ON-FARM EVALUATION AND DEMONSTRATION OF UREA TREATED STRAW AND UREA MOLASSES BLOCK SUPPLEMENTATION TO CROSS-BRED DAIRY COWS AT LUME DISTRICT, EAST SHOA ZONE

MSc THESIS

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On-Farm Evaluation and Demonstration of Urea Treated Straw and Urea Molasses Block Supplementation to Cross-Bred Dairy cows at Lume District, East Shoa zone

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MASTER OF SCIENCES IN AGRICULTURE
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We hereby certify that we have read and evaluated this Thesis entitled **"On-Farm Evaluation and Demonstration of Urea Treated Straw and Urea Molasses block Supplementation to Cross-Bred Dairy cows in Lume District, East Shoa zone**'' prepared under our guidance by Gelane Kumssa. We recommend that it be submitted as fulfilling the Thesis requirement.

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DEDICATION

I dedicated this thesis to my lovely husband **BIRUK ZAWUDIE,** my mother **ERGIBE MERGA** and my father **KUMSSA EFFA** for all the love they have given me and their dedicated partnership in the success of my life.

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this Thesis is my own work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this Thesis. Any scholarly matter that is included in the Thesis has been given recognition through citation.

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BIOGRAPHICAL SKETCH

Gelane Kumssa, the author, was born in Dandi District, West Shewa zone in 1990. She has completed Elementary Education at Gura Awash Elementary School in 2004. She pursued her Secondary education and then completed preparatory at Ginchi Senior Secondary and preparatory School in 2008. Then, she joined Ambo University, College of Agriculture and Veterinary Science in 2009, and graduated with B.Sc. degree in Agriculture (Animal Science) in 2011.

After graduation, she was employed by Ethiopian Institute of Agricultural Research at Debre Zeit Center and served as a Livestock Assistance Researcher. She joined Haramaya University to pursue Master of Science in Animal Production in 2014.

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ACRONYMS AND ABBREVIATIONS

ADF:	Acid Detergent Fiber
ADFI:	Acid Detergent Fiber Intake
ADL:	Acid Detergent Lignin
ADLI	Acid Detergent Lignin Lntake
ARDP:	Arsi Rural Development Project
BoARD:	Bureau of Agriculture and Rural Development
CIDA:	Canada International Development Agency
CO_2	Carbon Dioxide
Co	Cobalt
CP:	Crude Protein
CPI:	Crude Protein Intake
CRD	Completely Randomized Design
DWG	Daily Weight Gain
DM:	Dry Matter
DMI	Dry Matter Intake
DZARC	Debre Zeit Agricultural Research Center
ELMP:	Ethiopia Livestock Master Plan
EMDIDI	Ethiopia Meat and Dairy Industry Development Institute
ESAP:	Ethiopian Society of Animal Production
FAO:	Food and Agriculture Organizations of the United States
FNE:	Forage Network in Ethiopia
GTP:	Growth and Transformation Plan
H_2O:	Water
IAR:	Institute of Agriculture Research

ACRONYMS AND ABBREVIATIONS CONTINUED…

ICRA:	International Center for Development Oriented Research in Agriculture
ILCA:	International Livestock Centre for Africa
IVOMD:	In-vitro Organic Matter Digestibility
NADPH	Nicotinamide Adenine Dinucleotide Phosphate
ME:	Metabolisable Energy
N:	Nitrogen
NDFI	Neutral Detergent Fiber Intake
NDF:	Neutral Detergent Fiber
NH-N:	Ammonia Nitrogen
OMD	Organic Matter Digestibility
SNF	Solid Not Fat
SAS:	Statistical Analysis System
TS	Total Solid
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
SDDP:	Small Holder Dairy Development Project
SPSS:	Statistical Package for Social Sciences
UTS	Urea Treated Straw
UMB	Urea Molasses Block

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ON-FARM EVALUATION AND DEMONSTRATION OF UREA TREATED STRAW AND UREA MOLASSES BLOCK SUPPLEMENTATION TO CROSS-BRED DAIRY COWS AT LUMEDISTRICT, EAST SHEWA ZONE.

ABSTRACT

On-farm study was conducted to evaluate and demonstrate the effects of urea treated straw and urea molasses block on milk yield, milk composition, feed intake and body weight gain of cross-bred lactating dairy cows in urban and peri-urban dairy production system of Lume District. Three treatments were considered: T1: urea treated straw + concentrate, T2: urea molasses block + untreated teff straw + concentrate and T3: untreated straw + concentrate. Pre-visit and survey was made and 40 cross-bred dairy cows with 2nd and 3rd parities were selected. Then cows assigned to treatments with RCBD design. Highly significant differences were observed between treatments in daily feed intake, daily milk yield and daily body weight gain. T2 was significantly higher than T1 and T3 where, the least square mean of total DM intake was 10.58 ± 0.09, 10.18 ± 0.08 and 10.1 ± 0.1 for T2, T1and T3 respectively. Daily weight gain was higher in T1 (0.28 ± 0.03 kg) and followed by T2 (0.16 ± 0.04 kg per day) and T3 (0.02 ± 0.04 kg per day). The daily milk yield was high in T2 (10.06±0.10 L per day) and followed by T1 (9.61±0.11L per day) and T3 (8.701±0.09L per day). On the other hand, significant difference observed between second and third parity, where third parity showed higher result in daily feed intake and daily milk yield. Daily body weight gain was higher in second parity cows. Similarly, higher daily DM intake and daily milk yield were observed in peri-urban than urban dairy production system where daily weight gain was not significantly different in both systems. In conclusion urea molasses block (T2) has showed increased daily DM intake and daily milk yield. Therefore, use of urea molasses block for dairy animals will be effective in urban and peri urban area where milk market access is available. Therefore, the smallholder farmers and commercial milk producers advised to use UMB to improve milk production of cross-bred dairy cows.

Key words: Milk yield, Teff straw, Urea molasses block, Urea treated straw, Weight gain.

1. INTRODUCTION

The total cattle population in Ethiopia is estimated to be about 57.83 million. Out of this, the female cattle constitute about 55.38 percent. Total local cattle breed accounted 98.59 percent and the remaining is hybrid and exotic breeds accounting 1.22 percent and 0.19 percent, respectively (CSA, 2016). Dairy cattle produce milk which serves as nourishment for new born calves and as food for infants and also for adult humans (FAO, 2002). However, FAO (2003) indicated that, dairy productivity is very low and lag behind the growth of the human population, which leads to a net decline in per capita consumptions of dairy products, and this ranks Ethiopia, as having the lowest consumption of milk, among neighboring countries, although, it has Africa's largest national herd

Feed shortage both in terms of quantity and quality is a major problem hindering the development of dairy industry in Ethiopia due to fast deterioration of the natural grazing land associated with a rise in crop cultivation and over stocking. In addition to this, the length of dry season varies from year to year and influences the quality and quantity of the available feed resources. Therefore, dairy animals suffer most during periods of feed shortage and their peak lactation is largely affected.

On the other hand, residues of cereals and pulses account for about 31.29 percent of the total animal feed utilized and ranked second to grazing (55.33%) in Ethiopia (CSA, 2016). However, their potential is limited due to their high fiber, low protein, mineral and vitamin content (Kayongo *et al.*, 1993). Additionally, the low propionate fermentation pattern in the rumen and the negligible content of fermentable nitrogen, results in reduced productivity of animals (Van Soest, 1994).

On the other hands the main vision of Ethiopia Livestock Master Plan (ELMP, 2015) was to increase the number and productivity of cattle through improvements in genetics, health and feeding, and satisfy consumption demand and to export cow milk and milk products at 2020. Increasing efficiency of available feed resource such as

crop residue treatment and nutrient supplementation are one of the appropriate methods that improve milk production (Rehrahie, 2001; Takeba, 2012) and can be contributed to succeed the strategy. Furthermore, CSA, (2016) indicated that 706,793 and 109,733 highly productive Hybrid and Exotic cattle respectively, are kept in Ethiopia but, their productivity is low in contrast to their home country production level.

Therefore, increasing the efficiency and nutrient supplementation of locally available low quality feed is the effective strategy to increase feeding efficiency and thereby milk production of cross-bred dairy animals. Supplementation of concentrate with energy and/or protein sources, which can increase digestibility, nutrient supply, feed intake and utilization is one of the methods that improve the nutritive value of crop residues (Seyoum, 1995. However the small holder farmers can't afford the cost of concentrate currently which is increasing from time to time.

The potential for increasing digestibility and intake of fibrous residues through treating with urea has been researched and reviewed (e.g. Rehrahie, 2001; Getahun, 2006; Teshome, 2009; Rehrahie and Getu, 2010). Urea treatment has most practical significance in the tropics as a source of nitrogen to roughages resulting in a successful improvement in digestibility and intake of these feeds. During treatment, the ammonia gas acts upon the fiber and favours the release of soluble carbohydrates and energy for cellulolytic bacteria growth and enhancing efficient utilization of roughages. Moreover, urea application is relatively easy, less toxic and effective (Getahun, 2006).

A study was also conducted on urea molasses block in Amahara Region, Fogera district, and substantial result were reported (Takeba, 2012). Molasses improves palatability of straw voluntary intake and provides extra energy for animals and its supplementation is frequently advocated to be used in the form of UMB in Ethiopia (Aklilu, 2004; Teshome, 2009; Lemma, 2009). Hence, UMB supplementation to dairy cows is the effective method to supplement minerals, crude protein, and other nutrients to the animal.

Several studies showed positive effects of UMB on productive and reproductive performance plus an attractive benefit-cost ratio for both local and crossbred dairy cows (Sudhaker *et al*., 2002; Misra *et al*., 2006; Sahoo *et al.*, 2009; Takeba, 2012). If UMB are to be used as dietary supplements, it should be kept in mind that the response of dairy cows to an increased nutrient supply depends on several factors, such as the cows' genetic potential, stage of lactation and the related feeding level, feed quality and climate (Takeba, 2012).

The cost-benefit analysis and feasibility of using ammoniated straw and urea molasses block as animal feed in Ethiopia was reported by (Reherahie, 2001) and (Takeba, 2012) respectively for crossbred lactating dairy cows. Therefore evaluation and demonstration of urea treated teff straw and urea molasses block for cross-bred dairy animals is cost effective and significantly improve the milk production and, can contribute to the success of Ethiopia Livestock Master Plan in GTP II which is planned to increase milk production from 167 million liters in 2014/15 to 1490 million liters by 2020.

Lume district has a considerable potential and opportunities for development of improved smallholder dairy production both in forage and breed, and dairy production is market-oriented in East Showa zone. However, there is limited information on the use of UTS and UMB as comparative alternative strategy to improve the nutritive value of low quality roughages and to increase milk production of dairy cows in the area. Therefore, this study was designed to evaluate the on farm effects of urea treated teff straw and urea molasses block for cross-bred dairy animals at Lume District, East Shewa Zone, with the following objectives:

Objectives:

- To evaluate the effect of urea treated teff straw and urea molasses block supplementation on milk production, composition and weight gain in lactating cross-bred dairy cows.
- To demonstrate and create farmers awareness on importance of urea treated straw and urea molasses block.

2. LITERATURE REVIEW

2.1. Livestock Production System in Ethiopia

In Ethiopia, different types of livestock production systems can be identified based on various criteria. Based on agro-ecology, socio-economic structures of the population and type of breed and species used for milk production systems can be broadly categorized into urban, peri-urban and rural milk production systems based on location (Tsehay, 2001; Tsehay, 2002). Again, based on market orientation, scale, and production intensity, dairy production systems can be categorized as traditional smallholders, privatized state farms, and urban and peri-urban systems (Ahmed *et al*; 2003). Milk production depends on mainly indigenous livestock genetic resources dominated by small holder farmers specifically on cattle, goats and camels. The indigenous breeds accounted for 98.59 percent, while the hybrids and pure exotic breeds were represented by 1.22 and 0.19 percent, respectively (CSA, 2016). The productivities of local dairy animals of Ethiopia are remains among the lowest in the world, even by African standards (Zegeye, 2003).

Animal feeds are the major input in any dairy operation. Common feed resources are varying between production systems. In the mixed crop-livestock production system, grazing on marginal areas and after crop harvest is the major feed resource (Ahmed *et al*., 2003; Alemayehu, 2005). In addition, almost all households (97%) in rural areas use animal feeds from their own crop farm in addition to grazing, while others use own farm and purchased feed together with grazing. On the other hand, 86.8% of dairy producers in the urban production system use purchased feeds from different sources together with road side grazing. About 53.4 and 35% use roadside and/or home-yard grazing with some purchased feeds and other feed resources such as kitchen and open market wastes (Asrat *et al.*, 2012).

2.1.1. Dairy Production Systems in Ethiopia

Based on location or scale of market orientation and production intensity as criteria, three major dairy production systems are reported in Ethiopia (Azage and Alemu, 1998; Hizkias, 2000; Tsehay, 2002; Yoseph *et al*., 2003B; Zegeye, 2003; Dereje *et al*., 2005, Sintayehu *et al*., 2008). These are traditional smallholders, peri-urban and urban dairy production systems.

2.1.1.1. Traditional smallholder dairy production systems

The traditional smallholder system is part of the subsistence farming system, which includes pastoralists, agro-pastoralists and mixed crop-livestock producers (Tsehay, 2002). It roughly corresponds to the rural milk production system and supplies 97% of the total national milk production and 75% of the commercial milk production. This sector is largely dependent on low producing indigenous breeds of cattle, which produce about 400-680 kg of milk/cow per lactation period (Gebre-Wold *et al*., 2000). The milk produced is mainly consumed by the household in the traditional system.

2.1.1.2. Peri-urban dairy production systems

This system is found in the outskirts of the capital city and regional cities and mostly concentrated within a radius of 100 km around Addis Ababa, which includes dairy farms ranging from smallholder to commercial farmers (Felleke and Geda, 2001). The main feed resources in this system include agro-industrial by-products and purchased roughage. The system comprises small and medium sized dairy farms that own crossbreed dairy cows. Dairy farmers use all or part of their land for forage production. The primary objective of milk production in this system is generating additional income to the household (Hizkias and Tsehay, 1995; Azage *et al*., 2000).

2.1.1.3. Urban dairy production system

It consists of dairy farms ranging from smallholder to specialized businessmen owned farms, which are mainly concentrated in major cities of the country. These dairy farms have no access to grazing lands (Yitay *et al*., 2007) and basically keep exotic dairy

stocks (Azage *et al*., 2000). A number of smallholder and commercial dairy farms are emerging mainly in and around the capital Addis Ababa (Felleke and Geda, 2001; Azage, 2004) and most regional cities and towns (Ike, 2002; Nigussie, 2006).

2.2. Integrated Crop-Livestock Production

Mixed farming systems are characterized by interdependency between crop and livestock production. It is the main system of production for smallholder farmers in many developing countries (Blackburn, 1998). In the Ethiopian highlands, crop and livestock sub-systems interact with each other in many ways (Lemma *et al*., 2002). The largest share of the total milk and meat available in the country is produced by mixed farming systems (Ostergaard, 1995).

The principal objective of farmers engaged in mixed farming is to gain complementary benefit from an optimum mixture of crop and livestock farming and spreading income and risks over both crop and livestock production. In the mixed crop livestock farming systems, livestock provide important inputs to crop cultivation, especially manure and traction (CSA, 2016). Livestock are often the major source of cash that farmers can use to buy agricultural inputs. In turn, crops provide livestock with feed in the form of residues and by-products from crop production, which are converted into valuable products like meat, milk, and traction (BoRD, 2003).

The potential use of crop residues as livestock feed is greatest in integrated crop/livestock farming systems (Getachew, 2002; Lemma *et al*., 2002). Crop residues are required by animals to supply feeds during the dry seasons; while they are also vital to crop production (e.g. through way and time farmers harvest their crops and manage the residues offer a number of possibilities for increasing both crop and livestock production.

2.3. Animal Feed Resources in Ethiopia

The fibrous agricultural residues represent a considerable potential feed resource in the populated countries where land must be devoted to human food production as a priority. A comprehensive review of their potential in the developing countries and of the strategies for expanding their utilization has been achieved respectively by FAO (2003). Amongst the world total crop residues yields wheat the largest amount and followed by teff and pulses. The remainder consists of sorghum stovers, barley straws, sugarcane tops and leaves, roots and tubers, oil plants stovers and foliage (Kossila, 1988).

In Ethiopian highlands the natural pasture, crop residues, and stubble grazing are major sources of feed (Alemayehu, 2005). It is also estimated that above 18.5 million metric tons of crop residues are annually produced in the country (Azage *et al*., 2002). However, with the decline in the size of the grazing land and degradation through overgrazing and the expansion of arable cropping, agricultural by-products have become increasingly important (Getnet, 1999; Alemayehu, 2005).

Grazing is the predominant form of ruminant feeding system in most parts of the extensive and smallholder crop-livestock farming areas in Ethiopia (Getnet, 1999; Yosef, 1999; Getachew, 2002; Solomon, 2004). On the other hands, the contribution of crop residues to the feed resource base is significant (Seyoum and Zinash, 1998; Getachew, 2002; Solomon, 2004). Oxen are given priority for feeding crop residues mainly during the peak period of ploughing and followed by lactating cows and weak animals (Mohamed and Abate, 1995; ICRA, 2001).

Improved cultivated forage is one of the livestock feed resource especially for dairying and fattening. Research on cultivated pasture and forage-crop species was initiated in the late 1960s by IAR (Alemayehu, 2005). Agro-industrial by-products are fed as supplement to roughage based diets, particularly in livestock production system for dairy production or fattening activities. Concentrates rich in energy are feedstuffs such as grain, bran, maize middling. Concentrates rich in protein include noug seed

cake, linseed cake, cotton seed cake and brewers' grains. How much energy and protein a concentrate mixture should contain will depend on the quality of the basal roughage and the level of production. As a rule of thumb, 1 kg good concentrate will increase milk production by 1.5 kg (SDDP, 1999).

Additionally, agro-industrial by-products can be utilized by mixing two or more of the ingredients make concentrate at home or using a single ingredient. They have special value in feeding livestock mainly in urban and peri-urban livestock production system, as well as in situations where the productive potential of the animals is relatively high and require high nutrient supply (Ahmed, 2006).

2.3.1. Corp residue

Crop residues are the plant materials that remain after food crops have been harvested. It is the most abundant feed in most region of Ethiopia. They are widely used in animal feeding next to grazing (CSA, 2016). Additionally farmer use crop residue for different purposes, e.g., for minor construction, for fire wood(specially sorghum and maize stovers) for roofing local houses in the case of wheat, oat and barley straws; as binding material for walls of local houses specially teff straw. But the major use is for livestock feed particularly during dry season (Daniel, 1988). The importance of crop residue as potential livestock feed varies with the types of crops grown (cereals, grain legumes, roots/toobers) and also with the proportion of land under food crops and with the yields of the relevant plant parts. The proportion of total crop residues allocated as feed depends on the relative importance of livestock in the farming system (De Leeuw, 1997).

The contribution of crop residues to the feed resource base is significant (Getachew, 2002; Solomon, 2004). Under the Ethiopian condition, crop residues provide 31.29% of the annual livestock feed requirement (CSA, 2016). Maize and sorghum stover, teff, wheat and barley straw comprise the most commonly used crop residues. The quantities of different crop residues produced depend on the total area cultivated, the

season's rainfall, crop species as well as other inputs such as fertilizers (Ahmed, 2006).

Improved utilization of crop residues can be achieved either through appropriate supplementation (legumes, urea and molasses) or chemical treatment (urea/ammonia) both of which facilitate the microbial breakdown of the cell wall of the crop residues. Treatment of fibrous crop residues using urea as a source of ammonia is a technology that can be easily handled by small farmers (Getahun, 2006). However, adoption of the technology has been slow.

2.3.2. Chemical composition of crop residues

The species of the plant, the agronomic practice used, soil and temperature, and the stage of growth influence the chemical composition and palatability of straws. Solomon (2004) reported that there is a considerable variation in the contents of crude protein and crude fiber. However, the quality varies significantly from crop to crop (Alemayehu, 2005). Residues from leguminous crops have better quality than the residues from cereals. Legume straws contain less fiber, and high digestible protein than cereal straws (Solomon, 2004).

Crop residues are potentially rich sources of energy as about 80% of their DM consists of polysaccharide, but usually underutilized because of their low digestibility, which limits feed intake (FAO, 2002). These constraints are related to their specific cell wall structure, chemical composition and deficiencies of nutrients such as N, S, P and Co, which are essential to rumen microorganisms. The cell wall fraction includes cellulose, hemi-celluloses, lignin, cutin, lignified protein, silica and ash, which are present in most crop residues.

2.3.3. Factors affecting nutritive values of crop residues

Nutritive value of a given feed is generally determined by nutrient composition, intake and utilization efficiency of digested matter. Species of plants, stage of maturity at harvest, cultivars and proportion of leaf to stem ratio are important plant factors determining their nutritive value. For instance, the lower organic matter digestibility (OMD) of wheat stem as compared to the leaf fraction and sheath is due to higher

content of neutral detergent fiber (NDF) and lignin in the stem portion. Contrarily, the OMD of rice straw is lower for its leaf sheath and leaf fraction as the concentration of NDF and lignin is much higher in these parts than in the stem (FAO, 2002).

The usefulness and nutritive value of crop residues can also be variable depending on the species of livestock to which it is offered. Cattle, which retain fibrous matter in the rumen slightly longer than sheep have presumable advantage with lower quality crop residues. *Bos indicus* cattle can digest more NDF in rumen and have longer ruminal retention time than *Bos taurus* (FAO, 2002).

Environmental factors such as location, climate, soil fertility and soil type have also been found to influence the nutritive values of given crop residues. For instance, digestibility of roughage is related to temperature, reflecting a negative correlation with increase in temperature in which high temperature increases the rate of enzymatic process associated with lignin biosynthesis promoting lignifications of cell wall and more rapid metabolic activity resulting in decreased pool of metabolites in the cell (Van Soest, 1988).

2.3.4. Treatment of crop residues

At present, the main treatment methods for straws such as cereal straws are either mechanical (e.g. grinding), physical (e.g. temperature and pressure treatment) or a range of chemical treatments of which sodium hydroxide or ammonia are among the more successful (Greenhalgh, 1984). The use of chemicals to improve nutritive value of crop residues dated back to 1920s when the German scientist, Beckman, used sodium hydroxide to treat stacks of crop residues with consequent improvement in its digestibility. Alkali supply hydrogen ion that breaks down the fiber by saponification of ester bonds in the lignin-hemicellulose molecule. Many chemicals have been used to enhance the digestibility and intake of roughages; the most known ones are sodium hydroxide, sodium sulphate, sodium bicarbonate, ammonium hydroxide, ammonia (Sundstol, *et al*., 1984), calcium hydroxide and potassium hydroxide.

Among these chemicals, sodium hydroxide has proven to be the most effective in improving digestibility, but lacks nitrogen and less available. The use of alkalis from treatment of crop residues was given less attention after mid 1970s due to high cost and increased environmental pollution. Instead, use of ammonia from urea or other sources has increased in popularity for crop residues treatment.

Basics of urea treatment of straw: The nutritive value of poor quality roughages like straws and stovers can be improved by different methods of treatment. Urea treatment has, however, emerged as the method of choice for use at farm level in the tropics as it is best adapted to the conditions of smallholder farmers (Chenost, 1995). The major advantages of using urea for crop residue improvement are ease of handling, transport, and do not pose any risk to those handling and using it (Getahun, 2006). Moreover, fertilizer grade urea is readily available and relatively cheap compared to either aqueous or anhydrous ammonia. Urea treatment is a two-stage process consisting of ureolysis, where urea is converted to ammonia and the effect of generated ammonia on the cell walls of the forages being treated (Chenost, 1995). The hydrolysis of urea (ureolysis) proceeds according to the following reaction: NH2 (CO) NH2 + H2O → 2NH3 + CO2 (Sundstøl *et al*., 1984). The key to improve the use of crop residues for ruminants is to overcome the barriers to rumen microbial fermentation of lignocelluloses. The two well-known factors of straw that limit bacterial digestion in the rumen are its high level of lignifications and low contents of nitrogen, vitamins and minerals. Therefore, in principle, there are two approaches, which should be taken in combination, straw delignification treatment and nutrient supplementation.

Urea as a source of non-protein nitrogen: Urea is a chemical best known for fertilizer containing 46 percent of non-protein nitrogen. It is widely used to generate ammonia for improving poor quality fibrous feeds. This is because of its low cost or relatively easy availability compared with other chemicals used for treatment of crop residues lower effect on environmental pollution, its added value of nitrogen over other alkalis like sodium hydroxide for rumen microorganisms and ease of application (Ibrahim and Schiere, 1989). Urea as feed for animals can be supplemented to

concentrates to save on protein costs or supply some readily soluble non protein nitrogen along with other nutrients such as phosphorus, sulphur and some readily available energy that can improve the rumen function. Supplementation is possibly achieved either by spraying the roughage with urea solution or by incorporating urea in urea molasses blocks (FAO, 2002). Results of feeding trial in Sri Lanka showed that inclusion of urea by up to 2-2.5 percent of the dietary DM improved digestion and intake of roughages (Chenost, 1995). However, its effect in improving the nutritive value is reported to fall somewhere between urea treated and untreated roughage.

Urea treatment and method of application: Urea treatment is the result of two processes: firstly, ureolysis takes place which converts urea into ammonia. This is an enzymatic reaction in which the telluric bacteria present on straw produce urease enzyme that breaks the urea into two ammonia molecules. Then, the generated ammonia during this reaction acts upon the contents of the cell wall. This results in the breakdown of the fiber by saponification of ester bonds in the lignin-polysaccharide molecule, thereby enhancing the chance of fiber invasion by rumen microorganisms. Further, it adds nitrogen to stimulate the growth of rumen microbes to provide microbial protein for the animal.

During the reaction about 70 percent of the applied urea is highly hydrolyzed to ammonia gas (Kayouli, 1996), but most of the ammonia gases are lost during ventilation before feeding to the animal. Djajanegra and Doyle (1989) reported that about 28 percent of nitrogen is retained in treated rice straw before feeding to the ruminant. It was also reported that loss of ammonia is minimized by fermentation and inclusion of molasses while treating straw. Farmers in the highlands of Ethiopia also include molasses when treating crop residues to feed their farm animals (Rehrahie, 2001).

There are many variations in the methods of treatment of low quality roughages with urea. However, the principal method consists of dissolving urea in water and sprinkling it on layers of straw. The level of urea used varies, but it is commonly

between 4%-5% of air dried mass of the straw/stover, and the amount of water used also varies from as low as 0.2 liters per kg of straw to as high as 1 liter per kg of straw. The treatment of the straw can be done in pits, using polyethylene sheets as inner linings. Airtight conditions are important during the treatment period, especially for small quantities of straws (Tashome, 2009). Polyethylene sheet is very effective for excluding air. The treatment period depends on the temperature of the surrounding and may be 3 weeks in high land of Ethiopia (Getahun, 2006).

Factors affecting urea treatment of straw: The effectiveness of urea treatment depends on factors that influence ureolysis. These are the presence of urease, moisture, temperature, duration of treatment; application rates, type and quality of straw are the major ones.

Presence of urease: Urease particularly affects the process of ureolysis that requires the hydrolysis of urea to ammonia in the presence of the enzyme urease in the straw or stover to be treated (Chenost, 1995). Some straws are deficient in the enzyme, whereas others have adequate amounts. Studies have shown that urease produced by ureolytic bacteria during treatment of crop residues is sufficient when humidity is not a limiting factor, but addition of urease is necessary where low amounts of water (20 to 25% of straw weight) are used during the treatment of straws.

Moisture content: The moisture content of crop residues to be treated is critical for the success of urea treatment. In the application of moisture during urea treatment of crop residues, more emphasis should be given to the final moisture content of the crop residue rather than the quantity of water to be added which is recommended to be between 30- 60% for effective ureolysis and ammoniation of straws . Final moisture content of less than 30% in urea treated crop residue reduces severely the process of ureolysis and hence, the ammoniation process as a whole. It may as well result in loosely packed material as it causes difficulty of compression and packing. Poor ureolysis produces inadequate ammonia (which has preservative properties) and along with too much oxygen under moist conditions leads to bad treatment and molding.

Moisture level above 50 to 60% leads to compaction problems, downward leaching of urea solution and insufficient diffusion of ammonia. Within the recommended range, the amount of water to add can be adjusted according to local circumstances such as environmental temperature, humidity and the moisture level of the material to be treated.

Temperature and treatment duration: The optimum temperature for ureolysis lies between 30- 60 ^{o}C, and the rate of ureolysis doubles or decreases by a factor of 2 for every 10oC rise or fall in temperature, respectively (Gunun *et al*., 2013). Ureolysis can be completed within 1-7 days at temperatures between 20 ^{o}C and 45oC. However, the activity of urease is severely reduced or even canceled when temperature falls below 5^{o}C to 10^{o}C (Gunun *et al*., 2013). This is attributed to the reaction of carbon dioxide and ammonia to form ammonium carbonate at low temperatures in sealed stacks. However, the negative effect of low temperatures can be largely compensated for by increasing the treatment period (Gunun *et al*.,, 2013).

On the other hand, the actual ammoniation process is accelerated by increasing temperatures to a limited extent. Increasing temperature showed a positive effect up to 45^{o}C when short treatment periods were used. The ammoniation process is influenced by the ambient temperature which in turn influences the duration of treatment that may range from one week to eight weeks (Gunun *et al*., 2013). The effect of treatment length increased up to 4 weeks at 17^{o}C - 25^{o}C, whereas at lower temperatures (-2^{o}C and +4^{o}C) the increment of treatment length could continue to the eight weeks of treatment. Due to a relatively warm temperature requirement, urea treatment is more effective in tropical than in temperate regions.

Application rates: Most experiments (Chenost, 1995) indicated little improvements in digestibility from increasing the level of ammonia above 3 to 4%. However, treating straw with 5% urea as it has produced satisfactory results in Ethiopia (Teshome, 2009).

Straw Type and Quality: It has been noted that the effect of treatment is more pronounced for stovers/straws whose initial quality is very poor compared to those with better original quality. The difference in ways of different straws or varieties of straws to react with urea can be explained by the degree of hemicelluloses-lignin linkage (Gunun *et al.,* 2013; Getahun, 2006). Legume straws are less responsive to ammoniation compared to grasses since legumes contain fewer phenolic bonds and their lignin is less soluble in alkali.

Intake and digestibility of straws: Maximum intake will likely reach 3.5%-4% of their body weight for most cows, but can vary with production and an individual cow's appetite (Gunun *et al*., 2013). Rehrahie (2001) reported that ammoniation usually increases digestibility by 5-10%, nitrogen content by 1-2% DM and voluntary intake by as much as 50% when offered free choice. Most data reviewed (FAO, 2002; Rehrahie, 2001) have shown decreased NDF and ADL, and a considerable increase in CP contents of the crop residues due to ammoniation. The CP content of treated straw is always higher than untreated straw indicating the effectiveness of treatment. Teshome, (2009) indicated that urea treatment improved intakes(g/kgW0.75) from 48 to 61 with the corresponding improvement in digestibility (g/kg DM)from 428 to 545 for untreated and treated rice straw, respectively. Maximum use of straws as a feed for ruminants depends on efficient fermentation by rumen microorganisms.

2.3.5. Effect of Feeding urea treated straws on milk yield and composition

The major constraints to milk production on diets based on crop residues appear to be insufficient glycogenic compounds to provide the glucose for lactose synthesis and for oxidation to provide the NADPH for synthesis of fatty acids. Therefore, in order to improve milk production levels, energy inputs such as concentrate feeds have to be considered essential for any dairy enterprise.

In a feeding trial conducted using lactating crossbred cows in Ethiopia, urea treated barley or teff straw were noted to replace native hay, and ammoniation was found to be economically feasible producing about 6.2 kg milk/ day for teff (Reherahie, 2001) and 5.6 kg milk/ day for wheat straws (Getu, 2006), but the milk yield composition

(milk fat, milk protein, lactose, and total solids) is not significantly affected by feeding urea treated straw (Reherahie, 2001, Getu, 2006). Milk composition of cross bred cows, in Holeta has a percentage share of 4.5, 3.62, 4.15, and 14.03 of fat, protein, lactose, and total solids (Getu, 2006).

2.3.6. Economics of feeding urea treated straws for milk production

There has to be a good economic reason and visible effect for farmers to feed urea treated straw. The cost of feeding is a major part of total cost of milk production (Gunun *et al.,* 2013), and hence reduction of feeding cost of dairy cows is a major concern. The cost of concentrate is high compared with straw and fresh forage. Milk yield at early, mid and late lactation in cows both at rural and urban Banglore, India has clearly shown that urea treated straw based feeding to be economical (Gunun *et al.,* 2013).

When fresh forages are scarce and expensive, the use of urea treated straw as an alternative feed holds a promise, and treatment is not too costly. Using of urea treated straw in feeding animals reduced the cost of maintenance and milk production. Feeding experiments with treated barley and teff straw using concentrate as a supplement by Reherahie (2001) has also proven to be economically feasible in Ethiopia.

Treatment of straws with urea is the most promising alternative solution in order to enhance straw utilization by ruminants. Even if, use of cereal straws and stovers as an animal feed in Ethiopia has a long standing history, farmers have not yet applied the already developed methods for improved utilization of straw as feed. Rehirahie and Ledin (2004) indicated that the ever developed methods seem not technically and socio-economically suited to the local conditions under which small poor farmers are dominant. As a result, during developing methods for improvement of straw feeding system, the local physical environment, and socio-economic conditions must be considered.

2.4. Urea Molasses Block

Urea molasses block is a mineral lick multi-nutrient block (UMB) is usually made up of Molasses, urea, cement or lime, bran, eventually protein rich by-products, salt and water which are mixed and processed into the form solid and compact block. The block should be well accepted by livestock and shall provide essential nutrients such as protein and minerals, together with energy which most forages and crop residues are usually deficient in (PCARRD, 2001). The technology is particularly applicable in areas where ruminants basically feed on fibrous crop residues or poor quality forage diets. Several formulations are available for the production of UMB, which allows responding to different prices and variable availability of potential ingredients.

Experiences from a number of countries indicate that UMB supplementation resulted in a substantial improvement of productive, reproductive and economic performance of both local and crossbred dairy cows in different livestock production systems (Bheekhee, 2000; Elmansoury *et al*., 2002; Nkya *et al*., 2002; Rasambainarivo *et al*., 2002; Waruiru, 2004; Alam *et al.*, 2006; Seyoum and Fekede, 2006; Jian-Xin Liu *et al.*, 2007; Khan et al., 2007; Lemma *et al*., 2009; Sahoo *et al.*, 2009). Similar to these reports, on-farm UMB supplementation to indigenous dairy cows in Tanzania showed an increase in milk production of 1.5 l/d during the dry season (Plaizier *et al*., 1999).

The research work Nkya *et al.,* (2002); Rasambainarivo *et al*., (2002); Misra *et al*., (2006) conducted in Madagascar, Tanzania and India, respectively, indicated that crossbred cows which were supplemented with UMB together with concentrate were superior in their milk yield, milk composition, benefit cost ratio and body condition over groups which were supplemented with a concentrate mixture alone. The release of ammonia over a longer period of time and its utilization by micro-organisms in the rumen which is supported by the simultaneous energy supply, together with a generally improved dietary energy and protein balance in UMB supplemented groups were the reasons suggested for these. Ghulan (2010) and Khanum et al. (2010) in Pakistan and Wadhwa and Bakshi, (2010) in India also reported that UMB

supplementation improved feed intake, dry matter digestibility, weight gain, milk production, resumption of post-partum oestrus and health condition of milking cows.

In Bangladesh UMB supplementation of indigenous cows fed a straw based diet improved the body condition score from 2.31 to 2.51 (Khan et al., 2007). On the other hand, crossbred dairy cows which were under zero grazing (straw plus green fodder together with 2.75 kg concentrate) achieved a body weight gain of 6.1 and 42.9 g/day for control and UMB supplemented cows, respectively. The total roughage intake of these cows was also improved from 6.9 to 9.2 kg/day.

2.4.1. Method of UMB preparation

UMB was formulated from 37 % molasses, 10 % urea, 10 % cement, 25 % wheat bran, 15% nug seed cake and 3 % common salt (Seyoum *et al.*, 2009). Getahun, (2006) also formulated UMB from 10% noug seed cake, 25% wheat bran, 10% cement, 40% molasses, 10% urea 5% common salt and 4% of water (of total weight). Using the formula, any amount can be prepared such as a 5 kg or 10 kg UMB can be produced by thoroughly mixing the exact quantities of the components. Takeba, (2012) prepared UMB by dissolving cement and salt in water prior to being added to the other components. The mixture finally had a dough texture and was put into a plastic sheet lined, rectangular wooden frame of 30*20*20 cm depth, length and width, respectively, for molding. Compaction was applied using a wooden bar; afterwards the block was left for 15 minutes until it maintained a proper shape. Finally, it was removed from the frame and left to dry in a well ventilated room for about 72 hours, after which it was ready for feeding. Adaptation period can be needed in experimental animal and the supplemented groups can be offered UMB in addition to the basal diets. Cows were allowed to lick the block between 10 am and 5 pm, after which the blocks were collected. During this time, a cow was assumed to consume about 500-700 g UMB (Takeba, 2012).

2.4.2. Feeding system of urea molasses block

Urea molasses blocks should be introduced to animals slowly and should be fed after animals have consumed adequate forage. This prevents animals from consuming too much at any one time. UMB should never form the main diet. They are meant to be a supplement to a basal diet of forage (Yenesew, 2015).

UMB hardness will affect its rate of intake. If too soft, it is consumed too rapidly and there is a risk of toxicity. If too hard, intake may be too little. Urea at high levels is unpalatable. High levels of urea in UMB may reduce intake of the block as well as of straw due to the bitter taste. High levels or imbalances in minerals may result in excessive consumption in a short time also leading to urea poisoning. Precautions should be taken to avoid this problem of overconsumption in drought prone areas particularly towards the end of the dry season when feed is scarce (Yenesew, 2015).

2.4.3. Effect of feeding urea molasses block on milk yield and composition

Uthayathas and Perera (1998) reported that Sahiwal cows given UMB in the intermediate zone of Sri Lanka produced 475 kg of milk more than cows fed traditional concentrates during lactation. In addition, milk quality also improved due to a higher butter fat content (4.59 %). The improved livestock performance reflected the beneficial role of UMB on rumen fermentation, digestion and efficient feed utilization. UMB supplementation to lactating buffaloes in India also showed increased milk yield and higher milk fat content in all stages of reproduction (Brar, 2007). The increase in butter fat content may be a result of the effect of UMB on the proliferation of micro organisms. The increase in the number of rumen microbes in turn improve the digestion of structure carbohydrates and improve the acetic acid content in the rumen which serves as a precursor for milk fat.

2.4.4. Economies of feeding urea molasses block

Taking into account milk production and feed costs alone, the relative average improvement in net return per day as a result of supplementation with UMB was observed

for Fogera and cross-bred dairy cows in Fogera district (Takeba, 2012). He indicated that, financial gains resulting from supplementation were greater for crossbred dairy cows than for their Fogera counterparts, resulting in a three times greater benefit-cost ratio for the F * HF cows. Uddin *et al.* (2002) also reported that, when buffalo cows were supplemented with urea molasses or urea-molasses-concentrate mix, buffalo cows which were supplemented with urea-molasses had a greater net return per day than those of the urea-molasses-concentrate supplemented group. This was attributed to the lower cost of urea-molasses compared to concentrate.

3. MATERIALS AND METHODS

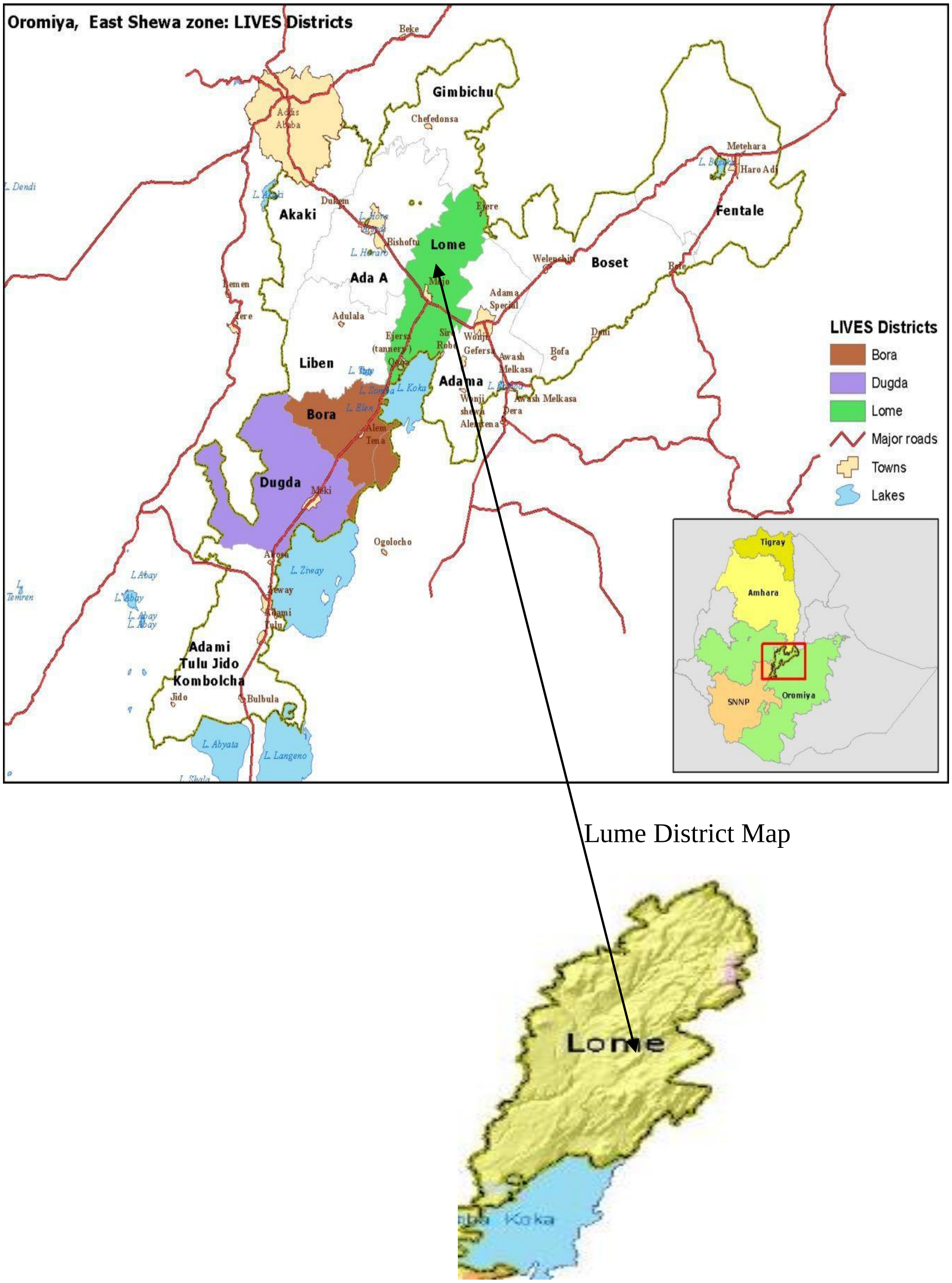
3. 1. Description of the Study Areas

The study was conducted in Lume district (urban and peri-urban areas), East Shewa zone which was the intervention area of ‘LIVES’ project (Figure 1). Lume (also spelled Lome) is one of the districts in the Oromia Region of Ethiopia. Lome is part of the eastern Shewa Zone located in the Great Rift Valley, and is bordered on the south by the Koka water dam reservoir, on the west by Ada'a Chukala district, on the northwest by Gimbichu district, on the north by the Amhara Regional, and on the east by Adama city. Modjo is the capital town of the district. The district is 70 km away from Addis Ababa in south direction. Currently the total human population of the district is 117,080, of whom 60,125 were men and 56,955 were women, and 38,771 or 33.06% of its population was urban dwellers.

Most part of the districts altitude ranges from 1500 to 2300 meters above sea level (masl), except for a small portion in the northern part, which is over 2300 masl. River Modjo is found in this district. The district has 54.3% is arable or cultivable land, 3% pasture, 2% forest, and the remaining 20% degraded or otherwise unusable land. Vegetables are an important cash crop. Currently farmers in the district keep 16,826 dairy cows, including cross-bred dairy cows as documented by LIVES Project (2013).

This study was conducted in two dairy production systems, peri-urban (Tade Dildima and Biyo Bisike Kebeles) and urban (Modjo town, kebele 01 and 02) dairy production system of Lume District of East Shewa Zone. In this study, peri-urban system constitutes those dairy farms, which are located outside of the town boundary at a distance of 5 to 10 kilometers, produce milk and deliver the same to town. Crossbred dairy cows were used for this study both in peri-urban and urban dairy production system.

Figure 1. Map of the study area.



Source: LIVES Project (2013)

3.2. Survey

To identify the production and feeding practices of the area, preliminary visits was made to four kebeles selected from urban and peri-urban based on dairy production potential. 150 farmers keeping cross-bred lactating dairy cows were selected for interview from the selected kebeles and both structured and semi-structured questionnaires prepared and used to collected data through interview. Secondary data sources were employed from District Office of Agriculture. Data with respect to household characteristics like sex, age, family size and education level were collected from dairy farmers.

3.3. Household Data Collection

Data with respect to family size, age, sex, education, land holding and land use pattern, livestock holding, awareness to different livestock technologies, production and utilization practices, and constraints were identified and collected in the survey. Farmers keeping lactating cross-bred dairy cows were considered for this study and interviewed for their willingness to provide their animals for the experiments, and then agreement was made to use their animals until the end of the experimental period.

3.4. Farmers Training and Farm Observation

Farmers keeping cross-bred lactating cow were selected purposively and trained on general management of dairy cows, urea molasses block (UMB) preparation, urea treated straw preparation, animals to be avoided from urea treated straw and urea molasses block feeding system, record keeping and milk hygiene. Discussion with local development agents was held on intervention approaches and systematic coaching. Farm observation was done to identify cow condition, water availability and others materials used during the research work. In addition, farmers who kept livestock and reside in the study area were also trained and advised individually or in group on livestock management and livestock related activities throughout the experimental period.

3.5. Experimental Animals and Design

Forty lactating cross-bred dairy cows at early to mid lactation (about 5-8 weeks after calving) were selected purposively for the on-farm feeding trial based on farmers willingness to undertake the experiment and commitment for data collection, and monitoring of feed intake and milking. Average body weight of the selected cows was ranging from 287 to 377 kg with an average initial milk yield ranging from 5 to 11 kg/cow/day. The selected cows were in second and third parity and treated with Fasinex 900 g (3.6 g/kg body weight of cow) to treat fasciola, Ivermectin injection (0.02 ml/kg cow) to treat internal and external parasites like menge, ticks, lice, nematode and trematode except fasciola, and Diminazin (0.05 ml/kg cow) to treat trypanosomosis prior to the start of the experiment. The treatment delivered to cows as recommended and treated by veterinarian of the Agricultural office of Lume district.

Table 1: Treatment arrangement

Treatments	*Feed supplement*	*Number of lactating cows*
T1	UTS + concentrate	15
T2	UMB + UTTS + concentrate	15
T3 (control)	UTTS + concentrate	10

Note: UTS= urea treated teff straw; UMB = urea molasses block; and UTTS = untreated teff straw

Fifteen cows were used for each of the first two treatments (T1 and T2), 15 cows for urea treated straw and other 15 for urea molasses block, and 10 cows used for control; (the numbers of cows considered in control were minimized due to limited number of lactating cows, that have to be included in this experiment or fulfill the criteria to be considered in the study). The cows that were received the two treatments (Urea treated straw and urea molasses block) were served as ‘Intervention farms’. Additional ten cows which were not receiving those treatments were monitored for milk yield, body weight and milk composition for comparison purpose. All cows have free access to water. The initial and final body weights of the experimental cows were estimated using heart girth measurements.

3.6. Experimental Feed Preparation and Feeding

Urea treated teff straw: Urea treated teff straw was incubated in pits with dimension of 2m x 2m x 2m (length, width and height). The volume of the pits was determined by assuming the estimated total straw consumption over the feeding period. The straw was treated with a urea solution prepared from 4% of urea and 10% of molasses per 100kg of air-dried straw and dissolved in 100 liter of water. The walls of the pit was covered with polyethylene sheet before weighing and placing of straw in the pit followed by a uniform spray of urea solution. The straw was treated, trampled and compacted batch by batch until filled to the pit capacity. Finally, the pit was sealed with plastic sheet and loaded on top by mass of soil to make it airtight. It was, then, left unopened for twenty-one days. By the end of incubation period, the pit was opened and a portion of the straw was taken daily and ventilated overnight to remove residual ammonia before offering to the animals (Misra *et al.*, 2006).

A concentrate mix that has been assumed to be sufficient for the entire experimental period was formulated based on milk yield (0.5kg per 1 liter of milk yield per day) (Rehrahie and Getu, 2010). A concentrate was mixed from 25% maize, 44.6% wheat bran, 5.8% noug seed cake, 14.4% soyabean, 2.6% *nora* (mineral source specially, calcium carbonate), 0.7% salt and 6.9% molasses.

Urea molasses block: Urea molasses block (UMB) was formulated from 10% noug seed cake, 25% wheat bran, 10% cement, 40% molasses, 10% urea and 5% common salt. Additionally, 4% of water (of total weight) was mixed to make a block weighing 5kg. Cement used as binding material in addition to supplementation of minerals to cows. The mixture finally had a dough texture and was put into a plastic sheet lined, oval can for molding. Compaction was applied using a wooden bar; afterwards the block was left for 15 minutes until it maintained a proper shape. Finally, it was removed from the can and left to dry in a well ventilated room for about 72 hours, after which it was ready for feeding. All experimental animals had free access to water and untreated teff straw throughout the experimental period. The concentrate mix also supplemented at a rate of 0.5kg per 1 liter of milk yield per day.

Untreated teff straw: In the third treatment or control, animals were provided with untreated *teff* straw *ad libtum* and concentrate mix at a rate of 0.5kg per 1 liter of milk yield.

Dairy cows were assigned and fed with three feed treatment groups for a period of 45 days to collect feeding response data and with an adaptation period of 15 days. The initial and final body weights of the experimental cows were estimated using heart girth measurements. Water was provided *ad libitum*. The cows were fed the supplementary feeds individually. Samples of feed offered from diets from experimental cows were collected, weighed and oven dried at 65^{o}C for 72 hours to determine daily feed DM intake and for chemical analysis. Body weight change was recorded at the beginning, middle and end of each experimental period for each treatment to monitor live weight changes across the experimental periods for each dietary treatment. The design used to assign animals to each treatment was randomized complete block design (RCBD) but T3 received only 10 lactating cows due to shortage of lactating dairy cows.

3.7. Feed Sample Analysis

All samples of feed offered were analyzed for DM, ash, neutral detergent fiber (NDF) and acid detergent fiber (ADF) as per the methods of Van Soest and Robertson (1985). Hemicellulose was calculated from the difference between NDF and ADF.

3.8. Milk Yield and Composition Analysis

All the cows were hand milked twice a day (7:00 am in the morning and 4:00 pm in the afternoon) and milk yield measurements were taken by using graduated cylinder every day throughout the study period. The milk samples were used to determine chemical composition of milk such as fat, protein, total solid, SNF, lactose and other as well as milk density.

For milk yield analysis a daily milk record (morning and afternoon separately) was taken by individual farmers themselves and enumerator. Every fifteen days interval

one hundred milliliter of morning and afternoon milk samples of mixed composite were taken using a glass measuring cylinder for each cow after the completion of the adaptation period. The samples were collected with a labeled container, kept in an ice box and delivered to Ethiopia Meat and Dairy Industry Development Institute for analysis of chemical composition. Chemical composition was determined using calibrated milk analyzer. Calibrated milk analyzer is a Lactoscan or milkotronic offers series of user-friendly, rapid analyzers which can be applied for measurement of fat, solids non-fat, density, proteins, lactose, salts, water content percentages, temperature, freezing point, pH, conductivity, as well as total solids of one and the same sample directly after milking, at collecting and during processing.

3.9. Statistical Analysis

Data with respect to family size, age, sex, education, land holding and land use pattern, livestock holding, awareness to different technologies, production and utilization practices were properly filled and coded in a computer. The analysis was handled using the Statistical Package for the Social Sciences (SPSS, 16.0) soft ware and summarized, and analyzed for descriptive statistics and frequencies.

Feed intake, milk yield, and composition were analyzed with General Linear Model (GLM) procedure of SAS (2004) for least square analysis of variance. Mean comparisons were done using Duncan's Multiple Range Test (DMRT) for variables whose F-values declared a significant difference. Differences were considered statistically significant at 0.01% significance level. The design used to assign animals to each treatment was randomized complete block design (RCBD) based on their initial body weight, parity and initial milk yield. Model used for all parameters were:

$$Yijk = \mu + Ti + Pj + Sk + Eijk$$

Where: μ = Overall mean

Ti = Treatment effect

Pj = Parity effect

Sk = Site effect

E_{ijk} = Experimental error

4. RESULTS AND DISCUSSION

4.1. Household Characteristics

The household head is known as the family head or which is called '*Abba Warra'* in local language. The term is defined as an individual in one family setting who provides actual support and maintenance to one or more individuals who are related to him or her through adopted, blood, or marriage.

The overall male and female headed households were 76% and 24%, respectively (Table 2). In peri-urban system, about 88% of the respondents were male while 12% were females. In urban 64% and 36% were male and female headed households, respectively. The results obtained in urban production system is in agreement with the report of Azage, (2004) who reported 33% female headed households and 67% male headed household livestock keepers in Addis Ababa. The results of the current work in peri-urban system was similar to the report of Zewudie, (2010) who reported that about 86.7% of the respondents were male while 13.3% were females in Debre Birhan, Sebta and Jimma and in the Central Rift Valley 93% and 7% were male and female headed households respectively. The lower percentage of female headed households in peri-urban livestock system in the current study could probably be due to cultural issues that force females to get married and/or for economic reason.

The average ages of the farmers between 46-60 years were 68.67% while the rest of 17.33% of the respondents were ≤ 45years, and 14% above 60 years. This indicates the farmers in the study area are in young age and can accept new technologies to increase livestock productivities. The average age of the household head in the current study was in line with the finding of Saba (2015) who reported the average ages of the household head at Ejere and Ada'a Barga of West Shewa zone were between16-60 years (78.3%) while the rest of 21% of the respondents were above 60 years.

Table 2: Sex and age categories of the respondents in the study area

Variables	Urban (N=75)	Percent	Peri-Urban (N=75)	Percent	Total	Percent
Sex of HH						
Male	48	64	66	88	114	76
Female	27	36	9	12	36	24
Age						
≤45	12	16	14	18.66	26	17.33
46-60	48	64	55	73.34	103	68.67
>60	15	20	6	8	21	14
Ave age	**25.0**	**33.3**	**25.0**	**33.3**	**50.0**	**33.3**

Note: HH= Household head, N= Number of participants, Ave age= Average age of the household

4.2. Educational Status of the Household

The educational level of the households was better in urban system than peri-urban. About 2.7 and 12%of the farmers in urban system have attended college and high school education compared to 1.3% and 4% in peri-urban, respectively. On the other hand, about 57.33% farmers in the peri-urban system were illiterate while the figure for urban was 13.3%. The difference could be attributed to better access to schools in the urban system compared to the peri-urban. This finding is in close conformity with the finding of Teshome (2009) who reported 31.67%, 46.67%, 17.50% and 4.17% for illiterate, able to read and write completed elementary school and High school, respectively at Fogera District South Gonder Zone.

As indicated in Table 3, most of the population (71.3%) was literate and able to read any written materials and understand it. Education is an important tool to bring fast and sustainable development and has roles in affecting household income, adopting technologies, demography, health, and as a whole the socio-economic status of the family as well. This could creat has a good opportunities to adopt technologies in the study area. Educational status of sample farmers with high education levels adopt

usually new technologies more rapidly than lower educated farmers (Ekwe and Nwachukwu, 2006; Ngongoni *et al*., 2006; Ofukou *et al*., 2009).

Table 3: Educational status, Religion and Ethnic group of the household heads in the study areas

Educational	Peri-Urban	Percent	Urban	Percent	Total	Percent
Illiterate	43	57.30	10	13.3	43	28.7
Write and read	17	53.13	33	50.77	50	46.73
Primary	11	34.38	21	32.31	32	29.91
Secondary	3	9.38	9	13.85	22	20.56
Diploma	1	3.13	2	3.08	3	2.80
Religion						
Protestant	24	32.00	29	38.7	53	35.3
Orthodox	46	61.33	36	48	82	54.7
Catholic	2	2.67	5	6.7	7	4.7
Muslim	3	4.00	5	6.6	8	5.3
Ethnic Group						
Oromo	39	52	50	66.7	89	59.3
Amahara	26	34.7	13	17.3	39	26
Gurage	2	2.7	0	0	2	1.3
Tigre	1	1.3	2	2.7	3	2.1
Others	7	9.3	10	13.3	17	11.3

In peri urban area the average number of Orthodox followers were higher 62.3% followed by Protestant 32%, Muslim 4% and Catholic 2.7%. Similarly high percentage, 48%, of Orthodox religion attendant household head recorded in urban system while the remaining were Protestant (38.7%), Catholic (6.7%) and Muslim (6.7%) (Table 3).

Ethiopia is one of the countries where people with different ethnic group, language and culture are living together peacefully and lovely. Lume district is one of the example of this where the people of different ethnic groups, religions and cultures are living together peacefully. In this district, the highest number of ethnic group was Oromo (59.3%) followed by Amahara (26.0%. The others that are not listed in the group were hybrid of Oromo and Amahara, Oromo and Guraghe, Tigre and Amahara and Southern people.

4.3. Herd Size and Purpose of Livestock keeping in the area

In urban area most of the farmers (90.67%) keep one or two local cattle while only one farmer keep 6 cattle. In peri-urban 53.33% farmers keep 1-5 cattle where 4% keep 16-20 cattle. Dairy farmers in the urban study sites had comparatively better access to crossbred animals. In addition, these farmers had more experience in raising crossbred cattle than those livestock owners involved in crossbred animal rearing at Peri-Urban area. However number of local cattle kept by individual farmers were higher in peri-urban.

In the Peri-Urban area, a larger number of herds were kept to maintain draft oxen related to the cropland. The less number of herds in urban area may be attributed to the off-farm activities in addition to livestock rearing. Moreover, in peri-urban crossbred male cattle were maintained within the herd for traction and sold as meat animal. In urban area all cross-bred male calves were sold as meat animal.

Many researches were reported on livestock holding and structure in different livestock production system of Ethiopia. For instance, Fayo (2006) reported that, in small size farm of Dire Dawa, 97% of household kept only dairy (51.5% were cross-bred cows) while the remaining 3% kept dairy and beef cattle. In large size farm, 15.4% and 84.6% households kept beef and dairy and only dairy, respectively.

Table 4: Cattle population in urban and peri-urban

Cattle No.	Peri-Urban	Percent	Urban	Percent
1-5	40	53.33	74	98.67
6-10	25	33.33	1	1.33
11-15	7	9.33	0	0
16-20	3	4	0	0
Total	**75**	**100**	**75**	**100**
Cross-bred Cow				
1-2	13	17.33	22	29.34
≥3	4	5.33	5	6.67

Note: Cattle No. = Cattle number category, ≥3= Three and above

Livestock were kept for different purpose such as traction, milk production, fertilizer, fuel, income generation and social prestige. The main purposes of keeping livestock in the study area were milk production, traction, milk products (cheese, butter), fertilizer and fuel (Table 5).

Peri-Urban dairy production system was mainly held to satisfy both milk and traction needs (Table 5). Almost all farmers in the urban system rear livestock for milk and dung cake production. In addition, the majority of farmers (93.33%) in peri-urban kept livestock for butter and cheese production. Animal dung produced in Peri-Urban farms was used to fertilize croplands and to make dung cake. Dairy farmers from urban used dung mostly to make dung cake to sale at the local market or for satisfying family's own energy needs. However, both Urban and Peri-Urban dairy farmers did not consider dung as a waste and use it in a productive way. This indicates good awareness of the farmers for appropriate use of animal products. In this study, the management of cattle wastes for fertilizer and dung cake were higher as compared to the findings of Fayo (2006) who reported that 75% of cattle wastes in large size farms were discarded in peri-urban of Dire Dawa area. In his study cow dung cake was

practiced only in medium farm size in urban and small farm size of peri-urban. Therefore, livestock dung management in Lume district was comparatively better.

Table 5: Purpose of keeping cattle in peri-urban and urban system of Lume district

Purpose of Keeping cattle	N=75 Peri-Urban	Percent	N=75 Urban	Percent
Milk and traction	74	98.67	0	0
Milk only	20	26.67	52	69.33
Fertilizer	68	90.67	4	5.33
Dung cake	75	100	40	53.33
Butter and cheese	70	93.33	10	13.33

Note: N= Number of households interviewed.

4.4. Land Holding and Land Use Pattern

Almost all respondents in peri-urban area had teff land while only 68% of the urban respondents cultivated teff. In Urban system, 65.3% farmers have teff land less than one hectare and 2.67% have 1-2 hectare. In peri-urban system large amount of teff land needed as compared to urban system. As indicated in the Table (6), more emphasis was given to production of teff than other crops that covered more of the farm land. This crop production pattern showed that teff contribute most of the feed resources as crop residues, and teff straw as well became the highest contributors of animal feed resources in the study area showing more attention should be given to utilization of teff products as animal feed.

Table 6: Land holding and Land use pattern in the study area

Teff land (hectare)	Peri-Urban Frequency	Percent	Urban Frequency	Percent
0.25-1	23	30.67	49	65.3
1-2	38	50.67	2	2.67
3 and above	14	18.67	0	0
Total	**75**	**100**	**51**	**68**
Chickpea				
0.25-1	26	34.67	2	28.57
Total	**26**	**34.67**	**2**	**28.57**
Barley				
0.05- 0.5	11	14.67	0	0
Grazing				
0.05-1	10	13.33	0	0
Total	**10**	**13.33**	**0**	**0**
House and barn				
>0.25	69	92	73	97.33
0.25-0.5	6	8	2	2.67
Total	**75**	**100**	**75**	**100**

Chickpea production was also practiced next to teff in the area. From 75 respondents 26 (34.67%) produce chickpea while only 28.57% of urban respondents produced chickpea in urban on the land less than one hectare. In general the majority of farmers in the study area hold less than three hectare of land particularly for pulse production.

4.5. Feed Resources and Feeding

The types of feeding systems noted from this study were grazing and stall feeding. As indicated in table 6, the major sources of feed in the study area were Teff straw, concentrates, natural pasture, barley and wheat straw, stovers (sorghum and maize by products) and haulms. Concentrates were used as supplementary feed widely by

farmers specially who keep cross-bred dairy cows. Generally, teff straw, wheat straw, barley straw and maize and sorghum stovers form the basal diet of the animals in the study area. All respondents in both urban and peri urban production system used crop residues followed by concentrate, stovers and barley and wheat straw. In Peri-Urban system 29.33% and 70.66%, of farmers used concentrate and stovers, respectively. The availability of all basal feeds in the study area was seasonally fluctuated.

Table 7: Major feed resources in the study area

Feed Resource	Peri-urban Frequency	Percent	Urban Frequency	Percent
Natural Pasture	10	13.33	0	0.00
Teff straw	75	100	75	100
Concentrate	22	29.33	23	30.67
Barley and wheat straw	12	16.00	9	12.00
Cultivated feed	30	40.00	11	14.67
Stovers	53	70.66	34	45.33
Haulms	5	6.66	0	0.00

This finding is in line with the report of Belete (2006) and Ashagrie (2008), who found out that the major feed resources for cattle in Fogera district were crop residues and crop aftermath.

Some of the improved cultivated feed (Table 8) which were delivered to farmers from Debre Zeit Agricultural Research Center and Agriculture Office were also observed in the area. The model farmers in the area adopted improved forage for different classes of animals especially for cross-bred dairy animals.

Oat and Vetch was popular in peri-urban area (Table 8) where they usually cultivated together. Oat and vetch grown separately only when the farmer want to make hay or for seed production to be used in the next season. The number of farmers who

cultivate improved forage was less in urban as compared to peri urban. This may be due to shortage of land in the urban area.

Table 8: Improved cultivated forage in the study area

Forages	Peri-urban Frequency	Percent	Urban Frequency	Percent
Oat	29	38.66	11	14.67
Vetch	29	38.66	8	10.66
Alfalfa	13	17.33	7	9.33
Elephant Grass	14	18.67	9	12.00

Zewudie (2010) reported that the use of improved forages as animal feed was not well adopted by farmers in Sebata, Debre Birhan, Jimma and central Rift Valley of Ethiopia. In his report, in Sebata, Jimma and Debre Birhan, only 13% of the respondents grow improved forages where as the proportion for central Rift Valley was very low. The improved forages used were oats and vetch in Debre Birhan and only few farmers in Sebeta grow Napier grass at the backyard, and used it as animal feed. Correspondingly, few respondents in the study area were using improved forage crops as animal feed. This may be due to the wide opportunities that farmers got access to improved animal forage through development agents and research organizations.

4.6. Feed Shortage

Feed shortage was encountered by farmers both in the dry and the wet seasons in the study area; where it was severe in wet season. Most of the farmers use crop residues from their farm in peri-urban whereas in urban the farmers bought crop residue from market which is seasonally fluctuating in terms of availabilities and price. Therefore, in wet season the low supply and high price of crop residues make feed one of the major constraints for dairy production. To overcome these seasonal shortages of feed, the respondents practice various coping mechanism through conservation of crop residues and supplementation of green legume feed sources mainly oat and vetch. None of the

respondent farmers use urea treatment of crop residues and urea molasses block supplementation to cattle.

Farmers in the study areas have perceived that feeding supplementations were important and knew the presence of supplementary feeds mainly like noug seed cake and wheat bran, but due to its high cost they are in fear to purchase these feeds continuously as its price increase from time to time.

Almost all respondents come across feed shortage, and 72.67% faced in wet season while the remaining farmers faced in dry season. The farmers that had grazing land encountered feed shortage in dry season because of scarcity of grazing land. The severity of feed shortage in wet season in the study area was due to seasonal availability of crop residues since, the main animal feed resource in the area is crop residues.

Table 9: Feed problem assessment in study area

Description	Response	Frequency	Percent
Do you have feed shortage	Yes	147	98.00
	No	3	2.00
When doe it occur	Dry season	41	27.33
	Wet season	109	72.67
Do you need supplementary feed	Yes	56	37.33
	No	94	62.67

4.7. Major Causes of Feed Shortage

As described by dairy farmers, conversion of grazing land to crop land, and high market price availability of concentrate feeds in the market were the main couses for feed shortage in the study area. On the other hand, feed shortage in relation to the current fluctuating cost of commercial feeds were high both in urban and peri-urban areas.

Table 10: Major cause of feed constraint in the study area

Description	Urban	Percent	Peri-urban	Percent
Change of grazing land to crop land	23	30.67	20	26.67
High feed price	43	57.33	43	57.33
Shortage of commercial Feed	9	12	12	16.00

High price of concentrate feed was the major problem in area where, 57.33% of farmers encountered high cost feed shortage. The consequences of feed shortage for livestock include weight loss, lower milk yield, mortality and cows fail to show conspicuous heat for mating (Zewudie, 2010).

4.8. Major Cattle Diseases

According to respondents most of the animals were not getting sick and usually occurring disease were mastitis mostly in high milk producing of cross-bred dairy cows. The other diseases affecting dairy animals in the study areas were anthrax, black leg and bloat that occasionally occurred based on the condition of weather and feed type.

Table 11: Major cattle disease in the study area

Disease	**Peri-Urban**	**Percent**	**Urban**	**Percent**
Anthrax	3	4.00	4	5.33
Black Leg	2	2.67	1	1.33
Mastitis	15	20.00	13	17.33
Bloat	2	2.67	3	4.00
No Disease	43	57.33	30	40.00
Total	75	100	75	100

4.9. Record Keeping

Record keeping is one of the important practices to evaluate performance of dairy animals. In peri urban, only farmers that keep cross-bred dairy cows keep record while there is no record keeping for local breed. Urban farmers keep records more than peri-urban. The most recorded data traits in both urban and peri-urban were milk yield and milk price (Table 12).

The number of farmers keeping the record in the current study was higher than (Fayo, 2006) the urban and peri-urban dairy system of Dire Dawa area where, only 15.2% farmers of small size farm in urban kept record while, all respondents in peri-urban area were not kept record for dairy cattle at all. This indicates the farmers in urban and peri-urban of Lume district have better awareness and practiced dairy cattle record keeping.

Table 12: Record keeping of farmers in the study area

Description	Response	Peri-Urban	Percent	Urban	Percent
Do you keep record?	Yes	24	32.00	50	66.67
	No	51	68.00	25	33.33
If yes, which type?	Milk yield	24	32.00	25	33.33
	Feed intake	3	4.00	4	5.33
	Milk price	24	32.00	25	33.33
	AI service	4	5.33	12	16.00
	Birth date	13	17.33	21	28.00

AI= Artificial insemination

4.10. Housing System

The main advantage of house is to protect animals from adverse weather condition, thief and for proper management (e.g. feeding, health care). All farmers in the study area keep cattle separately outside of their living house. In urban system most of the farmers (89.33%) used separate house from their living house while the remaining 10.67% keep in open corral (Table 13). The open corral were sheltered by covering plant materials or roofed with corrugated iron but the wall was not covered with mud or other covering materials. In peri-urban system the number of farmers kept animals in house was less as compared to urban system. This is because most of the farmers in the area are keeping local cattle breed and open corral is common for local breed house in the area. About 70.67 % of farmers kept cattle in shaded open corral while the remaining 29.33% kept in separated house. The farmers that kept their animals in separate house were those who kept cross-bred animals and they used it in order to protect cross-bred cattle from adverse weather condition.

Table 13: Types of house, floor and bedding material in the study area

Description	Alternatives	Urban N=75	Percent	Peri-Urban N=75	Percent
House Types	Housed Separately	67	89.33	22	29.33
	Open corral	8	10.67	53	70.67
Floor type	Concrete	20	26.67	16	21.33
	Mud floor	55	73.33	59	78.67
Bedding material	Grass bedding	38	50.67	11	14.67
	No bedding	37	49.33	64	85.33

Different floor types were also observed in the study area. Both in urban and peri-Urban area, only farmers having cross-bred dairy animals used concrete floor. Use of concrete floor was not well known but some model farmers have started to use such floor for their cross-bred dairy cows. The use of concrete floor was better in urban (26.67%) while only 21.33% use same in Per-Urban area. The remaining farmers both in urban and peri-urban system used mud floor. The current result is not in line with result of Zewudie (2010) who reported that, animal houses with concrete floor and roofs accounted for 75% and 100% of the house types in Jimma and Sebeta, respectively. He indicated that in the Highland production system animal houses were mostly concrete floor types with roofs while in the Central Rift valley animal houses were made up of kraal type.

Use of bedding materials was not common in peri-urban area and only 14.67% farmers used grass bedding. But in urban half (50.67%) of the farmers practiced grass bedding while the remaining farmers were not used (Table 13).

4.11. Watering Management

Milking dairy cow, compared to other ruminant animals, requires higher amount of water in proportion to their weight or surface area, since water constitutes 85-87 percent of milk produced and 55-65 percent of animal body weight (ARC, 1980). All dairy cows in urban and lactating cross-bred dairy cows in peri-urban had free access to water. In peri-urban water provided to local cattle twice a day. Main sources of water both in urban and peri-urban were tap water (Table 13). In urban, 92% of farmers used tap water while the remaining 8% used well water. In peri-urban 46.67% of the farmers used tap water followed by well water (38.67%) and (14.67) river water. The current result is in line with the finding of Zewudie, (2010), who reported that, the main sources of water in Highland livestock production system (Debere Birhan, Jimma and Sebeta) were river and tap water. Fayo (2006) also indicated that all farmers in urban (Dire Dawa town) use tap water while all farmers in peri-urban areas used well water.

Table 14: Water sources in the study area

Water sources	Urban	Percent	Peri-Urban	Percent
River	0	0.00	11	14.67
Well water	6	8.00	29	38.67
Tap water	69	92.00	35	46.67

In peri-urban system the farmers using tap water were encountering some problem because of few water pump in the surrounding. They were waiting for long time to fetch the water since of many people use single water pump as it was reported by the respondents during the interview period.

4.12. Chemical Composition of Experimental Feed

The chemical composition of experimental feeds is presented in Table 15. The percent composition varied depending on feed type, in which the contents of CP, was higher in urea molasses block (UMB) and concentrate mix.

Table 15: Chemical composition of experimental feeds

Composition%	UTTS	UTS	UMB	Conc.
DM	87.78	71.50	94.44	94.00
CP	3.20	7.83	23.94	23.20
Ash	8.10	6.50	22.77	5.71
NDF	68.53	61.60	12.50	37.70
ADF	41.85	37.13	4.10	9.63
ADL	8.88	10.80	0.90	2.67

DM= Dry matter; CP= Crude protein; ADF= Acid Detergent fiber; ADL= Acid detergent lignin; NDF= Neutral detergent fiber; UTTS= Untreated teff straw; UTS= Urea treated teff straw; UMK= Urea molasses block and Conc. = concentrates.

Urea-treatment increased CP content of the teff straw more than double from, 3.2 when to 7.83%, and decrease NDF from 41.85 to 37.13% denoting the breakage of lignified bond and release of hemicellulose. Similar changes was observed in CP and NDF of wheat straw following urea treatment (Getahun, 2006).

However, the CP content of treated straw observed in this study was lower than that of previous report of Rehrahie (2001). This reduction in CP was probably caused by volatile N loss while ventilating overnight before feeding, until sampling and during drying before analysis. Such discrepancies in CP content of urea treated straw were also observed in many studies (e.g., Sundstol *et al.*, 1984; Chenost, 1995) stating that up to two-thirds of the ammonia generated is usually lost because of evaporation. According to Chenost (1995), large increases in CP contents does not necessarily imply a good treatment effect, rather it may indicate the presence of residual urea that resulted from partial ureolysis, where all urea nitrogen are not hydrolyzed to ammonia gas.

The effectiveness of urea treatment has been reported to be dependent on many factors among which the poorer the quality of the roughage the better is the response to urea treatment (Sundstol *et al*., 1984). In the present study, at environmental temperature of mean minimum 13 ^{O}C and maximum 25 ^{O}C, treated *teff* straw had pH value of 9 and appeared dark yellowish in color having soft consistency with modest ammonia smell ensuring the effectiveness of the treatment.

4.13. Feed Intake of the Experimental Animal

In all treatments concentrate was used at a rate of 0.5 kg per 1 liter of milk yield per day. The total daily intake of concentrate in T2 was higher as compare to T1 and T3. Increased concentrate intake in T2 was a result of increased milk yield per day i.e. when milk yield increased in 1 liter the concentrate provision increased by 0.5 kg. As it indicated by Santra and Karim (2009), increasing the concentrate level in ruminant diets will increase dry matter intake as a result of proliferation of rumen microflora.

Table 16: Types of feed used and feed intake in each treatment groups

Treatments	UTS	UMB	UTTS	Conc.	Total
Intake (kg)					
T1	6.8	0	0	4.78	11.58
T2	0	0.322	6.25	5.3	12.472
T3	0	0	6.12	4.7	10.82

UTS = urea treated Teff straw; UMB=urea molasses block; = UTTS Untreated teff straw; T1; Treatment one; T2= Treatment two; T3= Treatment three

UMB supplementation (UMB lick) in T2 improved the dry matter intake of cows (Table 16). As reported by different researchers this may be due to the positive effects of UMB as a source of soluble nitrogen and easily fermentable carbohydrates which probably increased the activity of cellulolytic rumen microflora, enhence the fermentation of roughages and concomitantly their intake (Leng *et al*., 1991; Sudhaker *et al*., 2002; Takeba, 2012). Consumption of low quality forage may be particularly improved by UMB supplementation causing an increase in the activity of cellulolytic

rumen microflora (Van Soest, 1994), as has been shown for the intake of maize stover in goats at south Mozambique as reported by (Faftine and Zanetti 2010).

Total nutrient intakes are indicated in Table 17. Significant differences ($P < 0.01$) were observed between treatments in daily nutrients intake. The total DM intake was improved ($P<0.01$) in T2 as a result of UMB feeding as supplementary feed. Similar result was also reported in Fogera district where,supplementation of UMB increases DMI of cross-bred dairy cows (Takeba, 2012).

Feeding urea treated teff straw was found to improve straw DM intake (10.18 ± 0.08), compared to untreated teff straw (10.1 ± 0.1kg per day). This result is in agreement with the finding of Teshome (2009) who reported an increased DMI of cross-bred dairy cows fed urea treated wheat straw in Fogera district.

On the other hand total CP intake of T1 was significantly higher ($P<0.01$) than T2 and T3 (Table 17). Urea treatment increased CP content of the straw more than twice due to binding of ammonia to the straw and tended to decrease NDF denoting the breakage of lignified bond and release of hemicelluloses.

Similar results were also reported by (Srinivasulu *et al;* 1999; Getahun, 2006; Rehrahie, 2001). Generally UMB and UTS increase nutrient intake and decrease the lignifications of low quality fibrous feed.

Table 17: Total daily nutrient intake of the experimental animals

Nutrition	T1	T2	T3	Mean	CV	P-Value
TDMI kg/day	10.18 ± 0.08[b]	10.58 ± 0.09[a]	10.1±0.1[c]	10.46	19.03	***
TCPI g/day	530 ± 3[a]	350 ± 33[b]	270 ± 3[c]	407	17.01	***
TNDFI kg/day	5.50±0.04[a]	5.16 ± 0.04[a]	5.11 ± 4[b]	5.35	17.39	**
TADFI kg/day	2.51±20[c]	2.7 ± 20[a]	2.74 ± 2[a]	2.67	16.56	***
TADLI g/day	610 ± 4[a]	480 ± 4[b]	550 ± 5[c]	540	17.55	***

Note: [abc] Different superscripts indicate significant (P < 0.01) differences between means in the same row; TDMI kg/day= Total Dry Matter intake per day in kilogram; TCPI g/day= total crude protein intake in gram per day; TADFI kg/day= Total acid detergent fiber intake in kilogram per day; TNDLI g/day= Total neutral detergent lignin intake in gram per day; TNDFI kg/day= Total neutral detergent fiber intake in kilo gram per day; T1; Treatment one; T2= Treatment two; T3= Treatment three CV= Coefficient variation

Similarly, there was significant difference (P < 0.01) in nutrient intake between second and third parities, and between urban and peri-urban dairy production system (Table 18). All nutrient intake analyzed were significantly different between parities where third parity was higher than the second parity.

Table 18: Nutrient intake of cows in different parities and locations

Variables	TDMI kg/day	TCPI g/day	TADFI kg/day	TADLI g/day	TNDFI kg/day
PARITY					
3rd	10.68 ± 0.7^{a}	390 ± 2^{a}	2.71 ± 0.1^{a}	540 ± 3^{a}	5.42 ± 0.3^{a}
2nd	9.9 ± 0.7^{b}	380 ± 2^{b}	2.59 ± 0.2^{b}	520 ± 3^{b}	5.09 ± 0.3^{b}
Mean	10.46	385	2.67	530	5.35
CV	19.03	17.01	16.56	17.55	17.39
P-Value	**	**	**	NS	**
SITE					
Peri-Urban	11.03 ± 0.7^{a}	410 ± 2^{a}	2.81 ± 0.1^{a}	560 ± 3^{a}	5.61 ± 0.3^{a}
Urban	9.54 ± 0.08^{b}	360 ± 3^{b}	2.49 ± 0.2^{b}	530 ± 4^{b}	4.9 ± 0.4^{b}
Mean	10.46	385	2.67	545	5.35
CV	19.03	17.01	16.56	17.55	17.39
P-Value	**	**	**	**	**

Note: ^{abc} Different superscripts indicate significant ($P < 0.01$) differences between means in the same column; TDMI kg/day= Total Dry Matter intake per day in kilogram; TCPI g/day= total crude protein intake in gram per day; TASHI g/day= Total ash in take in gram per day; TADFI kg/day= Total acid detergent fiber intake in kilogram per day; TNDLI g/day= Total neutral detergent lignin intake in gram per day; TNDFI kg/day= Total neutral detergent fiber intake in kilo gram per day; CV= Coefficient variation.

Similarly, the nutrient intake of dairy cows in the urban and peri-urban dairy system was significantly different ($P < 0.01$). Total nutrient intake in Peri-urban was higher than urban system (Table 18). This may be due to management difference where in peri-urban, all roughage feeds were produced at farmers own farm, and seasonally different agricultural byproducts, grazing at backyard were available. This may increase the activities of rumen microorganisms to enhance feed intake.

4.14. Body Weight Gain

Significantly higher ($P < 0.01$) daily weight gain was recorded for cows fed urea treated teff straw and concentrate feed compared to cows fed UMB, untreated teff straw and concentrate and, untreated teff and concentrate. Cows fed UMB, untreated teff straw and concentrate (T2) had higher daily weight gain compared to those fed untreated teff straw and concentrate (Table 19).

In contrast, weight loss in lactating cross-bred dairy cows fed on treated rice straw was reported in Fogera District (Teshome, 2009). The loss in body weight of cows during early lactation (60-90 days after calving) was reported by Azage *et al.*, (1994). Muinga *et al.* (1992) also noticed body weight loss for the entire lactation period ranging between –20 to 90 kg for lactating crossbred cows fed *ad lib* napier grass fodder and supplemented with 0.4 or 8 kg/day of fresh leucaena forage from day 15-112 of lactation at lowlandsemi-humid tropics. In present study the weight gain observed may be due to optimum management or may be due to the use of cows in early to mid lactation period (5-8 weeks after parturition). However, Takeba (2012) reported that, the estimated daily body weight gain of cross-bred dairy cow supplemented with urea molasses block in Fogera district was 236g while others non-supplemented cross-bred lactating cows gain 120g per day.

Table 19: Least square mean body weight change of experimental cow

Treatment	IW1	FW2	DWG
T1	376.83 ± 15.01[a]	389.28 ± 14.83[a]	0.28 ± 0.03[a]
T2	287.46 ± 19.90[b]	294.59 ± 19.65[b]	0.16 ± 0.04[b]
T3	286.23 ± 18.99[b]	287.1± 18.75[b]	0.02 ± 0.04[c]
Grand Mean	316.3	323.70	0.19
P-Value	***	***	***
CV	15.71	15.12	61.65

Note: [abc] Different superscripts indicate significant ($P < 0.01$) differences between means in the same column; T1 = Treatment one; T2 = Treatment two; T3 = Treatment three; IW1= Initial weight; FW2 = Final weight; DWG= Daily weight gain and CV =Coefficient variation

On the other hand, there were also significant difference in daily weight gain between parities (second and third parities) of the cow (Table 20). The daily weight gain was higher in second parity. This indicates that the young lactating dairy cow can gain more body weight than the older cow.

Final body weight was significantly differed ($P < 0.01$) between the two production system which was higher in peri-urban. Daily weight gain was not significantly different in the systems. The highest final body weight recorded in peri-urban area may be due to optimum management where livestock feed was mostly depend on agricultural byproducts of farm while most of the feed used in urban was purchased.

Table 20: Least Square Mean of Body weight of the experimental cows by parities and production system

Parity	W1	W2	DWG
3rd	334.92 ± 11.92^{a}	341.84 ± 11.90^{a}	0.15 ± 0.03^{b}
2nd	307.98 ± 12.53^{b}	316.58 ± 12.52^{b}	0.19 ± 0.03^{a}
Grand Mean	328.3	336.7	0.19
P-Value	**	**	**
CV	16.31	15.88	63.88
Site			
Peri-Urban	338.65 ± 12.18^{a}	347.96 ± 12.48^{a}	0.15 ± 0.03^{ab}
Urban	311.13 ± 14.89^{b}	318.31 ± 15.25^{b}	0.18 ± 0.03^{a}
Grand Mean	328.30	336.70	0.18
P-Value	***	***	NS
CV	18.14	18.12	65.54

Note: ^{abc} Different superscripts indicate significant ($P < 0.01$) differences between means in the same column; W1= Initial weight; W2 = Final weight; DWG= Daily weight gain and CV=Coefficient variation.

4.15. Daily Milk Yield and Composition

The main purpose of dairying in Lume district was to produce milk for family use and marketing. The area has market oriented dairy farms and hence the farmers kept cross-bred dairy cows and give priority for raw milk sale to cooperatives or to private milk traders.

The mean of morning milk yield of lactating cross-bred dairy cows in urban and peri-urban of Lume District was 6.03kg/day, evening milk yield 3.01kg/day, and total milk yield of 9.45kg/day (Table 20). The result of this study also indicated milk composition of 3.22% fat, 3.37% Protein, 7.32% SNF, 11.19% TS and 1.026 G/ml density. There was significant difference ($P < 0.01$) where the cows supplemented with UMB recorded higher daily milk yield (Table 20). Morning and evening milk yield was high in T2 (6.44 ± 0.06 and 3.63 ± 0.04); and followed by T1 (6.22 ± 0.06

and 3.61 ± 0.05) and T3 (5.46 ± 0.07 and 3.24 ± 0.04), respectively. Daily milk yield were 10.06 ± 0.10, 9.61 ± 0.09 and 8.70 ± 0.11 in T2, T1 and T3 respectively. This finding is in agreement with Takeba (2012) who reported that the saleable milk off-take of cows received the UMB supplementation was significantly increased by 34 % for crossbred dairy cows in Fogera District of Amahara region. But the result obtained in this study is much higher than that of Nkya *et al.* (2002) who reported the average daily milk yield of crossbred dairy cows managed with cut and carry + UMB supplementation as 7kg per day at peri-urban areas of Tanzania. However, some finding shows higher milk yield than the milk yield obtained in this study. For instance, Seyoum and Fekede (2006) reported the average daily milk yield of cross-bred dairy cows managed under cut and carry + UMB as 10.62kg per day at Holetta Agricultural Research Center.

Table 21: Least Square Mean of Daily Milk Yield and Composition

Variables	T1	T2	T3	Mean	CV	P-Value
MMILK	6.22±0.06^{b}	6.44±0.06^{a}	5.46±0.07^{c}	6.03	22.42	***
E Milk	3.61±0.05^{b}	3.63±0.04^{a}	3.24±0.04^{c}	3.01	26.67	***
TMilk	9.61±0.09^{b}	10.06±0.10^{a}	8.70±0.11^{c}	9.45	22.17	***
Protein%	3.41±0.25^{a}	3.45±0.29^{a}	3.23±0.32^{ab}	3.37	29.07	***
Fat%	3.21±0.08^{a}	3.32±0.09^{a}	3.16±0.10^{a}	3.22	9.39	NS
SNF%	7.39±0.20^{a}	7.50±0.23^{a}	7.12±0.26^{a}	7.32	10.67	NS
DG ml	1.027±0.001^{a}	1.025±0.001^{a}	1.026±0.001^{a}	1.026	0.27	NS
T S%	10.99±0.44^{a}	11.04±0.49^{a}	11.48±0.55^{a}	11.19	15.10	NS

Note: ^{abc} Different superscripts indicate significant ($P < 0.01$) differences between means in the same row; MMILK= morning milk yield; E Milk= Evening milk yield; TMilk= Total milk yield; Protein= Protein; Fat= fat; M SNF= Solid not fat; DG ml=Density gram per milliliter; TS = Total solid; T1 = Treatment one; T2 = Treatment two; T3 = Treatment three and CV =Coefficient variation.

The overall least square mean of protein, fat, total solids, density and solids-not-fat (SNF) contents were not significantly different in the study area. The present study is not in line with the finding of Takeba (2012), who reported that, UMB

supplementation significantly increased the milk fat content by 7 % in cross-bred dairy cows. However Rehrahie, (2010) reported that only milk protein was significantly different while milk fat, total solid and lactose were not significantly different treated and untreated wheat straw. In addition, Rehrahie and Ledin (2001) reported that the effect of hay based diet, urea treated teff straw based diet and urea treated barley straw based diet on milk fat percent didn't differed significantly. According to O'Connor (1994), any ration that increases milk production usually reduces the fat percentage of milk. It is also believed that the fat content is influenced more by roughage (fiber) intake and the solid-not-fat content can fall if the cow is fed a low energy diet. In temperate type cows, the fat and SNF percentages tend to be higher in the early weeks of lactation, dropping by the third month then rising again as milk yield gradually declines (O' Manhony, 1988).

On the other hand, daily milk yield was influenced by location and parities of the cows. The cows with second and third parity were considered in this study. The cows selected with second parity were younger than the third parity cows. The daily milk yield of cows with the second parity was significantly lower than the yield of the cows with third parity cows (Table 22).

The Least square mean of morning, evening and total milk yield per day of the third parity cows were significantly higher ($p < 0.01$) than second parity cow. Several researchers reported the lower daily milk yield in second parity as compare to third parity cows. For instance Řehak *et al*. (2012) reported that, daily milk yield in first parity was lower than second, third and fourth and started to decline thereafter. This means in second and third parity milk yield was higher compare to first parity and the cows in third parity have higher milk yield than the cows in second parity. Similarly, Million and Tadelle (2003) reported that the average daily milk yield in second and third parity cows were 6.43 ± 0.24 and 7.10 ± 0.25kg per day per cow, respectively. Mackinnon *et al*, (1996) also reported a decrease in milk yield and lactation lengths after the third parity on Friesian crosses with Ayrshire, Brown Swiss and Sahiwal in Kenya. Ángel Ríos-Utrera *et al*. (2013) reported the daily milk yield of Holestin 10.9±0.13,

11.4±0.15 and 11.3 ± 0.14 for second, third and fourth parities respectively in Holestin cows.

Table 22: Least Square Mean of Daily milk yield between parities and locations

Parity	MMILK	E Milk	T Milk
3nd	6.58 ± 0.05[a]	3.76 ± 0.03[a]	10.34 ± 0.07[a]
2rd	5.92 ± 0.05[b]	3.32 ± 0.03[b]	9.24 ± 0.07[b]
Grand Mean	6.36	3.58	9.94
CV	22.42	26.67	22.17
P-Value	**	**	**
Site			
Peri-Urban	6.73 ± 0.05[a]	3.27 ± 0.03[a]	10.20 ± 0.07[a]
Urban	5.77 ± 0.06[b]	3.12 ± 0.04[b]	8.84 ± 0.09[b]
Grand Mean	6.36	3.58	9.94
CV	22.42	26.67	22.17
P-Value	**	**	**

Note: [abc] Different superscripts indicate significant ($P < 0.01$) differences between means in the same column; MMILK= morning milk yield; E Milk= Evening milk yield; TMilk= Total milk yield and CV= coefficient variation.

Comparatively higher milk yield in morning, evening and total milk yield per day were observed in peri-urban dairy system. This might be due to intrinsic factors like feed intake and others related to environment. Rasambainarivo *et al*. (2002) reported that, the average daily milk production of cross-bred dairy cow managed with Grazing+ Crop residue + Concentrate + UMB was 10.82kg per day per cow in peri-urban. Getu (2006) reported that the mean daily milk yield of cross-bred dairy cows fed urea treated straw and supplemented with different proportions of vetch hay as a replacement to concentrate mix was 6.48 kg per day per cow in urban area.

4.16. Partial Budget Analysis of Urea Molasses block and Urea Treated Teff Straw

The costs for feed and materials used in the experiment, and the cost-profit analysis are shown in Table 23 and 24, respectively.

Table 23: Cost of items used for the partial budget analysis

Items	Cost
Teff straw	1.30 Birr/kg
Urea	6.85 Birr/kg
Molasses	1.50 Birr/kg
Plastic sheet for straw treatment	7 Birr/m
Can material for UMB making	9.50Birr/piece
Wheat bran	2.1 Birr/kg
Salt	3 Birr/kg
Cement	3 Birr/kg
Noug cake	3.2 Birr/kg
Labor	16 Birr/man/day
Concentrate mix	3 Birr/kg

Based on average milk price paid to producers by milk cooperatives and private consumers, with 10.50 Birr/1t milk, cows fed UMB based diet have got the highest net return 83.27ETB /cow/day. This was followed by urea treated teff straw supplemented diet and control. Relatively, the better economic return of crossbred cows fed urea treated straw was reported by Rehrahie (2010. Takeba (2012) also reported that, UMB supplementation seems to be economically meaningful for crossbred dairy cows only: a greater increase was observed for income from milk sales as compared to feed costs in crossbred cows, whereas a benefit-cost ratio was smaller than the one found for late lactating Fogera cows. This indicates the net return of cows supplemented with UMB was higher for cross-bred cows compared to locals.

Table 24: Partial budget analysis for lactating crossbred cows fed UMB and UTS

Types of feed treatment	cost of milk production	Average milk yield /cow/day/(lit)	Milk price/lt ETB	Gross return/cow/day ETB	net benefit /cow/day ETB
T1	24.69	9.61	10.50	100.91	76.22
T2	28.24	10.06	10.50	105.63	77.39
T3	23.1	8.70	10.50	91.35	68.25

T1= Treatment one; T2= Treatment two; T3= Treatment three and ETB= Ethiopia birr

4.17. Feedback of urea Treated Teff Straw and Urea Molasses Block and Farmers Perception

The 30 farmers trained and employed to conduct this experiment were interviewed after the end of the 2 months of experiments to evaluate their acceptance and willing to continue the use of these feeds. The result of this interview revealed that almost all farmers accepted urea molasses block and urea treated teff straw as important livestock feed especially for dairy animals to improve milk production and milk quality. Furthermore, 86.7% farmers reported weight gain of cows as a result of UMB and UTS feeding (Table 25).

According to the respondent farmers, the acceptance of their milk by cooperatives and others buyers also increased during the use of urea treated straw and urea molasses block. This indicates the improvement of milk utilization and acceptance by the cooperatives and other stakeholders involved in milk marketing and consumption.

From 30 households 80% of the farmers select urea molasses block because of its less labor requirement, simple and easy. Urea molasses block is also easy to handle and it protected from rain can be used throughout the year while, urea treated straw utilization was complex in summer season. Only few farmers (20%) selected urea treated straw because of availability of teff straw and other materials used for straw treatment.

Table 25: Feedback of Urea treated straw and urea molasses block.

Description	Responses (N=30)	Percent
1. Do you think UMB and UTS are important for smallholder dairy farmers	a. Yes	100.0
	b. No	-
2. If yes why?	a. Improve milk yield & quality	100.0
	b. Improve body weight	86.7
3. Which one is more easier to produce (UTS or UMB)	a. UTS	20.0
	b. UMB	80.0
4. Did you practice UTS or UMB after the end of experiments?	a. Yes	43.3
	b. No	56.7
5. If yes which types of animals you fed?	a. Cross-bred Dairy cows	93.3
	b. Plough oxen	30.0
	c. Fattening animals	20.0
	d. Calves	10.0
	e. Sheep and goat	6.7
6. Which feed you prefer for milk production?	a. UTS	20.0
	b. UMB	80.0
8. Rank both feeds (UTS and UMB) used on the response of dairy cows productivities	a. High	90.0
	b. Medium	10.0
	c. Low	-

Note: N= Number of participants; UTS= Urea treated straw and UMB= Urea molasses block.

During the experiment, all farmers considered and other nearby farmers were advised to utilize feeds used in the experiment continuously to increase animal productivities. Therefore, nearly half of the farmers (43.3%) continued to produce urea treated straw and urea molasses block after the end of the experiments and fed for cross-bred (93.3%), oxen (30.0)%, fattening animals (20.0%), calves (10.0%) and shoats (6.7%). This indicates farmers' positive perceptions and awareness about UTS and UMB. In other words all of the farmers in the interviewed were responsive to use these feeds and accepted for future use. The remaining did not produced both urea treated straw and urea molasses block because of labor shortage, presence of rain and the remaining had no good reason. In addition, the value of feed used on dairy cow productivities was ranked by the farmers where, 90% farmers ranked high. This means the use of offered feed improved the dairy cows' productivities in the area. Moreover, notable

improvements in daily milk yield, body weight and an increased straw intake were the major notes during the final farm observation.

Additionally, the farmers keeping livestock in the selected kebeles were trained on how to make urea treatment straw and urea molasses block and experience sharing was made between farmers participated in experiment and others nearby them. Then, all trained and awared of farmers promised to use for future at their farm.

5. CONCLUSIONS AND RECOMMENDATIONS

Supplementation of UMB and UTS fed to cross-bred lactating dairy cows was effective method that improved the daily feed intake, daily body weight gain and daily milk yield of dairy cows. The effect of UMB was most likely improved the roughage intake of dairy cows. This indicates UMB supplementation improves the microbial activities in the rumen then, increase feed intake and digestion in addition to supply nutrients. The improvement of milk yield and daily weight gain of cow lead the framers to use the best feed treatment to improve locally available feed for optimum animal productivities. This is particularly important for countries like Ethiopia, where concentrate supplementation is limited and where the basal diets of the animals generally consist of low quality roughage.

The improvement in feed and nutrient intake and the concomitant increase in the daily milk yield have different economic implications for the farmers in different livestock production systems. For instance, the greater improvement in daily milk yield of crossbred dairy cows in market oriented, peri-urban livestock production systems, where milk marketing is very attractive, will result in a significant economic advantage as compared to rural production systems, where milk has to be frequently converted into butter because of lacking market access. Therefore, use of urea molasses block for dairy animals will be effective in urban and peri urban area where milk market access is available.

On the other hand third parity cow consume more feed, produce more milk and heavier than second parity cows. However, second parity cows were higher in daily weight gain. Similarly, total nutrient intake, body weight gain and daily milk yield were higher in peri-urban than urban dairy system. In peri-urban system the majority of basal feed utilized were from farmers own farm while in urban most of the feeds purchased. This may increase the feed intake and productivity of dairy cow in peri-urban. Therefore, optimum feed management should be provided to cross-bred dairy cows in urban system.

In this study urea molasses block raise DM intake of roughages and milk yield where its production procedure is very easy and simple, can be produced from locally available materials and requires less labor. Therefore, commercial and smallholder dairy farmers can improve milk production as well as body weight of the milking cows through supplementation of UMB.

FURTHER SCOPE OF WORK

- Further study is required to replace the part of concentrate supplementation by urea molasses block to decrease provision of concentrate diet.

- Additional investigation is required to study the supplementation of urea molasses block to different local dairy cattle breeds.

- Further investigation is required to determine appropriate daily intake of UMB in milk production for optimum economic utilization.

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7. APPENDICES

7.1. Survey Part Questionnaire

1. District (District): ____________________Site/town: _______________
2. Household name: ____
3. Gender of the household: A. Male B. Female
4. Age of the household: ____
5. Family size of the HH.

Family	1-15 age	16-45 age	45-60 age	>60 age
Male				
Female				

6. Educational level of the household

a) Illiterate b) Write and read c) Primary education (1-8)

d) 4.10th grade complete e) 5.12 grade completed f. Other (specify) ___________

7. Religion a) protestant b) Orthodox c) Catholic d) Muslim e) Others…..

8. Ethnic groups a) Oromo b) Amahara c) Gurage d) Tigre e) Other…….

9. Main occupation of the HH:

a. crop farming b. mixed crop and livestock c. farming and off farming activities

d. only livestock raring e. others, specify……….

10. Land holding and land use pattern.

Land use patern	Owned (ha)	Rented in (ha)	Rented out (ha)	Yield (ha)	Soil type
Teff					
Wheat					
Maize					
chickpea					

Barley					
Grazing					
House and barn					
Others …					

11. Do you keeping livestock? a) yes b) No

Type **Number**

a).________________________ ___________

b). _________________________ ____________

c). ____________________________ ____________

d). ____________________________ _____________

12. What type of breed, parity and number of cows do you have?

Type No. Parity

a. pure exotic _______ __________

b. zebu _______ ___________

c. crossbred cow _______ ____________

d. cross-bred heifer _______ ___________

13. For what purpose you keep livestock

a. milk production for family consumption b. milk production for sale

c. draft power d. transportation e. others, Specify____________

14. What is average daily milk yield per cow in your farm?

a. pure exotic: ______liter b. zebu: _____________liter

c. crossbred: ______liter

15. What is the lactation length for?

a. Pure exotic cows: ______months b. Zebu cows: _______months

c. Cross-bred cows: ____________months

16. What types of disease you suspected in your farm?

a. Mastitis b. Bloat c. Black leg c. *Abbasanga* d. Others, specify…

17. Do you need record keeping at your farm? a. Yes b. No

18. If yes which animal product or input you recorded?

a. Daily milk yield b. Daily feed intake c. daily milk price d. Others, specify…

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

a. Natural Pasture b. Crop residue c. Concentrates d. Stovers e. Green Fodder

20. What are the impact of feed resources on milk yield and composition?

a. Low quality of milk b. Low fat content c. Quickly perishable

d. Low milk thickness at market e. Others if any……………………

21. What type of improved feed technologies available in the area?

____

22. What are the types of feeding system you need?

a. Cut and carry system b. Grazing c. Barn feeding d. Others, specify……………

23. How you determine the amount concentrate feed provided to livestock?

____

24. Have you access any training for feed technology? a. Yes b. No

25. If yes from where you got?

a. District bureau of agriculture b. Research center c. NGOs d. others, specify…

26. What where the contents of the trainings?

a. improved forage production and conservation b. feed management practices

c. feeding practices d. others, specify……………………

27. How often you access this training?

a. monthly b. Bi-annually c. yearly d. others, specify………

28. Have you ever faced feed scarcity in your area? a. yes b. No

29. If yes why? a. Limited availability b. high cost c. poor infrastructure d. others

30. Did you access crop residue in your farm? a. yes b. No

31. If yes from where you get it? a. market b. farm c. others, specify………

32. Do you believe that crop residue is good source of feed for dairy cow?

a. yes b. no

33. If no, why? a. low in quality b. low intake c. others, specify…………………

34. Do you believe that crop residue can be improved through scientific method?

a. yes b. no

35. If yes, do you need to apply? a. yes b. no

36. In which Season live weight of animal change? A. wet season b. dry season

37. What are the main constraints to livestock production in prioritizing order?

Table 5. Livestock production constrains assessment

No	Constraints	Efforts made to avoid these constraint
1.		
2.		
3.		
4.		
5.		

38. When feed constraints occur? a. Dry season b. wet season
39. What supplementation needed during?______________________________________
40. Grazing land in ha: private ________ Communal __________
41. For what length of time animals graze on the grazing lands?
42. Trend of crop residues production

Trend (Rate the extent of change on a scale: a= decreased substantially (− −), b= decreased slightly (−), c= no change (0), d= increased slightly (+), e= increased substantially (+ +); and identify the main effects of the change)

43. What techniques you use to improve teff straw? (Chopping, mixing with other feed
resources, treating with urea) others……………………….
44. What are the constraints of teff straw production and utilization?
45. Do you believe that milk production will be improved as feed quality improved?
a. yes b. no
46. Do you know or ever heard urea treated straw and urea molasses block?
a. Yes b. No
47. Have you ever used urea treated straw and/ urea molasses block? a. yes b. No
66. If yes where do you got? ______________________________________

68. If no do you need to know this practice through training? a. Yes b. No

48. What type of barn do you own? a. Housed b. Fenced c. No barn

49. Bedding materials used?

a. Grass and/or cereal straw b. No bedding material c. Other (indicate) _________

50. How frequent do you clean your cow's house/barn?

a. Daily b. Two times a week c. Three times a week d. Once a week e. Do not clean f. Other comments (indicate) _____________

51. Do you wash your hands before milking? a. Yes………… b. No…………………

52. Do you wash your cow's udder before milking? a. Yes….. b. No……..

If yes, when do you wash it?

a. Cleaned before milking only b. cleaned after milking only c. cleaned before and after milking

53. If you wash the udder what materials do you use for drying?

a. Collective towel b. Individual towel

c. Just with hands d. Others (specify)

54. What is the source of the water used for washing the udder and milk utensils?

a. Piped or tap b. River/ stream c. hand dung d. Other (specify)…………

55. What type of milking procedure used?

a. Hand b. Machine c. Both

56. Milking frequency per day: a. Once b. Twice c. Three or more times _______

57. What is the method of milk quality test and criteria use? a. Alcohol test b. Density Test c. Clot on boiling test d. Lactoscan e. Other (Specify)

58. Has your milk been rejected by the cooperative? A. Yes…. B. No……

If yes, why was it rejected?

a. Low fat b. Abnormal color c. Failed Alcohol test d. Low Density e. Abnormal smells f. Dirt g. Other (Specify)

59. What is the selling price of the milk? ______________

60. Any comment that you want to make concerning:___________________________

7.2. General Linear Model (glm) of Total Nutrient Intake of Cows

Appendix Table 1: Total DM intake

Dependent Variable: DM

Source	DF	Squares	Mean Square	F Value	Pr > F
Model	4	1583.760146	395.940036	99.95	<.0001
Error	1795	7110.507754	3.961286		
Corrected Total	1799	8694.267900			

R-Square	Coeff Var	Root MSE	TDMI_ Mean
0.182161	19.02525	1.990298	10.46135

Appendix Table 2: Total CP intake

Dependent Variable: CP

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	22.10446053	5.52611513	1180.12	<.0001
Error	1795	8.40540261	0.00468268		
Corrected Total	1799	30.50986314			

R-Square	Coeff Var	Root MSE	TCPI Mean
0.724502	17.00759	0.068430	0.402350

Appendix Table 3: Total Ash intake

Dependent Variable: Ash

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	17.18910087	4.29727522	278.70	<.0001
Error	1795	27.67679364	0.01541883		
Corrected Total	1799	44.86589452			

R-Square	Coeff Var	Root MSE	TAshI Mean
0.383122	17.37604	0.124173	0.714620

Appendix Table 4: Total ADF intake

Dependent Variable: ADF

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	73.3506487	18.3376622	93.66	<.0001
Error	1795	351.4429307	0.1957899		
Corrected Total	1799	424.7935795			

R-Square	Coeff Var	Root MSE	TADFI Mean
0.172674	16.55654	0.442482	2.672549

Appendix Table 5: Total ADL intake

Dependent Variable: ADL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	6.90689208	1.72672302	193.59	<.0001
Error	1795	16.01052405	0.00891951		
Corrected Total	1799	22.91741612			

R-Square	Coeff Var	Root MSE	TADLI Mean
0.301382	17.55074	0.094443	0.538115

Appendix Table 6: Total NDF intake

Dependent Variable: NDF

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	300.406855	75.101714	86.87	<.0001
Error	1795	1551.837573	0.864533		
Corrected Total	1799	1852.244429			

R-Square	Coeff Var	Root MSE	TNDFI Mean
0.162185	17.39055	0.929803	5.346598

7.3. General Linear Model (glm) of Initial, Final and Daily Weight Gain

Apendex Table 1: Initial body weight

Dependent Variable: Initial weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	34657.1667	8664.2917	2.63	0.0507
Error	35	115258.7333	3293.1067		
Corrected Total	39	149915.9000			

R-Square	Coeff Var	Root MSE	W1 Mean
0.231177	17.36064	57.38560	330.5500

Appendix Table 2: Final body weight

Dependent Variable: Final Weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	48566.8331	12141.7083	4.07	0.0082
Error	35	104388.1419	2982.5183		
Corrected Total	39	152954.9750			

R-Square	Coeff Var	Root MSE	W2 Mean
0.317524	16.12056	54.61244	338.7750

Appendix Table 3: Daily body weight gain

Dependent Variable: Daily weight gain

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.28494555	0.07123639	4.99	0.0028
Error	35	0.50012852	0.01428939		
Corrected Total	39	0.78507407			

R-Square	Coeff Var	Root MSE	DWG Mean
0.362954	63.84831	0.119538	0.187222

7.4. General Linear Model (glm) on milk yield and components

Appendix Table 1: Morning milk yield

Dependent Variable: Morning Milk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	736.565736	184.141434	90.45	<.0001
Error	1795	3654.473014	2.035918		
Corrected Total	1799	4391.038750			

R-Square	Coeff Var	Root MSE	Morn Mean
0.167743	22.42015	1.426856	6.234167

Appendix Table 2: Evening milk yield

Dependent Variable: Evening Milk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	212.005264	53.001316	58.14	<.0001
Error	1795	1636.474736	0.911685		
Corrected Total	1799	1848.480000			

R-Square	Coeff Var	Root MSE	Eve Mean
0.114692	26.67101	0.954822	3.210000

Appendix Table 3: Total milk yield

Dependent Variable: Total Milk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	1681.70691	420.42673	86.52	<.0001
Error	1795	8722.93184	4.85957		
Corrected Total	1799	10404.63875			

R-Square	Coeff Var	Root MSE	Totmilk Mean
0.161630	22.16821	2.204444	9.456667

Appendix Table 4: Milk fat content

Dependent Variable: Milk Fat

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	6.39739362	1.59934840	1.47	0.2330
Error	35	38.14854388	1.08995840		
Corrected Total	39	44.54593750			

R-Square	Coeff Var	Root MSE	Fat Mean
0.143613	31.03711	1.044011	3.363750

Appendix Table 5: Protein content of milk

Dependent Variable: Milk Protein

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.15012309	0.03753077	0.39	0.8144
Error	35	3.36943691	0.09626963		
Corrected Total	39	3.51956000			

R-Square	Coeff Var	Root MSE	protein_ Mean
0.042654	9.683941	0.310273	3.204000

Appendix Table 6. Solid not fat of milk

Dependent Variable: SNF

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	1.97428481	0.49357120	0.87	0.4937
Error	35	19.93715269	0.56963293		
Corrected Total	39	21.91143750			

R-Square	Coeff Var	Root MSE	SNF_ Mean
0.090103	10.26683	0.754740	7.351250

Appendix Table 7: Milk density

Dependent Variable: Density

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.00005448	0.00001362	1.87	0.1383
Error	35	0.00025542	0.00000730		
Corrected Total	39	0.00030990			

R-Square	Coeff Var	Root MSE	Density Mean
0.175801	0.263156	0.002701	1.026550

Appendix Table 8: Total solid of milk

Dependent Variable: Total Solid

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	4.52028992	1.13007248	0.43	0.7883
Error	35	92.67638758	2.64789679		
Corrected Total	39	97.19667750			

R-Square	Coeff Var	Root MSE	solid Mean
0.046507	14.49105	1.627236	11.22925

7.5. Pictures Taken During Experiment

Pictures taken During Urea Molasses Block Preparation

Field observation made for selection of cows

Urea solution made on-farm for straw treatment

Solution was sprayed to teff straw, mixed thoroughly and compacted in pit

The treated straw covered and topered with soil

Preparation of ingridients forUrea Molasses Block

UMB making