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ASSESSMENT OF SMALLHOLDER DAIRY PRODUCTION SYSTEMS AND MAJOR REPRODUCTIVE HEALTH DISORDERS OF DAIRY CATTLE IN EAST WOLLEGA ZONE, ETHIOPIA

MSc Thesis

By

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Department of Animal Production Studies

June, 2015

Bishoftu, Ethiopia

ASSESSMENT OF SMALLHOLDER DAIRY PRODUCTION SYSTEMS AND MAJOR REPRODUCTIVE HEALTH DISORDERS OF DAIRY CATTLE IN EAST WOLLEGA ZONE, 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 Masters 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 Misgana Duguma titled "assessment of smallholder dairy production system and major reproductive health disorders of dairy cattle in East *Wollega* zone, 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

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DEDICATION

I dedicate this thesis manuscript to my father Ato ***DUGUMA GOMORO TUFA*** and to my mother W/ro ***TUJUBE NUQUS KUMI***, for their love with affection and dedicated affiliation they contributed in the entire success of my life and academic career.

STATEMENT OF THE AUTHOR

First, 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 an advanced (MSc) degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and is submitted to 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: Misgana Duguma

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Date of Submission: 15 June, 2015

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LIST OF ABBREVIATIONS AND ACRONYMS

ADF	Acid Detergent Fiber
ADL	Acid Detergent Lignin
AI	Artificial Insemination
AOAC	Association of Official Analytical Chemists
BCS	Body Condition Score
CSA	Central Statistical Agency
CP	Crude Protein
DM	Dry Matter
ESAP	Ethiopian Society of Animal Production
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
IVOMD	*In vitro* Organic Matter Digestibility
HHs	Households
HHH	Household head
IPMS	Improving Productivity and Market Success
m.a.s.l	meters above sea level
MOARD	Ministry of Agriculture and Rural Development
NDF	Neutral Detergent Fiber
NID	Normally Independently Distributed
PAs	Peasant Associations
SAS	Statistical Analysis System
SD	Standard Deviation
SNNP	South Nations Nationalities and Peoples
SPSS	Statistical Packages for Social Sciences
X^2	Chi square
δ^2	Population variance

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ABSTRACT

A combination of cross-sectional, longitudinal and retrospective study was conducted in Guto Gida (Urban and Peri-Urban) and Leka Dullacha (rural) districts, East Wollega zone from December 2014 to March 2015 with the objectives to assess smallholder dairy cattle production systems, identify major reproductive health disorders and estimate milk production performance of dairy cows in smallholder dairy farms in and around Nekemte town. A total of 105 households were individually interviewed with follow up of 36 pregnant and 56 milking dairy cows. The chemical composition and nutritive value of four different hulls of pulse crops were analyzed. An average family size, land holding and herd size of the respondents were 6.07±2.11persons, 2.34±1.9 hectare and 12.19± 7.6 heads of cattle per household respectively. Land shortage, seasonal feed scarcity, ineffective crossbreeding and disease prevalence were among the major constraints of smallholder dairy cattle production in the study area. Trypanosomosis, Lumpy skin disease, Black leg, Pasteurellosis, Anthrax, Foot and Mouth Disease and ecto-parasite were the prevalent diseases and parasite of cattle in the study area. Out of 36 reproductive cases, 23(63.88%) of the cases was normal parturition with no history of reproductive health problem. The other, 13 cases were reproductive health disorders. From a total of 129 dairy cows (36 terminated pregnancy) 13(36.1%) were having at least one of the reproductive health disorders. Retained fetal membrane was frequently observed with the magnitude of 7(19.44%) among the cases, followed by abortion (8.33%) and dystocia (5.55%). A retrospective clinical case based prevalence of reproductive health problems at Guto Gida and Getema vet clinics were 56(2.1%) and 164(7.13%) respectively. The average daily milk yield of local Horro, HF cross and Jersey cross cows was 3.1±0.88, 8.7±0.55 and 5.8±1.68 liters per day. Both management system and herd size significantly affect lactation length and milk yield (P <0.05). The average crude protein and organic matter digestibility content of pulse crops hulls showed 12.43% and 73.59%. Generally the status of smallholder dairy cattle production in the study area was poor and constrained by feed scarcity and lack of improved breeding system. Interventions with improved dairy extension packages may minimize the constraints and improve milk production.

Keywords: *East Wollega zone, major constraint, milk yield, reproductive health disorders, smallholder dairy production*

1. INTRODUCTION

Ethiopia's economy is based mainly on agriculture, including crop and livestock production, 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).

Naturally endowed with different agro-ecological zones and suitable environmental conditions, Ethiopia is a home for many livestock species and suitable for livestock production. Ethiopia is believed to have the largest livestock population in Africa (CSA, 2013; Tilahun and Schmidt, 2012). An estimate indicates that the country is a home for about 53.9 million cattle, 25.5 million sheep and 24.06 million goats (CSA, 2013). From the total cattle population 98.95% are local breeds and the remaining are hybrid and exotic breeds. The subsector contributes about 16.5% of the national and 35.6% of the agricultural GDP (Metaferia *et al*. 2011). It also contributes 15% of export earnings and 30% of agricultural employment (Behnke, 2010). Human population in Ethiopia is projected to reach 140 million by the year 2025 and the urban population will rise to 40 million. It is, therefore, obvious that milk and its derivatives will be in short supply unless both horizontal and vertical expansions of the dairy industry will take place (Azage and Asfaw, 2004). 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, 2011).

The large population density of dairy cows, conducive and diverse agro-ecologies, makes Ethiopia to be a country with significant potential for dairy production (Ahmed *et al*., 2004; CSA, 2013). In spite of such a substantial potential, the dairy sector is not developed to the expected level. The annual growth rate in milk production of 1.2 percent falls behind the annual human population growth estimated at 3 percent. The traditional milk production system, which is dominated by indigenous breeds of low genetic potential for milk production, accounts for about 97 percent of the country's total annual milk production (Felleke *et al*., 2010).

Despite high potential for dairy development, the performance of the dairy industry in Ethiopia has not been encouraging when evaluated against even the dairy performance of East African countries which have more or less similar agro ecology (Alemu *et al*., 1998). 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 per year (Azage *et al.*, 2002). For example, a study by the Ministry of Agriculture (1996) indicated that the per capita milk consumption in Addis Ababa has dropped from 25 kg in the 1980's to about 16 kg in 1996. 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, 2003).

The average milk production capacity of the indigenous cow per head per lactation is estimated at 213 kg and average daily milk production per cow is 1.2 liters and the average calving interval 27 months (Solomon, 2006). The low productivity is due to a number of factors among 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 in the country. Although the smallholder dairying is an important source of income and has attracted a lot of poor families, it is not without constraints. Poor management, poor nutrition, lack of good breeds, infertility, reproduction disorders, animal diseases and the poor marketing system are among of the major constraints (Swai *et al*., 2005a, b).

Low dairy cattle production, among other factors, is because of poor reproductive performance. In the last few decades, as the major epidemic diseases were brought under control, emphasis have increasingly given to economically important diseases to the dairy producer and reproductive health problems stands out as the most important. Additionally, there is a general lack of data or information on reproductive health problems of dairy cattle and associated risk factors in the rural predominant smallholder

production condition. Among the major problems that have direct impact on reproductive performance of dairy cows are abortion, dystocia, retained fetal membrane (RFM), metritis, prolapse (uterine and vaginal), anoestrus and repeat breeder. These could be classified as prepartum and postpartum reproductive problems (Shiferaw *et al*., 2005; Lobago *et al*., 2006).

In view of such a large number of dairy cows and the important number of producers engaged in the dairy sector, the development efforts so far made have not brought a significant impact on the growth of the sector. The country is a net importer of dairy products with import values significantly exceeding export values. Although milk production generally tended to increase during the last two decades at national level, the per capita milk consumption has decreased from 26 litres per annum in 1980, to 22 litres in 1993, 19 litres in 2000 and 16 litres in 2009 (Zelalem *et al*., 2011). In Ethiopia, dairy farms rely on varieties of feed resources. But inadequate and unbalanced nutrient supply is one of the major technical constraints of urban and peri-urban dairy production systems (Goshu and Mekonen, 1997). Feed resource markets provide primarily native grass hay, grain milling by-products and oil seed cakes to urban and peri-urban dairy producers. They also supply commercial mixed concentrates made up of mill by-products Purchased crop residues are also important basal feed resources for small-scale farms in the secondary towns. Generally, the provision of feeds for dairy animals is based on availability than nutrient requirement for a particular productive state of animals (Staal and Shapiro, 1996).

Like most developing countries, Ethiopia's increasing human population, urbanization trends and rising household incomes are leading to a substantial increase in the demand for livestock products, particularly milk and meat. In order to meet the growing demand for milk and milk products in Ethiopia, milk production has to grow at least at a rate of 4 percent per annum. Bridging this wide gap calls for the design of appropriate and sustainable dairy development strategies based on socio-economic, institutional and agro-ecological circumstances that build on the demand of consumers and the needs and opportunities of producers (Azage *et al*., 2001, 2003).

In East *Wollega* zone, especially in urban and peri-urban areas of Nekemte town, dairy development package interventions have been going on for the past two decades and the number of farmers owning crossbred dairy cattle and engaged on milk production and marketing has increased over years (Diriba *et al.*, 2014). To develop appropriate interventions and assist smallholder milk producers requires a clear understanding of the dairy production systems and associated constraints. Little is known about the smallholder dairy production systems, reproductive and metabolic health disorders, major husbandry constraints and opportunities. In the study area, most of reported studies on the constraints of dairy cattle reproduction and 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 reproductive problems of dairy cows in the study area. Therefore the current study was conducted based on the following objectives:

- To characterize smallholder dairy cattle production systems in the study area
- To identify major reproductive health disorders of dairy cows and associated risk factors in selected smallholder farms and,
- To estimate milk production performance of milking cows in and around *Nekemte* town

2. LITERATURE REVIEW

2.1. Dairy Production Systems in the Tropics

The productivity of the livestock sub-sector in the tropics is affected by the level of adoption to new agricultural technology, which is also affected by the level of education of the farmer, risk and risk management strategies (Saha *et al*., 1994), the institutional support system such as marketing facilities, research and extension services and transportation. Many reports show that the productivity of livestock sub-sector in the tropics is also affected by availability of production factors such as farm size, number of livestock owned and the level of off-farm income and income source (Yaron *et al*., 1992). Milk production in sub-Saharan Africa amounted to 1.27 million tons in 1988, of which three-quarters was produced in East Africa. Cow milk accounted for 80 per cent overall; varying from only half of the milk produced in East and West African to nearly 100 per cent in Central and Southern Africa (Staal *et al.,* 1997b).

Dairy production systems in the tropics are concentrated near consumption centers. It is no coincidence that cattle and rural human population densities are highly correlated with specialized smallholder (large-scale) dairy farms generally located close to (peri-urban) or within (intra-urban) major markets, or more distant when there is an efficient market infrastructure. On the Other hand, the systems of production and their productivity are influenced by agro-ecological factors and traditional consumption habits (De Leeuw *et al*., 1999).

2.2. Dairy Cattle Production Systems in Ethiopia

Ethiopia is reported to be endowed with the largest livestock population in Africa. According to the recent report of the Central Statistical Agency, the cattle population was estimated at about 53.9 million. The indigenous breeds accounted for 98.95 percent, which are well adapted to and distributed among the diverse ecological conditions and

management systems of the country, while the hybrids and pure exotic breeds were represented by 0.72 and 0.09 percent, respectively (CSA, 2013).

The traditional milk production system, which is dominated by indigenous breeds of low genetic potential for milk production, accounts for about 97% of the country's total annual milk production. The low productivity of the country's livestock production system in general and the traditional sector in particular is mainly attributed to shortage of crossbred dairy cows, lack of capital by dairy producers, inadequate animal feed resources both in terms of quality and quantity, unimproved animal husbandry systems, inefficient and inadequate milk processing materials and methods, low milk production and supply to milk processing centres and poor marketing and market information systems (Felleke, 2003).

The existing dairy cattle production systems in Ethiopia can be grouped in the following four major livestock production systems: rural smallholder (mixed crop livestock) production, pastoral and agro–pastoral production, urban and peri-urban smallholder dairy production, and specialized commercial dairy production systems (Lobago, 2007).

Ethiopia produces approximately 3.2 billion liters from 10 million milking cows – an average of 1.54 liters per cow per day over a lactation period of 180 days (MOA, 2010). The farm-level value of the milk is an estimated Birr 16 billion. The value of other important animal products and services includes: traction, transport and manure for organic fertilizers and fuel. Estimated calf consumption and wastage of milk is 32% of the milk produced (Getachew and Gashaw, 2001). Households consume approximately 85% of the milk collected, 8% of the milk is processed into products with longer shelf life, and 7% is sold (MoARD, 2007). During peak production in the wet seasons, rural farmers, not part of formal cooperatives, face challenges marketing their milk as most regions experience a surplus. More surplus milk may be processed at the home into local cheese or butter. For most subsistence farmers in all cultures in Ethiopia, the daily decision on how to allocate milk is decided by the head female in the household and is

dependent upon season, number of children in the household, presence of sick family members, and daily financial needs (Tefera, 2010).

Most of the researchers used different approaches at different time for the classification of livestock/milk production system in Ethiopia. The finding of Beyene (2004) identified four major dairy production systems, namely: Smallholder dairy farming system in the crop-livestock mixed farming system in the highlands; Urban and peri-urban dairy system found around and inside the big cities; Pastoral/agro-pastoral system in the lowlands; Parastatal large-scale dairy farms. Moreover, it was concluded that the production of milk in East African countries in general and in Ethiopia in particular is dominated by smallholder dairy production system. Again, based on climate, land holdings and integration with crop production as criterion, dairy production systems recognized in Ethiopia are classified as the rural dairy system which is part of the subsistence farming system and includes pastoralists, agro-pastoralists and mixed crop–livestock producers; the peri-urban and urban dairy systems (Zegeye 2003; Dereje *et al*., 2005). The first system (pastoralism, agropastoralism and highland mixed smallholder production system) contributes to 98%, while the peri-urban and urban dairy farms produce only 2% of the total milk production of the country (Ketema, 2000).

According to Tsehay (2002), milk production systems can be broadly categorized into urban, peri-urban and rural milk production systems, based on their location. Both the urban and peri-urban systems are located near Addis Ababa and the regional towns and take advantage of the urban markets. Of the total urban milk production, 73% is sold, 10% is left for household consumption, 9.4% goes to calves and 7.6% is processed into butter and cottage cheese. Ethiopia consumes approximately 17 kg/capita. About 83% of the total milk produced is consumed at the household level and only 7% is supplied to the formal and informal markets. The remaining balance is distributed between in-kind wages (0.43%), and used for processing local butter, yogurt, and cheese (10.06%) primarily as a means of extending the shelf life during times of surplus. Oromia region supplies more milk to the market as compared to the other three large dairy producing regions of the country (GOE-LMP, 2007).

In terms of marketing, 71% of the producers sell milk directly to consumers. The peri-urban milk system includes small- holder and commercial dairy farmers near Addis Ababa and other regional towns. This sector controls most of the country's improved dairy stock. The rural dairy system is part of the subsistence farming system and includes pastoralist, agro-pastoralist and mixed crop–livestock producers, mainly in the highland areas. The system is not market-oriented and most of the milk produced in it is retained for home consumption (Tsehay, 2002).

2.2.1. The mixed (crop-livestock) production system

Smallholder dairy production systems are potentially very important for the food production of animal origin in developing countries. Their importance is expressed by the government support to this sector in many countries, due to excessive imports of milk and milk products, and more importantly, because of the recognition of the influence of dairy on income generation, tangible economic benefits, household nutrition and poverty reduction (Devendra, 2001).

About 93 percent of the total milk production in Ethiopia is produced by the smallholder dairy farmers living in the villages and exercising, in most instances, traditional dairying. The smallholder milk production system is dominated by subsistence farming. Cattle are the main source of milk even though they are kept primarily as draught power source with very little or no consideration given to improving their milk production capabilities. This dairy system is part of the subsistence farming system. According to Staal and Shaprio (1996), it is the predominant production system accounting for over 97% of national milk production. Largely, the system is based on low producing indigenous breeds of zebu cattle. The livestock are kept under traditional management conditions and generally obtain most of their feed from native vegetation, aftermath grazing and crop residues (Tsehay, 2002).

In the highland areas agricultural production system is predominantly substance smallholder mixed farming, with crop and livestock husbandry typically practiced within

the same management unit. In this farming system all the feed requirement is derived from native pasture and a balance comes from crop residues and stub grazing (MOA, 1996). Given the long tradition of using milk and milk products by the Ethiopian society, there is no doubt that increasing smallholder dairy production and productivity would bring about a conspicuous impact on improving the welfare of women, children and the nation's population at large.

2.2.2. Pastoral and agro- pastoral dairy production system

Pastoralism is the major system of milk production in lowlands areas. However, because of the low rainfall, shortage of feed and water availability, milk production is low and highly influenced by season (IPS, 2000; Tsehay, 2002). The system is not market oriented and most of the milk produced in it is retained for home consumption (Ahmed *et al.,* 2003) or household processing. Processing is usually done using traditional technology in to products such as butter, ghee, "*ayib"* and sour milk. Milk and milk products are usually marketed through the informal market after the households satisfy their needs. When the area exploited by a herd cannot continue to ensure its maintenance and the stockman cannot do anything about this deterioration, the animals should be moved. The insufficiency of the available forage and water resources also aggravate the mobility of the pastoralists (Tsehay, 2002). Agro-pastoralists are segments of the pastoral society who promote opportunistic crop farming to improve food security. Traditionally its one way of maintaining ownership rights over the use of land. It enables the production of crops to be used by both humans and livestock. A shift to agro-pastoralism could allow pastoralists to procure more food energy and still restrict sales of animals for grain purchases so that herd capital can be retained for other purposes (Coppock, 1993).

2.2.3. Urban and peri-urban dairy production system

Well-developed dairy industries are not common in sub-Saharan Africa although they exist to some degree in few countries around urban centers. Dairying is developing in response to the fast growing demand for milk and dairy products around urban centers.

The genetic compositions of these animals range from zebu to pure temperate dairy cattle (Tesfaye, 1995).

Commercial systems generally operate in urban and peri-urban dairy farms with or without holdings of land for feed production (Azage *et al.*, 2002). Commercial urban and peri-urban dairy system is concentrated near or in the vicinity of Addis Ababa and other regional towns. As indicated by Kelay (2002) the main objective of keeping dairy cattle in Addis Ababa was mainly to obtain income from sale of milk and milk products. 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 milk marketed in this system is of questionable quality, it is not pasteurized, and there is a possibility of adulteration. Moreover, price is high even when quality is low. No standardize quality control mechanisms or dairy policy exists to safeguard consumers (Tsehay, 2002). Currently, with increase in the intensity of management due to increase in economic pressure, competition for limited resources, together with increase in the level of intensification and level of exotic breed inheritance, new challenges in the management, control of disease, reproductive problems are becoming important factors in influencing these production systems (Million and Azage, 2000).

2.3. Available Feed Resources

Livestock industry is an important and integral part of the agricultural sector in Ethiopia. Livestock farming is vital for the supply of meat and milk; it also serves as a source of additional income both for smallholder farmers and livestock owners' (Ehui *et al*., 2002). Livestock production constraints can be grouped into socio-economic and technical limitations (Mulu, 2009). Inadequate feed, widespread diseases, poor breeding stock, and inadequate livestock policies with respect to credit, extension, marketing and infrastructure are the major constraints affecting livestock performance in Ethiopia (Desta *et al*., 2000). Feed resources as reported by Adugna *et al*. (2012) can be classified as natural pasture, crop residue, improved pasture and forage and agro industrial by-products of which the first two contribute the largest share. The fibrous agricultural

residues contributes a major parts of livestock feed especially in the populated countries where land is prioritized for crop cultivation. It was reported that crop residues contribute to about 50% the total feed supply in Ethiopia. Under smallholder livestock production system, animals are dependent on a variety of feed resources which vary both in quantity and quality. For optimum livestock productivity, the available feed resource should match with the number of animals in a given area (Wondatir, 2010).

Agro-industrial by-products produced in Ethiopia include by-products from flour milling, sugar factory, oil processing factories, abattoir and breweries. These products are mainly used for dairy, fattening and commercial poultry production and the scope for their wider use by smallholder producers is low due to availability and price (Solomon and Alemu, 2009). Livestock feed resources are classified as conventional and non-conventional, where the non-conventional ones vary according to feed habit of the community and others, e.g. vegetable refusals are non conventional. The major roughage feed resources for dairy animals across all the different production systems included natural pasture/grasslands, crop residues, non-conventional feed resources (e.g. leaf and stem of "*enset"*, banana and sugarcane; crop thinning) and crop aftermath (with the exception of urban dairy producers). The contribution of these feed resources, however, depends up on the agro-ecology, the types of crop produced, accessibility and production system (Azage *et al.,* 2013).

Ruminant livestock continue to rely mainly on natural pastures as their source of feed. However, it is recognized that milk production remains low. Commercial dairy meal as a supplement will no longer be affordable by most farmers due to escalating costs and unavailability. The approach to explore the use of locally available ingredients to formulate substitutes to daily meal therefore becomes necessary (Alemayehu and Sissay, 2003). In Ethiopia, dairy farms rely on varieties of feed resources. But inadequate and unbalanced nutrient supply is one of the major technical constraints of urban and peri-urban dairy production systems (Goshu and Mekonen, 1997). Feed resource markets provide primarily native grass hay, grain milling by-products and oil seed cakes to urban and peri-urban dairy producers. They also supply commercial mixed concentrates made

up of mill by-products Purchased crop residues are also important basal feed resources for small-scale farms in the secondary towns. Generally, the provision of feeds for dairy animals is based on availability than nutrient requirement for a particular productive state of animals (Staal and Shapiro, 1996).

Conserved native grass hay, agro-industrial by-products and commercially formulated concentrate rations are the major feed resources used in the urban and peri-urban dairy production systems. However, there is no practice and skill of using nutritionally balanced concentrate diet in these production systems (Azage and Alemu, 1998). In addition, there is no quality controlling system to regulate the nutrient compositions of commercially formulated concentrate in the way it can fulfill the nutrient requirements of dairy animals in different productive states. This can be one of the major factors which can limit the expression of genetic potentials of exotic dairy cattle. Generally, documented information on the nutrient composition of the available feed resources and its influences on the productive and reproductive potential of urban and peri-urban dairy farms are also limited and needs assessment (Nega, 2013).

2.4. Milk production performance of dairy cattle

It is said that the performance of Ethiopia's livestock sector is disturbingly poor. It does not even compare favorably with the average performances of East Africa and sub-Saharan Africa (Tesfaye, 1990). The significant share of Ethiopia in East Africa's total output is certainly attributable mainly to the size of the livestock population rather than productivity. Data on production and reproductive performance traits of traditionally managed cattle in the country are scant. The majority of the information that is available on indigenous cattle in Ethiopia is from on-station evaluation (Azage and Alemu, 1998).

Research findings from Institute of Agricultural Research related to milk production and reproductive performance of indigenous breeds of cattle indicated that Ethiopian zebu cattle types produce between 500 to 700 kg of milk in less than 100 days of lactation, under conditions of average to good management. Even under station management,

average milk yield does not exceed 500 kg with lactation length of about 150 days. However, the low productivity of indigenous cattle is complemented by their high adaptability to the stressful conditions where they are found (Zelalem, 1999).

2.5. Major Reproductive Health Disorders of Dairy Cattle

Dairy cattle in the tropics and sub-tropics mostly belongs to smallholder producers and are maintained on crop residues with limited supply of concentrates and other than artificial insemination (AI) technology uptakes by farmers are very little. This is widely accepted around urban areas but there is a problem of efficiency. High reproductive efficiency of a cow is very important for achieving the maximum return from dairy farming. Researches to understand reproductive physiology and the disorders that limit the reproductive efficiencies are important for improving the production system and profitability of dairy farms (Paul *et al*., 2011). Any abnormality in reproductive system can interrupt animal production performance. Reproductive disorders are the major cause of reducing productivity in cattle that result in failure to produce or delay in producing the annual life calf and reduced lifetime production of cows. Inefficiencies in reproduction cause losses in dairy farms because pregnancy and parturition are prerequisite for the initiation and maintenance of subsequent lactation (Shamsuddin, 2001).

2.5.1. Abortion

Abortion is defined as fetal death and expulsion between 42 (an estimated time of attachment) and 260 days (the age at which a fetus is capable of surviving outside the uterus) of gestation. The condition does not include fetal maceration and mummification. Abortion is the premature expulsion of the fetus from the dam and usually occurs because the fetus has died in-utero. If death occurs at 1-2 months (usually before 42 days) of gestation, it is usually termed “early embryonic death”. This embryo or early stage fetus is usually just resorbed by the uterus with no external signs evident that the pregnancy has terminated. After 2 months of gestation, there is usually the expulsion of the fetus and placental tissues. These may not be seen, however, when the cattle are maintained on

pasture, field or range. When the fetus is near term and born dead it is often called "stillborn or stillbirth". But stillbirth also includes death of the calf within 24 hours of birth (Forar *et al*., 1996).

Most cattle herds suffer an abortion rate of 1-2%. Under intensive management system where exotic cattle are maintained, this figure is high (up to 10%). It is certainly best to separate the aborting dam from other animals and to clean up and dispose the aborted tissues. If the abortion rate increases to 3 to 5% that should be of some concern and the manager should begin to make efforts to obtain a diagnosis. In this process it is best to discuss the problem with the ranch veterinarian, including the vaccination and reproduction history of the herd (Dajer *et al*., 1999).

The prevalence of abortion in cattle in Ethiopia is varying in different production system and from place to place. It is 11.8% in Jersey cows of Wolaita Soddo Dairy farm, 6.8% in North Gonder zone and 7.4% in Tigray. However, lower abortion prevalence 3.2% was reported at Kombolcha by a different author (Dawit and Ahmed, 2013). This difference in prevalence rate may be due to the variation in cattle breed of cows and management system. As cited in Teferi *et al*. (2011), different literatures indicated that incidence of abortion more than 2 to 5% should be viewed seriously and measures should be taken to control it.

2.5.2. Retained fetal membrane

Retained fetal membrane is defined as the failure to pass all or part of the placenta from the uterus after 12 hours of calving. There are several potential causes for placental retention but the effects on the general health of the cow and her subsequent reproductive performance are costly events to the dairyman (Charles, 1999).

Retention of fetal membranes is the most common condition occurring in domestic animals following parturition (Noakes *et al.*, 2009). Causes of retained placenta include deficiency of selenium, vitamin E, vitamin A, B-carotene, and protein during the

transition period. Increased placental retention occurs as cows' age and at calvings during warm seasons and periods of extreme heat stress. Occurrence of induced parturition, twinning, milk fever, ketosis, dystocia in heifers, and increased calving difficulty in all cows are associated with increased risk for retained placentas. Retained placenta often lead to serious infections of the reproductive tract and increased risk for ketosis, displaced abomasum, culling and death (Stevenson, 2000). Cows in a greater degree of negative energy balance prepartum are 80% more likely to have retained fetal membrane (Le Blank *et al.,* 2004). Milk fever or hypocalcemia is a severe periparturient disorder characterized by lowered blood Ca concentration in high-yielding dairy cows and such cows are in increased risk of retained fetal membrane. The factors to be avoided are high body condition score at calving, dietary deficiencies of vitamins and minerals, and hypocalcaemia. Prepartum administration of Se or vitamin E and Se reduces the incidence of retained fetal membrane and increases fertility after parturition (Han and Kim, 2005).

2.5.3. Calving difficulty (dystocia)

Dystocia, more commonly known as difficult calving, is a problem which most dairy producers encounter. Consequences range from the need for increased producer attention to the loss of the cow and calf. Dystocia is a leading cause of calf death at or shortly after birth and leads to uterine infections, more retained placentas, and longer calving intervals. While dystocia is primarily a function of the size of the calf and pelvic area of the dam, other factors related to the calf, dam or sire, level of nutrition during gestation, BCS, season, disease, and endocrine aspects are implicated. Calving difficulty is increased with large birth weight calves, male calves, twins, malpresentations, stillbirths, lack of energy consumed during the dry period, and winter months of the year. The implications of dystocia on disease, culling, milk yield, and reproduction are many. Dystocia generally increases the risk of retained placenta, metritis, cystic ovaries, culling, and death. Cows that have had dystocia have longer calving intervals and produce less milk during the first month of lactation. Cows that require surgical delivery of a dead calf at parturition generally experience a 5 to 9% loss in milk yield (Stevenson, 2000).

The first estrus, first service, service period, days open and calving interval were significantly longer in cows that exhibited dystocia compared to normal cows (58.1, 92.5, 150.5, and 428.5 vs. 49.2, 74.0, 123.2 and 400.6 day, respectively) (Gaafar *et al*., 2010). However, gestation period was nearly similar for normal and cows that exhibited dystocia. These results indicated that dystocia led to increasing the service interval, service period, days open and calving interval by 8.9, 18.5, 27.3, and 28.0 day, respectively. The incidence of dystocia resulted in a significant reduction in conception rate, where the conception rate at 90, 120, and 150 days, and the entire lactation for cows that exhibited dystocia reduced by 10.7%, 11.5%, 12.02%, and 12.5% compared with normal cows, respectively (Gaafar *et al*.,2010).

2.5.4. Stillbirth

Two of the largest problem at dairy farm level is calving complications and stillborn calves. Stillbirth was defined as a calf loss from day 260 until the end of normal gestation period. Trait definitions vary slightly between countries, with most defining stillbirths as those calves born dead or dying within 24 h of parturition, still Germany and the United States include deaths within 48 h of birth (Berglund *et al.*, 2003). Heifers and cows that go through a difficult calving tend to have impaired health, fertility, and production in the following lactation. Death of the calf or its dam can also occur, and calving difficulty or dystocia is a leading cause of stillbirths. It is quite clear that calving is a critical time in the cow calf production cycle, and calving problems can be summarized by two traits: dystocia and stillbirth (McDermott *et al.*, 1992).

Stillbirths and difficult calving may result in direct losses due to calf mortality, dam mortality and premature culling, as well as indirect costs due to additional veterinary services, labour and treatment. The incidence of stillbirth parturition in dairy cows seems to have increased in recent years (Bicalho *et al*., 2007). During the past 20 years an increase from about 6 to 10% has occurred in the incidence of stillbirth in the U.S. Stillbirth parturition does constitute considerable financial losses to the dairy farmer in

different ways. This disorder is associated with increased risk of developing metritis and retained placenta and has a considerable negative effect on lactation performance, conception rate and longevity. Stillbirth parturition reduces the number of calves for sale and replacement (Maizon *et al*., 2004).

2.5.5. Milk fever

Milk fever is defined as clinical hypocalcaemia before, during or after calving. The most critical time in the life of a dairy cow is the first few days postpartum. The cow's metabolism is under severe stress during the first 4-6 weeks of lactation since the demand is not met from the DMI because of depressed intake of the same. To meet requirements for milk production, her body has a high nutrient demand. This early lactation period is when she is most susceptible to some diseases and metabolic disorders. Milk fever, also known as parturient paresis, is a well-known metabolic disorder that occurs at or near calving, particularly in high producing cows. Recently, the economic loss associated with milk fever was estimated at $334 per occurrence, including cost of treatment and loss in milk production (Guard, 1996). Cows that recover from milk fever are less productive and more susceptible to other health disorders such as ketosis, mastitis, retained placenta, displaced abomasum, and uterine prolapsed (Moore *et al*., 1997). Hypocalcemic cows tend to spend more time lying down than do normocalcemic animals. Again, this could increase teat end exposure to environmental opportunists that can cause damage of the canal (Goff *et al.,* 1999). Theories as to how milk fever results in reduced fertility in dairy cows include alteration in uterine muscle function, slower uterine involution, and reduced blood flow to the ovaries. There are also indirect effects of milk fever on fertility, which are mediated through dystocia, retained placenta and endometritis (Mulligan, 2006).

2.5.6. Ketosis

Ketosis is defined as a metabolic disease characterized by high levels of ketone bodies in blood, milk and urine. Ketosis is caused by negative energy balance and excessive body

fat mobilization. The ketone bodies, acetone, acetoacetate and ß-hydroxybutyrate (BHBA), are formed in the liver during oxidation of fatty acids (nonesterified fatty acids-NEFA) (De Roos *et al.*, 2007). During the transition from late gestation to early lactation, dairy cattle undergo a period of negative energy balance as the demands for milk synthesis cannot be met by feed intake. To adapt to this negative energy balance, among other mechanisms, cows mobilize lipid reserves, which circulate in the blood as NEFA. Circulating NEFA can then be used directly as a fuel source, metabolized in the liver to ketone bodies, or converted back into triglycerides. When the liver is overwhelmed by NEFA, ketone bodies are produced in excess and the cow becomes hyperketonemic (Herdt, 2000).

Ketosis characterized by increased NEFA and BHBA concentrations leads to a loss in milk production, a greater incidence of cystic ovaries, increased days open and increased culling. Cows with milk BHB above100 μmol/L in the first week postpartum were 1.5 times more likely to be anovular at 9 weeks postpartum. Cows that experienced ketosis in the first two weeks of lactation had low probability of pregnancy at the first insemination. Furthermore, cows that had ketosis in one or both of the first two weeks after calving had a lower pregnancy rate until 140 days in milk (Walsh *et al.*, 2007). Elevated liver triglyceride is common in cows after calving suggesting that measures to prevent fatty liver take place during the pre-fresh transition period. Reducing severity and duration of negative energy balance (NEB) is crucial in the prevention of fatty liver and ketosis. The critical time for the prevention of fatty liver is one week prior through to one week after calving, the period when a cow is most susceptible to development of fatty liver, which is an indicator of ketosis (Duffield *et al*., 2002).

The prevalence of major reproductive disorders of dairy cattle in Ethiopia was variable. This depends on the difference in study site, methodology, production system, breed and duration of the study. The prevalence of major reproductive health problems in Ethiopia was reviewed and presented (Table 1).

Table 1: Prevalence of major reproductive disorders of dairy cattle at different locations

S.No	Location	Prevalence (%)	Author(s)
1	Addis Ababa	67.8	Abreham *et al*. (2010)
2	Jimma	33.59	Abebaw *et al*. (2011)
3	Adama	31.76	Gizaw *et al*. (2011)
4	Arsi	13	Teferi *et al*. (2011)
5	Bedelle	26.5	Molalegn and Shiv (2011
6	Kombolcha	40.3	Dawit and Ahmed (2013)
7	Central Ethiopia	44.3	Hadush *et al*. (2013)
8	Asalla	18.5	Hunduma (2013)
9	Hossana	43.07	Adane *et al*. (2014)
10	Borana	47.7	Ararsa and Wubishet (2014)
11	Ada'a	37	Getachew and Nibrat (2014)
12	Sodo	8	Getinet *et al*. (2014)

3. MATERIALS AND METHODS

3.1. Description of Study Area

The study was conducted in *Guto Gida* and *Leka Dullacha* districts of East *Wollega* zone, of Ethiopia from December 2014 to March 2015. The climatic condition of the area is characterized by heavy long rainy season (June to September) which alternates with short rainy season (March to May) and winter dry season (December to March). The altitude of East *Wollega* zone ranges from 1200-2500 m.a.s.l and classified in to three agro ecological zones, temperate (7.18%), midland (51.08% and low land (41.74%). East *Wollega* zone *(Nekemte*), as development corridor and agro industry development center in western Ethiopia, links five zones of *Oromia* (Western *Shoa, Horro Gudrru, Kelem* and Western *Wollega, Illubabor) Benishangul* and *Gambella* Regional states, and South Western *Gojam* parts of *Amhara* Regional state. The vegetation of the area belongs to the moist evergreen mountain forest and this type of forest is common for southwest Ethiopia (Wondu, 1999). The recent data of East *Wollega* zone Livestock Development and Health Agency estimates the livestock population of the zone to be more than 925,000 heads of cattle, 220,875 sheep, 146,775 goats, 2,988 horses, 4,551 mules, 84,711 donkeys, 794,484 chicken and beehive 176,532 (CSA, 2013).

Guto Gida district is one of the study districts of East *Wollega* zone and geographically bounded by *Wayu Tuka* district from the east, *Sassiga* and *Diga* districts from the west, *Gida ayana* and *Gudaya Bila* from the north and *Leka Dullacha* from the south. *Nekemte* is the largest town of East *Wollega* zone and *Guto Gida* district which is located 331 km west of Addis Ababa on the main road from Addis Ababa to *Assosa.* It lies between 9° 5'N and 36° 33'E, on an altitude of 2088 m.a.s.l. The human population of the district is about 174,412 from which 84,502 living in the town and 89,910 living in peri urban and rural area of the district (CSA, 2007).

The area is characterized by mixed farming system practicing both crop and livestock production. But currently, market oriented smallholder dairy cattle production and fattening activities are emerging in urban and periurban areas of *Nekemte* and other small towns in the zone. The mean annual rainfall with values ranging from 1500 - 2200mm and average daily minimum and maximum temperatures range between 15 and 26° C, respectively. The major soil types are clay loam covering about 60%, sandy soil covering about 35% and about 5% clay soil. This area is suitable for both crop and livestock production. The dominant crops cultivated in the area include Maize (*Zea mays*), Sorghum (*Sorghum bicolor*), "*Teff*" (*Eragrostis tef*), Millet (*Elucine coracana*), "*Noug*" (*Guizotia abyssinica*), Wheat (*Triticum aestivum*), Barley (*Hordeum vulgare*), Coffee, pulse and oil crops (Birhanu *et al*., 2011). Cattle population of *Guto Gida* district was estimated to be 94,137 heads (274 of them are cross breeds) as it was taken from East *Wollega* Zone Livestock Development and Health agency (unpublished data).

Leka Dullacha district is another district of the zone located southwest from *Nekemte* on the main road to *Bedelle*. *Getema* is the town of the district located 27km from *Nekemte.* The total land area of the district is estimated to be a total of 61,745 km^2. This district is bounded by 4 other districts of the zone, namely; *Diga* partly and *Guto Gida* from the north, *Jimma Arjo* from south, *Wayu Tuka* from east and *Diga* district from west. The two districts share the same agro- ecology since they are boundaries to each other. The human population of the district is estimated to be more than 82,000 (42,000 male and 41,000 female). The district receives annual rain fall which ranges from1600-2000mm and range of minimum and maximum temperature 15^0C-26^0C respectively. The altitude of the district ranges from1500-2500 m.a.s.l (*Leka Dullacha* district Livestock Development and Health agency, unpublished data). The cattle population of *Leka Dullacha* district was estimated to be 95,858 heads (CSA, 2013). The livestock population of East *Wollega* zone, *Guto Gida* and *Leka Dullacha* districts were indicated (Appendix 16).

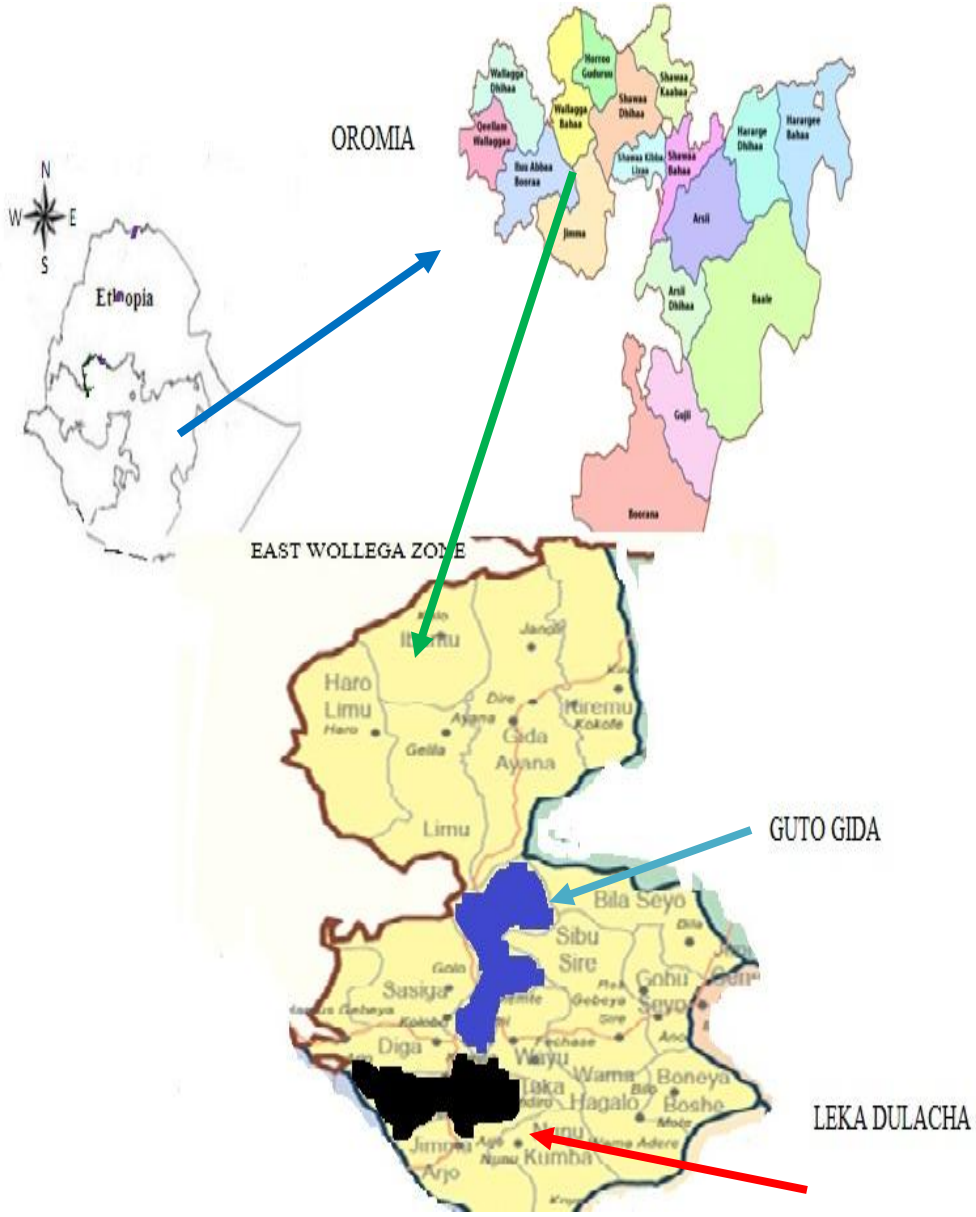

Figure 1: A map showing the location of study area

Source: CSA (2013)

3.2. Study Population and Sampling Procedure

For this study, two districts from East *Wollega* zone (*Guto Gidda* and *Leka Dullacha*) were purposively selected based on dairy cattle population potential and accessibility for follow up. Households possessing at least one dairy cow in selected districts and cattle owned by these households represent the study population. From all 28 registered smallholders dairy producers in *Nekemte* town (taken from office of urban agriculture) only 22 willing to participate in the research activity included.

For peri urban smallholder dairy production from a total of 21 PAs, two (2) PAs from rural *Guto Gida* district namely; *Gari* and *Dune Kane* were randomly selected from 4 accessible PAs to represent peri urban smallholder dairy production site. For the rural district (*Leka Dullacha*), from 22 PAs only 3 (*Horda Qawwisa, Jarso Gute* and *Diga Fododo)* were randomly selected from 6 accessible PAs of the district. Simple random sampling procedure was used to select representative herds or households for the study. The list of households with their cattle population was found at each respective farmer training centers (FTC).

For household questionnaire survey, the sample size was determined by using the formula recommended by Ashram (2007) for formal survey. $N = 0.25/SE^2$, SE= standard error, 0.05. Thus, N= 0.25/0.0025=100 households. But the total number of households used for questionnaire interview was increased to 105 to increase precision [Leka Dullacha or rural site (63), periurban (20) and Nekemte or Urban site (22).

The sample size required for the study of reproductive health problems is determined depending on the expected prevalence of reproductive problems and the desired absolute precision by the formula given by Thrusfield (2005). Research studies in different parts of the country (Arsi zone and Sodo) indicate that the average prevalence of major reproductive health disorder to be 10%. Therefore, using 95% confidence interval, 5% precision(d^2) and 10% expected prevalence (Pexp), the number of cows needed to demonstrate the prevalence of reproductive health problems in the study area was

estimated by using the following formula: $n = 1.96^2 Pexp(1 - Pexp)/d^2 = 1.96*.10(1-.10)/.0025 = 138$ dairy cows. But do to unwillingness and lack of large number of pregnant cows, follow up was done on 129 pregnant cows and heifers found in 42 smallholder dairy producers in and around *Nekemte* town. Milk yield performance was monitored on purposively selected and or available milking cows. Accordingly, a total of 56 milking dairy cows (44 Holstein Friesian cross, 9 Jersey cross and 3 local breed) found in 11 smallholder dairy farms were monitored for maximum milking days of 120.

Four samples of alternative concentrate feed ingredients used by smallholder dairy producers were sampled from flour mills located in *Nekemte* town. The feed type sampled was hulls of four different pulse crops commonly used as supplementary concentrate ingredient by the dairy producers in *Nekemte* town. Pulse crops were Field pea (*Pisum sativum*), Faba bean (*Vicia faba*), Lentil (*Lens sativum*) and *Lathyrus*. Three samples of each ingredient were first collected from three different mill houses, and these three samples were bulked and homogenized and one subsample was finally taken for laboratory evaluation.

3.3. Study Design

Different study designs were used for different activities of the research work. Three different study designs were used; namely: cross-sectional, longitudinal and retrospective study.

3.3.1. Cross sectional

A cross-sectional survey was conducted using questionnaire interview, participatory group discussion and personal observation to collect data on characteristics and management practices of smallholder dairy production systems and associated cattle production constraints at three dairy cattle production sites, namely; urban, peri urban and rural dairy cattle production sites.

3.3.2. Longitudinal observational

The second part of the study was longitudinal observational type of study through a regular follow up (monitoring) on pregnant dairy cows and heifers of urban and peri urban dairy herd/farms to collect data and establish the occurrence and measure the magnitude of major reproductive disorders in the selected herds/farms. Milk production performance of indigenous and crossbred cows was monitored on purposively selected milking cows in urban and peri-urban areas of *Nekemte* town. Selected feed samples were taken from alternative concentrate feed ingredients fed to dairy cattle for chemical composition, digestibility and energy values analysis.

3.3.3. Retrospective

A retrospective study was conducted at two veterinary clinics to determine the prevalence of major reproductive health disorders based on data recorded on clinic case book.

3.4. Methods of Data Collection

A variety of approaches of data collection methods were used for this study. This includes: questionnaire interview, focus group discussion, follow up, laboratory analysis and secondary data collection.

3.4.1. Questionnaire interview

A semi-structured and pre-tested questionnaire was used to interview selected households in each production sites. A total of 105 respondents (22 from *Nekemte* town, 20 from peri urban of *Guto Gida* and 63 from rural) were interviewed. The questions mainly focus on socio-economic characteristics of the household, smallholder dairy cattle production system and management practices like breed and breeding system, feed resource available and feeding system, major cattle diseases in the area and health care, milk

production and utilization, type and occurrence of reproductive health disorders and constraints of cattle production in the area (Appendix 1).

3.4.2. Focus group discussion (FGD)

Informal group discussion with zonal and district livestock agency staff was done to generate relevant information about livestock production system and associated constraints. A checklist of different topics for focus group discussion was prepared and presented for participants and data was recorded for each topic. Points for discussion include: status of dairy cattle production, major crops grown in the area, major constraints of cattle and dairy production, available feed resources, dairy extension services, cross breeding activities and major diseases of cattle and associated constraints to health care services in the area (Appendix 2). Group of 6 people at zonal (*Nekemte*) and 4 at *Leka Dullacha* district (*Getema*) from extension, production, health, feeds and nutrition department were participated. After thorough discussion on each topic, very important and relevant ideas on which an agreement reached related to each topic were collected and taken as a data from focus group discussion.

3.4.3. Follow up (monitoring)

This follow up activity was used to monitor the occurrence of major reproductive health disorders of pregnant cows and milk yield performance of both local and crossbred cows. Regardless of the stage of pregnancy all pregnant dairy cows and heifers approved by AI technicians were used for the study. The longitudinal study consists of individual cow history recording and interview of the owner at the beginning of the study period with follow-up visits of the animals. Follow up of pregnant dairy cows and heifers for occurrence of reproductive health disorders was done at every two week and sometimes through telephone calls. At the beginning of the study 129 pregnant dairy cattle in and around *Nekemte* town were identified in 42 accessible farms. The follow up study was done for any reproductive and metabolic health disorder from December 2014 to March, 2015. Out of 129 pregnant dairy cattle (116 cows and 13 heifers), 36(28%) of them

terminated pregnancy. The other 93 (72%) of them were pregnant at the end of monitoring.

Daily milk yield of 56 Milking cows found in 11 dairy farms of Nekemte and the area was monitored for a minimum and maximum days of 44 and 120, respectively. Daily milk yield of individual cow was recorded depending on milking schedule of the household (two times a day). The data of each activity was recorded on data collection sheet prepared for this purpose (Appendix 4 and 5). For daily milk yield data collection, a mobile spring balance was used and training was given for responsible individuals in the farms where there is no experience of recording daily milk yield.

3.4.4. Laboratory analysis of selected feed samples

Wet feed materials were allowed to lose moisture under shed before transportation. After appropriate sampling and coding, the samples were kept in air tight containers pending analysis for chemical composition at *Bako* agricultural research center and then with other feed samples of the research center, lab analysis was done at *Holeta* agricultural research center, animal nutrition laboratory.

The dry matter (DM) and ash content of each ingredient was determined by oven drying at 105°C overnight and by igniting in a muffle furnace at 500°C for 6 hours, respectively. Nitrogen (N) content was determined by *Kjeldahl* method and crude protein (CP) was calculated as N x 6.25 (AOAC, 1995). The neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) fractions were analyzed according to Van Soest and Robertson (1985). The modified Tilley and Terry *in vitro* method was used to determine the *in vitro* organic matter digestibility (IVOMD) (Van Soest and Robertson, 1985), and the metabolizable energy (ME) content was estimated from IVOMD using the equation: ME (MJ/ kg DM) = 0.15*IVOMD (Beever and Mould, 2000).

3.4.5. Retrospective study

For retrospective data collection, two veterinary clinics at respective study areas (*Guto Gida* and *Getema* veterinary clinics) were used. Secondary data of 5 years (2009/10-1013/14) was used to study the prevalence of major reproductive health disorders registered at each clinic. Animals treated for different cases and reproductive health disorder was directly taken from each animal health case book during the monitoring period. For longitudinal study identification of study animal were done by giving code or by using color or name of the animal. All the necessary information like herd size, breed, age, parity, body condition, management system, reproductive health and daily milk yield was recorded on the format prepared for this purpose (Appendix 4 and 5). Pregnant dairy cow and heifers at different stage of pregnancy and milking cows at different stage of lactation in selected smallholder dairy farms were study animals.

3.5. Description and Definition of Variables

Age: Is the number of days the cow/heifer has lived at the time of data collection and was determined from available record, using dentition, parity and history from the owner. It is possible to guess the age of a cow by looking at its teeth. The milk incisors (cutting teeth) are replaced by permanent incisors at fairly regular intervals; age of a cow can be estimated quite accurately until approximately 4 years old. After this age we can only look at the wear of the chewing surface on the permanent incisors now. The ridges on top of the teeth which form a zig-zag line gradually become worn down until the surface is smooth (Puck *et al*., 2004). For further information it was indicated in Appendix 6.

Parity: Parity can be classified as sequence of lactations (calving) and grouped in to first, second, third, fourth and fifth.

Body condition score (BCS): it is a measure of energy reserve of the lactating cow and classified as BCS 1, 2, 3, 4 and 5 by using guidelines described by Edmonson *et al*. (1989) and based on subjective judgment of the researcher (Appendix 17).

Management system: Grade of management system of dairy farms was classified as good, medium and poor depending on status of some husbandry variables: site of the farm, housing condition, health status, feeding system, record keeping, general farm hygiene, manure disposal, labor use and future expansion plan (Appendix 3).

Herd size: According to the number of cattle kept in the farms (herd size), farms were categorized in to small scale farm (<10 animals), medium scale (10-25 animals) and large scale farm (>25 animals) based on the classification of Emebet and Zeleke (2008).

Urban: according to the context of the current study and area, urban means the area within *Nekemte* town administration and dairy cattle owners found within this boundary are considered to be urban dairy producers.

Peri-urban: according to the context of the current study and area, peri-urban means the area within 5-20km from the periphery of *Nekemte* town administration and dairy cattle owners supplying milk to *Nekemte* are considered to be peri-urban dairy producers.

Rural: according to the context of the current study and the area, rural means sites above 20km from the periphery of *Nekemte* town administration and dairy cattle owners who don't provide fluid milk to *Nekemte* are considered to be rural smallholder milk producers.

Alternative concentrate feed ingredient: according to the context of the current study and the area**,** alternative concentrate feed ingredient means a kind of supplementary feed included in the ration or given alone and commonly used by the dairy cattle owners for milk production purpose.

Milk yield: the amount of milk yield collected from individual cow during the study period. Daily milk yield was weighed/measured and determined by using daily production record of the farms or otherwise directly measured after milking.

Dystocia: defined as a difficulty in birth and was determined based on the history of occurrence and clinical examination of the dam that requires calving assistance.

Retained placenta: defined as the failure to pass all or part of the placenta from the uterus after 12 hours of calving and was determined based on the history of placenta that

had not dropped within 12hours after calving and observation of the placenta hanging outside the vaginal opening.

Abortion: is defined as fetal death and expulsion between 42 (an estimated time of attachment) and 260 days (the age at which a fetus is capable of surviving outside the uterus) of gestation. Abortion was determined based on observation and history of termination of pregnancy before the full term. But there are stages of abortion which depends up on stages of pregnancy (early or late).

Stillbirth: defined as calf loss or calves born dead or dying within 24 hours of parturition. Stillbirth was determined based on history and observation of the fetus born dead at full term or death of the calf within 24hours postpartum.

3.6. Data Management and Analysis

The raw data of qualitative and quantitative obtained from cross-sectional survey and regular follow up was coded and entered on a Microsoft Excel (2007) data spreadsheet for data management. Analysis was done using Statistical Package for Social Sciences version 20.0 (SPSS, 2011). The prevalence of reproductive problems was determined by descriptive statistics as a proportion of affected animals out of the total animal examined. The association of different risk factors with over all prevalence of reproductive problems was calculated by using $\chi 2$ (Chi-square) technique for screening significance as uni-variate analysis (p- value consideration as significant was calculated at alpha 0.05 or 95% level of confidence). The degree of association between risk factors and reproductive health disorders was computed by using spearman's correlation coefficient (rho). The General Linear Model (GLM) of SAS (2002) was utilized for variance analyses of milk yield traits. Duncan's multiple range test (DMRT) was used for multiple comparisons of each trait. The statistical model for daily milk yield was as follows:

$Y_{ijklmn} = \mu + H_i + M_j + B_k + P_l + C_m + e_{ijklmn}$ Where,

Y_{ijklmn} = the value of n^{th} individual under i^{th} herd size, j^{th} management system, k^{th} breed and l^{th} parity and m^{th} body condition score,

μ = the population mean,

H_i = the effect of i^{th} herd size (i=1, 2, 3),

M_j = the effect of j^{th} management system (j=1, 2, 3),

B_k = the effect of k^{th} breed (k=1, 2, 3),

P_l = the effect of l^{th} parity (1=1, 2, 3, 4 and 5^{+})

C_m =the effect of m^{th} body condition and

e_{ijklmn} =the random error, NID~(0, δ^2)

The qualitative information regarding commonly used feed ingredients were systematically summarized and presented, and the quantitative data related to feed quality were analyzed using MEANS procedures in Statistical Analysis System (SAS, 2002).

4. RESULTS

The result of the current research work was generated from various primary data sources; namely: focus group discussion with the livestock experts and development agents, questionnaire interview (survey) of livestock owners, longitudinal (follow up) study on milk yield and reproductive health disorders. Additionally laboratory analysis was done for selected concentrate feed ingredients. Related data was also collected from available secondary sources.

4.1. Questionnaire Survey

The result of diagnostic survey presents mainly the socio economic situation of the study area, cattle management practices, available feed resources, major diseases and reproductive disorders of dairy cows constraining production and productivity of animals and utilization of milk produced in smallholder dairy producers.

4.1.1. Socioeconomic characteristics of the respondents

The socio-economic characteristic of the sampled households like sex, age, educational status and marital status of household head (HHH), purpose of keeping cattle, labor division, household land holding and major constraints of cattle production in the area was assessed and presented under this section.

Household characteristics

From the result of the survey, it was indicated that the sex groups of sample respondents were male 95(90.5%) and female 10(9.5%). About 52(49.5%) of the age of the respondents falls in the range of 36-50 years, but 28.5% and 21% of the age of respondents fall in the range of 20-35 and 51-65 years respectively (Table 2).

Table 2: Distribution of age group of respondents

Age group (years)	Frequency	Percentage
20-35	30	28.5
36-50	52	49.5
51-65	22	21
>65	1	1
Total	105	100

The minimum and maximum family size per HH was 1 and 10 persons respectively. An average family size of 6.07 persons (standard deviation of 2.11) per HH was indicated (Appendix 9). The marital status of the sample respondents were married (95%), widow (2%), divorced (2%) and single (1%). The educational levels of nearly half of the sampled respondents (48%) were secondary school complete and 30% were primary school complete. The rest 8.5% and 13% of respondents were illiterate and higher education respectively (Table 3).

Table 3: Marital status and educational level of the sampled households

Variables	Production site			
	Urban	Peri urban	Rural	Overall (%)
Single	1	0	0	1
Married	20	20	60	95
Widowed	0	0	2	2
Divorced	1	0	1	2
Total	22	20	63	100
Illiterate	0	1	8	8.5
Primary	2	5	25	30.5
Secondary	9	11	30	48
Higher education	11	3	0	13
Total(N=105)	22	20	63	100

N=number of observations, %= percentage

Land holding and source of income of the respondents

The overall average of landholding for the sampled respondents was 2.34±1.9 hectares. From this average total land holding, 1.07 hectares of land was allocated for crop production and 0.88 hectare for grazing purpose. The rest 0.45 hectare was used for other purposes (Table 4).

Table 4: Distribution of land holding (ha) of the households at different locations

Location	N	Total Mean±(SD)	Crop	Grazing	Other
Urban	22	2.21(2.51)	0.22	1.28	0.90
Peri urban	20	2.15(1.01)	0.81	0.75	0.73
Rural	63	2.45(1.88)	1.51	0.79	0.17
Total	105	2.34(1.90)	1.07	0.88	0.43

N= number of observations, SD= standard deviation, ha= hectare

Majority of the sampled respondents (62%) get their household likelihood income primarily from crop production and livestock as secondary source of income especially in the rural and peri urban areas. Others consider livestock production as the main source of household income with supplementary crop production (9.5%) and other side business activities (24.5) like shop, transport service, hotel and etc. only 3% of the households get their income from livestock only. The latter two were mainly the characteristics of urban dwellers (Table 5).

Table 5: A summary of source of income of the households in different location

Variables	Location			Overall (%)
	Urban	Peri urban	Rural	
From crop production (livestock secondary)	1	11	54	66 (62)
From livestock production(crop secondary)	1	3	6	10 (9.5)
From livestock production and side business (shop, restaurant, etc)	18	5	3	26 (24.5)
Livestock production only	2	1	0	3 (3)
Total	22	20	63	105 (100)

N=number of observations, % percentage

Purpose of keeping cattle

Figure 2 shows the purpose of keeping cattle in the study area. In the urban area 20(91%) of the dairy cattle producers keep cattle for milk and milk product, and only 2(9%) keep for milk, crop production and other purpose. In the rural area, 56(89%) of the farmers keep cattle for crop production followed by milk production and other purposes. About 7(11%) of the rural cattle owners keep cattle for both milk production and crop production followed by other purposes. In peri urban areas of *Nekemte*, 13(65%) of the respondent keep cattle mainly for both crop and milk production followed by other purposes. But 6(30%) of the respondents in peri urban of Nekemte, keep cattle primarily for crop production followed by other purposes (Figure 2).

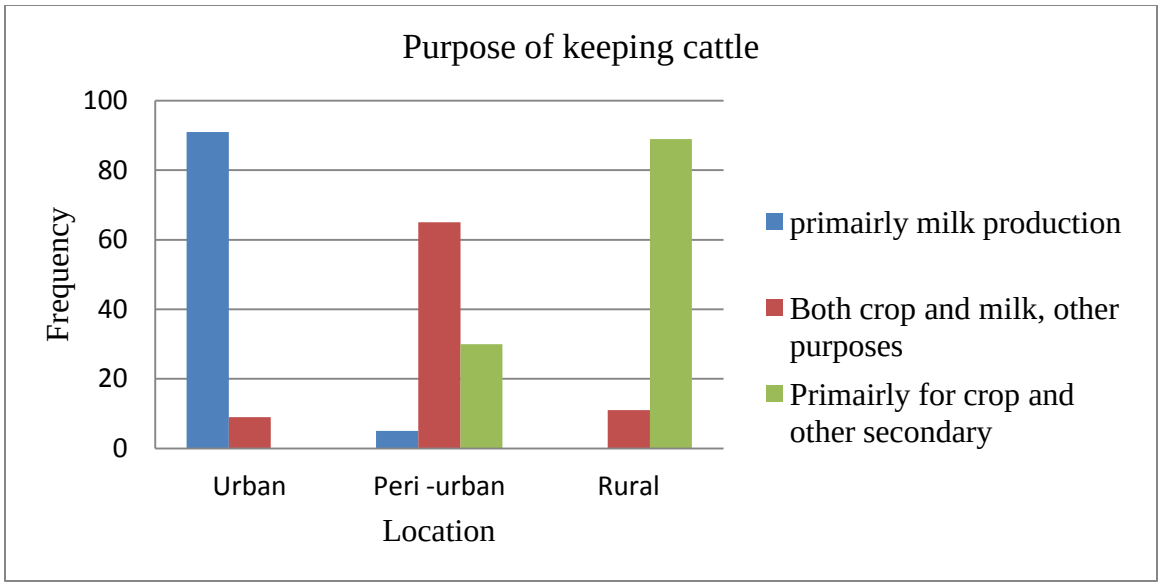

Figure 2: Purpose of keeping cattle in the study area (N=105)

Labor division of households

For different activities of dairy cattle production there was sharing of labor among household members in the study area. The result of the study showed that breeding activities are mainly the job of HHH and male children (59%). About 18% and 11% of the respondents said breeding is mainly done by HHH and daily laborer, respectively. According to the response of the interviewed households, the majority (46.7%) and (26.5%) of the cases, milking activity is the activity of HH spouse or both HH spouse and female children respectively. About 23% of milking activity is conducted by daily laborer and very small proportion of the respondents said (3%) it is done by HHH. Herding, feeding and watering activities are very closely related and important activities in dairy farms. About 35.2%, 28.6% and 23% of the respondents said that herding, feeding and watering activities are done by hired daily laborer, children or children and hired daily laborer, respectively. But 11.5% of the cattle owners said herding, feeding and watering activities can be conducted by all family members (Appendix 15).

Animal marketing (buying or selling) is mainly (47.6) the activity of HHH or both HHH and spouse (46.7%). Again, milk and milk product marketing is done in most of the cases (69.5%) by daughter and spouse of the household and 9.5%, 7.6%, 7.6% and 5.5% of the

respondents said that milk and milk product marketing done by HHH and spouse, HHH, hired daily laborer and all family members respectively.

4.1.2. Dairy cattle management practices

The different husbandry practices of dairy cattle assessed were breeds and breeding system, housing management, feeds and feeding practices, major diseases and health care, milk production and utilization. The result of dairy cattle management practices were presented under this section.

Breeds and Breeding

The mean herd size of cattle per HH was 12.19 heads of which 8.58 heads of local breed and 3.61 heads of cross breed. Herd size and breed composition at HH level in the study area was indicated (Table 6).

Table 6: A summary of cattle herd composition and herd size of sample households

Cattle type	Min	Max	Sum	Mean(SD)
Cow	1	19	456	4.34(3.02)
Heifer	0	11	230	2.19(2.15)
Male Calves	0	7	194	1.84(1.1)
Female Calves	0	9	127	1.21(1.75)
Oxen	0	6	154	1.47(1.59)
Bull	0	6	119	1.13(1.26)
Herd Size	2	49	1280	12.20(7.6)
Local	0	29	901	8.58(6.7)
Crossbred	0	37	379	3.61(6.27)
N=105				

N= number of observations, Min. =minimum, Max. =maximum

Different cattle breeding system practices were mentioned by the sampled households in the three locations. More than 45% of the respondents have used natural breeding by using bull service only. Only 4% of the households were using artificial breeding through AI and majority of them (50.5%) have used both natural and artificial insemination for breeding their cattle. Households who were using natural breeding system get breeding

bull from different sources. Majority (83.6%) of the households were using breeding bull either a selected bull from their own herd or neighbor bull. The rest of households (13.5%) were using purchased bull and only 3% did not able to locate source of bull (Table 7).

Table 7: Cattle breeding practices in the sampled households (N=105)

	Location				
	Variables	Urban	Peri-urban	Rural	Overall (%)
Breeding system	Natural	9.5	4.6	31.4	45.5
	AI	2	2	0	4
	Both can be used	9.5	12.4	28.6	50.5
Source of bull	Selected from herd	6.5	5.9	29.5	42
	Purchased	3.5	5	5	13.5
	Neighbor bull	9	6.6	25.5	41.6
	Couldn't identify	1.5	1.5	0	3
					100

N= number of observations, % percentages

Regarding the optimum time of breeding cows after calving, cows were bred on the average after 4.32±1.39 months. In the urban area (crossbred cows), cows were bred on an average of 3.7±1.52. But for both rural and peri-urban, cows were usually bred after 4.5 months (Table 8).

Table 8: A summary of time of breeding dairy cattle after calving in the study area

Location	N	Min.	Max.	Mean ±(SD)
Urban	22	1-2months	>1year	3.68 (1.52)
Peri urban	20	1-2 months	>1year	4.5(1.50)
Rural	63	2-3 months	>1year	4.5(1.26)
Total	105	1-2 months	>1year	4.32(1.39)

N=number of observation, Min.=minimum, Max.=maximum, SD=standard deviation

Housing management

The result of the current study indicates that there are three types of dairy cattle housing system in the area. In the rural and peri-urban of *Nekemte* the traditional housing system (open crush barns) shares 49.52% of cattle housing system. Fenced roofed shades type of housing system was used in all locations and contributes 15% of housing type. Closed barn housing system was mainly used for urban dairy housing and 33.33% of the sampled households use closed type of dairy house.

Table 9: Types of dairy cattle housing system in East *Wollega* zone

Housing system	Location			Overall (%)
	Urban	Peri-urban	Rural	
Open crush barns	0	9	43	52 (49.52)
Fenced and roofed shade	5	4	7	16 (15.23
Closed barn	17	11	7	35 (33.33)
No house	0	0	2	2 (1.90)
Total	22	20	63	105 (100)

N= number of observation, %=percentage

Only 1.9% of the respondents use no house for their dairy cattle. In all locations great attention was given for crossbred animals housing than local breeds housing. Almost all local breed animals were housed in open crush barns and all crossbred animals were housed in closed barn or to some extent in roofed shade barns (Figure 3).

a. Open crush b. Fenced and roofed shade c. Closed barn

Figure 3: A pictorial representation of different dairy cattle housing system in study area

Majority of the sampled households (55.20%) house their calves in isolated calf pen and 25.7% of the respondents keep their calves in the family house. But about 19% of the respondent didn't house their calves (Table 10).

Table 10: Types of calf housing in the study area

Variables	Frequency	Percentage
In family house	27	25.7
Calf pen	58	55.2
No house	20	19.1
Total	105	100

Feeds and feeding system

Feeds and feeding system was the main constraint of cattle production in the study area. The result of this study indicates that the types of feeding systems noted were grazing (own and communal pasture), intensive feeding, combination (grazing, cut and carry and intensive) and tethering (Table 11). Majority of the sampled households (66.7%) feed their animals through free grazing on own pasture land and only 7.6% were using communal pasture. These two feeding systems were observed mainly in rural areas. Zero grazing and combinations of feeding systems were mainly the characteristics of urban

and peri urban areas. Only 10.5% of the respondents use stall (intensive) feeding and 11.4% practice a combination of feeding system (Table 11).

Table 11: A summary of different dairy cow feeding system in East *Wollega* zone

Feeding system	Frequency	Percentage
Free grazing on own pasture	70	66.7
Free grazing on communal pasture	8	7.6
Intensive feeding	11	10.5
Combination (Stall, grazing, cut and carry)	12	11.4
Tethering	4	3.8
Total	105	100

This study also indicated that the major sources of feed for cattle in the study area are natural pasture, grass hay, crop-residues, improved forage plants (elephant grass, Rhodes grass), concentrate feeds and non-conventional feedstuffs such as '*Atela*', locally produced brewery by product and cafeteria left over (Table 12).

Table 12: A summary of available feed resource in the study area

List of available feed resource	Frequency	Percentage
Concentrate feeds, natural grass hay, pulse crops hulls and improved forage	37	35.24
Natural grass, crop residue, leaf of trees, local brewery by product ("Atela")	68	64.76
Total	105	100

About 35.24% of the sampled respondents supplement their animals with concentrate feeds (maize grain and noug cake, pulse crops hulls) and established improved forage varieties like Elephant grass and Rhodes grass. On the other hand, the majority of respondents (64.76%) feed their animals exclusively on roughage feeds (natural grass, crop residue, leaf of trees) with non-conventional supplementary feeds like "*Atela*".

a. Crop residue

b. Natural grass hay

c. Pasture

d. Natural forage

e. Improved forage

f. Improved grass hay

Figure 4: Different sources of roughage feeds identified in the study area

Majority of the sampled households (84.76%) faced critical feed shortage during dry season from February to May. This is primarily the problem of rural and peri urban production system due to lack of grass for cattle to graze. On the other hand, 11.43% of respondents complained critical feed shortage during wet season from June to November because of shortage and costly price of concentrate feeds on local market. This wet season feed scarcity was the problem of urban and to some extent peri urban dairy producers in Nekemte and the area. Very small proportion of respondents (3.8%) in the study area faced animal feed shortage always as a problem (Figure 5).

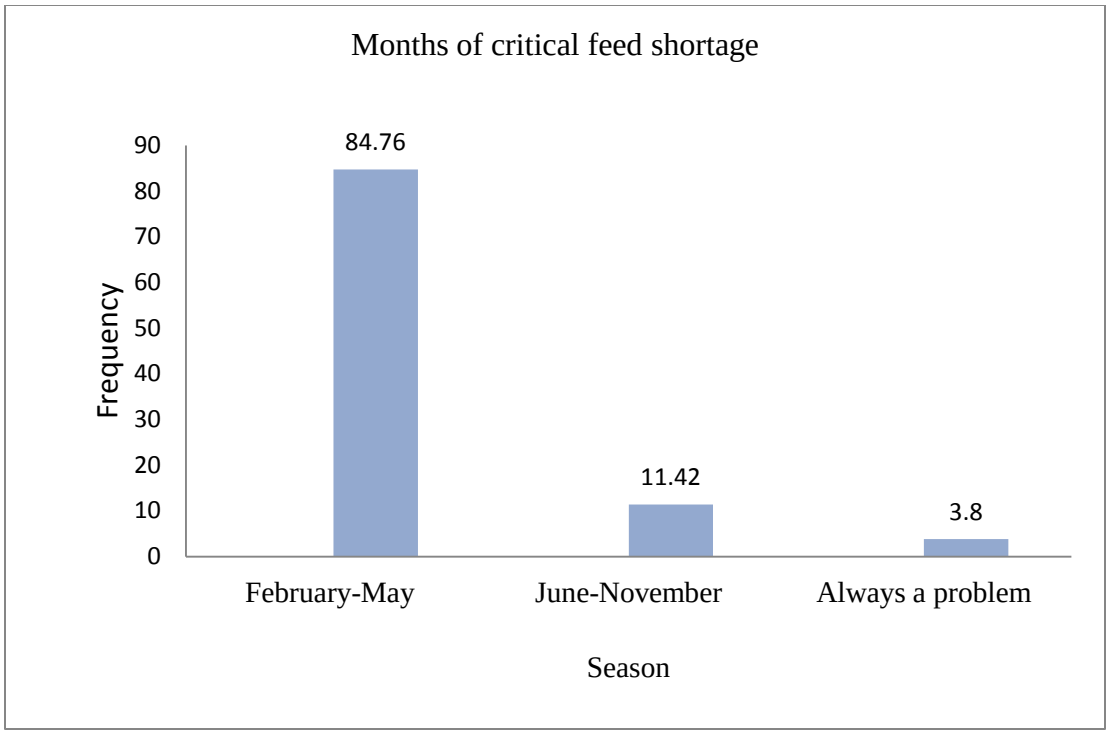

Figure 5: A graph showing months of critical animal feed shortage in the study area

The result of this study shows 19% of the respondents isolate newly born calves within 2-3 days and use bucket feeding system. But the majority of the sampled households (81%) do not isolate the calves from their dams (Table 13).

Table 13: Newborn calves management practices in the study area (N=105)

Newborn calves Isolation	Location				Overall (%)
	Variables	Urban	Peri-urban	Rural	
	Yes	13 (59)	4(20)	3 (5)	20 (19)
	No	9	16	60	85 (81)
Total		22	20	63	105 (100)

N=number of observations, %=percentage

For Bucket fed crossbred calves in and around *Nekemte*, 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 rural and peri urban areas, weaning age ranges from 9months-1.5 years of age (Table 14).

Table 14: A summary of calf weaning age in the study area

Weaning age (months)	Location			Overall (%)
	Urban	Peri-urban	Rural	
3-6	21	7	1	29 (27.61)
9-12	1	11	34	46 (43.8)
12-18	0	2	28	30 (28.57)
Total (N=105)	22	20	63	105 (100)

N=number of observations, %=percentage

As the study result indicates, source of water is also another problem for dairy cattle production in the study area. About 75% of the sampled dairy cattle producers in the study area get water for their dairy cattle from river. Again 6.66% of the respondents get water from river and underground for their animals whereas, only 17.14% get pure pipe water for their animals (Table 15).

Table 15: A summary of source of water for dairy cattle

Source of water	Frequency	Percentage
River Water	79	75.2
Pipe water	18	17.14
River and Underground water	7	6.66
Pond water	1	1
Total	105	100

Major diseases of cattle and health care

About 91(86.66%) of the respondents have listed the major cattle diseases affecting production and productivity of their animals. These common diseases include: *Trypanosomosis*, Lumpy Skin Disease (LSD), Black leg, Bovine *Pasteurellosis*, Anthrax and Foot and Mouth Disease (FMD). A Small proportion of the respondents 14(13.33%) have listed external parasite (tick), leech parasite and mastitis as the main health concern for dairy production (Table 16). As it can be seen from the result of this study, majority

of the respondents (40.9%) treat their animals at veterinary clinic, (37.14%) treat their sick animal by using both veterinary clinic and private drug purchase from market and (11.42%) treat their sick cattle exclusively by using purchased drug only. The rest (10.5) of respondents use traditional drug and private veterinarian on agreement (Table 16).

Table 16: Common cattle diseases and their management at the study area

Type of disease and management	Frequency	Percentage
Trypanosomiasis, Lumpy skin disease, black leg, *Pasteurellosis*, Anthrax, Foot and mouth disease	91	86.66
Tick and leech infestation, mastitis, bloat	14	13.33
Management		
Treat by traditional drug	1	1
Treat at veterinary clinic	43	40.9
Purchase drug and treat at home	12	11.42
Treat at veterinary clinic and home	39	37.14
Treat by private Veterinarian	10	9.5
Total	105	100

The occurrence of reproductive and metabolic disorders within the last two years (September 01, 2012- August 30, 2014) was assessed by interviewing the respondent to recall the occurrence in his own cattle herd. The sample respondents have listed the reproductive and metabolic disorders they encountered in their own herd within specified time period. The result of the assessment indicated that 20%, 31%, 36%, 10% and 6% of the respondents have encountered dystocia, abortion, retained fetal membrane, stillbirth and milk fever respectively. The average number of animals with reproductive or metabolic disorder within specified time at herd level was 1.01, with standard deviation of 1.156 (Appendix 14).

Milk production and utilization

Overall average herd size of 12.19 heads of cattle per household was indicated from which 8.58 and 3.6 heads of cattle were local and cross breed respectively. More than 75% of cattle kept in the urban area were composed of crossbred whereas; more than

92% of cattle kept per household in the rural area were composed of local breed (Table 17).

Table 17: Average herd size and breed composition per household at different sites

Location	Frequency	Herd size	Local	Cross
Urban	22	14.86	3.63	11.22
Peri urban	20	11.05	7.25	3.8
Rural	63	11.61	10.73	0.90
Overall	105	12.19	8.58	3.60

The mean number of cows owned per household varies across the three production sites. Total number of cows owned/HH at urban area (6.22±4.30) is higher than that of peri-urban (4±1.73) and rural (3.77±2.55) areas (Table 18).

Table 18: average number of dairy cows per household at different locations

Location	Frequency	Total cows (Mean±SD)
Urban	22	6.22(4.30)
Peri urban	20	4 (1.73)
Rural	63	3.77(2.55)
Total	105	

The rural milk producers utilize the milk produced through traditional churning the majority of milk and process to butter, the only marketable milk by- product and very small amount consumed fresh at home (given to HHH and young children). Majority 68(64.72%) of the respondents consume at home and process the milk produced. About 26(24.80%) of the respondents channel the milk produced to public market and 4.8% channel the milk to their own catering services. For 5.7% of the respondents all utilization routes are possible (Figure 6).

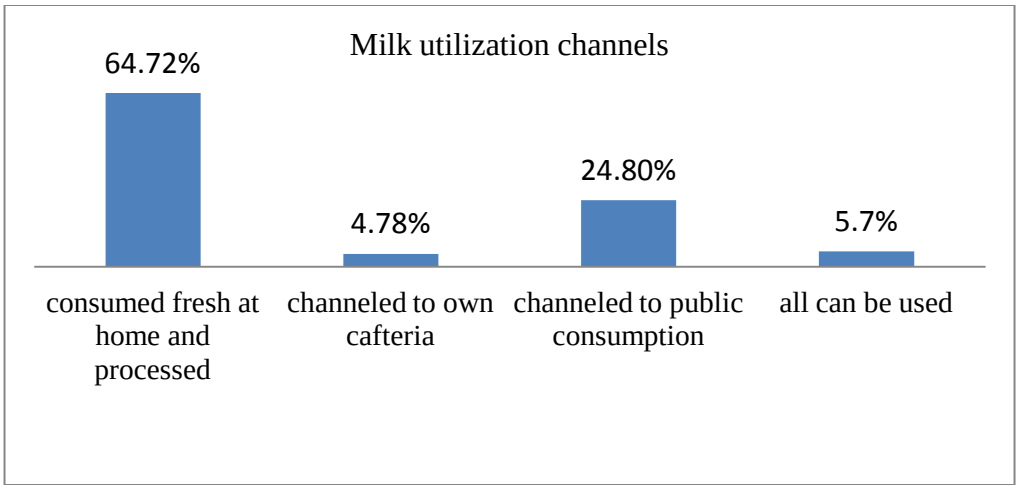

Figure 6: Bar chart showing fluid milk utilization channels of the households

4.1.3. Alternative concentrate feed ingredients commonly used in the area

A range of alternative feed ingredients were observed to be used by the urban and peri-urban dairy farmers in the study area. Pulse crop hulls and mill house scraps were found to be used widely in all the farms visited and were observed to be purchased almost throughout the year. "Noug" seed cake (NC) was the conventional protein supplement used on larger proportion (91%) of the dairy farms visited. During the study period, maize grain was also used in only 18% of the farms which can fluctuate depending on the price of maize and income of the farms. *Atela*, a byproduct obtained from traditional breweries and wheat bran were observed to be used in 54% and 9% of the farms visited, while lesser proportion of the farms was observed to use cafeteria leftover (Figure 7).

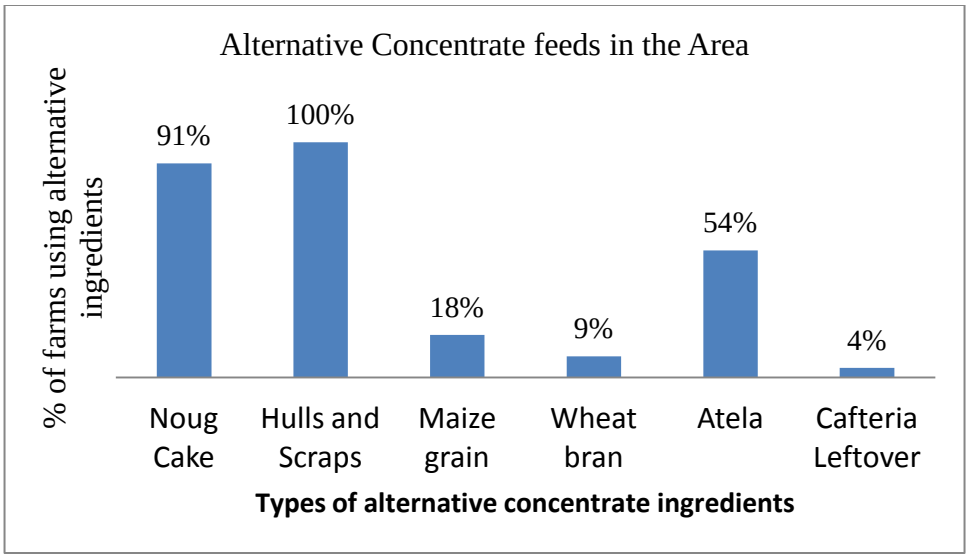

Figure 7: Percent of respondents using concentrate feed ingredients (N=22)

a. "*Noug*" cake | b. Maize grain | c. "*Atela*"

d. Wheat bran | e. Pulse crops hulls | f. Cafeteria leftover

Figure 8: Types of common concentrate ingredients used in Nekemte and the area

4.1.4. Major constraints of cattle production in the study area

Major constraints of cattle production in the study area was assessed by interviewing the sampled respondents and personal observation. Majority of the sampled respondents 62(59%) complained the major constraints of cattle production in the study area in the order of feed and land scarcity followed by unimproved breeding practices and health problems. Whereas 43(41%) of the respondents put health problem the first constraint followed by lack of grazing land and unimproved breeding practice (Table 19). For the urban and peri-urban dairy producers, the primary constraint is land shortage and feed scarcity (86 and 85 percent respectively). But for the rural farmer, the primary constraint is health problem followed by lack of grazing land and water (62%).

Table 19: Major constraints of cattle production in order of importance in the study area

Variables	Location			
	Urban	Peri urban	Rural	Overall %
1st -Land and Feed shortage 2nd -Unimproved breeding practice 3rd -Health care problem	86.36%	85%	38%	59
1st -Health care problem 2nd -Lack of grazing land and water 3rd -Unimproved breeding practice	13.64%	15%	62%	41
Total (N=105)	22	20	63	100

N=number of observation, %=percentage

One of the cattle production problems in the area is unimproved breeding practice. The respondents have listed out the factors that hinder their cattle breeding activity in the area. As it has been summarized in the table below, from a total of 105 sampled respondents, 79 (76%) have complained the problem of cattle breeding. The rest of respondents, 26 (24%) were not considered breeding problem in their herd (Table 20).

Table 20: Factors affecting cattle breeding in the study area

Factors	Frequency	Percentage
Feed scarcity, lack of bull, reproductive disorders and mastitis	52	50
AI ineffective and limited access to improved breed	27	26
No breeding related problem	26	24
Total	105	100

4.2. Participatory (Focus Group Discussion)

According to the agreement of the discussants at zone and district level, cattle production is generally mixed crop-livestock production system (complementary to one another) in the rural area with market oriented smallholder dairy and fattening practices in and around larger towns in the zone. Market oriented dairy cattle production is still not popularized and stagnant in the area due to scarcity of inputs. In the rural areas of East *Wollega* zone cattle production is characterized by keeping local breed with low input low production and intended primarily for crop production. The milk produced is mainly processed to butter and selling milk is not cultural.

Major crops grown in the area include Maze, "*Tef*", Noug, Wheat, Barely, Sorghum, Coffee, pulse and oil crops. Many points on constraint of cattle production were raised by the discussants at zone and district level but very important constraints were more stressed and summarized. These constraints include; lack of breed selection practices, unimproved management system, input scarcity, poor infrastructure and problems of cross breeding.

From all constraints of cattle production, animal feed scarcity both in quantity and quality is the major problem of livestock production in East *Wollega* zone. Grazing land is decreasing from time to time due to pressure from crop production and overgrazing. Due to low conception rate of artificial insemination, there has been resistance from farmers to

adopt cross breeding through AI and there was no detail investigation done on the cause of low conception rate after insemination.

The major feed resource available in the area are natural pasture, crop residue, natural grass hay, oil seed cakes, maize grain and improved forages. Animals especially during dry season starve and predisposed to health problems due to lack of feed in rural areas. Extension activities on development of forage plants are ongoing but adoption of the technology was minimal at farm level. The major animal diseases prevailing in the zone include: *Trypanosomiasis,* Lumpy Skin Disease (LSD), bovine *Pasterurellosis*, Black leg, Mastitis, reproductive health disorders, calf diarrhea, FMD, Internal and external parasites. Poor animal health extension system, very poor outbreak surveillance, lack of facilities, poor control of illegal drug market and lack of on job training were described by the discussants as main constraints to disease control and prevention strategy in the area. According to the result of the discussion, awareness creations on cattle selection for milk production, estrous synchronization and insemination with training on dairy package are actively ongoing in selected districts. But due to very low conception rate of AI for unknown reason dairy cattle owners usually purchase crossbred animals from other places.

4.3. Observational (Longitudinal) study

In addition to cross-sectional survey, there was an observational study on selected dairy farms and cows for assessment of reproductive health disorders and daily milk production performance to complement the data of interview and discussion. Additionally, assessment and lab analysis of alternative concentrate feed ingredients used by smallholder dairy farms in *Nekemte* and the area was done on selected commonly used feed samples. Retrospective study was also done by using five years secondary data from two vet clinics of the study area.

4.3.1. Reproductive health disorders

From the total of 36 reproductive cases, 23(63.88%) of the cases were normal parturition with no history of reproductive and metabolic health disorder. The other 13(36.1%) cases were reproductive health disorders. According to this finding, the magnitude of reproductive health disorder was 36.1% (13/36). All of the cases were reproductive health disorders and there was no metabolic case observed during the study period. From reproductive health disorders observed during the study period, retained fetal membrane was frequently observed with the larger magnitude of 7(19.44%) among the cases, followed by abortion (8.33%) and *dystocia* (5.55) (Table 21). From the total of 129 dairy cattle monitored, 23(18.01%) were affected by clinical mastitis with one or two teats blind.

Table 21: Distribution of reproductive disorders of dairy cows in and around *Nekemte*

Reproductive cases	Type of cases	Frequency	Percentage
Disorder	Dystocia	2	5.55
	Abortion	3	8.33
	Retained fetal membrane	7	19.44
	Stillbirth	1	2.77
Total disorder		13	36.1
Normal parturition		23	63.88
Overall		36	100

In this study among risk factors herd size, body condition score, parity and management system were considered to assess its association with the occurrence of the reproductive problems as shown in Table 22. Based on the result of this study, the effect of herd size, BCS, parity and management system didn't show significance since the p-value for each factor was 0.653, 0.226, 0.291 and 0.428 which is greater than alpha value (P>0.05). To see the association of these factors with reproductive health disorders, Spearman's correlation coefficient(r) was calculated for each risk factor. The correlation coefficient (r) values for herd size, BCS, parity and management system were indicated in table 22.

Table 22: Risk factors associated with major reproductive health disorders of cows

Risk Factors	Category	Examined (N)	Affected (n)	Proportion (%)	X^2	P-value	ρ
Herd size	Small	2	1	50	4.179	0.653	0.23
	Medium	23	8	34.78			
	Large	11	4	30.8			
BCS							
	2.5	7	5	71.42	8.171	0.226	0.26
	3	17	5	29.41			
	3.5	9	0	0			
	4	3	3	100			
Parity							
	1	5	2	40	17.48	0.291	0.285
	2	9	1	11			
	3	9	5	55.5			
	4	9	3	33.3			
	5	3	1	33.3			
	6	1	1	100			
Management system							
	Good	5	3	60	5.958	0.428	-0.29
	Medium	18	4	22.22			
	Poor	13	6	46			
	Overall	36	13				

N=Number, X^2=Chi square, %=Percentage, ρ=Spearman's correlation coefficient, P-value=level of significance at alpha=0.05(95% confidence level)

4.3.2. Milk production performance of smallholder dairy cows

Milk yield performance of smallholder dairy cows was monitored at urban and peri urban areas of *Nekemte* town; where market oriented dairy producers keep mostly cross breed animals. As the result indicates, herd size of the farms was observed to have a significant effect on lactation length, total milk yield and daily milk yield. But management system significantly affects both lactation length and total milk yield. According to this study, breed, parity and body condition didn't showed significant effect (Table 23).

Table 23: Variance analysis for the effect of fixed factors on lactation length (LL), total milk yield (TMY) and milk yield per day (MYP)

		Mean squares		
Source	*df*	LL	TMY	MYP
Herd size	2	2033.3*	787856.7*	61.7*
Management system	2	2966.0***	1020493.3*	41.6^{ns}
Breed	2	249.6^{ns}	169370.6^{ns}	38.1^{ns}
Parity	4	67.4^{ns}	45535.0^{ns}	5.1^{ns}
Body condition score	3	77.6^{ns}	37563.7^{ns}	4.0^{ns}

Note: *=p<0.05, ***=p<0.001, ns=non significant

The average daily milk yield of local cows, Holstein Friesian cross and Jersey cross shows 3.1±0.88, 8.7±0.55 and 5.8±1.68 liters respectively. Body condition score and parity were observed to have no significant effect on milk yield performance. The effect of each fixed factor on milk yield and lactation length was presented in Table 24.

Table 24: Least square means (±SE) for the effect of fixed factors on lactation length (LL), total milk yield (TMY) and milk yield per day (PMY)

Source	n	Means ±SE		
		LL	TMY	PMY
Overall	56	86.9±15.1	710.5±325.2	8.0±3.7
Herd size				
Small	4	110.0±0.00[a]	984.0±30.31[a]	8.9±0.27
Medium	31	85.1±2.29[b]	728.4±60.25[ab]	8.8±0.80
Large	21	85.2±5.48[b]	632.2±107.62[b]	6.6±0.78
Management system				
Good	8	108.0±9.07[a]	1128.6±156.24[a]	10.2±0.96[a]
Medium	30	81.2±2.81[b]	655.2±72.04[b]	8.0±0.91[ab]
Poor	18	87.0±3.51[b]	617.1±63.04[b]	6.9±0.53[b]
Breed				
Horro	3	90.3±10.13	293.0±110.73[b]	3.1±0.88[b]
HF cross	44	88.4±2.91	786.1±55.51[a]	8.7±0.55[a]
Jersey cross	9	78.7±5.68	480.7±148.71[ab]	5.8±1.68[ab]
Parity				
1	11	87.3±4.56	596.8±84.67	6.8±0.89
2	8	92.7±8.18	905.6±185.87	9.4±1.55
3	15	89.0±6.19	757.1±111.78	8.2±1.14
4	13	81.1±5.05	681.6±123.06	8.1±1.43
5+	9	86.0±3.59	640.7±83.56	7.6±1.03
Body condition score				
2.5	6	86.6±4.78a[b]	725.2±169.88	8.8±2.41
3.0	27	82.4±3.48[b]	649.3±74.72	7.7±0.82
3.5	15	88.4±5.62[ab]	746.3±124.93	7.8±1.03
4.0	8	99.5±6.07[a]	839.4±87.53	8.4±0.82

Note: n=number of observations, [a, b, ab]= differences between groups with same letter in the same column are non-significant, differences with different letter are significant ($p<0.05$)

4.3.3. Chemical composition, digestibility and energy values of the different hulls

Chemical composition of hulls differed widely (Table 25). The mean dry matter (DM) and ash content was 88.87% and 3.06%, respectively. The crude protein (CP) content of the hulls ranged from 6.8% for field pea to 18.80% for *Lathyrus*, with mean 12.43%. The mean neutral detergent fiber (NDF) content was 47.78%, with values ranging from 39.36% to 56.72%. In the same way, the acid detergent fiber (ADF) content ranges from

6.82% to 14.72% with a mean of 10.32%, while acid detergent lignin (ADL) ranged from 0.24% to 0.94%. The mean *in vitro* organic matter digestibility (IVOMD) content of different hulls was 73.59%, with values ranging from 71.16% for Field Pea hulls to 77.16% for Faba Bean hulls. The mean ME content was 12.51% with values ranging from 12.1% (field pea hulls) to 13.12% (faba bean hulls).

Table 25: Chemical composition, digestibility and energy values of alternative supplementary feeds used in and around *Nekemte*

Feed sample	DM	Ash	CP	NDF	ADF	ADL	IVOMD	ME
Field pea hulls	87.76	2.35	6.80	56.72	14.72	0.94	71.16	12.10
Lentil hulls	87.96	2.67	8.45	39.36	6.82	0.86	74.34	12.64
Faba bean hulls	88.45	3.87	15.68	40.38	7.49	0.24	77.16	13.12
Lathyrus hulls	91.31	3.35	18.80	54.64	12.24	0.90	71.72	12.19
Mean	88.87	3.06	12.43	47.78	10.32	0.74	73.59	12.51
SD	1.65	0.68	5.74	9.18	3.79	0.33	2.75	0.47

Note: SD, standard deviation; DM, dry matter; CP, crude protein; NDF, neutral detergent fibre; ADF, acid detergent fiber; ADL, acid detergent lignin; IVOMD, *in vitro* organic matter digestibility; ME, metabolizable energy

4.4. Retrospective Study of Reproductive Health Problems

A retrospective (secondary data) clinical case based assessment study was conducted on *Guto Gida* and *Getema* veterinary clinics to see the prevalence of reproductive health disorders in the area. For this study, veterinary case book was used at both sites to collect all registered cases of five years back (2009/2010-2013/2014). According to this retrospective study result, there were 2640 and 2300 cases of health problems at *Guto Gida* and *Getema* vet clinics during the five year period respectively. The prevalence of reproductive health problems at the two clinics, *Guto Gida* and *Getema* was 56(2.1%) and 164(7.13%) respectively. Mastitis was also a problem in the area and the

retrospective study shows that the magnitude of cases of clinical mastitis at Guto Gida and Getema vet clinic within five years period was 111(4.15% and 136 (5.91%) respectively. For detail information it was presented in the annexes (Appendix 12 and 13).

5. DISCUSSION

The major findings of the current study were discussed and more clarifications were given under each heading and subheadings.

5.1. Questionnaire Survey

The result of face-to-face interview of sampled respondents and personal observations were used to discuss the major findings the study.

5.1.1. Socio-economic characteristics of the households

The result of this study indicated that majority of sampled respondents were male headed (90.5%) and only (9.5%) were female headed households. This result was in agreement with the result of similar activities in Ethiopia, Yitaye (2008) and Kassaw (2007) who reported majority of the respondents (87%) and (93.6) were male headed households respectively. Diriba *et al.* (2014) also reported that the majority of respondents (92%) at Nekemte and (88%) at Bako were male headed households. As it can be observed from the result of this study the majority of sample respondents were married (95%) whereas 2%, 2% and 1% of the respondent were widowed, divorced and single, respectively.

Almost the average age of the majority (76.5%) of respondents was between 20-50 years. But 21% of the ages of respondents fall in the range of 51-65 years (Table 2). This result indicates the majority of household heads are found in young working age group and it is important for livestock production and agricultural activities. The assessment study in parts of Ethiopia, Asaminew and Eyasu (2009) shows the age group of majority, active working force ranges from 15-55 years which constitute 42% of the total. This figure is lower than the present finding maybe due to difference in study area and sampling technique. The result of the present study also indicates that, the average household level family size of the respondents was 6.07 with minimum and maximum number of (1 and 10) peoples respectively (Appendix 9).

A similar finding in different parts of Ethiopia shows no significance difference with this figure. Adebabay (2009), Kassaw (2007), Teshager (2013), Belay (2012) and Kedija (2007) have indicated an average HH level family size of 6.22, 5.58, 7.09, 5.06 and 6.62 peoples respectively. However this finding is lower than that of Asaminew (2007), Birhanu *et al*. (2007) and Solomon (2004) who found an average family size of 7.71, 7.5 and 8.73 persons respectively. This difference might be due to socio economic difference of the respondents and difference in sampling procedure.

A summary of marital status and educational level of the HHs in the study area was presented in Table 3. The marital status of the sample respondents were married (95%), widow (2%), divorced (2%) and single (1%). As it was indicated, the majority of the informants were married (95%). This is in agreement with the finding of Adebabay (2009) who reported the marital status of the sample respondents were married (90.1%), widow and widower (4.4%), divorced (3.9%), and single (1.7%).

Educational level of the farming households may have significant importance in identifying and determining the type of development and extension service approaches. The role of education is obvious in affecting household income, adopting technologies, demography, health, and as a whole the socio-economic status of the family as well (Kerealem, 2005). The educational levels of almost 50% of the sampled respondents were secondary school complete and 30% were primary school complete. This shows the growing of educational coverage which provides better opportunity to implement improved agricultural practices and wise use of scarce agricultural resources in the study area. The rest, 13% and 8.5% of respondents were at higher education level and illiterate respectively (Table 3). Only 8.5% of the household interviewed can't read and write. This result indicates at least about 88% of the respondents can read and write. The percentage of illiterate family members (8.5%) reported in this study was less than the reported figure in Amahara regional state by Adebabay (2009), Fisseha (2009) and Birhanu *et al*. (2007) which were 31.5%, 39.3% and 50%, respectively. This may be due to study area socio economic difference or increasing percentage of educated group in our society.

Therefore, technology adoption may be easy for intervention of livestock development in the area.

Landholding and source of income

In average, the sampled respondents possess 2.34 hectares of land. From this average total land holding, 1.07 hectares of land was allocated for crop production and 0.88 hectare for grazing purpose. The rest 0.45 hectare was used for other purposes (Table 4). As it can be seen from the table, average land holding in urban area seems equal to both peri urban and rural areas. But this is not the reality in practice. The average total land holding at urban area was increased due to inclusion of government and non government dairy farms during sampling with relatively large land holding. Asaminew and Eyasu (2009) found an average land holding per HH 2.66 ha at Bahir Dar zuria which was greater than the current finding. This may be due to difference in location and population density difference in the two sites. Higher average land holding per HH was also indicated by Teshager *et al.* (2013) who found 3.06 ha in Ilu Ababor zone. The settlement structure of Ilu ababor and east wollega zones is not the same. Households were more sparsely settled in Ilu ababor due to coffee plantation and forest. But, the current finding is greater than that of Yigerem *et al.* (2008) who identified 1.1 ha average land holding at Shashamane-Dilla area. This could be due to population density difference in both sites.

Cattle owners of the sampled households generate income from different sources and for the majority of rural producers livestock is not the main income source. Majority of the sampled respondents (62%) get their household likelihood income primarily from crop production and livestock as secondary source of income especially in the rural and peri urban areas. Sintayehu *et al*. (2008) reported that the contribution of dairying to the total household income in rural areas of Ethiopia was much lower (1.6%). Because of the very comfortable agro ecology of the area for cereal crop and coffee production more attention is given to crop production than livestock. Others consider livestock production as the main source of household income with supplementary crop production (9.5%) and other side business activities (24.5), like shop, transport service, hotel and etc. in the urban

area, only 3% of the households get their income from livestock only. The latter two were mainly the characteristics of urban dairy producers (Table 5). The result of this study indicates that as one goes from urban to rural in the current study area, the contribution of livestock to be the source of income for household livelihood decreases and vice versa. Similar studies Yigerem *et al.* (2008) shows urban producers generate substantial (50% of their total income) level of income that dairy producers achieve from dairying. Contrary to this, dairying contributed only 1.6% to the total income of families in the rural areas.

The result of studies in the mid highland crop–livestock production system of Ethiopia have shown 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 (Zelalem and Ledin, 2000). Contrary to this finding, Hussein (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 area crop production may not be the larger contributor to household income due to ecology and geographical set up of the area when compared to the present study area.

Labor division of the households

For different activities of dairy cattle production there is sharing of labor among household members. As it can be seen from the result of the study, dairy cattle breeding activities are mainly the job of HHH and male children (59%). About 18% and 11% of the respondents said breeding is mainly done by HHH and daily laborer, respectively. According to the response of the interviewed households, the majority (46.7%) and (26.5%) of the cases, milking activity is the activity of HH spouse or both HH spouse and daughter respectively (Appendix 15). This is in agreement with the study result of Belay (2013) in Oromia, which indicates milking is usually done by women or their daughters. This is also consistent with the practice in other parts of the country (Alganesh, 2002; Lemma, 2004; Solomon, 2004) where female members of the household undertake milking. However, Asaminew and Eyassu (2009) reported that for Bahir Dar Zuria and

Mecha districts mainly males did milking. This may depends on the tradition of the area or might be due to study location. About 23% of milking activity is conducted by daily laborer and very small proportion of the respondents said (3%) it is done by HHH. Herding, feeding and watering activities are very closely related and important activities in dairy farms. As it was indicated in the result, 35.2%, 28.6% and 23% of the respondents said that herding, feeding and watering activities are done by hired daily laborer, children or children and hired daily laborer, respectively. But 11.5% of the cattle owners said herding, feeding and watering activities can be conducted by all family members. Children when they come back from school they over take the herding activities from their parents in the rural area. But in the urban area almost all of the smallholder dairy producers hire daily laborer for the activities of herding, feeding and watering. Similar finding by Adebabay (2009) in Bure district of Amahara region, reported that hired labor is mainly responsible for herding and feeding of dairy cattle.

Animal marketing (buying or selling) is mainly (47.6%) the activity of HHH or both HHH and spouse (46.7%). Again, milk and milk product marketing is done in most of the cases (69.5%) by daughter and spouse of the household and 9.5%, 7.6%, 7.6% and 5.5% of the respondents said that milk and milk product marketing done by HHH and spouse, HHH, hired daily laborer and all family members respectively. This is in agreement with the finding of Asaminew and Eyassu (2009) who reported that female members of the HH performed marketing of dairy products at northwestern part of Ethiopia.

Purpose of keeping cattle

Knowledge of reasons for keeping cattle is prerequisite for devising breeding goals (Rewe *et al*., 2006). Based on the results of this study, cattle were mainly kept to satisfy both milk and crop production needs in the rural areas. In the rural area, 56(89%) of the farmers keep cattle for crop production followed by milk production and other purposes. This is in agreement with the finding of Asaminew (2007) who reported that the first and second priority functions of cattle are draught power and milk production, respectively.

Similar finding, Etafa *et al.* (2013) reported that the primary purpose of keeping cattle in *Hararghe* was for draft power, milk production and for other purposes. About 4(6%) of the rural cattle owners keep cattle primarily for milk production followed by crop production and other purposes.

In the urban area, 20(91%) of the respondents keep dairy cattle for milk and milk product, crop production and other purpose are secondary. In peri urban areas of *Guto Gida* district 13(65%) of the respondents keep cattle equally for crop production and milk followed by other purposes. But 6(30%) of the respondents keep cattle primarily for crop production followed by other purposes (Figure 2). When compared to the urban area, Smallholder farmers in the peri urban of Nekemte town practice both dairy and crop production and benefit from the two sources than urban farmers. Very few farmers in the urban area practice crop production (mainly horticulture) on very small plot of land.

5.1.2. Dairy cattle management practices

Breeds and breeding

According to CSA (2013), country livestock survey indicated that out of the total cattle population in the country, 98.95% are local breeds. The remaining are hybrid and exotic breeds that accounted for about 0.94% and 0.11%, respectively. According to the current study result, the mean herd size of cattle per HH indicates 12.19 heads from which 8.58 heads of local breed and 3.60 heads of cross breed. This result was in agreement with the findings; Mekonnen *et al*. (2012) and Laval *et al.* (2002) who reported 13 and 10.5 heads per HH at *Horro* district and *Boji* district of Western *Oromia* respectively. Very different figure was reported from *Iluababor* zone by Teshager *et al.* (2013) that indicates the proportion of cross breed animal at HH level to be 1.1% and the rest indigenous breed. This difference comes from the fact that in the current study especially from urban areas HHs were selected purposively for monitoring. In urban and peri urban areas of Nekemte, smallholder dairy farms mostly keep cross breed animals for milk production. Herd size and breed composition at HH level in the study area was indicated in table of Annexes.

One of the cattle production problems in the area is unimproved breeding practice. The respondents have listed out the factors that hinder their cattle breeding activity in the area. As it has been summarized in table 7, from the total of 105 sampled respondents, the majority 79 (76%) have complained the problem of cattle breeding. The rest of respondents, 26 (24%) had no problem on cattle breeding. Cattle breeding constraints mentioned in the study area include feed scarcity, lack of breeding bull, reproductive disorders and mastitis, ineffective cross breeding and access to improved breed is limited. This finding is in agreement with the work of Seid and Berhan (2014) that shows the majority 77% of farmers in southern part of Ethiopia ranked feed shortage as the number one problem that hindered cattle production greatly in the area. Uncontrolled natural mating is the dominant form of animal breeding system practiced in rural areas. Currently, access to AI service is increasingly expanding in the highlands, though the efficiency and effectiveness is not satisfactory. One of the consequences of breeding problem observed in the area was inability of farmers to breed their dairy cows on time after calving. This is related with the problems listed by farmers like feed scarcity, lack of bull, reproductive disorders and AI failure.

Different cattle breeding practices were mentioned by the sampled households in the three locations. More than 45% of the respondents have used natural breeding by using bull service only. Only 4% of the households were using artificial breeding through AI and majority of them (50.5%) have used both natural and artificial insemination for breeding their cattle alternatively. The current finding is almost similar with the result of Belay (2013) 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.

AI service has been used in the area since two decades. But there is a resistance to use AI from the dairy producers due to low conception rate and birth of more male calves. 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. Emebet and Zeleke (2008) also described the breeding practice similar to the current finding. 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.

The breed composition of local and crossbred animals at household level indicates an average 8.58 and 3.61 heads of cattle respectively (Appendix 11). Households who were using natural breeding system get breeding bull from different sources. Majority (83.6%) of the households were using breeding bull either a selected bull from their own herd or neighbor bull. The rest of households (13.5%) were using purchased bull and only 3% did not able to locate source of bull (Table 7).

Profitability and eventually sustainability of dairy smallholdings are to the larger extent determined by reproductive performance (Peters and Ball, 1995). The respondents were asked to recall the usual time of breeding their dairy cow after calving. Accordingly, as it can be seen from the result, the overall mean of breeding cows after calving in the study area was 4.32±1.39 months (Table 8). This figure indicates that there is a longer time of breeding dairy cows after calving which also affects calving interval. A study on reproductive performance of dairy cows at Gonder shows average days open of 86.5±4.5 days (Tadele and Nibret, 2014), which is lower than the present study result. Another study at Jimma zone indicates an average day open of 6.65± 0.11 months. Such differences could have been caused by difference in environmental factors under which animals kept or management factors such as ability of farmers to detect heat signs after calving, and interval from calving to conception was prolonged, and eventually influencing the number of days open.

Housing management

The result of the current study indicates that there are three types of dairy cattle housing system in the area (open crush, fenced shade and closed barns). But there were individuals who didn't house their cattle at all. In the rural district and peri-urban of Guto Gida about 49.52% of the respondents house their cattle in the traditional housing system (open crush barns). Fenced roofed shades type of housing system was used in all locations and contributes 15% of housing type. Closed barn housing system was mainly used for urban dairy housing in Guto Gida district and 33.33% of the sampled households use this type of dairy house. Only 1.9% of the respondents use no house for their dairy cattle (Table 9). In all locations great attention was given for crossbred animals housing than local breeds housing. Almost all local breed animals were housed in open crush barns and all crossbred animals were housed in either fenced shade or closed barns. But if local dairy cows were housed like crossbred ones the performance maybe improved. In the area usually as a tradition, local breed are multipurpose animals not only for milk production and all cattle types and even other species share same barn.

Majority of the households (55.20%) house their calves in isolated calf pen and 25.7% of the respondents keep their calves in the family house. But about 19% of the respondent didn't house their calves at all (Table 10). In urban and peri urban areas usually they house calves in the same house with cows which is fenced or closed. In rural areas, the majority of calves were housed either within family house or just kept loosely in resident compound. A major problem in dairy herds regarding housing is the lack of sufficient space for age and physiological status groups of animals (Martin, 1973) as cited in Emebet and Zeleke (2008). The need to group cows, based on their physiological status of production or reproduction was reported as mandatory, especially in large herds. Some of the most important reproductive problems were associated with the design of facilities and management of the environment (Radostitis *et al.*, 1994).

Feeds and feeding management

Feeds and feeding system was the main constraint of cattle production in the study area. The result of this study indicates that the types of feeding systems noted were grazing

(own and communal pasture), intensive feeding, combination (grazing, cut and carry and intensive) and tethering. Majority of the sampled households (66.7%) feed their animals through free grazing on own pasture land and only 7.6% were using communal pasture. These two feeding systems were observed mainly in rural areas. Stall (intensive) feeding and combinations of feeding systems were mainly the characteristics of urban and peri urban areas. Only 10.5% of the respondents use stall (intensive) feeding and 11.4% practice a combination of feeding system (Table 11). This study also indicated that the major sources of feed for cattle in the study area were natural grass, natural grass hay, crop-residues, improved forage plants (elephant grass, Rhodes grass), concentrate feeds and non-conventional feedstuffs such as pulse crop hulls and '*atela*', locally produced brewery by product and cafeteria left over. As it was indicated in (Table 12), 35.24% of the sampled HHs use primarily concentrate feeds to feed their animals for milk production (mainly Noug cake and maize grain). Additionally as basal diet they feed their animal with grass hay, crop residue, non conventional feeds like pulse crops hulls and food left over. Adoption of improved forage varieties like elephant grass and Rhodes grass was also observed in urban and peri urban areas of Nekemte town; but not popularized among all smallholder dairy producers. Majority of respondents (64.76%) feed their animals exclusively on roughage (natural grass, crop residue) with non-conventional supplementary feeds like, leafs of trees, hulls and mill house scraps and "*Atela*". "*Atela*" is usually used by HHs who own small herd size. Girma *et al*. (2014) also found that higher proportion of small scale farms (35%) use *Atela* as protein supplement compared to medium scale (21%) farms in and around *Shashamane* town.

Similar research output by Azage *et al.* (2013), in different parts of Ethiopia also suggest dairy producers in the peri-urban and rural systems across all the production system ranked grazing natural pasture as their first priority followed by crop residues. The finding of the current study also agrees with report of Central statistical Agency (CSA, 2010a) which indicates natural grazing method of feeding is supplemented with natural grass hay, crop residues such as straws of cereals and agro-industrial by-products mostly from the flour/oil industries and brewery residues. Dairy producers who keep improved

dairy cows also cultivate improved forage crops such as elephant grass, oats, vetch and alfalfa to supplement grazing.

There is a seasonal critical feed shortage in the study area. Majority of the sampled households (84.76%) faced critical feed shortage during dry season from February to May. This was primarily the problem of rural and peri urban production system due to lack of grazing land. On the other hand, 11.43% of respondents complained critical feed shortage during wet season from June to November (Figure 5). This was complained by urban and peri urban smallholder dairy producers. During wet season in urban areas there is shortage and costly price of concentrate feeds on local market. This wet season feed scarcity was the problem of urban and to some extent peri urban dairy producers in Nekemte and the area. This result is in agreement with the result of Diriba *et al.* (2014), which indicates seasonality and high feed cost to be one of the most critical challenges for dairy producers in western Oromia. Very small proportion of respondents (3.8%) said that animal feed shortage is always a problem in the area (Figure 5). In southern part of the country, Seid and Berhan (2014) found similar result regarding seasonal feed shortage indicating according to the study, feed supply is adequate from September to half of January while, half of January to half of April represented critical feed shortage time.

These critical feed shortage problems arise from inadequate and slow introduction, promotion and expansion of improved forage production on these farms and shortage of land to grow forage crops on many farms, especially for the urban dairy producers who do not own land (Zelalem *et al*., 2011). Source of water is also another problem for dairy cattle production in the study area. About 75% of the sampled dairy cattle producers in East *Wollega* zone get water for their dairy cattle from river and 17.14% get pure pipe water for their animals. Again 6.66% of the respondents get water from river and underground for their animals (Table 15). In rural district (*Leka Dullacha*), almost all of the cattle owners use river water for their animals. Due to this their animals were exposed to parasitic infestations like Leech, mostly during dry season. In urban areas dairy producers use mostly pipe water and underground water. But as it was indicated by the interviewed HHs, The problem is lack of continuous supply.

In the study area bucket feeding and suckling were the methods used for feeding calves. Farms with local cattle used suckling practices as opposed to farms with crossbred cattle. The traditional practice of using calf to suckle for stimulation of milk let-down is followed. Calf isolation is exclusively used for crossbred calves in urban and peri-urban areas of Nekemte. For Bucket fed crossbred calves in and around Nekemte, weaning age ranges from 3-6months of age depending on the growth rate and body condition of the calf. Weaning age in the rural area ranges from 9months-18 months of age (Table 14). This finding is similar with the report of Asaminew and Eyasu (2009) that shows the Bucket feeding of milk is practiced before weaning mainly by farmers who owned crossbred cows. The overall average weaning age of local calves was 11.8 months while for crossbred calves the average weaning age was 8.1 months. Average weaning age for bucket fed cross bred calves of the current study was lower than this report may be due to difference in socio economic situation of the households.

In the study area, most of the dairy animals were purchased from Addis Ababa and very few heifers were distributed from Bako agricultural research center. As it was complained by the respondents, due to problem of AI failure and calf mortality, it was said difficult to get replacement heifer in smallholder dairy farms. In the rural areas, the weaning age of a calf is determined by conception rate, mothering ability and milk production potential of the dam and isolation is not a tradition as it is in urban area. Calf weaning practice was also different for crossbred and local calves.

Major cattle diseases and health care in the study area

The result of focus group discussion with zonal and district livestock experts indicates that animal health and reproductive health disorders were among the factors that hinder dairy development in the area. According to the current survey result, 86.66% of the interviewed farmers and dairy producers have listed the major cattle diseases affecting production and productivity of their animals. These common diseases include: Trypanosomosis, Lumpy Skin Disease (LSD), Black leg, Bovine Pasteurellosis, Anthrax

and Foot and Mouth Disease (FMD). A Small proportion of the respondents (13.33%) have listed external parasite (tick), Leech parasite and mastitis as the main health concern for dairy production. Leech parasite was very critical (but ignored) problem especially during dry season when feed and water shortage also a problem (Table 16). This finding was similar with Workneh and Rowlands (2004) and Mekonnen *et al*. (2012) who identified major cattle diseases of cattle in Oromia regional state including Trypanosomosis, Black leg, Anthrax, Pasteurellosis and FMD.

Despite the presence of government and private veterinary clinics and drug shops at both districts of east Wollega zones animal health care service is still with many problems. Every year, there has been a report of disease outbreaks in different parts of the zone at different times (example: LSD). As it was described by zone animal health staff during focus group discussion, the problem is lack of quality drugs at government clinics and illegal drug distribution in the area. As it can be seen from the result of this study, majority of the respondents (40.9%) treat their animals at veterinary clinic, (37.14%) treat their sick animal by using both veterinary clinic and private drug purchase from market and (11.42%) treat their sick cattle exclusively by using purchased drug only. The rest (10.5) of respondents use traditional drug and private veterinarian on agreement.

The occurrence of reproductive and metabolic disorders within the last two years (September 2012/13- August 2013/14) was assessed through recall in the study area. Only 24.8% of the interviewed HHs keeps record of their dairy cattle. The sample respondents have listed the reproductive and metabolic disorders they encountered in their own herd within specified time period. The result of the assessment indicated that 20%, 31%, 36%, 10% and 6% of the respondents have encountered dystocia, abortion, retained fetal membrane, stillbirth and milk fever respectively. The average number of animals with reproductive or metabolic disorder within specified time at herd level was 1.01, with standard deviation of 1.156 (Appendix 14). This figure is very small and may not demonstrate the exact situation at herd level because it was assessed by remind of cattle owners.

Milk production and utilization

The mean number of cows owned per household varies across the three production sites. Total number of cows owned/HH at urban area (6.22±4.30) is higher than that of peri-urban (4±1.73) and rural (3.77±2.55) areas (Table 18). Similar number of cows per HH in the urban area was reported by Dirriba *et al*. (2014) which shows number of cows per household is 2.67 ± 1.88 for Bako and 7.29 ± 8.12 for Nekemte. Number of cows per HH at Bako was lower than the current finding may be due to unsuitable climatic condition of Bako for dairy cattle. The result indicates that, Majority 68(64.72%) of the respondents consume fresh milk produced at home or process to butter. About 26(24.80%) of the respondents channel the milk produced to public market and 4.8% channel the milk to their own catering services.

There are two milk production systems in the area (fluid milk and butter system). In the rural district, *Leka Dullacha*, farmers keep cattle mainly for crop production and milk and milk by product is considered as secondary benefit from cattle. The rural milk producers utilize the majority of milk produced for butter production the only marketable milk by-product and very small amount consumed fresh at home (given to HHH and young children). In the urban and peri-urban areas of *Nekemte* town, there is market oriented milk production system where the majority of milk produced is marketable to either through own catering services or informally to the consumer. This finding is in agreement with the report of Diriba *et al*. (2014) which indicates fluid milk and processed milk products obtained from traditional processing are the main items traded at Bako and Nekemte. By same author, at Nekemte, milk is primarily produced for market purpose and the larger share is channeled through informal market outlets. All respondents at Nekemte indicated that only little fraction of milk produced is retained for family consumption.

In general, the high cost of milk found in the market in the study area is a reflection of the high cost of feed supplements used by the majority of dairy farms that are engaged in market-oriented milk production. This is especially true for those farms that maintain

crossbreed and grade dairy cattle. The major problem is the lack of high quality forage feeds in dairy farms.

5.1.3. Major constraints of cattle production in the study area

The major Constraints of cattle production in the study area are ranked by sampled respondents according to the importance of the problem. The constraints were not the same across different locations. From a total of 105 sampled respondents (59%) have listed the major constraints of cattle production in the study area in the order of feed and land scarcity, unimproved breeding practices and health care problem. The other group (41%) of interviewed respondents put health care problem the first constraint followed by lack of grazing land and unimproved breeding practice. As it can be seen from (Table 6), the problem of majority of the urban and peri urban dairy producers was feed and land shortage. But for the majority of rural farmers the main problem is health care. For Urban and peri urban cattle owners it is very difficult to get access to grazing land and access to veterinary health care is better than that of rural farmers. But for rural mixed crop-livestock based cattle production system, feed and water scarcity is a problem only during dry season and access to veterinary health care service is minimal when compared to the urban area.

Similar finding regarding major constraints of cattle production in Ethiopia was indicated by Zelalem and Ledin, (2001a) which shows 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 Ethiopia. Feeds are generally not available in sufficient quantities owning to overgrazing of lands and uncertain weather conditions.

5.1.4. Alternative concentrate feed ingredients commonly used in and around Nekemte

A range of alternative feed ingredients were observed to be used by the urban and peri-urban dairy farmers in the study area. "*Noug"* seed cake was the conventional protein

supplement used on larger proportion (91%) of the dairy farms visited (Figure 7). The price of this protein supplement was, however, reported to gradually rise (ranging from 4-5 Ethiopian Birr kg^{-1} at the time of the present study) depending on the time of the year, and this increase in price is indicated to be one of the factors threatening the sustainability of dairy farming in the area, leading to a search for alternative ingredients. Pulse crop hulls and mill house scraps were also found to be used widely in all the farms visited, and were observed to be purchased almost throughout the year. During the study period, Maize grain is also used in only 18% of the farms which can fluctuate depending on the price of maize and income of the farms. Entirely all the dairy farmers interviewed reported that the larger proportion of the income acquired from milk sales is allocated for feed purchase leading to a search for alternative feed ingredients like pulse crop hulls. "*Atela"*, a byproduct obtained from traditional breweries and wheat bran were observed to be used on 54% and 9% of the farms visited, while lesser proportion of the farms was observed to use cafeteria leftover (4%). "*Atela"*, is used in small herd sized farms and mostly for local breed cows. The use of wheat bran is not common due to unavailability of processing plants in the area and it is purchased from Addis. Cafeteria leftover was used exclusively in institutional farms like *Wollega* University and religious organizations.

5.2. Participatory (Focus Group Discussion)

The result of focus group discussion shows that, in East *Wollega* zone, Cattle production is generally mixed crop livestock production system. In the urban and peri urban areas, market oriented smallholder dairy cattle production is another system of cattle production. The discussants listed major constraints of cattle production including feed shortage, lack of knowledge on local breed selection, unimproved husbandry practices, input scarcity, poor infrastructure, cross breeding problems and informal marketing of milk. Market oriented dairy cattle production is still not well exercised and at emerging stage in the area due to scarcity of inputs.

In the rural areas of east wollega zone cattle production is characterized by keeping local breed with low input low production and aimed for home consumption of milk and traditional processing to sell butter. This result was in agreement with the finding of Asaminew and Eyasu (2009), who identified the most important constraints associated with milk production: feed shortage, disease prevalence, and poor genetic potential of local cows for milk production, inadequate artificial insemination services, and lack of milk collection centers. This result also agrees with the finding of Mekonnen *et al.* (2012) in western Oromia that indicates the production system in the study area is mixed crop-livestock production system and constrained by grazing land degradation, shortage of feed, population pressure, diseases and parasite burden, and lack of improved bull and inadequate extension service are the main problems that affect the productivity and survival of livestock in the study area.

From all constraints of cattle production, animal feed scarcity both in quantity and quality was the main constraint raised by the discussants in East *Wollega* zone. It was said that grazing land is decreasing from time to time due to pressure from crop production and degradation. The major feed resource available in the area are natural grass, crop residue, local grass hay, oil seed cakes, maize grain and improved forages. Beside these resources, there is a critical feed shortage especially during dry season due to lack of appropriate conservation of crop residue, lack of animal feed processing plant in the nearby and more attention was given to crop production.

Livestock diseases are among the major factors that limit cattle owners' benefits as a result of mortality. According to the result of focus group discussion, the major animal diseases prevailing in the zone include: Trypanosomiasis, LSD, bovine Pasterurellosis, Black leg, mastitis, reproductive health disorders, calf diarrhea, FMD, Internal and external parasites. Poor animal health extension system and outbreak surveillance, lack of facilities, poor control of illegal drug market and lack of on job training were described by the discussants as main constraints of disease control and prevention in the area. This finding was similar with Workneh and Rowlands (2004) and Mekonnen *et al.* (2012) who

identified major cattle diseases of cattle in Oromia regional state including Trypanosomosis, Black leg, Anthrax, Pasteurellosis and FMD.

5.3. Observational (Longitudinal) Study

In addition to diagnostic survey, there was an observational study on selected dairy farms and cows for assessment of reproductive health disorders and daily milk production performance to complement the questionnaire survey. Additionally, lab analysis of composition and nutritive values of commonly used alternative concentrate feed ingredients used by smallholder dairy farms in Nekemte and the area was done on selected commonly used feed samples.

5.3.1. Prevalence of reproductive health disorders in smallholder dairy farms

Out of 36 reproductive cases, 23(63.88%) of the cases was normal parturition with no history of reproductive and metabolic health disorder. The other, 13 cases were reproductive health disorders. According to this finding, the magnitude of reproductive health disorder was 36.1 % (13/36). All of the cases were reproductive health disorders and there was no metabolic case observed during the study period. From reproductive health disorders observed during the study period, retained fetal membrane was frequently observed with the larger magnitude of 7(19.44%) among the cases, followed by abortion (8.33%) and *dystocia* (5.55) (Table 21). From the total of 129 dairy cattle monitored, 23(18.01%) were affected by clinical mastitis with one or two teats blind. The current study result is in agreement with the result of Dawit and Ahmed (2013) that indicates abortion, *dystocia* retained fetal membrane and mastitis were the major reproductive health problems in and around *Kombolcha.*

The prevalence of major reproductive health problem in the current study is lower than the result of Adane *et al*. (2014), Hadush *et al*. (2013), Dawit and Ahmed (2013) and Ararsa and Wubishet (2014) who found 43.07%, 44.3%, 40.3% and 47.7% respectively. But the current study was higher than that of Molalegne and Shiv (2011), Abebaw *et al.*

(2011), Gizaw *et al*. (2011) and Hunduma (2013) who found 31.8%, 33.59%, 31.76% and 18.5% respectively at different parts of the country. The prevalence of dystocia at present study area is the same with that of Adane *et al*. (2014) which indicate prevalence rate of 5.9% at Hossana, but lower than that of Molalegne and Shive (2011) and Dawit and Ahmed (2013) with prevalence rates of 6.6% at Jimma, and 7.75 at Kombolcha respectively. The prevalence of abortion at current study area is almost similar with the finding of Dawit and Ahmed (2013) with prevalence rates 9% but lower than Molalegne and Shive (2011) who found 13.9% prevalence. The result of retained fetal membrane (19.44%) is the same as the prevalence rate (19.2%) indicated at *Jimma* by Abebaw *et al.* (2011).

Different figures were reported in the country regarding the magnitude of major reproductive disorders of dairy cattle. The difference in prevalence of reproductive performance in different parts of the country might be due to sampling technique and sample size, study methodology, production system, breed of the animal under study and environmental factors.

The association and effect of risk factors for the occurrence of reproductive disorders in smallholder dairy herds of Nekemte and the area was assessed. In this study among risk factors herd size, body condition score, parity and management system were assessed for association with the occurrence of the reproductive problems. Based on the result of this study, the effect of herd size, BCS, parity and management system didn't show significant effect since the p-value for each factor was 0.653, 0.226, 0.291 and 0.428 which is greater than alpha value ($P>0.05$). This doesn't mean that these factors didn't affect the prevalence of reproductive disorders. Adane *et al*. (2014) found that parity and BCS significantly affect reproductive health problems. But management system doesn't significantly affect reproductive disorders. Dawit and Ahmed (2013) also described management system and age of the animal doesn't significantly affect reproductive disorders; but parity affects significantly. Similar investigation in Bangladesh Atikul (2013) also shows BCS affect reproductive disorders significantly but parity and management system didn't affect significantly. This difference might be due to the

sampling, location, breed, study duration, production system and level of management in respective study areas.

To see the association of these factors with reproductive health disorders, rank correlation coefficient (ρ) was calculated for each risk factor. The correlation coefficient (ρ) values for herd size, BCS, parity and management system are 0.23, 0.26, 0.30 and -0.30, respectively (Table 22). Depending on these figures all the factors showed weak positive association with reproductive disorders. But management system is associated with reproductive disorders negatively (improvement with management system declines reproductive disorders). This weak association might be due to the short duration of the study and small sample size.

5.3.2. Milk production performance of smallholder dairy cows

Daily milk yield performance was monitored at urban and peri urban areas of Nekemte town for a total of 56 milking cows at different stage of lactation and parity; where market oriented dairy producers keep mostly cross breed animals. The average daily milk yield of local cows monitored was 3.1±0.88 liters per day. This finding is similar with a report of Belete *et al*. (2010) which indicates daily milk yield 3.4 for local breed. Daily milk yield of local cattle in this study was higher than that of Tesfaye (2007), Mekonnon *et al.* (2012), Dereje (2005), Workneh and Rowlands (2004) who reported 1.9, 1.65, 1.9 and 1.4 liters, respectively. This might be due to very small sample size of the current study and production system. The average daily milk yield of cross breed HF and Jersey cows was 8.7±0.55and 5.8±1.68 liters respectively. A finding of Yosef *et al*. (2003b) for cross bred HF cows was very similar to this finding which is 8.9 litres per day. But lower than that of Wondatir *et al.* (2011) who reported 9.7litres per day. This difference could be due to the level of exotic gene inheritance among different crossbred dairy cows. Different scholars in different parts of Ethiopia (Kelay, 2002; Fayo, 2008; Belete, 2006 and Asaminew, 2007) found average daily milk yield of cross breed dairy cows to be 11.1, 10.72, 8.0 and 5.2 liters, respectively. The difference in average daily milk yield of cross breed dairy cows across different areas may be due to study design,

location, breed type, production system, management, sample size and methodology used. Despite the fact that maximum total milk yield and lactation length was reached at parity 2, it was not statistically different from other parities. Maximum lactation length and yield was reached under good management system and it was statistically different from medium and poor levels.

According to the current study, in different level of management, average daily milk yield varies. The average daily milk yield of dairy cows under three different management systems was 10.2, 8 and 6.9 liters for good, medium and poor management systems respectively (Table 24). It is also revealed that the daily average milk production of dairy cows in different herd size varies. The average daily milk yield of dairy cows in three different herd size was 9, 8.8 and 6.6 liters for small, medium and large herd sizes respectively. This disagrees with the finding of Kelay (2002) in Addis Ababa, which indicates in small, medium and large sized herds the average daily milk yield was 8.97, 10.47 and 13.87 respectively. This depends on location, level of management of farms, duration of monitoring and sample size.

5.3.3. Chemical composition, digestibility and energy values of pulse crops hulls

In Ethiopia, the peri-urban dairy sub-sector is facing a number of technical and non-technical constraints; and among the technical constraints, feed shortage in both quality and quantity has continually been reported to be very important (Diriba *et al*., 2014). A recent study on small holder dairy farms across varying production systems showed that only 0.15% and 0.8% of the farmers in the sites surveyed use improved forages and concentrate feeds, respectively (Tefera, 2010). The rising prices of commercially compounded dairy feeds, and conventional concentrate ingredients such as "noug" (*Guizotia abyssinica*) seed cake, linseed cake and wheat bran was also observed to compel peri-urban dairy farmers to opt for low-cost alternative ingredients such as pulse crop hulls (Adugna, 2007) and mill house scraps sourced from flour processing mills of varying scales (Diriba *et al*., 2014). The likely growing gap between the supply and demand for such feeds necessitates the search for other locally obtainable alternative or non conventional ingredients in formulating peri-urban dairy cattle rations.

These concentrate feed ingredients are used in a mixture form with other concentrate feeds commonly with "*noug*" cake, maize grain, *Atela* or wheat bran during ration formulation. Dairy producers purchase these feeds for their dairy cows equally as they purchase *noug* cake or crop grain. The price of these feeds type is increasing due to high demand from dairy farms equal to "*noug*" cake. During the study period was almost the same to the price of *noug* cake at *Nekemte* (3-4 ETB kg^{-1}).

Descriptive statistics for quality traits of the four main hulls observed to be widely used in the surveyed peri-urban area is presented in Table 25. The mean DM and ash content was 88.87% and 3.06%, respectively. The CP content of the hulls ranged from 6.8% for field pea to 18.80% for *Lathyrus*, with the mean of 12.43%. The mean NDF content was 47.78%, with values ranging from 39.36% to 56.72%. In the same way, the ADF content ranged from 6.82% to 14.72% with a mean of 10.32%, while lignin content was found to be very low ranged from 0.24% to 0.94%. This is important for dry matter intake of the feeds. The mean IVOMD value was 73.59%, with values ranging from 71.16% for field pea hulls to 77.16% for faba bean hulls. The mean ME content was 12.51% with values ranging from 12.1% (pea hull) to 13.12% (bean hull).

As it was indicated in the table 25, DM, Ash, ADL, IVOMD and energy contents of these ingredients were almost the same. But in terms of CP content, *Lathyrus* and Faba beans were rich in CP. The difference was in terms of ADF and ADL content which varies across the samples. The mean CP value of these feed resources was 12.43%DM which ranges from 6.80-18.80 and it is more than the range of FAO's (1984) recommendation, that the threshold value of feedstuffs for CP is between 7% and 8%DM, which is adequate for maintenance of livestock and above the minimum requirement for optimum rumen function (7.5%) suggested by Van Soest (1982). Therefore, the CP contents of these feeds can support both maintenance requirement and production. A finding reported by Girma *et al*. (2014) in southern Ethiopia that indicate higher mill house by product CP content of 19.2% compared to the present study. This may be due to difference in type of mill house by product. Pea and bean hull CP content of 16.4% and 6.5% was reported by Wondatir *et al*. (2011) which is in agreement with the current finding.

5.4. Retrospective Study

The Secondary data collected from case books of two veterinary clinics shows clinical cases of 2640 and 2300 health problems at *Guto Gida* and *Getema* vet clinics during the five year period respectively. From the total cases presented to the clinics, the prevalence of reproductive health problems at the two clinics, *Guto Gida* and *Getema* was 56(2.1%) and 164(7.13%) respectively. Mastitis was also a problem in the area and the retrospective study shows that the magnitude of cases of clinical mastitis at *Guto Gida* and *Getema* vet clinic within five years period was 111(4.15% and 136 (5.91%) respectively. The result of retrospective study of major reproductive health disorders was much lower than that of the current finding. This indicates majority of cases may not visit veterinary clinics in the study area. For detail information it was presented in the annexes table (Annex Table 4 and 5). The prevalence of reproductive cases at these clinics was very low. This may not exactly indicate the magnitude of the problem in the area because of many reproductive cases in the area may not come to the clinic. The prevalence at *Getema* vet clinic was higher than that of *Nekemte* vet clinic. The prevalence at *Nekemte* was lower than that of *Getema* due to treatment of many cases of reproductive health disorders at farm by private veterinarians.

6. CONCLUSION AND RECOMMENDATIONS

In light with cross-sectional and longitudinal study, two main dairy production systems exist in the study area: market oriented urban and peri urban smallholder dairy and rural mixed crop-livestock 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.

The rural mixed crop livestock production system is characterized by keeping of local cattle primarily for the purpose of crop production and secondary milk production with interrelated constraints like prevalence of diseases, unimproved breeding practice and shortage grazing land especially during dry season.

In rural smallholder production system, natural pasture and crop-residues are the major feed resources during wet and dry seasons, respectively. In urban and peri urban production system, grass hay, concentrate feed and non-conventional feed and improved forage are the feed resources with irregular availability.

The most prevalent diseases of cattle in the study area include *Trypanosomosis*, Lumpy skin disease, Black leg; Foot and mouth disease, Anthrax, tick infestation and mastitis. The status of major reproductive health disorders of dairy cattle in selected dairy farms show higher prevalence of the problem affecting the production and productivity of dairy cows. The longitudinal study revealed that the milk produced per day per animal in and around Nekemte smallholder dairy farms was very low and costly despite high demand and favorable environment for dairying.

The nutritional value of different hulls is comparable with other supplementary feeds and adequate to support both maintenance requirement and production. The main constraints of livestock production and productivity in the study area can be summed up as land and

feed shortage, livestock disease and parasites, low conception rate to artificial breeding, unimproved husbandry practices and poor livestock extension services.

Based up on the above conclusive remarks the following points were forwarded:

- Feed scarcity and land shortage were among the main bottle necks to market oriented dairy cattle production in the study are. Thus animal feed professionals together with administrative bodies should intervene and discuss with the dairy producers to minimize the effect of constraints for improvement of milk production in the area
- Animal health problem, dry season feed scarcity and limited access to improved cattle breed for milk production were among the main constraints of rural smallholder cattle production system. Awareness creation, epidemiological investigation of economically important diseases of cattle, sustainable animal feed extension services like improved forage development and crop residue conservation techniques should be exercised to alleviate the problem.
- Low conception rate to artificial insemination and poor dairy extension services were common complains in all the production systems. Therefore assessment should be conducted to identify the cause of AI failure and sustainable dairy cattle extension services needs great attention from stakeholders
- The role of unconventional feeds in ruminant nutrition continues to increase and use of these non-conventional feedstuffs might be a viable alternative. To maximize the feeding value of unconventional feeds, an evaluation system based on detailed analysis and animal performance studies should be developed

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7. APPENDICES

Appendix 1: Questionnaire format for household interview

Research Title: ASSESSMENT OF SMALLHOLDER DAIRY PRODUCTION SYSTEMS AND MAJOR REPRODUCTIVE HEALTH DISORDERS OF DAIRY CATTLE IN EAST WOLLEGA ZONE, ETHIOPIA

Questionnaire NO _____

INTRODUCTION AND INFORMED CONSENT

Good morning! / Good afternoon!

My name is _____. I came from _____ to conduct research on Assessment of Smallholder Dairy Production Systems and Major Reproductive Health Disorders of Dairy Cattle in Guto Gida and Leka Dullacha districts of East Wollega Zone. You are randomly selected to provide information for this research activity and expected to be representative for others. Hence without your participation it is impossible to answer the research objectives. The information you provide will help the researcher for assessing cattle production systems and major reproductive health disorders in the area. The interview may take few minutes to complete. Any information you provide will be strictly confidential and will not be used for any purpose outside this research.

Consent given: Yes [ ] / No [ ] *(If the answer is "No" to this question, end the interview now*)

General

Questionnaire Number: _____ Date of interview: _____/_____/_____

Name of respondent _____Age _____Sex _____

Region: _____Zone: _____District _____

PA_____

Enumerator's Name: _____Age_____ Sex_____

Level of education_____

SECTION I. SOCIOECONOMIC CHARACTERISTICS

1**.** Occupation of the respondent 1=Farmer 2=Trader 3=government employee 4=other

2. Marital status: 1 = Single 2 = Married 3 =Widowed 4 = Divorced

3. Family size _____

4. Educational status of the respondent

1= Illiterate 2=Primary 3= Secondary 4 = High School 5=Higher education

5. Source of income for livelihood of the household 1 ----------

---------- -2 ---------- 3 ----------

6. Type of farming activity (1)= crop (2)= livestock (3)= crop and livestock

7. Land holding and land use systems: Total land holding of household _____ (ha)

Crop land _____ Grazing land _____ Others _____

8. Labor division of family member for different activities of cattle production

S/No	Activities	Family member responsible
1	Breeding (AI/Bull)	
2	Milking	
3	Herding, feeding and watering	
4	Barn cleaning and construction	
5	Animal marketing	
6	Milk and milk product marketing	
7	Sick animals care	

9. What are the major constraints of cattle production in your area? Rank in order of importance _____ _____

_____

SECTION II: MANAGEMENT

A/General farm information

1. Type of dairy cattle kept for production (1) crossbreed (2) local (3) Both breeds

2. Purpose of keeping cattle 1= _____ 2=_____ 3= ___

3. Do you keep records for your dairy cattle? 1=Yes, 2= No

4. Do you practice culling? 1=yes, 2=No

If yes, what are the reasons of culling? _____, _____

5. Cattle herd structure and breed composition

Animal category	Breed		Number
	Local	Cross	
Total Cows			
Milking			
Milking pregnant			
Milking non pregnant			
Dry Cow			
Pregnant			
Non pregnant			
Heifer (< 2 years)			
Heifer (>2 years)			
Pregnant			
Non pregnant			
Calves < 6m			
Male			
Female			
Calves > 6months			
Male			
Female			
Oxen			
Breeding bull			
Total cattle			

B/ Breeding Management

1. Do you have any problem with cattle breeding? 1=Yes 2=No, If yes, list them

   _____ _____ _____

2. Who detect heat in your herd? 1=Bull 2=herder 3=both can detect heat
3. Breeding system:1=Natural 2=AI 3=Both can be used
4. If you are using natural breeding system, from where do you get breeding bull? 1= grown within the herd 2=purchased 3= Neighbor bull
5. Have you practiced artificial breeding in your dairy herd? 1=Yes 2=No, If yes, what are the problems with AI?_____
6. Most common time of breeding your cows after calving_____
7. Have you encountered a cow with problems of : (I) Anoestrous: 1=Yes, 2=No, (II) Repeat breeder: 1=yes, 2=No

C/ Housing System

1. What is your housing system for your dairy cattle?

1= Fenced open crashes 2= Fenced and roofed shade 3= closed house 4= tethered at poles 5=No housing

2. Where do you house your calves? 1= with family in the house 2= separate calve pen 3= tethered at pole outside 4= No house for calves

3. Do you clean cattle house? 1=Yes 2=No If yes, at what intervals _____

D. Feeds and Feeding System

1. What are the available feed resources in your area?

_____ _____ _____

2. Do you have own grazing land? 1. Yes 2. No, if No, where do you keep your cattle?

3. What feeding system do you practice? 1=free grazing on own pasture 2=free grazing on communal grazing land 3=cut and carry system 4=intensive feeding indoor 5=other

4. At which season of the year do you face critical feed shortage?

1= dry (From_____ to _____) 2=wet (from_____ to _____)

5. What is the Source of water for your dairy cattle? 1=river 2=pipe water 3= underground water (4)=pond

6. List the most common crop residue you used to feed your dairy animals

_____, _____, _____

8. Do you supplement your animals with concentrates? 1=Yes 2=No, If Yes, which concentrate type_____

E. Cattle Herd Health and Reproductive Health Disorders of Dairy Cattle

1. List common cattle diseases in your area _____

_____, _____

2. What are the diseases of dairy cows you faced in your herd? 1_____, 2 _____ (3) _____, (4) _____

3. Which Major reproductive and metabolic health problem/disorder you have encountered in your dairy herd within the last two years?

(I) **Dystocia**: 1=yes 2=No, (II) **Abortion:** 1=yes 2=No, (III) **Retained Placenta:** 1=yes 2=No (IV) **Stillbirth**: 1=Yes 2=No, (V) **Milk fever:** 1=Yes 2=No, (VI) **Ketosis**: 1=yes 2=No

5. How many of your cows have encountered one of the disorders under Q.No 4 during last calving? _____

7. How do you manage sick cattle? 1=treat using traditional drugs 2=take to nearby vet clinic 3=purchase drug and treat 4= do nothing

SECTION 3. MILK PRODUCTION AND UTILIZATION

1. Do you isolate new born calves from their dams after calving? 1=Yes, 2=No, if yes indicate the time _____

2. Do you know the daily amount of milk produced from your cows? 1=yes 2=No

If Yes, what is the amount of milk produced per day? Local cow____crossbred cow___

3. For how long your cows give you milk per lactation? 1= 5-7months, 2=8-10 months, 3=more than 10 months

4**.** How do you utilize the milk produced? _____

5. Do you have any milk marketing problem? 1=yes 2=No, if yes, what are the problems?_____, _____

6. Which milk product do you prefer for marketing? 1= Liquid milk 2=butter 3=other (specify_____ why do you prefer?_____

7. How do you feed your calves? 1=freely suckle 2=bucket 3=restricted suckling

8. At what age do you wean your calves?

Appendix 2: Checklist for focal group discussion

Date _____

Location_____

List of participant

Name	Job/Profession
1. _____	_____
2. _____ _____	_____
3. _____	_____
4. _____	_____
5. _____	_____
6. _____	_____

Chair person Secretary

_____ _____

List of topics for group discussion

(a). Cattle production system in the area

(b). Major constraints of dairy cattle production in the area

(c). Major crops grown in the area

(d). Major feed resources

(e). Dairy extension services and associated constraints

(f) Major diseases and associated constraints to health care service

Appendix 3: Checklist of indicators to evaluate management system of smallholder dairy farms

Owners Name: _____

Farm No: _____ Herd size: _____

Checklist of Indicators used

1. Farm site
2. Housing system and conditions
3. Feeds and feeding management
4. Herd Health care conditions
5. General hygiene of the farm
6. Manure disposal system
7. Workers management
8. Record keeping
9. Plan for expansion of the farm

Appendix 4**:** Data collection sheet for monitoring of reproductive health disorders

Owners Name: _____, Herd size: _____, Management system, Site (urban[] Peri urban[])

S/No	Cow ID	Breed	Age	Parity	BCS	Stage of pregnancy	Reproductive &Metabolic.health disorders						Remarks
							D	A	RP	MF	Stb	K	

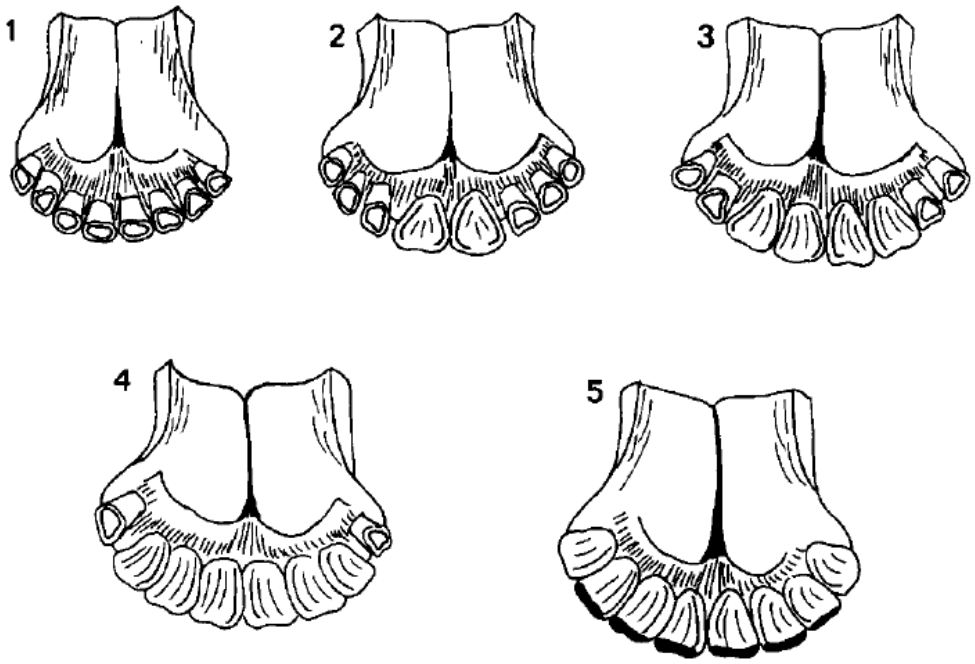
Note: A=Abortion, D=Dystocia, RP= Retained placenta, MF=Milk fever, Stb=Stillbirth K=Ketosis

Appendix 5**:** Data collection sheet for milk yield monitoring of smallholder dairy cow

Name of the owner: _____ Herd size: _____ Management System:_____ Site (Urban[] Periurban[]

Date	Cow ID	Breed	Age	Parity	BCS	Lactation stage	Condition of teat/udder	Daily milk yield	Remarks

Appendix 6**:** Figure showing dentition of cows at different ages (Puck *et al.*, 2004)



Appendix 7**:** Clinical cases of retained fetal membrane observed during the survey (a &b)

a). Technician treating retained fetal membrane

(b). Clinical case of retained fetal membrane waiting for treatment

Appendix 8**:** Figure showing local breed heifer (a) and crop residue utilization system (b) at *Leka Dullacha* district

a. Local heifer (4.5 years old)

b. Crop residue utilization (poor conservation)

Appendix 9**:** Average family size of sampled households of the study area

Variable	N	Minimum	Maximum	Mean±SD
Family size	105	1	10	6.07±2.11

Appendix 10: A summary of occupation of sampled households

	Production site			
Variables	Urban (N)	Peri urban (N)	Rural (N)	Total, N (%)
Farmer	7	19	57	83 (79)
Trader	8	0	2	10 (9.5)
Government employee	2	0	3	5 (4.8)
Other	5	1	1	7 (6.7)
Total	22	20	63	105 (100)

Appendix 11: Herd size and breed composition across the 3 locations

Herd size	Location	Min.	Max.	Sum	Mean	SD
	Urban	2	49	327	14.86	11.26
	Peri urban	5	19	221	11	3.74
	Rural	2	35	732	11.61	6.93
	Total	2	49	1280	12.19	7.66
Local breed	Urban	0	29	80	3.63	6.73
	Peri urban	0	14	145	7.25	5.12
	Rural	2	30	676	10.73	6.18
	Total	0	30	901	8.58	6.71
Cross breed	Urban	0	37	247	11.22	9.32
	Peri urban	0	12	76	3.8	4.09
	Rural	0	9	56	0.88	1.83
	Total	0	37	379	3.60	6.27

Min=minimum, Max=maximum, SD=standard deviation

Appendix 12**:** Clinical cases of health problems at *Guto Gida* vet Clinic (2009-2014)

Name of the disease	5 Years data					
	2009/10	2010/11	2011/12	2012/13	2013/14	Total (%)
Trypanosomiasis	18	26	8	63	60	175 (6.62)
Black Leg	12	6	16	27	3	64 (2.42)
Pasteurellosis	6	2	6	9	6	29 (1.08)
Anthrax	7	5	4	3	6	25 (0.95)
Neumonia	0	20	12	11	4	47 (1.78)
Septicemia	0	6	22	57	20	105 (3.97)
Parasitism	302	335	380	230	382	1629 (61.7)
Protozoal infections	33	44	74	11	24	186 (7.04)
Mastitis	6	22	26	27	30	111 (4.2)
Bloat	45	20	16	21	6	108 (4.09)
Wound	3	22	14	63	3	105 (3.97)
Reproductive health disorders	0	10	8	3	35	56 (2.12)
Total	432	518	586	525	579	2640 (100)

N=total number of cases, %=percentage

Appendix 13: Clinical cases of health problems at *Getema* vet clinic (2009-2014)

List of cases	Years					
	2009/10	2010/11	2011/12	2012/13	2013/14	Total N (%)
Trypanosomiasis	102	140	172	70	40	524(22.78)
Black Leg	40	26	30	15	38	149(6.48)
Pasteurellosis	42	12	22	14	4	94(4.08)
Anthrax	2	10	4	0	2	18(0.78)
Neumonia	4	2	8	5	4	23(1)
Septicemia	66	60	30	32	22	210(9.13)
Parasitism	96	68	56	74	166	460(20)
Actinobacillosis	8	4	0	3	8	23(1)
Mastitis	28	6	22	38	42	136(5.91)
Bloat	14	6	14	37	10	81(3.52)
Infectious Keratoconjunctivitis	8	4	6	5	38	61(2.65)
Reproductive health disorders	10	18	26	70	40	164(7.13)
Actinomycosis	4	8	6	5	6	29(1.26)
Lumpy skin disease	4	14	18	60	32	128(5.56)
Babesiosis	6	4	2	8	62	82(3.57)
Dermatophytosis	4	10	0	20	0	34(1.48)
Dermatophyllosis	4	8	20	30	0	62(2.7)
Foot and mouth disease	6	0	4	6	6	22(0.96)
Total						**2300**

Appendix 14: Common reproductive disorders of dairy cow encountered within the last two years (2012-2014)

Reproductive and metabolic disorders	Response	N	%	Mean±SD (min-max)
Dystocia	Yes	22	20	
	No	83		
Abortion	Yes	33	31	
	No	72		
Retained fetal membrane	Yes	38	36	
	No	67		
Still birth	Yes	11	10	
	No	94		
Milk fever	Yes	7	6	
	No	98		
Ketosis	Yes	0	0	1.00±1.156(0-5)
	No	105	100	

N=Number of observation, %=Percent, SD=standard deviation

Appendix 15: Labor division in the household for dairy cattle management

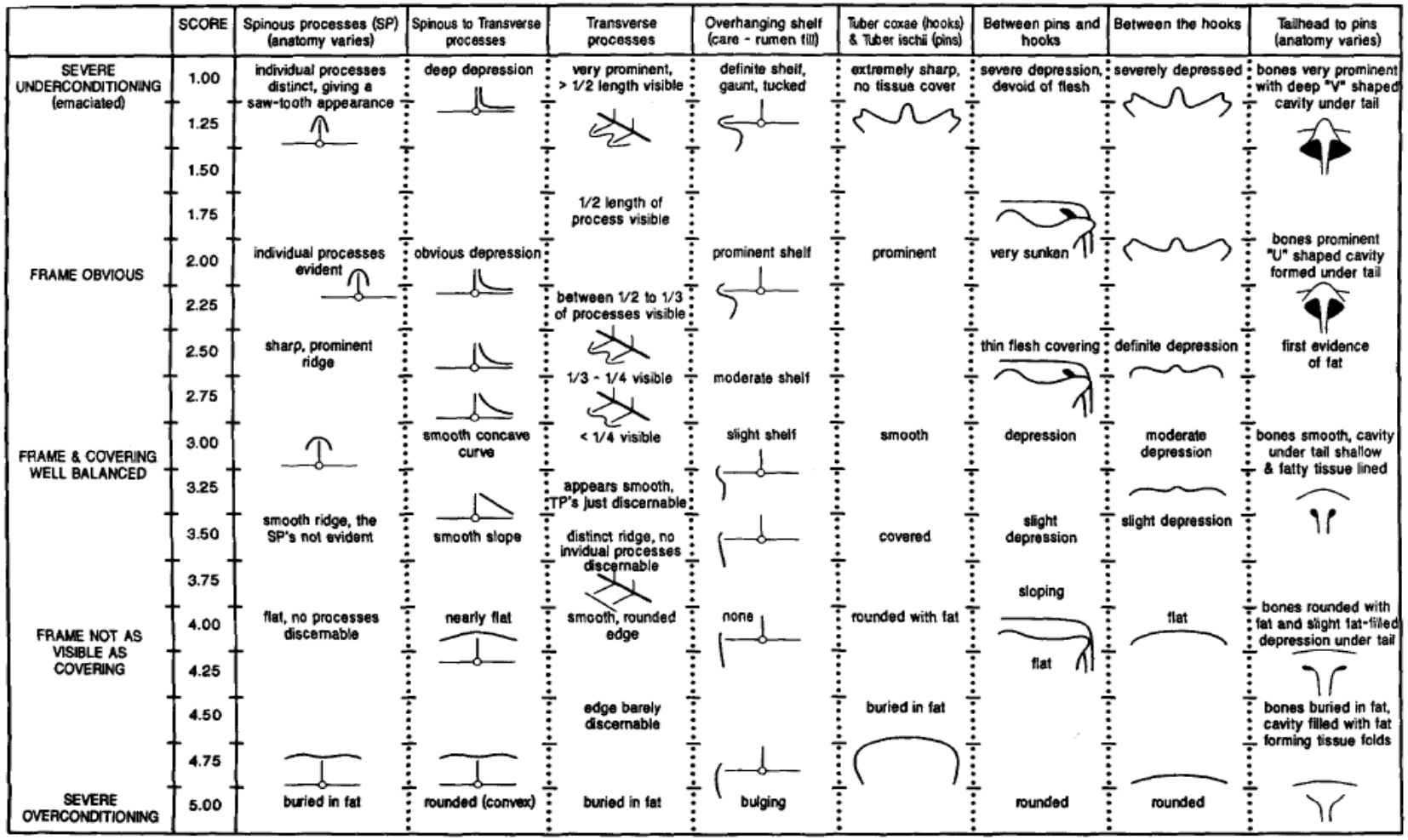
Activities		Frequency	Percentage
Breeding	HHH	19	18.1
	Spouse	3	2.9
	Children	4	3.8
	HDL	12	11.4
	HHH and male children	62	59
	All family	5	4.8
Milking	HHH	3	2.9
	Spouse	49	46.7
	HDL	24	23
	SPOUSE and children	29	26.5
HFW	HHH	2	1.9
	Children	30	28.6
	HDL	37	35.2
	HHH and children	24	23
	All family can involve	12	11.5
Animal marketing	HHH	50	47.6
	HHH and Spouse	49	46.7
	Male Children	2	1.9
	All can be involved	4	3.9
MMPM	HHH	8	7.6
	HHH and Spouse	10	9.5
	Daughter and Spouse	73	69.5
	HDL	8	7.6
	All family can involve	6	5.5

Note: HHH=household head, HDL=hired daily laborer, HFW=herding feeding and watering, MMPM=milk and milk product marketing

Appendix 16: Livestock population of East *Wollega*, *Guto Gida* and *Leka Dullacha* districts

	Species	Total Population	Local	Cross
East *Wollega* Zone	Cattle	925,144		
	Sheep	220,875		
	Goat	146,775		
	Donkey	84,711		
	Horse	2988		
	Mule	4551		
	Poultry	794,484		
	Beehive	176,532		
Guto Gida district				
	Cattle	94137	93,863	274
	Sheep	15800		
	Goat	12210		
	Donkey	8095		
	Horse	1518		
	Mule	1345		
	Poultry	40645	28763	11882
	Beehive	70623		
Leka Dullacha district				
	Cattle	95,858		
	Sheep	23,316		
	Goat	13,093		
	Donkey	675		
	Horse	625		
	Mule	751		
	Poultry	65,685		

Appendix 17: Body condition score chart for dairy cows



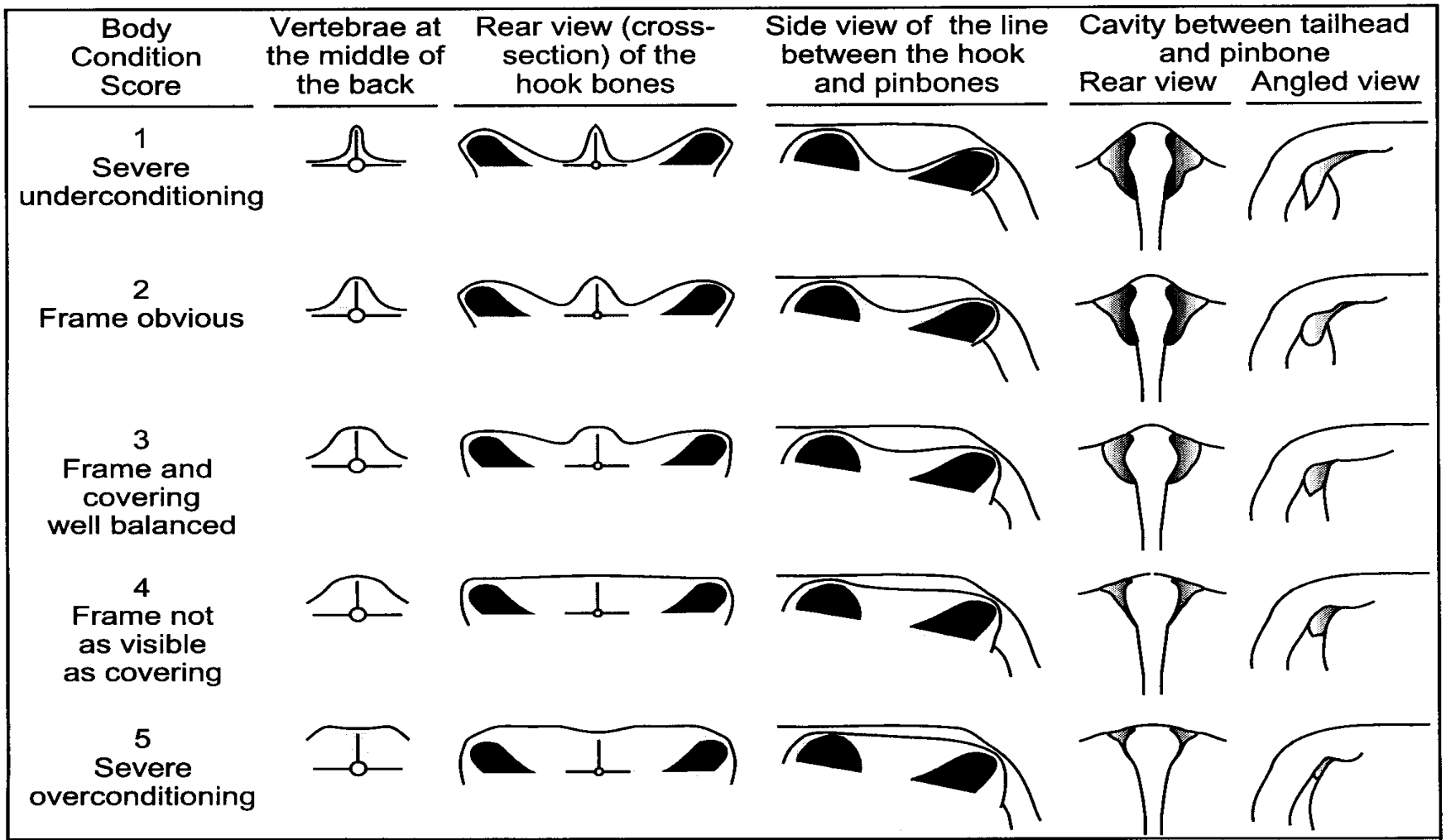


Figure 3: Body condition scores (Adapted from A.J. Edmondson, I.J. Lean, C.O. Weaver, T. Farver and G. Webster. 1989. A body condition scoring chart for Holstein dairy cows. J. Dairy Sci. 72:68-78.)