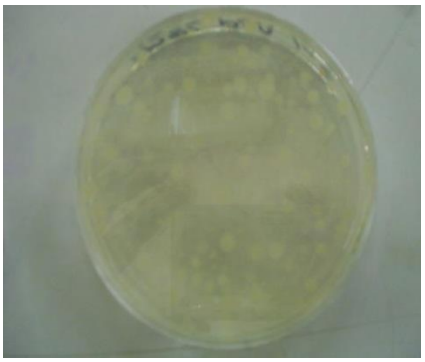
Appendix 2. Materials and equipment used for laboratory

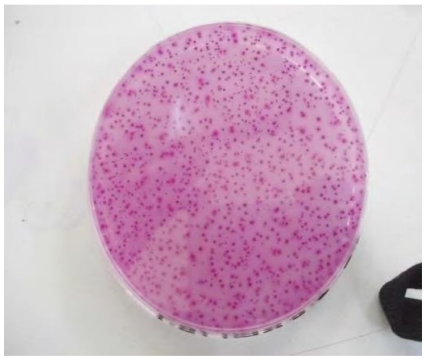
Colony counter Microscope

Appendix 3: Different bacteria count



Appendix 4: bacteria grown in prepared media prior for counting

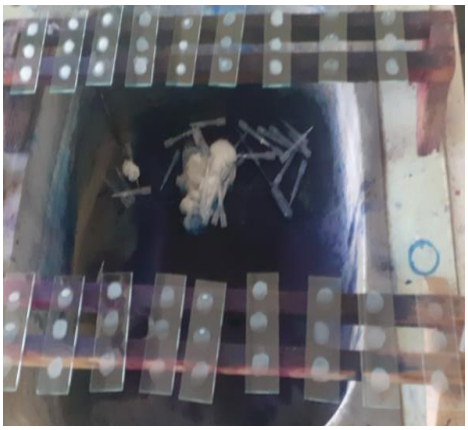




Standard plate count

coli form count

Appendix 5: Stained somatic cell



Appendix 6: autoclave

Appendix 7: Dairy cattle management in the study areas

A

B

C

D

A) watering materials in urban study areas

B) watering material in peri-urban study areas

C) feed storage management in peri-urban study area

D) feed storage management in urban study area