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HOUSEHOLD LEVEL MILK PRODUCTION AND CHILD MILK CONSUMPTION IN AND AROUND BAHIR DAR, ETHIOPIA

MSc Thesis

By

Fanaye Shiferaw

Addis Ababa University, College of Veterinary Medicine and Agriculture,

Department of Animal Production Studies

June, 2014

Bishoftu, Ethiopia

HOUSEHOLD LEVEL MILK PRODUCTION AND CHILD MILK CONSUMPTION IN AND AROUND BAHIR DAR, 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 Tropical Animal Production and Health

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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: Fanaye Shiferaw titled: Household level milk production and child milk consumption in and around Bahir Dar, Ethiopia and recommend that it be accepted as fulfilling the thesis requirement for the degree of: Masters of Science in Tropical Animal Production and Health.

Proff. Birhan Tamir	_____	_____
Chairman	Signature	Date
Dr. Kelay Belihu	_____	_____
External Examiner	Signature	Date
Dr. Gebreyohanis Berhane	_____	_____
Internal Examiner	Signature	Date
1. Dr. Ashenafi Mengistu (PhD.)	_____	14/7/14
Major Advisor	Signature	Date
2. Dr. Getachew Terefe (PhD.)	_____	14/7/2014
Co- Advisor	Signature	Date
3. Proff.Birhan Tamir	_____	_____
Department Chairperson	Signature	Date

TABLE OF CONTENTS

I declare that this thesis is my *bonafide* work and that all sources of material used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and is deposited at the University/College library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

Name: Fanaye Shiferaw Signature: _____

College of Veterinary Medicine and Agriculture, Bishoftu

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LIST OF TABLES

ALZR	Amhara Livelihood Zone Report
APHA	American Public Health Association
BCAO	Bahir Dar City Agricultural Office
BoFED	Bureau of Finance and Economic Development
BRTA	Bahir Dar Rode and Transportation Authority
BoARD	Bureau of Agriculture and Rural Development
BoA	Bureau of Agriculture
BZOARD	Bahir Dar *Zuria* Office of Agriculture and Rural Development
CACC	Central Agriculture Census Commission
CC	Coliform Count
CFU/ml	Colony Forming Unit per milliliter
CSA	Central Statistical Authority
EDHS	Ethiopian Demo House Survey
ES	Ethiopian Standard
FAO	Food and Agriculture Organization of United Nation
FDREPHCC	Federal Democratic Republic of Ethiopia Population Housing Census Commission
ILCA	International Livestock Centers for Africa
ILRI	International Livestock Research Institution
IPS	International Project Service
MMAF	Manuals of Methods of Analysis of Food
QCB	Qualification and Characterization- Bahir Dar

RMIYC	Recommendations on Milk Intake for Young Children
SPC	Standard Plate Count
TNTC	Too Numerous To Count
VRBA	Violet Red Bile Agar
ZDA	Zone Department of Agriculture

ABSTRACT

Malnutrition is a serious problem in 1-5 years old children of Ethiopia and livestock products have a contribution in solving malnutrition. This study was conducted in and around Bahir Dar with the objectives of investigating the contribution of cow ownership and milk production to child milk consumption; assessing constraints in cow milk production and child milk consumption; and assessing the quality of cow milk consumed by children at household level. Cross- sectional study design was employed. A total of 300 households were individually interviewed. The results indicated a positive relationship between dairy cow ownership and child milk consumption. A child in a household with dairy cow consumes 464.9 ml of milk while in a household without dairy cow consumes 457.5ml of milk. Among households with dairy cow and without dairy cow larger volume of milk offer was observed in the peri-urban (512.8ml) and urban areas (465.7ml), respectively as compared with the rest. In terms of child milk feeding practice, higher practice of child milk feeding was obtained in the urban households with 39% and without 60.7% dairy cow. The major constraint of child milk consumption across households with and without dairy cows was selling of milk for income generation and lack of knowledge; and shortage of money and cultural issues, respectively. Coliform and standard plate counts in the urban, peri-urban and rural areas were $4.7X10^3$ and 10^4, $3.1X10^4$ and$4.6X10^4$, $2.2X10^5$ and $5X10^5$, respectively. The overall result of adulteration and acidity were 26.11 and 0.21, in CFU respectively. The general hygienic practice followed by households with dairy cows in the area is poor. Feed shortage is the biggest problem for all the study sites, whereas shortage of land is a priority problem for urban and peri-urban dairy owners and lack of improved breeds is a priority problem for the rural farmers. Reduction of milk production and quality affects child milk consumption. Therefore, further research works to address constraints and to improve child milk consumption are imperative.

Key words: *Bahir Dar, Child milk consumption, Milk production, Milk quality, Dairy cow ownership*

Malnutrition continues to be the leading cause of morbidity and mortality in children in many developing countries. In Ethiopia, for example, child malnutrition is a serious problem. About 57% of child mortality is under the age of five years old. The mortality is related to malnutrition (Girma and Timotiows, 2002). In Ethiopia alone, 44 % of children are chronically malnourished (EDHS, 2011). A study conducted in Bahir Dar, indicated that the overall prevalence of malnutrition was very high among children with wasting, underweight and stunting being 14.1%, 35.9% and 44.4%, respectively (Yille, 2006).

The human and animal populations are very much affected by nutritional problems, primarily due to lack of food of high nutritional value. Therefore, to solve this problem and to improve the nutritional status of the population, measures should be taken to improve animal productivity, so as to ensure better supply of animal protein of high nutritive value (Asheber, 1992). Child nutrition could be affected with parental education, household income, family size and types of agricultural activities (Vella *et al*., 1995; Grosse, 1998b; Yimer, 2000).

In selected regions of sub-Saharan Africa, one option for increasing food production and household incomes is dairy production and marketing (Staal *et al*., 2008). Milk is one of the major products of livestock (cattle, camels and goat) but in and around Bahir Dar goat and camel milk is not used for human consumption. People in the area use only cow milk (Asaminew, 2007; Adebabay, 2009). In addition to its importance as source of income for livestock owners, milk contributes to household food security especially for healthy child nutrition (Sigman *et al*., 1991; Grosse, 1998b). Therefore, ownership of livestock and livestock technologies can be one possible option which gives households more opportunities to improve the nutritional status of their children (John *et al.*, 2014).

Ethiopia is gifted with good livestock production potential mainly due to relatively fair natural resource availability, suitable climate, and large cattle population (IPS, 2000).There are about 53 million cattle, 24.9 million sheep, 22 million goats, 3.5

livestock population accounts for 29% of the country's total livestock population (CSA, 2005). According to Adebabay (2009), in Bure *Woreda*, the reported average number of local and cross-breed cow per household was 2.57 and 0.20, respectively. However, the average number of local and cross-breed dairy cows per household in Bahir Dar *Zuria* was 2.77 and 1.15, respectively. The average number of local lactating cow and dry cows per household was 1.34 and 0.88, respectively (Asaminew, 2007).

In Amhara region livestock productivity is low. For instance, the daily milk yield per cow is about 1.2 liters in 234 days of lactation period in Western Gojjam Zone, resulting in an estimated milk production of 46,710,335 liters per lactation for all lactating cows in the Zone (CSA, 2005). In the Region, about 73% of smallholders practice mixed farming, 19% practice crop farming, while the remaining 8% undertake only livestock rearing (ZDA, 2005). The average daily milk yield in and around Bahir Dar was 7.6 liter/household (Getachew, 2010).

In addition to milk quantity, milk quality is also one factor that affects child milk consumption (Vella *et al*., 1995; Grosse 1998b; Yimer, 2000).The safety of dairy products with respect to food-borne diseases is of great concern around the world. This is especially true in developing countries where production of milk and various milk products takes place under unsanitary conditions and poor production practices (Mogessie, 1990). The microbial load of milk is a major factor in determining its quality. It indicates the hygienic level exercised during milking, that is, cleanliness of the milking utensils, condition of storage, manner of transport as well as the cleanliness of the udder of the individual animal (Parekin and Subhash, 2008; Torkar and Teger, 2008). According to Bekele and Bayileyegn (2000), in Ethiopia the dairy hygiene is given less attention. They reported that, exogenous sources of milk contamination with bacteria are very common. According to Asaminew (2007), the overall milking hygienic practice followed by the farmers in Bahir Dar *Zuria* and Mecha *Woreda* is poor. But, provision of milk and milk products of good hygienic quality, quantity and good composition is desirable from consumer health point of view (Giangiacomo, 2000).

1. To investigate the contribution of cow ownership and milk production to child milk consumption
2. To assess constraints in cow milk production and child milk consumption
3. To assess the quality of cow milk consumed by children

2.1. Cow Ownership and Child Milk Consumption in Developing Countries

Malnutrition continues to affect large numbers of children in the low-income countries of the world. According to Smith and Haddad (1999), between 43 and 55 million children in the region will be underweight in 2020. Nutritional problems continue to be the leading cause of morbidity and mortality in children in many developing countries. About 57 % under-five year mortality in Ethiopia is related to malnutrition (Girma and Timotiows, 2002).The result of the study conducted in Bahir Dar indicated that the overall prevalence of malnutrition was very high among children 1-5 years old with wasting, underweight and stunting being 14.1%, 35.9% and 44.4%, respectively. Therefore, in order to address this problem further study should have to be conducted on child nutrition (Yille, 2006).

Child nutrition could be affected with household income, family size and types of agricultural activities (Vella *et al.*, 1995; Grosse, 1998b; Yimer, 2000). In addition to this poverty, lack of knowledge, disease, and inadequate food supplies also affects child nutrition (Latham, 1997).

Livestock resources have great contribution in improving the nutritional status of the people (BoFED, 2006). Livestock rising plays a vital role in economic development, particularly as societies evolve from subsistence agriculture into cash-based economies (IPS, 2000). Foods from animal origin have high energy densities and provide low bulk diets, compared to foods from non-animal origin. This makes it possible for children to obtain more calories in tolerable quantities (Sigman *et al.*, 1991; Grosse, 1998b). Studies in rural Rwanda indicated that children between the ages of 2 and 5 years old from households with dairy animals were significantly taller than children from households without (Grosse, 1998a). Similarly, Nicholson *et al.* (2003); John *et al.* (2014) reported, ownership of cattle has a statistically significant positive effect on the mean height of the children in both coast and in highlands of Kenya and Ethiopia, respectively. Therefore, ownership of dairy cow and livestock technologies can be one possible option to give households more opportunities to

the first natural food of all young mammals during the period immediately after birth (Teka, 1997). Milk is one of the major products of livestock (cattle, camels and goat) that in addition to serving as source of income for livestock owners; it can contribute to household food security especially for healthy child nutrition. Milk is a nutrient-dense food and is known to contribute a high proportion of the nutrients, such as high quality protein and micronutrients (Barasa, 2008). Milk is the most nutritious food known to man; it contains nine essential nutrients, making it one of the most nutrient-rich beverages. This nutrient of milk includes: Calcium, Vitamin D, Protein, Potassium, vitamin A, vitamin B, Riboflavin, Niacin, and Phosphorus (Falvey and Chantalakhana, 1999). In the rural areas the milk consumption could be determined by livestock ownership and season (Land O'Lakes, 2012).

2.2. Milk Production Systems in Ethiopia

Milk production is highly labor-intensive and provides a lot of employment (Falvey and Chantalakhana, 1999). Dairy production is a critical issue in Ethiopia a livestock-based society where livestock and its products are important sources of food and income. However, dairying has not been fully exploited and promoted (Belete *et al.*, 2010). There are 10 million dairy cows in Ethiopia producing 3.2 billion liters per year. For an average lactation period of six months the estimated milk production per cow is 1.54 liters (Staal *et al.*, 2008).According to CSA (2007), Amhara region occupies the third rank by producing 506 million liters. Based on the study which was conducted in the *woredas* of Bure, Fogera and Metema in Amhara Regional State; in the *woredas* of Shashemene and Mieso in Oromia Regional State; and in the *woredas* and towns of Hawassa, Dale/Yirgalem and Dilla in Southern Nations, Nationalities and Peoples Regional State, milk yield performance of cows as reported by farmers varies across the different dairy production systems, mainly due to differences in breed and management (Tegegne *et al.*, 2013). Indigenous breed of cows are generally considered low milk producers (Abaye *et al.*, 1991). For instance, the annual milk yield per day in the peri-urban area of Addis Ababa was 3.9 liters for cross-breed cows and 1.2 liters for local cows (Garth *et al.*, 1999). The average milk production per cow in Western Gojjam zone is about 1 liter per day, resulting in an estimated milk production of 46,710,335 liters per lactation for all lactating cows

around Bahir Dar was 10.4 (Getachew, 2010).

Commercial systems which produce milk mainly for market and subsistence systems which produce milk mainly to meet household needs for dairy products are the two broad categories of dairy production system in Ethiopia (Azage *et al.*, 2003). Based on marketing situations milk production system can be broadly categorized in to three systems, such as urban, peri-urban and rural milk production system (Tsehay, 2002). The system is estimated to consist of 5,167 small, medium and large dairy farms, with about 71% of the producers selling milk directly to consumers (Tsehay, 2001).

Urban and peri-urban milk production system is developed in and around major cities and towns which have high demand for milk. In this system the main feed resources are grass hay, crop residues and agro- industrial by-products. In this system milk is a means of additional cash income. Most of the improved dairy stocks in Ethiopia are used for this production system (Belachew *et al.*, 1994; Tsehay, 2001). The rural dairy production system is part of the subsistence farming system and includes pastoralists, agro pastoralists, and mixed crop-livestock producers mainly in the highland areas (Getachew, 2003).

2.2.1. Urban milk production system

Urban milk production system is developed in major cities and regional towns, which have a high demand for milk, and they are a largest source of milk producer (Azage and Alemu, 1997). Urban dairy systems focuses on production and sale of fluid milk, with little or no land resources, using the available human and capital resources mostly for specialized dairy production under stall feeding conditions. As compared to other systems they have relatively better access to inputs (e.g. feeds) and services (e.g. artificial insemination and clinic) provided by the public and private sectors, and use intensive management (Tegegne *et al.*, 2013). Total milk production from urban dairy farmers amounts to 34.649 million liters per annum. Of this total 10 % is left for household consumption (Azage and Alemu, 1997).Producers deliver milk to consumer or consumers may collect it at the producer's gate. Payment to producers is generally on the monthly bases. The contribution of urban milk production to child

by informal vendors (Masembe, 2003).

2.2.2. Peri-urban milk production system

According to Tegegne *et al.* (2013), Per-urban milk production system located at the periphery of major towns which have relatively better access to urban centers in which dairy products are highly demanded. Similarly, Zegeye (2003); Yoseph *et al.*(2003) reported that, the Peri-urban dairy production systems is found in the bounds of major cities and comprises small and medium sized farms that own crossbreed dairy cows. Similar to urban dairy production system, in this system milk production in general is mainly based on cattle (both improved and indigenous) (Tegegne *et al.*, 2013). The peri-urban dairy production system includes most of the improved dairy stocks (Ahmed *et al.*, 2003).

2.2.3. Rural milk production system

The rural dairy production system is part of the subsistence farming system and includes pastoralists, agro pastoralists, and mixed crop-livestock producers mainly in the highland areas. The system is not market oriented and most of the milk produced in this system is retained for home consumption. The level of milk surplus is determined by the demand for milk by the household and its neighbors, the potential to produce milk in terms of herd size and production season, and access to a nearby market (Getachew, 2003).

The rural small-scale mixed system mainly uses indigenous breeds, grazing of natural pasture and crop residues as major inputs. Rural small-scale mixed subsistence dairy production in Fogera is undertaken by subsistence farmers who own 1–7 indigenous and 1–2 cross-breed cows. There are only six cross-breed lactating cows (0.79%) in this system. The total number of milking cows in this system is 764(Tegegne *et al.*, 2013). The traditional smallholder system in rural Ethiopia produces 97% of the total national milk production using the indigenous cattle breeds. This sector is largely dependent on low levels of inputs and indigenous breeds, which produce about 400–680 kg of milk/cow per lactation length (Tsehay, 2001). Apart from a few cross-breed

producing indigenous breeds of zebu cattle (Staal and Shapiro, 1996).The rural dairy production system is largely dependent on low levels of inputs and indigenous breeds (Tsehay, 2001).

2.3. Constraints of Milk Production

Underdevelopment and lack of market-oriented production, lack of adequate information on livestock resources, inadequate permanent trade routes and other facilities like feeds, water, holding grounds, lack or non-provision of transport, ineffectiveness and inadequate infrastructural and institutional set-ups, prevalence of diseases, illegal trade and inadequate market information (internal and external) are generally mentioned as some of the major reasons for the poor milk production (Belachew 1994; Ayele and Peacock,2003).

The smallholder milk production system is mainly constrained by feed and water shortages. Others problems of smallholder milk production system include lack of cash, shortage of labor, low prices especially for fresh milk, inefficient milk processing practices and poor quality products, and diseases (Asaminew,2007). Beside, feed shortage problems in terms of both quality and quantity, and the lack of specialized indigenous dairy breeds of cattle, are the two major factors limiting the development of dairy production in rural part of Ethiopia (Kedija, 2007). On the other hand, Low demand during fasting, shortage of cow feed, low milk price, lack of artificial insemination service, inadequate animal health and extension services are the major constraints for dairy producers (Tadele, 2010).

2.3.1. Shortage of feed

Livestock feeds are the major inputs in any milk production activity (Sintayehu *et al.*, 2008).Feed constraints could be seen from different dimension in terms of quality and quantity and seasonal feed supply to meet the nutritional requirements of dairy animals. Both roughage and concentrate feeds are either too expensive or unavailable in sufficient quantity and quality to improve dairy production (Kedija, 2007). The general belief that feed is abundant during the wet season is not true in all production

about 35% of the farmers reported feed shortage between July and September, the main rainy season. In Fogera, farmers face severe feed scarcity during the wet season due to flooding of the natural pastureland. In addition, grazing lands in Fogera have been shrinking due to expansion of large-scale rice cultivation and the invasion by the noxious weed (*Asracanthalongifolia,* amykila), overgrazing and mismanagement due to the free and uncontrolled use (Tegegne *et al.*, 2013). Feed is generally not available in sufficient quantities owning to overgrazing of lands and uncertain weather conditions. When they are available, they are of poor quality to provide adequate nutrition. As the grazing area is heavily populated and as there has been virtually no effort to limit the livestock population, the pastures are over-stocked and over-grazed. Thus, the animals are even unable to meet their maintenance energy requirements and as a result lose a substantial amount of weight (Lakew *et al.*, 2000).

2.3.2. Shortage of water

Ruminates require water to maintain the water content of the body, and water availability affects voluntary feed intake; less water leads to inadequate intake of dry matter. For animals kept under pastoral production system, the frequency of watering is very important. During the dry season water is available only from wells and some lakes and streams (Ibrahim and Olaloku, 2002).Watering frequency of dairy cattle depends on access to water sources, the age structure of the herd, physiological stage of animals and season. In rural highland dairy system of Bure, watering frequency of calves on average is about 2.5 times per day. In rural lowland dairy system of Metema, watering animals is more frequent in the wet season (twice) than the dry season (only once). In the urban and peri-urban system (Shashemene – Dilla milk shed), about 36% of the households water their cattle once a day. Scarcity of water is severe during the dry season since rivers and wells dry out as reported by households in rural lowland dairy system of Metema and Mieso (Tegegne *et al.*, 2013).

2.3.3. Animal health care

The major constraint of dairy development in Ethiopia is animal health care and improved health management, which caused poor performance of dairy animal across

varies localities through the use of communal pastures and watering as well as marketing places play an important role in the transmission of economically significant infectious and parasite diseases such as Schistosomiasis and Fasciolisis (Zinash, 2004). Government veterinary staffs are few in number and cannot cover such a vast area to adequately address the veterinary needs of livestock keepers (Tafesse, 2001). According to Adebabay (2009), the main reported animal health problems were lack of veterinary drugs, less frequent animal health service, remoteness of animal health centers, lack of skilled animal health technicians, lack of laboratory services, and lack of timely vaccination of their animals. On average farmers travel about 2.16 km and a maximum of 20 km to get to an animal health centre. As Kedija (2007) reported, a high incidence of clinical mastitis in milking cows was observed during the study conducted in Mieso *woreda* of Oromia region. As the author indicated, from the total responses 45.8 % of farmers indicate Mastitis. However, there may be high incidence of sub-clinical cases. This disease has received little attention. Occurrence of mastitis may be influenced by some heritable characteristics such as capacity of milk production, teat structure and udder conformation as well as genetic variation in disease resistance among breeds (Abdurahman *et al.*, 1995). This disease is also economically important disease in milking cows as it causes financial loss as a result of decreased milk yield (Morse *et al.,* 1988). In Fogera, Veterinary service is given by three governments and one private clinic. There are also three private drug vendors. Vaccination service is provided only by the government clinics. Only two clinics have microscopes to conduct disease diagnosis (Belete *et al*., 2010).

2.3.4. Lack of improved breed

In Mieso *woreda* there has been no effort to improve milk production through cross-breeding (Kedija, 2007). In the rural lowland production system of Metema and Mieso natural mating is the only method since artificial insemination service is not available (Tegegne *et al*,2013).On the other hand, in Amhara region Fogera *woreda* artificial insemination service is available at the Office of Agriculture and Rural Development for cross-breeding purposes to improve milk production. However, the service is limited to urban and peri-urban areas only. Availability and high price of

in the *woreda*. According to Azage *et al.* (2006), problem with efficiency and effectiveness of artificial insemination technician and monopolized public delivery of the service are some of the major problems in the country artificial insemination system. The price of a cross-breed heifer is also the major factor, the price of cross-breed heifer ranges from 3000 to 5000 Ethiopian birr (Belete *et al.*, 2010).

The livestock genetic resources of Ethiopia's have evolved largely as a result of natural selection influenced by environmental factors. This has made the stock better conditioned to withstand feed and water shortages, diseases challenges and harsh climates. But the capacity for the high level of production has remained low (IPS, 2000). The consequence of the low genetic potential of indigenous breed for productive traits makes total national milk production to be low (Mukasa-Mugerwa, 1989).

2.3.5. Shortage of land

With regards to change in land use, about 82 % of the respondents which are found in Mieso *woreda* of Oromia region indicated that, grazing lands have been continuously lost to crop lands (Kedija, 2007). The average livestock holding per household in urban areas of Debre Markos (5.32 in tropical livestock unit) was significantly ($P<0.05$) lower than livestock holding in rural areas of Debre Markos (8.36 in tropical livestock unit). This is because there is relatively better feed resource and space for cattle shed construction in rural areas than in urban areas to keep more animals (Yayeh *et al.*, 2014).

2.4. Constraints of Child Milk Consumption

Milk is a compensatory part of daily diet especially for the expectant mothers as well as growing children (Rajagopal *et al.,* 2005; Javaid *et al.*, 2009; Olatunji *et al.*, 2012). However, fluid milk consumption is affected by factors that has related with consumers' attitudes and perceptions about price and health effects of milk (Berhanu *et al.*, 2012).In addition to this, fluid milk consumption by the children is affected with parental education, household income, diet quantity and quality, child health

activities (Vella *et al.*, 1995; Grosse 1998b; Yimer, 2000). Within milk producing households, child nutrition or milk consumption could be affected by household economy, education, child health problem and culture (Girma and Timotiows, 2002). The role of education is obvious in affecting health and as a whole the socio-economic status of the family as well (Keralem, 2005). Therefore, parental education is main constraint that affects child milk consumption (Vella *et al.*, 1995).

The microbial content of milk is a major feature in determining the milk quality (Rogelj, 2003). Milk quality is one factor that affects child milk consumption (Vella *et al.*, 1995; Grosse 1998b; Yimer, 2000). Provision of milk and milk products of good hygienic quality is desirable from consumer health point of view (Giangiacomo, 2000). The microbial content of milk indicates the hygienic levels during milking that include cleanliness of the milking utensils, proper storage and transport as well as the wholesomeness of the udder of the individual cow (Spreer, 1998). A commonly used procedure to measure the sanitary quality of milk is to estimate its bacterial content. The number of bacteria in dairy products is an indication of conditions under which it was produced and handled determines its keeping quality (Mogessie, 1990).

Milk quality control is the use of approved tests to ensure the application of approved practices, standards and regulations concerning the milk and milk products. The tests are designed to ensure that milk products meet accepted standards for chemical composition and purity as well as levels of different micro-organisms (FAO, 2000).

The number of bacteria in aseptically drawn milk varies from animal to animal and even from different quarters of the same animal (O'Connor, 1994). In proportion to the numbers present, existence of coliform bacteria in milk is suggestive of fecal contamination and unsanitary practices during production (Richardson, 1985). Whereas, according to Alganesh (2002), the minimum and maximum values for microbiological quality of raw cows' whole milk produced in two *woredas* of Eastern Wollega to be 9.0 and 1.4 x 109 CFU/ml.

Adulteration of milk by intentional addition of water is a common problem in many developing countries. Adulteration is illegal because it alters the natural composition

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The number of bacteria in aseptically drawn milk varies from animal to animal and even from different quarters of the same animal (O'Connor, 1994). In proportion to the numbers present, existence of coliform bacteria in milk is suggestive of fecal contamination and unsanitary practices during production (Richardson, 1985). Whereas, according to Alganesh (2002), the minimum and maximum values for microbiological quality of raw cows' whole milk produced in two *woredas* of Eastern Wollega to be 9.0 and 1.4 x 109 CFU/ml.

Adulteration of milk by intentional addition of water is a common problem in many developing countries. Adulteration is illegal because it alters the natural composition

Adulteration affects milk quality. About 114 milk samples from households that supplied milk to Mieso and Asebot markets were taken to see the percentage of adulteration. The result indicated that 78%, 18%, and 4 % were normal, adulterated and skimmed, respectively (Kedija, 2007). Normal milk has specific gravity of 1.026–1.032 g/ml (or 26–32 on the lactometer reading). If water has been added, the lactometer reading will be below 26. If any solid such as flour has been added, the reading will be above 32 (Kurwijila, 2006).

3.1. Description of the Study Area

The study was conducted in and around Bahir Dar. Bahir Dar is the capital city of Amhara National Regional State, located at about 565 km away from Addis Ababa (Figure 1). The Regional State covers a total area of 152,600 km^2 (BoFED, 2008). The total human population of the Region is estimated to be 17.21 million of which 15 and 2.21million people live in rural and urban areas, respectively (FDREPHCC, 2008). The livelihood of the peoples is based on agriculture and 80% of the population practice mixed crop livestock farming system. The Region has 10.6 million cattle, 5.7 million sheep, 4 million goats, 2.1 million equines and 17,400 camels managed under extensive management system (BoA, 2000).

3.1.1. Bahir Dar City

Bihar Dar City is located at 11" 38'N, 37" 10'E on the South of Lake *Tana* where Blue Nile River starts. The elevation reported for the City is about 1801m.a.s.l. There are 9 *kebeles* in the City (QCB, 2010). The area receives an average annual rainfall ranging between 850mm to 1250mm with the minimum and maximum average daily temperatures of 10^0c and 32^0c, respectively (BoARD, 2006). According to the BCAO (2012/13), the population of Bahir Dar is about 220,344 /including rural *kebeles*/. When disaggregated by place of settlement, the rural population of Bahir Dar constituted 40,250 while the urban population is 180,094. In terms of gender composition the female population of Bahir Dar is slightly higher than the male population. Out of 180,094 urban populations 93,005 are female and 87,089 are male. Annual population growth of the City is about 6.6%. From this 2.6% is the birth rate and 2.8% is migration rate. Average household size was 4.4 in 2005.

3.1.2. Bahir Dar zuria woreda

Bahar Dar *Zuria Woreda* is one of the *Woredas* found in West Gojjam administrative zone. The *Woreda* is located at an altitude of 1500-1800 m. a. s. l with mean annual

and maximum average daily temperature of the *Woreda* is 10°c and 32°c, respectively (BZOARD, 2007). Uncultivated lands due to various reasons are estimated to 31.271 km^2. The livestock population of the Bahir Dar *Zuria Woreda* is estimated to be 206,865 cattle, 14,329 sheep, 26,049 goats, 18,728 donkeys, 716 mule and 346,546 poultry. Furthermore, there are about 19,706 honeybee colonies found in the *Woreda* (CACC, 2003). According to the ALZR (2012/13), the *Woreda* has 39 *kebele* administrations with total human population of 230432 (133707 male and 96725 female).

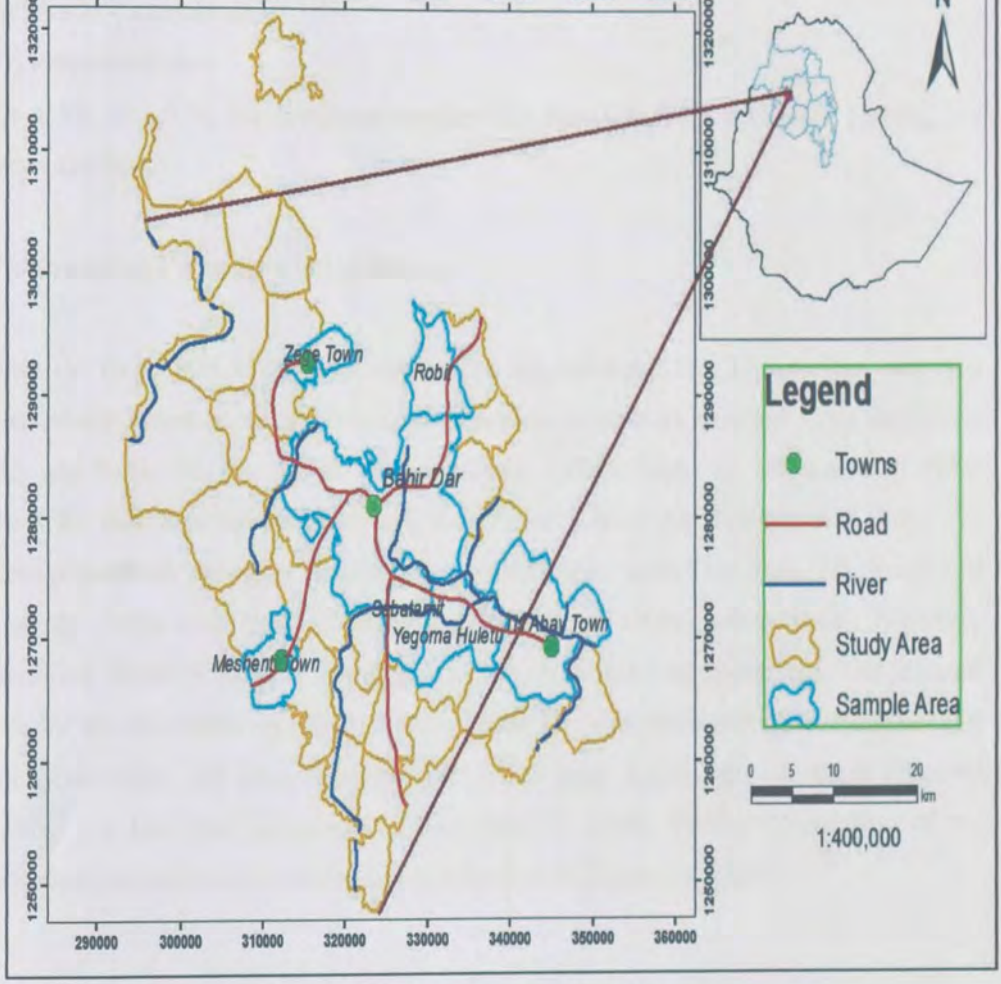

Figure 1. Map of Bahir Dar City and *kebeles* bound Bahir Dar

3.2. Study Design and Study Population

A cross-sectional study design was conducted to assess household level milk production and child milk consumption. The study populations were households with and without dairy cow. Totally 300 households were interviewed, among this 150 of them were households with dairy cow while 150 of them were households without dairy cow. The sample size was determined based on the following mathematical model recommended by Arsham (2007):

Where N = sample size,

SE = standard error

For a SE of 5.0 % the computed sample size was 100 from each area (urban, per urban and rural).

3.3. Sampling Procedure of the Survey

From the three sites which are found in and around Bahir Dar 12 area were selected purposively based on dairy potential information which was obtained from Bahir Dar City and Bahir Dar *Zuria Woreda* Agricultural Office. From the urban area of Bahir Dar City four *kebeles* were selected, i.e., *Tana, Ginbot 20, Shimbet and Hidar 11.* From peri-urban area three *kebeles* were selected they were *Tiss Abay, Meshentii* and *Zege 01* .From rural areas of Bahir Dar five *kebeles* were selected, i.e., *Woramit, Zenzelma, Robit, Sebatamit and Andassa* (*Yigoma Huletu*) were selected. The selected *kebeles* has the following distance from Bahir Dar city *Meshentii* (21km), *Robit* (10 km), *Tiss Abay* (30 km), *Sebatamit* (11 km), *Zege 01*(28 km), *Andassa (Yigoma huletu)* (18 km) and *Zenzelma* (15 km) (BRTA, 2006). Further elaboration of the sampling procedure of the study site is presented in Figure 1 bellow.

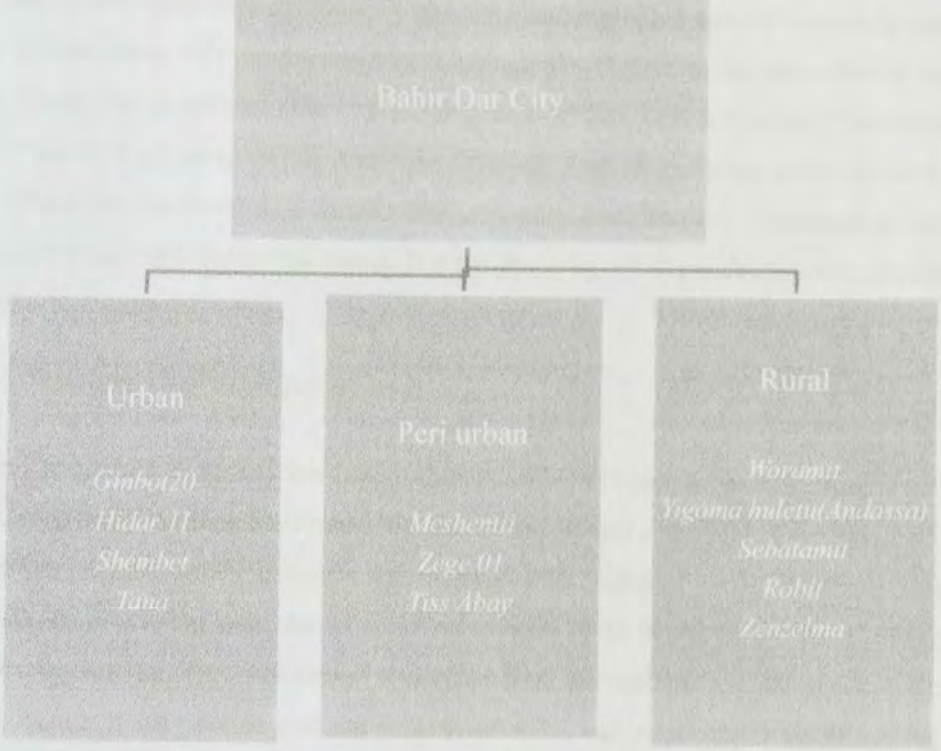

Figure 2. Illustration of sampling procedure of the study sites

Households from the selected *kebeles* were chosen purposively based on the availability of children 1-5years old in the households with and without dairy cow. A total of 300 individual households with and without dairy cow with a child 1-5 years old were purposively interviewed using a semi-structured questionnaire (Appendix 11).

Before the collection of the actual data, the developed semi- structured questionnaire was pre-tested. Pre-testing was made with 30 sampled household respondents. Two enumerators were trained by the researcher for three days before data collection was started. For the field survey, the method of data collection used was single- visit-multiple-subject survey (ILCA, 1990).The main theme of the survey was assessing the amount of milk consumed by the child, constraints of child milk consumption, time of milk supply for the children, identification of dairy production constraints at household level, total volume of milk produced at household level, cattle type, dairy

practices, milk equipment disinfecting technique, demographic data of household and educational status of the household head (Appendix 1).Before the collection of the actual data, the developed semi- structured questionnaire was pre-tested. Pre-testing was made with 30 sampled household respondents. Two enumerators were trained by the researcher for three days before data collection was started. Information was obtained from both household heads. But the majority of respondents were females (Appendix Figure 10).

3.4.2. Sampling of milk and quality analysis

A total of 30 milk samples were collected from each site based on primary survey (n= 90).Out of these samples from urban (6), peri urban (3) and rural (2) had mastitis case. Therefore, a total of 79 samples were tested. Milk samples were collected from households producing milk that is provided to their child based on the result of the preliminary survey. The milk sample was taken from the cup that a child used to drink from, before it was boiled and the volume of milk was measured with measuring cylinder (Appendix 2).

From Andassa Research Center, 90 sampling bottles and one measuring cylinder was obtained. The bottles and measuring cylinder were sterilized by washing with a detergent and boiled water (Appendix 3). Sterilization of sample collecting bottle was performed before and after sample collection from each three sites. The collected milk samples were mixed together into sterilized universal bottles of about 1000 ml capacity and labeled the name of the site on the bottle. Sterilizing equipment called autoclave (Appendix 4). From each house 33 ml of milk was collected. The milk for mastitis test was taken directly from the cow while for quality analysis it was taken from the cup that the child used to drink from. The collected milk was delivered to Bahir Dar Regional Veterinary Laboratory 30 minute after collection in ice box, then the mastitis test was completed for 1hour and 30 minutes then the milk samples which passed the mastitis test was delivered to Bahir Dar University Food and Biochemical Technology Department within the ice box for milk quality analysis. All milk quality analysis was performed immediately after delivery. Microbial counts were made after 24 hours.

titratable acidity, alcohol test and lactometer test. The corresponding SPC and CC 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).The colonies were counted with colony counter(Appendix 5). For analysis purpose only counts in the normal (25-250) were taken directly. When all plates counted less than 25, the nearest count to 25 was taken and when all plates counted greater than 250 colonies for all dilutions, the nearest colony count to 250 was taken (APHA, 1992). To avoid a fictitious impression of precision and accuracy when computing the counts, only the first two significant digits were reported by rounding up or down to the next number. The following formula was used to calculate the counts (APHA, 1992).

$$N = \frac{\Sigma C}{[(1 \times n_1) + (0.1 \times n_2)]\, d}$$

Where:

N = Number of colonies per ml or g of product; Σ C = Sum of all colonies on all plates counted; n_1 = Number of plates in first dilution counted; n_2 = Number of plates in second dilution counted d = Dilution from which the first counts were obtained.

3.4.2.1. Coliform Count (CC)

The CC was made by mixing 25 ml of milk sample into sterile stomacher bag having 225 ml peptone water (1%). After mixing, the sample was serially diluted up to 10^{-4}in sterile test tubes having 9ml of peptone water and duplicate samples (1 ml) were plated using 15-20 ml Violet Red Bile Agar solution (VRBA) in sterile Petri dish. After thoroughly mixing, the plated sample was allowed to solidify and then incubated at 30°C for 24 hours. Finally, colony counts were made using colony

2012) (Appendix 6).

3.4.2.2. Standard Plate Count (SPC)

The SPC was made by adding 25 ml of milk sample into sterile stomacher bag having 225ml peptone water (1%). After thoroughly mixing, the sample was serially diluted up to 10^{-4}in sterile test tubes having 9ml peptone water and duplicate samples (1 ml) were pour plated using 15-20 ml SPC agar solution and mixed thoroughly. The plated sample was allowed to solidify and then incubated at 30°C for 48 hours. Colony counts were made using colony counter (MMAF, 2012). After incubation, all colonies including those of pin point size in SPCA medium and purplish red colonies in VRBA medium as shown in (Appendix 7).

3.4.3.3. Acidity test

Titratable acidity is a measure of freshness and bacterial activity in milk. The production of acid in milk is normally termed souring and the sour taste of such milk is due to production of lactic acid. The percentage of acid present in dairy products at any time is a rough indicator of the age of the milk and the manner in which it has been handled. Fresh milk can have an initial acidity due to its buffering capacity (O'Mahony, 1988; O'Connor, 1994). Acidity was measured by titration with 0.1 N sodium hydroxide solutions and using 1% ethanol solution of phenolphthalein as indicator (O'Connor, 1994). Popescu and Angel (2009) reported that, high quality milk essentially needs to have less than 0.14 percent acidity. The following formula was used to calculate the lactic acid percentage (O'Connor, 1995).

$$\text{Lactic acid (\%)} = \frac{\text{ml N/10 alkali} \times 0.009 \times 100}{\text{ml of sample}}$$

Five ml of milk and 5 ml of 68% alcohol (ethanol) were placed in a test tube. The test tube was inverted several times with the thumb held tightly over the open end of the tube. The tubes were shaken to mix and any clot formation was noted (Ombui *et al.*, 1995; O'connor, 1995). Clot formation indicates absence of freshness of the milk (Appendix 8).

3.3.1.5. Specific gravity test

Milk sample was filled gently into a measuring cylinder at room temperature. Then a lactometer was placed to sink slowly into the milk. The reading was taken just above the surface of the milk. According to the method described by Kurwijila (2006), these calculations are done on the lactometer readings (Appendix 9).

The following formula was used to calculate the milk specific gravity.

$$\text{Specific gravity} = \left[\frac{\text{Lc}}{1000} \right]$$

Where, Lc - Lactometer reading at a given temperature, i.e., for every degree above 60^0F, 0.1 degree was added, but for every degree below 60^0 F, 0.1 degree was subtracted from the lactometer reading (O'Mahony, 1988).

Normal milk has specific gravity of 1.026–1.032 g/ml (or 26–32 on the lactometer reading). If water has been added, the lactometer reading would be below 26. If any solid such as flour has been added, the reading will be above 32 (Kurwijila, 2006).

Different statistical tools were employed for the data collected. The collected data was directly entered to statistical package for social sciences version 20 software and were analyzed with this software. Descriptive statistics were employed to summarize family size and educational level of the household, livestock ownership and herd structure, importance of dairy animals, milk handling, boiling practice of milk, child milk feeding practice and frequency. However, analysis of variance procedure was used to measure location effects on measured milk production and quality parameters. Chi square test was used to examine differences in child milk feeding practice and volume of milk provided for the child, between households with and without dairy cow and as a factor of urban, peri-urban and rural *kebele*. Multiple response analysis was applied for constraints of milk production in the area. To see the association between number of cow, milk production, educational level and child milk consumption, number of children and milk consumption bivariate correlation was employed.

Table 2: Family size per household in and around Bahir Dar

Location	Mean ± SD	Minimum	Maximum
Urban	5.34 ± 1.90	2	11
Peri-urban	5.14 ± 1.79	2	9
Rural	5.98 ±2.41	2	15
Overall	5.49 ± 2.07	2	15

4.1.2. Livestock ownership and herd structure

Table 3 shows the herd structure in livestock owning contacted households. The average number of cows per household ranged from 2.76 in urban to 3.54 in rural whereas the figure for the peri-urban was 3.02. There were 61.6% and 29.1% cross-breed cows included with average 2.8 and 2.1 of cross-breed cows per household in the urban and peri-urban areas, respectively. However, in the rural areas there were 14.1% cross-breed dairy cows with average 1.3 of cross-breed cows encountered per household.

Table 3: Livestock ownership and Herd structure per household in and around Bahir Dar

Location	Statistics										
		Oxen	Cows	Calves	Heifer	Bull	Sheep	Goats	Donkeys	Mule	Horse
	N	38	138	78	37	34	22	7		27	1
Urban	Minimum	1	1	1	1	1	1	1		1	1
	Maximum	5	12	4	3	10	2	1		16	1
	Mean	2.24	2.76	1.56	1.54	2.13	2.20	3.50		2.70	1
Peri-urban	N	40	151	73	44	21	43		2	10	
	Minimum	1	1	1	1	1	1		1	1	
	Maximum	2	13	4	4	2	9		1	3	
	Mean	2.35	3.02	1.46	1.63	1.17	3.58		1	1.67	
	N	84	177	74	69	47	49	26	9	10	
Rural	Minimum	1	1	1	1	1	1	2	1	1	
	Maximum	5	15	3	4	4	12	15	2	1	
	Mean	2.10	3.54	1.48	2.09	1.74	4.46	6.50	1.29	1	

N= Total Number of Livestock

According to the respondents, the primary reason of keeping dairy animal was income generation. However, from the three sites the majority of households with dairy cow in the urban (42.2%) keeps dairy cow for income generation. On the other hand, household milk consumption (44.7%) was the major purpose in the peri-urban area. However, keeping dairy animals for reproductive purpose (72.7%) was the major purpose of keeping dairy animals in the rural areas (Table 4).

Table 4: Purposes of keeping dairy animals in and around Bahir Dar

Location	Major purpose of keeping dairy animals priorities		
	Milk consumption N (%)	Income generation N (%)	Reproduction N(%)
Urban	8(21.1)	38(42.2)	4(18.2)
Peri-urban	17(44.7)	31(34.4)	2(9.1)
Rural	13(34.2)	21(23.3)	16(72.7)

N= Number of respondent

4.2. Milk production, Cow Ownership and Child Milk Consumption

4.2.1. Milk production

As it is indicated in Table 5, on average higher volume of milk yield per day was reported in the urban area (5.92 ± 5.25 liters) followed by peri-urban area (4.67 ± 4.65 liter). On the reverse, small volume of milk yield per day was reported in the rural area of the study which was about 3.12 ± 2.78 liters. The overall cow milk yield/household/day in and around Bahir Dar was 4.57 ± 4.47liters. There was a significant variation ($P<0.05$) among urban and rural *kebeles*. However, there was no significant difference ($P>0.05$) between urban and peri urban, and peri-urban and rural *kebeles* in milk production.

Table 5: Reported daily milk yield of cows per household in and around Bahir Dar

Location	N	Minimum (Liters/Day)	Maximum	Mean ± SD
Urban	50	1	18	$5.92^{a} \pm 5.25$
Peri-urban	50	0.5	16	$4.67^{ba} \pm 4.65$
Rural	50	0.5	10	$3.12^{b} \pm 2.78$
Over all	150	0.5	18	4.57 ± 4.47

N= Number of respondents, SD= Standard Deviation, Means followed with different superscripts in a column are significantly different ($P<0.05$)

4.2.2. Cow ownership and child milk consumption

From the total respondent households with and without dairy cow in the study area, a household with dairy cow had better practice of child milk feeding (63.3%).On the other hand, lower number of respondents without dairy cow (42%) has a practice of child milk feeding. Moreover, the volume of milk fed/child was significantly higher for households with dairy cows than those without ($P<0.05$) (Table 6). According to this finding 25.3% of households with dairy cows and 7.1% of those without dairy cows provide below the recommended volume whereas 29.5% of households with dairy cows and 26.8% of those without dairy cows feed their children above the recommended volume. On the other hand, 45.2% of households with dairy cow and 66.1% of households without dairy cow provides milk within the recommended standard.

(ml/child/day) in and around Bahir Dar

Cow ownership	Practice of cow milk feeding		Volume of cow milk consumed by children
	N (%)		Mean ± SD
	Yes	No	
With dairy cow	95 (63.3)	55(36.7)	$464.9^{a} \pm 299.62$
Without dairy cow	56(42)	94(58)	$457.5^{b} \pm 154.54$
X^2P-value	0.000		0.001

N= Number of respondents, SD= Standard Deviation, Means followed with different superscripts in a column are significantly different (P<0.05)

The highest proportion of households that feed milk to children was found in the urban area whereas the lower was in the peri-urban localities (Table 7). However, there was no significant difference (P>0.05) over locations in cow milk feeding practice. In terms of volume significantly higher (P<0.05) volume of milk feeding was reported in the peri-urban (512.8ml/child/day) than urban (482.4ml/child/day) and rural (403.2 ml/child/day) (Table 7).

Table 7: Child milk consumption among households with dairy cow in and around Bahir Dar

Location	Practice of cow milk feeding for child		Volume of cow milk consumed by children in ml
	Yes	No	
	N (%)	N (%)	Mean ± SD
Urban	37 (74)	13(26)	$482.4^{a} \pm 218.5$
Peri-urban	27 (54)	23 (46)	$512.8^{b} \pm 376.9$
Rural	31 (62)	19 (38)	$403.2^{c} \pm 312.7$
Overall	95 (63.3)	55 (36.7)	464.8 ± 299.6
X^2P-value	0.113		0.000

N= Number of respondents, SD= Standard Deviation, Means followed with different superscripts in a column are significantly different (P<0.05)

children in households without dairy cow. Significantly higher number of respondents who provide milk for their children was found in the urban area of Bahir Dar (68%) while none of respondents in the rural areas of the study has a practice of purchasing and feeding for their children. In terms of volume, significantly highest volume of child milk consumption was recorded in the urban area of study than the other sites.

Table 8: Child milk consumption by households without dairy cow in and around Bahir Dar

Location	Practice of cow milk feeding for child		Volume of cow milk consumed by children
	Yes N (%)	No N (%)	Mean ± SD
Urban	34(68)	16(32)	$465.7^{a} \pm 157.7$
Peri-urban	22(44)	28(56)	$444.4^{b} \pm 152.1$
Rural		50(100)	
Total	56(36)	94(64)	457.5 ± 154.5
X^2 P-Value		0.000	0.000

N= Number of respondents, SD= Standard Deviation, Means followed with different superscripts in a column are significantly different ($P<0.05$)

Table 9 shows the reported frequencies of milk provision to children over locations. The majority of respondents in the urban 46.6% and peri-urban 32.7% area of the study provide milk twice per day while 38.7% in the rural area provide milk occasionally.

Table 9: Frequency of child milk consumption across locations in and around Bahir Dar

Location	Frequency of child milk consumption				
	Occasionally N (%)	Once per day N (%)	Twice per day N (%)	Thrice per day N (%)	Without restriction N (%)
Urban	6 (8.2)	22 (30.1)	34 (46.6)	1 (1.4)	10 (13.7)
Peri-urban	13(26.5)	12(24.5)	16(32.7)	3(6.1)	5(10.2)
Rural	12(38.7)	5(16.1)	8 (25.8)	0	6 (19.4)

N= Number of respondents

4.2.3. Impact of number of cows, volume of milk produced and household education on child milk consumption

In this study, no correlation was found between number of cows and amount of milk produced at household level. However, households with higher number of cross-breed cows produce more milk than households with local breed dairy cow. The association between educational level of the household head and total milk production indicates significant positive correlation whereby as educational level of the household increases the total volume of milk produced per household would increase (Table 10). However, there was no significant correlation between household education and volume of milk provided to children less than five years of age (correlation not found). On the other hand, positive correlation was found at significant level between total milk production and amount of milk consumed by children. Similarly, significantly negative correlation was found between amounts of milk consumed by children and number of children 1-5 years old of household without dairy cows ($P<0.05$).However, no significant correlation was found between amounts of milk consumed by children and number of children 1-5 years old of household with dairy cow.

education and child milk consumption

Associations	Pearson correlations	P-Value
	milk production	
Number of cows/HH	0.032	0.700
	milk production	
Respondent education	0.371	0.008
	volume of milk consumed by children	
Milk production	0.542	0.000
	number of under 5 children/HH with dairy cows	
volume of milk consumed by children	-0.079	0.449
	number of under 5 children/HH without dairy cows	
volume of milk consumed by children	-0.455	0.000

4.3. Constraints of Milk Production and Child Milk Consumption

4.3.1. Constraints of milk production

According to the respondents there were different challenges faced in dairy production in and around Bahir Dar. These include shortage of feed, shortage of water, lack of improved breed, shortage of land, disease and lack of veterinary service (Table 11). Generally, feed shortage is the biggest problem for all the study sites whereas shortage of land space is a priority problem for urban and peri-urban dairy owners and lack of improved breeds is a priority problem for the rural farmers.

Table 11: The major constraints of milk production in and around Bahir Dar

Problems	Urban (n=50)	Peri-urban (n=50)	Rural (n=50)
	Rank	Rank	Rank
Disease	5	6	5
Feed shortage	1	1	1
Water shortage	NR	5	3
Lack of improved breed	3	3	2
Shortage of land	2	2	NR
Lack of veterinary service	4	7	4
Shortage of labor	NR	5	6
Lack of consumer	NR	4	NR

N=Number of response, NR= No Response

4.3.2. Constraints of child milk consumption

Table 12 indicates the major constraint of child milk feeding among households with dairy cow across locations. The major constraint cited by the majority of urban dairy cow holders preventing them from feeding milk to their children was selling of milk for income generation followed by lack of interest for milk by their children. On the other hand, the major constraint cited by the majority of peri-urban dairy holders was selling of milk for income generation and low milk production where as for the rural dairy cow owners; the main problem was lack of knowledge and local processing of all produced milk.

Table 12: Major constraint of child milk consumption by household with dairy cow in and around Bahir Dar

Problems	Urban	Peri-urban	Rural
Lack of knowledge	NR	3	1
Selling of milk for income generation	1	1	NR
Interest of kids	2	3	3
Low milk production	NR	2	NR
Health problem of the child	NR	5	3
Culture of providing milk	NR	4	NR
Processing of produced milk	NR	NR	2

NR= No Response

Similarly, problems identified by household without dairy cows that prevent them from supplementing their children with cow milk suggested that economic constraints and fear of milk-borne diseases for urban areas, economic constraints and lack of access to buy milk for peri-urban areas and absence of culture of buying milk and shortage of money were the major constraints in the rural areas (Table 13).

Table 13: Major constraint of milk consumption by household without dairy cow in and around Bahir Dar

Problems	Urban	Peri-urban	Rural
Health problem of the children	4	NR	NR
Poor interest of kids	3	NR	4
Shortage of money	1	1	2
Fear of milk-borne diseases	2	NR	NR
Lack of supply in market	NR	2	NR
Culture of purchasing milk	NR	3	1
Lack of Knowledge	NR	4	3

NR= No Response

4.4. Milk Handling Practices and Quality of Milk

4.4.1. Milking, milk handling and boiling practices

In the study area, cows were hand milked and calves are allowed to suckle their dams prior to as well as after milking. The usual practice is to let the calves suckle their dams for a few minutes to stimulate milk let down. Milking the cow was at a standing position with one knee raised to support the milking vessel on their lap while another person holding the calf from suckling (Appendix 10).As it is shown in Table 14, in the urban area, 56% of respondents' wash the cow udder whereas the proportions of respondents who practice udder washing prior to milking were 22% and 2% in peri-urban and rural areas, respectively.

All of the interviewed respondents wash hands and milking vessels before milking cows (Table 14).However, dipping of milker's fingers into the milking vessel and moistening teats of the cows to facilitate milking were practiced in the study area. In this finding, the use of towel and hand glove to clean the udder of the cow and to keep the milk quality is very limited.

Table 14: Milking frequency and milking procedure in and around Bahir Dar

Variables	Urban(N=50)	Peri-urban(N=50)	Rural(N=50)
	%	%	%
Milking procedure			
Wash the hand and milking vessels	100	100	100
Washing the udder before milking	56	22	2
Do not wash the udder	44	78	98
Use of glove			
Glove users for milking	20		
Do not use glove for milking	80	100	100

N=Number of respondents

Table 15 indicates boiling practice of households before providing the milk to their children. In this finding 88.7%,67.3% and 45.2% of respondents has a practice of milk

boiling before feeding the milk to their children in the urban, peri-urban and rural areas of the study, respectively. On the other hand, 11.3% in the urban, peri-urban 32.7% and in the rural 54.8% of respondents doesn't have milk boiling practice before giving the milk to their children.

Table 15: Milk boiling practice of households in and around Bahir Dar

Location	Yes	No
	N (%)	N (%)
Urban	63(88.7)	8 (11.3)
Peri-urban	33(67.3)	16 (32.7)
Rural	14(45.2)	17 (54.8)

Table 16 indicates the type of detergents used to wash milk collecting and feeding containers in and around Bahir Dar. The majority (88%) of respondents in the urban and peri-urban (50%) areas, wash milking, milk feeding and storing containers with detergents (*Ajacks)* and boiled water. However, in the rural areas of the study, 66% of respondents use plants to wash milk vessels. The vernacular and scientific names of the plants are presented in (Appendix 12).

Table 16: Detergents used to wash milk collecting and feeding containers in and around Bahir Dar

Detergents used	Urban	Peri-urban	Rural
	%	%	%
Boiled water only	6	14	8
Plant and boiled water	6	8	66
Ajacks and boiled water	88	50	8
Madaberia and boiled water	NR	28	18

N= Number of respondents, NR= No Response

4.4.2. Microbiological quality of milk

Table 17 illustrates microbiological quality of milk samples taken immediately before it is consumed by children at different study areas. Higher (SPC/ml) was found in the rural $5X10^5$ areas of the study compared to the urban and peri-urban sites. However, there was no significant difference ($P > 0.05$) across locations. This value is lower than the minimum quality standard value of the country (2×10^6), ES (2009). Likewise, of SPC, higher CC ($2.2X10^5$) was obtained in the rural area of the study without significant ($P > 0.05$) difference across location (Table 17). However, according to American and European community member states, the acceptable limit for CC for raw milk is 150 cfu/ml (APHA, 1992). Therefore, milk collected from all study sites does not meet the minimum quality standard as the coliform population was much higher than the value indicated.

Table 17: Microbial quality of cow raw milk in and around Bahir Dar

Location	SPC (CFU/ml)	SPC (Log_{10})	CC (CFU/ml)	CC (Log_{10})
Urban	10^4	4	$4.7X10^3$	3.7
Peri-urban	$4.6X10^4$	4.7	$3.1X10^4$	4.5
Rural	$5X10^5$	5.7	$2.2X10^5$	5.3
X^2 P-value			0.378	
	0.378			

SPC= standard plate count, CC= coliform count, CFU= colony forming unit

Titratable acidity is a measure of freshness and bacterial activity in milk. Fresh milk contains natural acidity which is due to the natural ability to resist pH changes. Popescu and Angel (2009) reported that, high quality milk essentially needs to have less than 0.14 % acidity for consumption. Therefore, milk collected from all study sites does not meet the quality standard of acidity as it was much higher than the value indicated. However, no significant difference was observed ($P>0.05$) in acidity across locations. When milk contains more than 0.21% acid, or when calcium or magnesium compound are present in greater than normal compounds, it coagulates on the addition of alcohol. This fact is the basis of alcohol test, which furnishes a means of judging the quality of milk (O'Mahony, 1988; Ombui *et al.*, 1995). Therefore the result

indicates fresh milk in the urban and peri-urban areas while, in the rural areas the milk was not fresh.

Normal milk has specific gravity of 1.026–1.032 g/ml (or 26–32 on the lactometer reading). If water has been added, the lactometer reading will be below 26. If any solid such as flour has been added, the reading will be above 32 (Kurwijila, 2006). Therefore, the milk in the urban area was under the range which indicates addition of water whereas, milk consumed by peri-urban and rural children was not adulterated. . However, no significant difference was observed (P>0.05) in specific gravity across locations.

Table 18: Physico-chemical quality of cow raw milk in and around Bahir Dar

Location	Mean values of milk physico-chemical quality parameters across the study *woredas*	
	Adulteration	Acidity test
	Mean ± SD	Mean ± SD
Urban	$25.00^{a} \pm 0.00$	$0.19^{a} \pm 0.01$
Peri-urban	$26.67^{a} \pm 0.58$	$0.20^{a} \pm 0.10$
Rural	$26.11^{a} \pm 0.58$	$0.23^{a} \pm 0.02$
Over all	26.11 ± 0.93	0.21 ± 0.02
X^2 P-value	0.061	0.532

SD= Standard Deviation, Means followed with different superscripts in a column are significantly different (P<0.05)

5.1. Milk production, Cow Ownership and Child Milk Consumption

The number of dairy cow in the urban and peri-urban area of Bahir Dar was lower as compared with rural areas of Bahir Dar. This may be due to shortage of land and feed as it is already been understood from questionnaire respondents. Similarly, Yayeh *et al.* (2014) reported that, the average livestock holding capacity in the urban area was lower than rural areas of Debre Markos. It may also be due to the fact that rural households keep large number of dairy animals as they produce less milk and they are of multipurpose usage.

On the other hand, on average higher milk yield was recorded in the urban followed by peri-urban households with dairy cow than rural areas. This may be due to the availability of large number of cross-breed cow and better management condition in the urban areas than in other study sites. Urban dairy systems have relatively better access to inputs (e.g. feeds, improved breeds etc) and services (e.g. artificial insemination) provided by the public and private sectors, and use intensive management than peri-urban and rural dairy production systems (Tegegne *et al.*, 2013).On the other hand, rural dairy production system is largely dependent on low levels of inputs and indigenous breeds (Tsehay, 2001).Education is an important entry point for empowerment of rural communities and an instrument to sustain development (Adebabay, 2009). The educational level of the household in the urban area of the study was better than the other sites and this educational level of the household head has positive correlation with the total volume of milk produced at household level i.e., when educational level of the household head increases milk production would increase.

Households with dairy cow has a better practice of cow milk feeding for children than households without dairy cow, and in terms of volume, households with dairy cow provide better volume of milk for their children. This indicates the impact of dairy cow ownership on child milk feeding. Similarly, Nicholson *et al.* (2003);John *et al.* (2014) reported that, households with dairy cows consume more milk than other

households without dairy cow suggesting that cow ownership is an important determinant of child milk consumption. IPS (2000); BoFED (2006) ascertain that livestock rising plays a vital role in economic development and has great contribution in improving the nutritional status of the people.

According to RMIYC (2012), the recommended volume of milk consumes by the children 1-5 years old per day is 350-480 ml of milk. However, 25.3% of households with dairy cows and 7.1% of those without dairy cows provide below the recommended volume whereas 29.5% of households with dairy cows and 26.8% of those without dairy cows feed their children above the recommended volume. To enable children to eat a balanced diet of variety and quality, excessive milk intake (more than 480 ml/day) should be avoided as since it displaces a child's appetite for other nutritious foods. Inadequate dietary intake can also cause weight loss or growth failure in children and leads to low nutrition reserves (Smith and Haddad, 1999). On the other hand, 45.2% of households with dairy cow and 66.1% of households without dairy cow provides milk within the in the recommended standard.

In this finding, highest child milk feeding practice was recorded in the urban and rural areas of households with dairy cow. This might be associated with educational level of the household heads in urban areas. According to this study, highest literacy was recorded in the urban area of the study. The role of education is obvious in affecting household income, adopting technologies, demography, health, and as a whole the socio-economic status of the family as well (Keralem, 2005). On the other hand, the high child milk feeding practice in the rural area could be associated with market. Rural dairy production system is not market oriented and most of the milk produced in this system is retained for home consumption (Getachew, 2003). However, higher volume of milk feeding was recorded in the peri-urban area of study than the other sites. This was due to the purpose of keeping dairy animals.

From the total respondents without dairy cow, higher number of respondents who provide milk for their children was found in the urban area of Bahir Dar. Similarly, in terms of volume, higher volume of milk consumption by children per day was also recorded in the urban area of the study. This could be associated with the educational level of the household and accessibility of milk in the market. The extensive

contributes to the level of milk consumption (Masembe, 2003). Marketing of fluid milk in urban area is arranged through direct contact between producers and consumers, and/or involves wholesalers/processors, cooperatives, and retailers (Tegegne *et al.*, 2013).In the absence of such marketing system, access to milk for those who can afford to buy could be difficult. None of the respondents in the rural area of study practice purchasing milk for their children. This is mainly associated with culture of purchasing milk followed by shortage of money to purchase milk. According to the respondents in the rural area of study, milk is not accessible in market and purchasing of milk for household consumption is assumed as taboo.

5.2. Constraints of Milk Production and Child Milk Consumption

According to the respondents there were different challenges facing dairy production in the study area. The major ones are shortage of forage for all study sites, shortage of land for urban and peri-urban areas and lack of improved breeds. The interaction of these constraints affects the overall milk production in the areas. Generally, feed shortage is the biggest problem for all the study sites. Yilma *et al.* (2011) also reported that the primary constraints to increased milk production under all dairy production systems were inadequate feed resources, poor pasture development and the ever increasing feed prices. Shortage of farm space also limits the number of livestock per household in the area. Similarly, the report of Yayeh *et al.* (2014) indicated, shortage of space or land as a prioritized constraint that limits livestock holding capacity per household in the urban areas of Debre Markos. Although urban expansion creates great opportunity for commercialization of dairy production, it has to be supported with appropriate policy framework to promote dairy development (Tegegne *et al.*, 2013).On the other hand, lack of improved breeds was a priority problem for the rural dairy cow producers. The findings of this research indicated that in the rural areas, there was very limited access to improved breed which is in agreement with the report of Tsehay (2001) as rural dairy production system is largely dependent on low levels of inputs and indigenous breeds.

Cow ownership is said to have a large and positive impact on milk consumption and linear growth of young children. Household ownership of a single cow predicts an increase in the Height-for-Age Z-score (HAZ) of between 0.25 and 0.47 standard deviations and reduces stunting by between 6 to 13 percent (John *et al.*, 2014). The main constraints cited by the majority of urban and peri-urban dairy cow holders to preventing them from feeding milk to their children was selling of milk for income generation followed by lack of interest for milk by their children. Lack of knowledge and processing of milk into other products were reasons prioritized by the rural dwellers.

Azage and Alemu (1997) indicated that in the urban areas there is high demand for milk promoting producers to sell their milk before the household demand is mate. This is also supported by the questionnaire survey result where urban and peri-urban dwellers keep dairy cows mainly for income generation. According to Tegegne *et al.* (2013), Per-urban milk production system located at the periphery of major towns also have relatively better access to urban centers in which dairy products are highly demanded. The majority of rural household respondents were illiterate in this study supporting the idea that household level cow milk consumption of children is affected with parental education (Vella *et al.*, 1995). Processing milk was also a major constraint that affects children cow milk feeding practice. In this finding, respondents hide the milk from their children in order to processes and produce butter which enables them to generate income by selling the butter as there is no market access for fresh milk to be sold.

Similarly, problems identified by household without dairy cows that prevent them from supplementing their children with cow milk suggested economic constraints and fear of milk-borne diseases for urban areas. Similarly, fluid milk consumption is affected with the factors that has related with consumers' attitudes and perceptions about price and health effects of milk (Berhanu *et al.*, 2012).In the peri-urban area, economic constraints and lack of access to buy milk was the major problem of cow milk feeding for their children. In the peri-urban area of *Meshentii* parents seriously complained of lack of access to purchase fresh milk for their children. On the reverse, in other peri-urban area such as Zege *01* there was high milk production as reported by respondents but no local demand to sell fresh milk. Absence of culture of buying

preventing them from supplementing their children with adequate milk. In the rural areas of the study, purchasing milk is assumed as taboo due to this parents refuse to purchase and feed milk for their child at times when no milk is available at home.

5.3. Milk Handling Practices and Quality of Milk

Provision of milk and milk products of good hygienic quality is desirable from consumer health point of view (Giangiacomo, 2000). The SPC is used for estimating the total viable bacterial population in most types of dairy products. It is the method commonly used to examine the microbiological quality of raw and pasteurized milk and milk products (Marth, 1978).The mean value of SPC/ml in urban, peri-urban and rural areas of the study was similar and was below the minimum quality standard value (2 x 10^6SPC/ml) established for Ethiopia (ES, 2009). The SPC obtained in this study was also lower than the report of Asaminew and Eyassu (2007);Solomon *et al.* (2013), who reported in Bahir Dar *zuria* and Mecha *woreda* and in selected dairy farms in Debre Zeit town, respectively. Similarly, the total coliform count did not vary between the three study sites. The CC which was obtained in the three sites of the study was lower than the report of Zelalem and Bernard (2006) done on different producers in the central highland of Ethiopia. However, according to American and European community member states, the acceptable limit for CC for raw milk was150 cfu/ml (APHA, 1992). Therefore, milk collected from all study sites does not meet the minimum quality standard as the coliform population is much higher than the value indicated which may suggest the need for further investigation on the presence of human pathogenic bacteria in milk in the study areas.

The higher CC may be due to the initial contamination of the milk samples either from the cows, milker hands, milk containers or milking environment in general (Asaminew and Eyassu, 2007). In agreement with this suggestion, this study has established the presence of potential risk factors such as udder hygiene, proper hand washing and cleanness of milking and storage utensils that might predispose the milk to contamination. For example, maximum reduction of teat contamination of 90 % can be achieved with good udder preparation (washing with disinfectant and drying with paper towel) before milking (Murphy, 1996). Before milking cows, dipping of

milker's fingers into the milking vessel and moistening teats of the cows to facilitate milking is practiced in the study area. This practice may allow microbial contamination of the milk from the milker's hand and thus should be discouraged (Asaminew and Eyassu, 2007).

Titratable acidity is a measure of freshness and bacterial activity in milk. Popescu and Angel (2009) reported that, high quality milk essentially needs to have less than 0.14% acidity. Therefore, milk collected from all study sites does not meet the minimum quality standard of acidity as it was much higher than the value indicated. However, the overall mean titratable acidity of cows' milk produced in the study area was 0.21 .This figure is lower than the finding of Asaminew and Eyassu (2007) who reported an average acidity of 0.23 in Bahir Dar *zuria* and Mecha *woreda*. Similarly, this finding was lower than the report of Alganesh (2002) who reports 0.28 and 0.31 for raw cows' milk produced in Bila Sayo and Guto Wayu *woredas* of eastern Wollega, respectively. Acidity of the milk samples did not show significant variation ($P > 0.05$) by location. Fresh milk can have an initial acidity because of the buffering capacity (O' Mahoney, 1988), but the milk tested was kept long at ambient temperature between milking and analysis attributing to high acidity. According to Richardson (1985); O'Connor (1994), the percentage of acid present in dairy product at any time is a rough indication of the age of milk and the manner in which it has been handled.

When milk contains more than 0.21% acid, or when calcium or magnesium compound are present in greater than normal compounds, it coagulates on the addition of alcohol. This fact is the basis of alcohol test, which furnishes a means of judging the quality of milk (O'Mahony, 1988; Ombui *et al*., 1995). Therefore, children in the urban and peri urban area consumes fresh milk while, in the rural children consumes milk which is not fresh.

Normal milk has specific gravity of 1.026–1.032 g/ml (or 26–32 on the lactometer reading). If water has been added, the lactometer reading will be below 26. If any solid such as flour has been added, the reading will be above 32 (Kurwijila, 2006). Therefore, a child in the urban area consumes adulterated milk whereas; milk

reduces the quality of milk.

From this study, it was noted that child milk consumption mainly depends on dairy cow ownership. A household with dairy cow provides more volume of milk and has a better practice of feeding milk for their children. Milk production and milk feeding practice was much higher in urban areas as is their educational level which affected these variables. Generally, animal feed shortage is the biggest problem for all the study sites. In this finding the major constraint to child milk consumption in the urban and peri-urban area of study was selling of milk for the sake of income generation while in the rural area of study the major constraint was lack of knowledge. On the other hand, for households without dairy cow, the major constraints that prevent parents from supplementing their children with cow milk was economic constraints and fear of milk-borne diseases in urban areas, economic constraints and lack of access to buy milk for peri-urban areas and absence of culture of buying milk and economic problem for the rural areas. The quality of milk fed to children by dairy cow owners was found to be affected by factors such as udder hygiene, cleanness of hands and utensils which might have ultimately resulted in higher coliform counts in milk of all study sites.

Based on the findings of the present study the following recommendations are made:

- In order to expand cow milk production and child milk feeding at household level, owning an improved breed of dairy cows is an option. Therefore, households have to be supported in terms of acquisition of cross-breed cows, accessing better quality animal feed and extension services on the management packages.

- Milk and dairy product marketing channels have to be improved or established in sites such as *Meshentii*, *Zege 01* and others as appropriate. Because in *Zege 01* there is milk production but no milk market while, in *Meshentii* there no supply. So it needs coordinator. This is important for both consumers and producers

importance of hygienic milk production, handling, feeding and processing. Areas of concern are proper washing and drying of the udder, hand washing before milking, proper cleaning of milking and storage vessels as well as child feeding utensils.

- Further study is required to investigate human pathogenic microbes in milk as the coliform level was found high. Moreover, similar study on the quality of milk provided to children in households without dairy cows is recommended.

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8. APPENDIXES

Date_____

Appendix 1. "HOUSEHOLD LEVEL MILK PRODUCTION AND CHILD MILK CONSUMPTION IN AND AROUND BAHIR DAR, ETHIOPIA"

Procedures for data collector

- Introduce yourself and the purpose of the research briefly,
- Approach the respondents politely
- Ask the respondent step by step as indicated in the questionnaire.

. General

. Location _____

Date _____ Name of respondent(s) _____

Region _____ Zone _____urban _____ peri-urban ____ Rural___ Altitude _____ m.a.s.l

2. Marital status of the household head

A. Married B. Divorced C. Widowed D. Single

3. Sex of household head

A. Female B. Male

4. Family size per household and age distribution

Total _____ Male _____ Female _____ Age (Years) 1-5 _____

4. Educational level of the household

A. Illiterate B. Read and write C. 5-8 grades D. 9-12 grades E. Higher institution completed

6. What are your major agricultural activities?

A. Crop-livestock production B. Crop production only C. Livestock production only

2. Livestock ownership, herd structure and related

7. Number of livestock in household

	Types of livestock	Number
6.1	Calf	
6.2	Oxen	
6.3	Cow	
6.4	Heifer	
6.5	Bull	
6.6	Sheep	
6.7	Goat	
6.8	Donkey	
6.9	Horse	
6.10	Mule	

8. Do you have dairy [ ] [ ]

If the answer is yes processed to the following questions (10-16)

9. What are the major purposes of keeping dairy animals? Prioritize

A. For household consumption B. For reproduction C. Income generation D.A and B E.A and C F. B and C G. All

10. When do you perform milking at what time?

A. Morning at_____ B. Evening at_____

C. Morning and evening at_____

11. What types of barn/housing do you have for dairy cattle?

A. Separate shelter B. fenced without roof C. Housed together with humans D. Others

12. How many times the barn will clean in a day?

A. Once a day B. Twice a day C. Occasionally D. Will not be clean E.

13. What are the facilities in the barn?

A. Water trough (WT) B. Feed trough (FT) C. WT + FT D. No facilities

14. How many times facilities in the barn will be clean?

A. Once a day B. Twice a day C. Occasionally D.A and B E. All

3. Feeds and Feeding

15. Feed sources for your dairy cattle?

A. Natural pasture B. Cultivate pasture C. Cereal straws D. Supplements E. By products F.All G.A, C and E H.A and E I.B and E J.A and E K. Others_____

4. Milk consumption

16. Do you feed cow milk for your children < five years of age? Yes [ ] No [ ]

17. If no for 8, do you purchase milk for children that are < five years old? Yes [ ] No [ ]

18. If no for 17, what is the reason?

A. Lack of supply in the market C. Fear of sanitation B. Shortage of money D. Cultural Taboo of purchasing milk E.A and B F. Other_____ G. All

19. If yes for 17, how much liter do you purchase for your kid?

A.1liter/day B. 2 liter/day C.3 liter/day D.4 Liter/day E. 5 liter/day

20. How frequently provide?

ithout restriction

1. If the answer of 20 is A, what is the reason?

. Milk is cost is high B. No milk supply in the market C. Fear of sanitation D. ack of knowledge E. Family size F. Others_____

2. If the answer of 20 is B, what is the reason?

. Milk is cost is high B. No milk supply in the market C. Fear of sanitation D. ack of knowledge E. Family size F. Others_____

3. If no for 8, what are the reasons?

A. No milk production B. Lack of knowledge C. Health problem of the children

D. All milk produced sold to generate income E. kid hate milk/Feel boar

24. On average how much of milk you provide/child/ day/ml?

_____

25. On average how much milk do you exploit for household consumption (day/ml)?

_____

26. When do you provide cow milk for your child?

A. After milking of the same day B. Day old milk (After one day) C. After two days D. Other_____

27. Do you boil the milk? Yes [ ] No [ ]

28. If the child gets milk < 333 ml/day what is the reason?

A. Milk is cost is high B. No milk supply in the market C. Fear of sanitation D. Lack of knowledge E. Family size F. Others_____

29. Do you wash the milk purchasing material? Yes [ ] No [ ]

30. If yes which kind of detergent you use to clean milk collecting and feeding equipments?

A. Ajacks B. Charcoal/Ash C. Plant D. Only with water E. A and B F. B and C G. B and C H. Other_____

6. Cattle productivity

31. Which type of breed mostly you use for milk production?

A. Local B. cross-breed C. Exotic D. A and B E .B and C F. A and C G.All

32. If the answer of 31 is local breed cow why?

_____

33. Parity, age, delivery time and milk yield of the lactating cow?

Breed	Age	parity	Day or month the cow gives birth	Average milk yield/day/liter
Local				
33.1				
33.2				
33.3				
33.4				
33.5				
Cross-breed				
33.6				
33.7				
33.8				
33.9				
33.10				
Exotic				
33.11				
33.12				
33.13				
33.14				
33.15				

34. Is the cow healthy? Yes [ ] No [ ]

35. What are the major problems for milk production?

A. Diseases B. Feed shortage C. Breed D. Shortage of land E.A and B F. A, B and C G. B and D H.All J. Others _____

36. At the moment milk supply in market is low, what is the reason?

A. Due to low productive performance of the cow B. Infrastructure C. No consumer

37. Describe milking procedure

38. Do you wash your hands, udder and milk vessels? Yes [ ] No [ ]

39. Do you use common towel to wash the udder? Yes [ ] No [ ]

40. Where do you place the milk after milking? Does the milking and milk storage material has a cover? _____

41. What kind of equipment you use to collect, store and transport milk?

_____

_____

_____

_____

42. What are the major diseases that affect the dairy animals?

_____

_____

_____

43. Do you have a problem to access the veterinary clinics in the area? Yes [ ] No [ ]

44. If yes, please specify the type of problem you have.

_____

45. What do you need to improve milk Production?

_____

46. What are livestock production systems?

A. Intensive B. Extensive C. Semi intensive D. Other_____

47. From what does the floor made?

A. Soil B. Concrete C. Smooth cement D. Others_____

48. What is the source of income for the household?

A. From selling of livestock and their product B. Other source_____

C. A and B

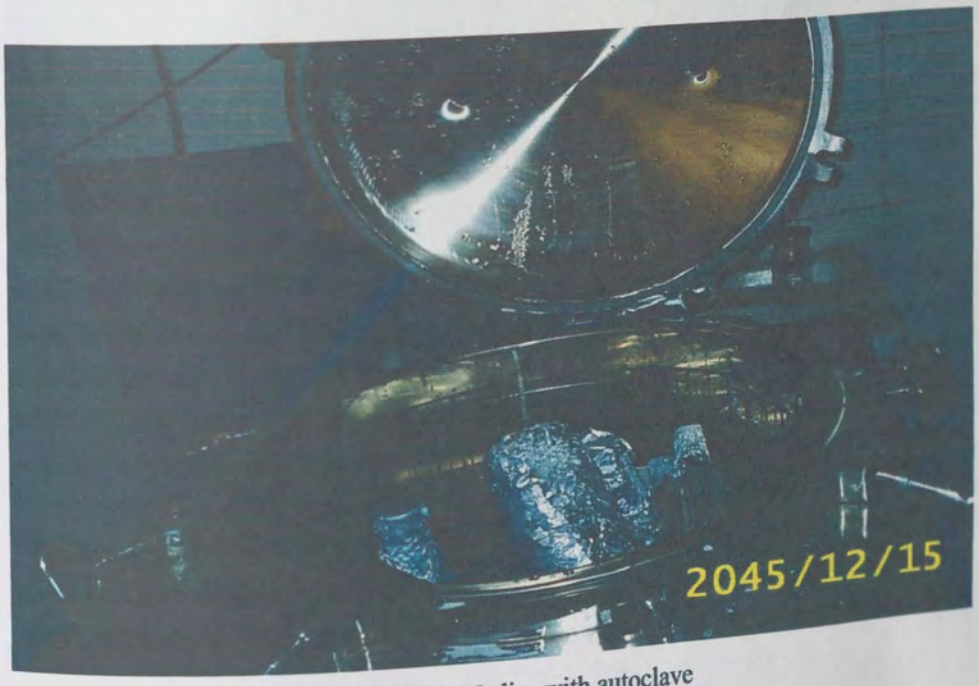
49. Do you want to have dairy cow? Yes [ ] No [ ]

Appendix 2. A child consuming milk (up) and taking sample from the milk that the child consumes (down)

Appendix 3. Sterilizing of sample collecting bottle and measuring cylinder with detergent

Appendix 4. Sterilization of bottles and Medias with autoclave

Appendix 3. Sterilizing of sample collecting bottle and measuring cylinder with detergent

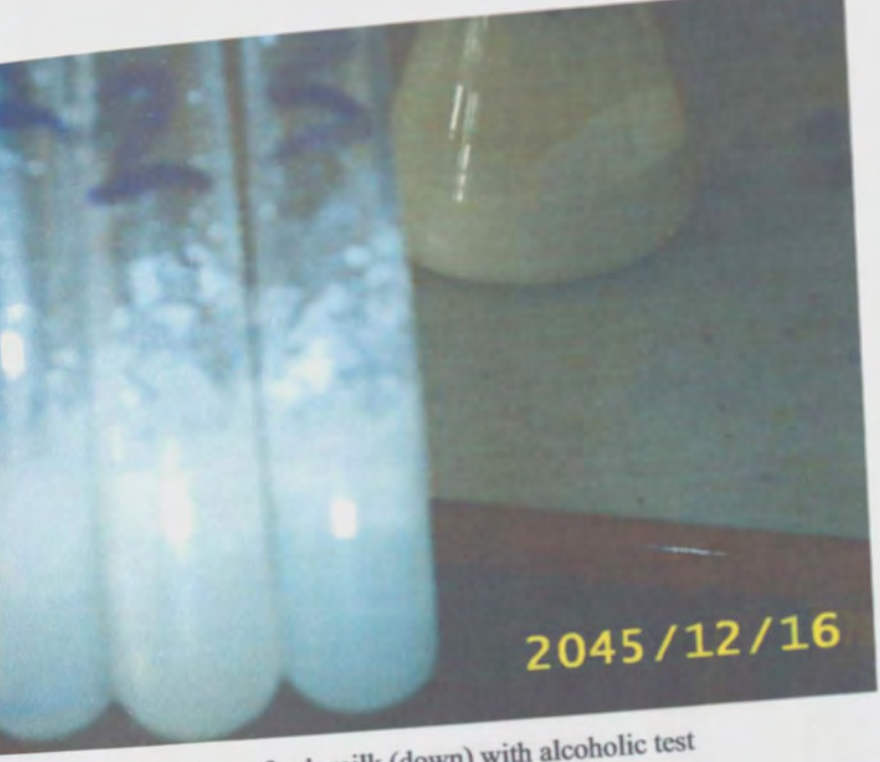


Appendix 4. Sterilization of bottles and Medias with autoclave

endix 5. Colony counter

endix 6. Colonies of coliform organisms in the plate

ɔendix 7.Standard plate counts



esh milk (up) and non fresh milk (down) with alcoholic test

9. Lactometer test of milk

ilking after the calf suckles the dam without washing udder

conducting in and around Bahir Dar

Appendix 12. Scientific and Vernacular name of plants used for cleaning of milk utensils in and around Bahir Dar

Vernacular name (Amharic)	Scientific name
Yesetkest	*Unidentified*
Lenkuata	*Kokono*
Yemashilalaba	*Unidentified*
Yemederembuay	*Cucumis ficifolius*
Woyira	*Olia. Africana*
Kesey	*Ocimum hardiense*