ANALYSIS OF DAIRY FEED VALUE CHAIN, CHEMICAL COMPOSITION AND CARBON FOOTPRINT IN ADAMA - ASSELA AND JIMMA MILK SHEDS

MSc. THESIS

BY

SHIGUT DIDA WODAJO

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JIMMA, ETHIOPIA

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A Thesis

Submitted to the School of Graduate Studies of Jimma University, College of Agriculture and Veterinary Medicine, Department of Animal Science in Partial Fulfillment of the Requirements for the Masters of Science in Agriculture (Animal Production)

Major advisor: Taye Tolemariam (PhD, Professor)

Co-advisor: Eyerus Muleta (MSc, PhD candidate)

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I have incorporated the suggestions and modifications given during internal thesis defense and got the approval of by my advisers. Hence, I hereby kindly request the Department to allow me to summit my thesis for external defense.

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We, the thesis advisers have evaluated the contents of the Thesis and found to be executed according to the approved proposal, written according to the standards and formats of the University and is ready to be submitted. Hence, we recommend the thesis to be submitted for external defense.

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Chairperson, CGS ______ Signature ______ Date ______

DEDICATION

I dedicate this thesis to my family Ato Dida Wodajo and Tadelu Bekele for their wholehearted partnership in the success of my life.

STATEMENT OF THE AUTHOR

I declare that this thesis is my original work and that all sources of material that are used for this thesis have been duly acknowledged. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and completion of this thesis.

This thesis is submitted in partial fulfilment of the requirements for M.Sc. degree at Jimma University and is deposited at the university library to be made available to borrowers under rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the awards of any academic degree, diploma, or certificate.

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Place: Jimma University

Date of submission:

Animal science (Animal production)

BIOGRAPHICAL SKETCH

Shigut Dida was born at Bedele district, Buno Bedele Zone on April 22, 1987. He attended his elementary, Junior Secondary and High school education at Bedele Senior and Elementary School and Bedele Senior Secondary School, respectively. He joined Bekoji ATVT College in 2004 and awarded a Diploma in Animal Science in 2006, and then he was employed at Chora Livestock Development and Health Care Office. He then joined Jimma University, College of Agriculture and Veterinary Medicine in 2010 and received Bachelor of Science (B. Sc) degree in Animal Science. After his graduation he served in Chora Livestock Development and Health Care Offices as Animal Production Expert until he joined the School of Graduate Studies of Jimma University on September 30, 2017 to pursue his studies leading to Master of Science in Animal Production.

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LIST OF ABBREVIATIONS

ADF	Acid Detergent Fiber
ADL	Acid Detergent Lignin
AOAC	Association of Official Agricultural Chemists
CH_4	Methane
CO_2	Carbon dioxide
CP	Crude Protein
CSA	Central Statistical Agency
CSD	Climate Smart Dairy
DA	Development agent
DAP	Diammonium phosphate
DM	Dry Matter
EE	Ether Extract
EF	Emission factor
FAO	Food and Agricultural Organization of the United Nations
FDRE	Federal Democratic Republic of Ethiopia
GHG	Greenhouse Gas
GMM	Gross Marketing Margin
GMMp	Gross Marketing Margin of producer
IPCC	Intergovernmental Panel on Climate Change
JUCAVM	Jimma University College of Agriculture and Veterinary Medicine
KFA	Kenya Farmers Association
KG	Kilogram
Km	Kilo meter
L	Liter
LCA	Life Cycle Analysis
N	Nitrogen
N_2O	Nitrous oxide
NDF	Neutral Detergent Fiber
NGO	Non-Governmental Organization

NMM	Net marketing margin
OCSI	Oromia Credit and Saving Institution
SNV	Nederland’s Development Organization
TGMM	Total Gross Marketing Margin
WLFRDO	Woreda Livestock and Fishery Resource Development Office

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ABSTRACT

This study was aimed to identify dairy feed value chain actors and their role, analyze the chemical composition of feed and carbon footprint in Adama-Assela and Jimma milk sheds. Data were collected from primary and secondary sources. Multistage sampling technique was used to select representative producers. Eight towns from Assela and Jimma milk sheds were purposively selected based on access, potential for milk production and supply to the market. Descriptive statistics and General Linear Model Procedures were used to analyze the data using SPSS Software version 20. The feed value chain actors identified include input supplier, feed producer, feed processor, feed traders and end-users. The highest Gross Marketing Margin (GMM) of producer from wheat bran and concentrate feed were obtained in Assela channel I (producer ► end-use) (100%). The highest crude protein (CP) content both from roughage and concentrate was obtained in Assela milk shed while the highest crude fiber (CF) content was recorded in Jimma milk shed. The CO_2 emission in Assela milk shed from feed production, processing and transportation was significantly higher ($P \leq 0.05$) than that of Jimma milk shed. But inversely the mean CO_2 emission from feed transportation by Jimma feed traders was significantly higher ($P \leq 0.05$ than that of Assela feed traders. In both milk sheds, increasing of feed productivity is associated with decreasing CO_2 emission. Hence, in Assela milk shed increasing one quintal of feed production resulted in decreasing CO_2 emission by 7% while in Jimma milk shed increasing feed production by one quintal decreased CO_2 emission only by 1%. Likewise, in Jimma milk shed to transport one quintal feed increased CO_2 emission by 44% while in Assela milk shed it increased CO_2 emission by only 10%. Generally, the study indicated that high CO_2 emission was recorded using high rate of synthetic fertilizer and traveling long distance to purchased feed. In the future, using both organic like animal manure and synthetic fertilizer instead of using synthetic fertilizer alone especially for Assela milk shed and planting of feed processing plant for Jimma milk shed are necessary to improve milk production and to reduce greenhouse gas emission.

Key word: CO_2 emission, Dairy feed, Dairy producer, Milkshed, Value chain

1. INTRODUCTION

Ethiopia holds the largest cattle population in Africa with an estimated herd of approximately 60.39 million head (CSA, 2018). Similarly, there are 12.39million dairy cows yielding 3.32 billion liters of milk per year, with national average milk production of 1.371 lits per cow per day. Despite the large and diverse livestock genetic resources, the economic contribution of the livestock sector to livelihoods of the livestock keepers in Ethiopia is very low (Tolera, 2007; Aklilu *et al.*, 2013). Among the major problems affecting livestock production and productivity in Ethiopia, feed shortage in terms of quantity and quality is the leading problem (FAO, 2018). There is a wide spectrum of livestock feed situations globally and within individual countries, varying from intensive use of crop-based feeds and pastures to spatially extensive use of grasslands and rangelands. Land availability and water are key constraints on the production of alternative feeds for ruminants in the most intensive systems. A structured approach to planning for this increase in demand will be necessary if demand is to be met cost-effectively, with minimal social disruption and minimal environmental impacts (FAO, 2012).

In Ethiopia, livestock feed resources are natural pasture, crop residue improved pasture, agro industrial by products and other by-products like food and vegetable refusal (CSA, 2018). The contribution of these feed resources, however, depends up on the agro-ecology, the type of crop produced, accessibility and production system (Seyoum *et al.*, 2001; Ahmed *et al.*, 2010). Natural pasture is the major source of livestock feed in Ethiopia. However, its importance is gradually declining because of the expansion of crop production into grazing lands, redistribution of common lands to the landless and land degradation (Berhanu *et al.*, 2009; Kassahun *et al*, 2016).The availability of feed resources and the nutritional quality of the available feeds are the most important factors that determine the productivity of livestock. One of the major problems to low milk production in the country is associated with shortage of livestock feeds both in quantity and quality, especially during the dry season (Zewdie, 2010).The potential role of available feed resource for dairy cattle in meeting current and future producer needs is recognized as vital to the development of dairying in Ethiopia. Therefore, the availability of information on the dairy cattle feed resource is vital if proper and steady dairy development is expected in Ethiopia (Alemayehu, 2003).

Value chains encompass the full range of activities and services required to bring a product or service from its conception to sale in its final markets whether local, national, regional or global (Campbell, 2008).The value chain connects the farmer and consumer which are at one end the farmers who grow the crops and raise the animals and at the other end the consumers who eat and drink the farm product. According to Adugna *et al.* (2014), feed value chain can also be defined as a market-focused collaboration among different stakeholders who produce and market value-added products. It helps to identify the critical constraints limiting the production, delivery and proper utilization of feeds for improved livestock production. The use of feed value chain analysis is a relatively recent phenomenon especially under Ethiopian conditions. The works of Gebremedhin *et al*. (2009) dealing with appraisal of fodder marketing and that of Getu *et al.* (2012) and Beneberu *et al.* (2012) in the dairy-feed and sheep-feed value chains, respectively, are some of the few efforts that can be mentioned .The major actors in the Livestock feed value chain are input supplier, feed producer, trader or retailer, feed processor and consumer or end user for their livestock .They have different activities one from another (Addisu *et al.*,2012).

Climate change is taken as the main threat to the survival of different species, ecosystems and the livestock production sustainability in many parts of the world. GHG (Greenhouse gases) are released into the atmosphere both by natural sources and anthropogenic (human-related) activities (Sejian and Naqvi, 2012). Developing countries are more susceptible to the effects of climate change due to their high reliance on natural resources, insufficient capacity to adapt institutionally and financially and high poverty levels (Thornton *et al*., 2009).

Greenhouse gas (GHG) emissions have gained international attention due to their effect on global climate. There are many sources of GHG emissions, with agriculture estimated to contribute about 11% of all global emissions (Smith *et al*., 2014), of which the livestock sector contributes 14.5% of global greenhouse gas emissions, driving further climate change (Rojas-Downing *et al*., 2017). Globally, feed production, processing and transport contributed about 3.2 Gt CO_2 eq.; accounting for about 45 percent of the sector's emissions (Gerber *et al*., 2013). The production of animal feed can be considered as one of the major hotspots in the environmental impact from livestock production. According to FAO (2010), related with feed production nitrous oxide and carbon dioxide emissions range from 27 - 38% and 5-

10% of total emissions, respectively. The GHG emission from animal feed production comes from both the primary stage of crop production and primarily as N_2O and from fossil energy related to fertilizer production emission and from use of fossil energy in the processing of the crop into animal feed. The magnitude of the contribution of transport to the overall environmental impacts of animal feed varies, depending on whether the feedstuff is home-grown or imported (FAO, 2010).The climate-smart agriculture (CSA) concept reflects an ambition to further integrate agricultural development and climate responsiveness. CSA aims to achieve food security and broader development goals under a changing climate and increasing food demand. CSA initiatives sustainably increase productivity, enhance resilience, and minimize greenhouse gas (GHGs) emissions (FAO, 2013). Climate-smart Dairy (CSD) practices help the world dairy in keeping aim to meet our future food requirements without further increase in emissions.

1.1. Statements of the problem

Several studies have been conducted on dairy feed production and use in Ethiopia. However, most of the studies focused on the agronomic and nutritional characteristics of available feed resource and feeding practices (Bediye *et al*. 2001). In Western Oromia including Jimma, study was made on dairy production potential and challenges focusing on dairy breed, feed and feeding problems by Galmessa (2013). As well as in South Eastern Oromia including Assela, the problems identified by different researchers in relation with dairy sector dealt more with the supply of feed and its quality. Feed value chain analysis is a relatively recent phenomenon especially under Ethiopian conditions. So, few researchers made an attempt on feed value chain like dairy-feed value chain by Getu *et al* (2012), sheep and feed value chain by Beneberu *et al* (2012) and analysis of livestock feed value chain in Diga district by Tolera *et al* (2014 which need to be mentioned. However, these studies did not address the benefit share of actors throughout the feed value chain. On the other hand, the gas emission from feed supply chain starting from production up to the end-user was not identified in relation to feed value chain in the selected milksheds. Annually 7750tone and 4340tonef milk was produced in Adama-Assela and Jimma milk sheds (Zijlstra *et al.*, 2015). To produce that amount of milk the base and more important one is feed supply for dairy. To fill the gap between feed demand and supply for their dairy, the producer used either producing by own or purchasing from others. So the dairy producer get feed from own by producing, from feed trader and feed processing plants that process feed and sale to others. The GHG emission is counted in the feed chain from input supply for production, transportation and machinery which is used for plowing the land and processing the feed. All activities which the dairy producer passed through to get feed for their dairy has own contribution to climate change by CO_2 emission to the environment but the way and potential of emission varies one from the another. Globally, GHG emissions from the production, processing and transport of feed account for about 45 percent of sector's emissions (Gerber *et al*., 2013). Fossil carbon dioxide (CO_2) and nitrous oxide (N_2O) are the dominant greenhouse gases in animal feed production. The dairy producer focused on improving milk production for their economic benefit. They do not know whether their activity releases toxic gases to the environment or not. This makes a conflict with environment and dairy sector. The climate resilience green economy had strategy to reduce GHG emissions from livestock sector concerning dairy production (FDRE, 2011).

Therefore, to reduce GHG emission and improve milk production identifying and selecting the best way of feed production and supply for the dairy sector could be the best solution. Hence this thesis is trying to identify the dairy feed value chain and greenhouse gas emission due to feed supply for the dairy in Assela and Jimma milk sheds.

1.2. Research question

The study tries to address the following question

1. Who are the dairy feed value chain actors and what are their roles in the chain?

2. What is the value share of the actors in dairy feed value chain?

3. What are the available feed resources and chemical composition of feeds found both in Assela and Jimma milk sheds?

4. What is the CO_2 contribution of the dairy to the environment?

1.3. Objectives of the study

General objective

The general objective of the study is analysis of dairy feed value chain, chemical composition and carbon footprint in Assela and Jimma milk sheds

Specific objective

- ✓ To identify the dairy feed value chain actors and their role
- ✓ To analyze the benefit share of actors in the dairy feed value chain
- ✓ To analyze the chemical composition of dairy feed in Assela and Jimma milk sheds
- ✓ To compute CO_2 emission in Assela and Jimma milksheds

2. LITERATURE REVIEW

2.1. Feed resources and marketing in Ethiopia

The major feed resources to livestock in Ethiopia and other tropical and sub-tropical regions include natural pasture, crop residue, agro-industrial by-products, stubble grazing and browse species which are used at the site of production or conserved for use during seasons of shortage. Their contribution to the total feed resource base varies from area to area based on cropping intensity (Seyoum *et al*., 2001). The potential role of available feed resource for dairy cattle in meeting current and future producer needs is recognized as vital to the development of dairying in Ethiopia. Therefore, the availability of information on the dairy cattle feed resource is vital if proper and steady dairy development is expected in Ethiopia (Tsehay, 1998).

Very few studies have addressed issues of feed supply and marketing. There is a serious dearth of information on the types of feed markets, the supply and demand conditions of feed, and how the feed markets operate (Gebremedhin, 2009). However, information concerning livestock feed demand and supply, feed quality issues, feed marketing, feed prices, price trends are scarce (Dejene *et al*., 2014).Feed marketing is one of the means by which smallholder livestock keepers address deficit feeds and get access to better quality feeds. Through the realization of comparative advantages, market development induces specialization, and may increase productivity and production. Improved incentives through profitable market outlets can facilitate technical efficiency (technical productivity increases) of feed production, which could include better agronomic practices, improved genetic resources, and better use and conservation methods. Improving market efficiency will increase demand and margins to producers and other market actors. Hence, feed market development can be considered as an important factor in alleviating the feed shortage problem (Birhanu *et al*., 2009).Feed marketing is normally carried out by licensed traders and largely involves the marketing of flour mill and oilseed by-products (Adugna *et al*., 2014).

2.1.1. Natural pasture

In most areas of sub-Saharan Africa, the major even the sole feed source available for large parts of the year in smallholder production systems are natural pastures (Gylswyk, 1995). Natural pasture in the high altitudes is rich in species diversity, particularly indigenous legumes (Kechero *et al*., 2010). As a result, pasture lands in the highlands are the main sources of feed for 5-8 months, depending on the size and productivity of the grazing land (Gizawu *et al*., 2017). Moreover, Beyene *et al*. (2011) and Assefa *et al*. (2015) proved that natural pastures remain the major source of feed in both dry and wet season. Natural pasture is the major feed resources especially in wet season in highlands and mid-altitude of Horro and Guduru district (Kassahun *et al.*, 2015) However, the productivity of pasturelands shows a declining trend from year to year due to over-gazing, increasing of farm land and livestock population per unit area. Size of private grazing lands range from 0.25 to 0.5 hectare per household. Indeed grazing lands owned privately were in good condition contributing more to animal feeding (Gizawu *et al.*, 2017). Natural pastures mostly suffer from seasonally spells of dry periods during which they drop in quality and quantity (Topps, 1995; Assefa, 2012). Poor management and over stocking is the main problem of grazing land followed by low yield and quality of pasture in Ethiopia (Ashagre, 2008).

2.1.2. Improved forage

A large number of annual and perennial forage and fodder species have been tested in the mid altitude under rain fed conditions in Ethiopia. Improved forages mainly legumes, can improve the productivity of natural pastures by improving the fertility status of the soil. They can also improve the feed value of the native pastures since they have more protein content than naturally occurring grasses. There are many different ways of forage development techniques to be adopted to survive feed scarcity periods by small holder farmers even though the level of these techniques usage by farmers of our country is quite minimal (Yeshitila, 2008).Improved fodder production is generally highly limited. The major bottleneck to improved fodder production is the small land holdings which is too small in many parts of the country even for sustaining smallholders' livelihoods from crop agriculture (Gizawu *et al.*, 2017). At present, the production of improved pasture and forages is insignificant

(Alemayehu, 2005). For instance, Assefa *et al*. (2015) exposed that improved forages like Rhodes grass, Elephant grass, Napier grass, Leuceana and Sesbania were common in the Shashogo Woreda, Hadiya zone.

2.1.3 Hay making and marketing

Hay making is commonly used means of feed preservation technique in Ethiopia, which is expected to mitigate problems of livestock feeding during the dry period and therefore such experience is a good indicator that there are certain practices of efficient feed utilization (Wondatir, 2010). Hay used as animal feeds that comprise about 6.55 percent of the total feeds (CSA, 2018). High quality hay can be defined as forage that is dried without deterioration and retaining most of its nutrients. Moreover, being free from mold development, retention on natural color and palatability and capability for storage over a long period of time are other important desirable qualities considered in hay. In many of urban and peri-urban areas, livestock farm owners rely on bought fodder, which is irregularly available and often of dubious quality (Vernooij, 2007). Commercial hay production is practiced in Sululta and Sendafa in the surroundings of Addis Ababa, and Tseda village in the surroundings of Gondar town. Farmers in these areas allocate their land for hay production because it becomes waterlogged during the wet season or is more profitable to produce hay. The sale of hay generates good income to the farmers in these areas. Hay is also produced in public, community and religious compounds (Gebremedhin, 2009).Hay is sold in situ, in human load, donkey load, heaps or bales. In some areas (e.g. Gondar and Zeway) hay is bought by a group of people (comprising of about 25 individuals) and divided among them. According to Adugna *et al*. (2014) and Gebremedhin (2009) different public ground compounds sell hay in situ. Airports, schools, churches, municipality offices etc. sell hay in situ (on farm). The amount of hay supplied from these sources is usually large and thus sold on auction. Sometimes dairy producers lease in plot for hay production and manage the plots (e.g. weeding and harvesting) themselves to produce good quality hay. The lease price of a unit of land is usually 50% less than if the hay would be bought in situ at harvest.

2.1.4. Crop residues production and marketing

Crop residues are the fibrous by-products which result from the cultivation of cereals, pulses, oil plants, roots and tubers and represent an important feed resource (Yayneshet, 2010). Alemu *et al*., (1991 reported that Crop residues is produced widely around crop livestock farming system but, most of which are underutilized. They are important in fulfilling feed gaps during periods of acute shortage of other feed resources. A report by CSA (2018) indicated that crop residues contribute to about 30.12% of the total feed supplied in Ethiopia. Cereal straws such as teff, barley, and wheat and pulse crop residues are stalked after threshing and fed to animals during the dry season when the quality and quantity of available feed from natural pasture declines drastically in different parts of the Ethiopian highlands (Bogale, 2004). The types of crop residues in the country differ from place to place depending on the type of crop grown as determined by the agro-climatic conditions. The major crop residues supplied in the market are cereal crop residues like teff straw, barley/wheat straw, green maize fodder, sorghum Stover and oat (Avena sativa) fodder (Dejene *et al*., 2014). However, there is a limited supply of pulse crop residues. The area of grazing land has declined markedly particularly in the highlands, and this trend is continuing at an increasing rate due to expansion of crop cultivation and urbanization, and to a lesser extent through land degradation (MoARD, 2007).

Teff grows in a wide range of altitude and is a preferred straw. In the Bishoftu, Mojo and Adama areas, it was reported that there was a decrease in the amount of teff straw supplied since farmers were shifting from teff production to wheat production due to the rise in the relative price of wheat grain, although wheat straw is less demanded than teff straw and has lower price. Farmers reported that good quality barley/wheat straw has whitish color. In Shashemene area pure wheat straw is one of the major types of feed available in the market. If stover is sold to neighbors' or relatives, sales price is usually lower than market price. In Alamata area, it was reported that Stover sale started only about 10 years ago, mainly due to the increasing feed shortage due to drought and distribution of grazing lands to the landless youth. Maize Stover is sold mostly green; sale of dry maize Stover is limited. In some areas, such as in the surroundings of Adama, maize production for green corn is common during the rainy season. Irrigated private and government farms also supply green maize Stover. In some areas, green maize Stover is sold in situ to traders who retail it in towns (Gebremedhin, 2009).

2.1.5. Agro-industrial by-products producing and marketing

Agro-industrial by-products are widely used include those resulting from flour factories, modern and traditional oilseed processing units, breweries, sugar factories, among others. The availability of these by-products varies from region to region and season to season, which is attributable to the location of the industries and seasonal availability of raw materials (Seyum *et al*., 2018). The major agro-industrial by-products commonly used are obtained from milling industries, edible oil extracting by-products, brewery, and sugar producing industries (Tolera, 2007 and Birhanu *et al*., 2009). Though increased utilization of agro-industrial by-products has been reported (Benin *et al*., 2004), they are not available, affordable or feasible for most of the farmers in the highlands of Ethiopia. According to Gizawu *et al*. (2017) the feed types traded in different area in addition to roughage marketing the IBP marketed are mill residues, cereal bran, pulse bran, oil seed cakes, and formulated rations. The types of feed traded varied between regions and districts depending on the type of crops grown and the presence or accessibility of cereal processing mills, oil extracting plants, and feed processors.

In the country level 1 872 368 Tone of wheat bran was produced annually (Seyum *et al*., 2018). Three types of wheat bran are supplied namely fine, coarse and mixed. Mixed bran is produced by some factories that do not sieve out the coarse bran. Wheat bran is also differentiated based on the type of wheat. For example, it was reported that wheat bran from durum wheat is of higher quality than from the bread wheat, because it has more flour content. It is the most common by-product marketed and used for livestock feeding (Dejene *et al*., 2014)

Seed cakes are the residues produced as by-products during extraction of oil from oilseeds. The main ones are noug cake, cottonseed cake, groundnut cake, sesame cake, and sunflower cake (Seyum *et al*., 2018). In west, South West and North Shewa zones, the seeds cakes traded are noug and linseed cakes. In Adama town, cottonseed, linseed and nougseed cakes are most supplied (Dejene *et al*., 2014)**.** In Adigrat area, the seed cakes traded are noug, linseed, and sesame seed cakes, in that order of importance, in Shashemene, linseed cake is the most traded in Zeway, linseed cake is most traded, followed by noug and cotton seed cakes in Gondar, the seed cakes produced in the town are sesame, noug, cotton, safflower, mixed sesame noug, and mixed safflower sesame seed cakes. There is no linseed cake production in Gondar in Debre Tabor area, only noug cake is produced and traded in the town, very occasionally mixed with safflower. The area is an important grower of noug (Gebremedhin, 2009).

2.2 Chemical composition of different feeds

The availability of feed resources and the nutritional quality of the available feeds are the most important factors that determine the productivity of livestock (Ahmed *et al*., 2010). As proved by Deribe (2015) dry season natural pastures and crop residues are of poor quality due to high cell wall fibre components (ADF and NDF) hence their digestibility is low. Moreover, these feed resources showed CP contents below the critical level (7 %) required for optimum rumen function and feed intake. On the other hand, he found out that indigenous browses and nonconventional feeds contain low NDF and high CP values with better digestibility, and that suggests their potential suitability for strategic supplementation, particularly during the dry season. Crop residues have certain inherent disadvantages in that nutritionally they have low digestibility and are deficient in nitrogen and in many mineral elements, they are physically resistant and may contain high amounts of indigestible lignin and silica. Low digestibility associated with low nitrogen content of the feed limits intake and animals on these diets are often in negative energy and nitrogen balance (Yeshitila, 2008).

2.3. Value chain

2.3.1 Concept of Value Chain

Value chain is the full range of activities and services required to bring a product or service from its conception to sale in its final markets. A value chain, thus, encompasses the entire network of actors involved in input supply, production, processing, marketing and consumption. These value chain actors operate within an institutional environment, which can either facilitate or hinder its performance (Gereffi, 1995). Laws, rules, regulations, policies, international trade agreements, social norms and customs all contribute to this institutional environment, as do public goods such as infrastructure, research, extension, price information systems and business development services. Businesses that provide crosscutting services such as finance and transport likewise contribute key elements to the institutional environment affecting the value chain performance (Haggblade and Theriault, 2012). The idea of value chains is quite intuitive. It exists when all of the actors in the chain operate in a way that maximizes the generation of value along the chain. Value chain can be in a narrow or in a broad sense. In the narrow sense, a value chain includes the range of activities performed within a firm to produce a certain output. In other words, all activities constitute the chain which links producers to consumers and each activity adds value to the final product. The broad approach does not only look at the activities implemented by a single enterprise. Rather, it includes all its backward and forward linkages, until the level

Value chain analysis is about understanding how activities and actors that are involved in bringing a product from production to consumption are linked.

Value chain actors are all the individuals or organizations, enterprises and public agencies related to a value chain and therefore important for understanding the functioning and performance of the value chain (Stein and Barron, 2017).

Feed value chains may consist of various functions such as input supply, production, processing, marketing and consumption. They may also consist of a range of enablers and supporters interacting within the borders of a given locality or beyond borders in different ways to sustain the operation of the entire value chain (Adugna *et al.,* 2014). This suggests the need to visualize the input supply, production, marketing and utilization of feed through a value chain lens to better understand the constraints and to be able to put in place appropriate value chain improvement strategies.

Value chain mapping is defined as drawing a visual representation of the chain, which involves various linkages among the dairy actors. According to McCormick and Schmitz (2001), value chain mapping enables to visualize the flow of the product from conception product design to end consumer through various actors. The value chain approach facilitates mapping and characterization of feed production activities, identification of the actors involved as well as their roles and the nature of the interaction between them (Anandajayasekeram and Gebremedhin, 2009; Rich *et al*. 2011).

Value chain supporters/Enablers are the service providers by actors who never directly deal with the product but whose service add value to the product for instance like banks, microfinance institutions, insurance companies, transporters, brokers; and other supporters including NGOs, government agencies, and research centers (KIT and IIRR 2010).The financial services they provide include loans, pre-financing, shareholdings, factoring, leasing arrangements, and so on. It is not just financial institutions that provide financial services; for example, an input supplier may give a farmer a loan in the form of fertilizer, in return for repayment plus interest after harvest (KIT and IIRR 2010).

2.3.2. Empirical review on dairy feed value chain

The feed value chain and analysis of the feed value chain is essential for an understanding of the core processes, activities and the major actors involved in the chain. It also helps to identify the critical constraints limiting the production, delivery and proper utilization of feeds for improved livestock production. The use of feed value chain analysis is a relatively recent phenomenon especially under Ethiopian conditions. The work of Getu *et al* (2012) on the dairy-feed value chain and that of Beneberu et al (2012) in sheep feed value chain are some of the few efforts which need to be mentioned. The feed value chain includes input supply, production, retailing and consumption. For example, at one end of livestock value chain are the producers who raise the animals and at the other end are the consumers who consume the livestock products, and in the middle stages are other actors undertaking intermediate activities (Diriba *et al.*, 2014). Value chains may also include a range of services needed to maintain function including technical support (extension), business enabling and financial services, innovation and communication and information brokering. Value chains can be simple when producers directly sell to the consumers but long and complex when other actors play roles in buying, processing, transporting and selling to the end user.

2.3.3. Actors participate in Feed value chain

Major feed inputs used for on-farm feed production include forage seed, labour for on-farm activities, fertilizer and fencing materials for native hay production plots, the latter often sold to peri-urban dairy farmers (Adugna *et al.*, 2014). Addisu *et al.* (2012) reported that input supply for feed production includes provision of land, seed, fertilizer and industrial by products used as inputs for the production of animal feed.

Feed Production/producer are farmers generally use crop residue and natural pasture for their animals and produce oats primarily for grain and use the residue for animal feed (Beneberu *et al*., 2012**).** According Nangole *et al*. (2013), feed producer are farmers who undertake production of livestock feeds with an intention to sell, some grow for their own livestock but sell when there is excess

Feed Processing/processor are processing of the feed includes baling of hay and straws; stacking of the feed materials for future use including grinding or crushing the feed resource for subsequent uses and mixing of the feed ingredients for various form of utilization (Addisu *et al.*, 2012).

In the feed value chain the feed trader category contains marketing agents who take the feed commodities from different value chain actors and sell the feeds to end users, i.e. livestock producers (Nangole *et al*., 2013).

Consumers/end user actors include consumers of various types who use the feeds at the final stage in the value chain. Consumers are in general smallholder farmers, small- and large-scale commercial dairy and fattening farms and higher learning and research institutions (Kitaw *et al*., 2012).

2.4. The major Ethiopian milksheds

In Ethiopia eight milksheds were identified, those are Adama–Assela, Great Addis, Ambo – Waliso, Bahir Dar, Dire Dawa, Jimma, Zeway - Hawassa and Mekelle milksheds (Brandsma *et al.*, 2013) The Adama-Asella milkshed is the largest in the country in terms of the potential volume of raw milk production as well as the number of milking cows. It has well-developed infrastructure to access the large Addis Ababa market and other small towns using new express roads. The area also has high potential for roughage production, access to feed from nearby feed factories (Alema Koudijs Feeds, Ethio Feed and others) and factory by-products are also widely available. The Great Addis milkshed is the most developed milkshed and is leading the dairy development in the country. Many linkages between chain partners are already developed and are evolving further. In the Ambo-Woliso milkshed, which consists of West and South-West Shoa in the Oromia region, market potential is high because of access to nearby places like Addis. Milk production is low compared to the number of milking cows, since most of them are local breeds with low average daily production (Zijlstra *et al*., 2015).

The Bahir Dar milkshed also has good conditions for fodder production and is developed by a significant number of cooperatives and a few active cooperative unions involved in milk processing. In the Hawassa milkshed, still much has to be developed. The small cooperative and private processors are so far only able to process small volumes. In the Dire Dawa and Jimma milksheds, farmers make their livelihoods from cash crops such as chat and coffee, and it may be hard for milk production to compete with these crops. This situation is exacerbated by the low availability of fodder in both areas; in Dire Dawa due to low rainfall, and in Jimma due to intensive cropping. The situation in Mekelle is uncertain, with fodder availability and the investment climate being uncertain factors (Zijlstra *et al.*, 2015).

2.5. Greenhouse gas emission from feed supply chains

Feed production is very important for all or a large fraction of the emissions of GHGs in the life cycle of livestock supply chains. Beside its contribution to climate change, the feed supply chain contributes to other impacts, such as eutrophication, acidification and fossil energy use. Globally, GHG emissions from the production, processing and transport of feed account for about 45 percent of sector emissions (Gerber *et al*., 2013). Feed production for pork and chicken supply chains contributes 47 percent and 57 percent of emissions, respectively (MacLeod *et al*., 2013). For cattle, small ruminants and buffalo, feed production accounts 36 percent, 36 percent and 28 percent respectively of the total emissions (Opio *et al*., 2013). In ruminant production systems, methane from feed digestion is the largest contributor of GHG emissions. Fossil carbon dioxide (CO_2) and nitrous oxide (N_2O) are the dominant GHGs emitted in animal feed production. The fertilization of feed crops both synthetic and organic fertilizer about half of the emissions from feed (one-quarter of the sector's overall emissions). Carbon dioxide emissions result largely from the use of fossil fuels, particularly diesel in tractors and harvesting machinery and from feed transportation. In the post-farm stages, carbon dioxide is emitted in conjunction with various feed processes and is associated with processing, mixing, and distribution of feed ingredients. Crops produced for feed account for an additional quarter of emissions, and all other feed materials (crop by-products, crop residues, fishmeal and supplements) for the remaining quarter (Gerber *et al*., 2013).

2.6. Effect of climate change on quantity and quality of feed

Quantity and quality of feed will be affected mainly due to an increase in atmospheric CO_2 levels and temperature (Chapman *et al*., 2012). The effects of climate change on quantity and quality of feeds are dependent on location, livestock system, and species (IFAD, 2010Changes in temperature and CO_2 levels will affect the composition of pastures by altering the species competition dynamics due to changes in optimal growth rates (IFAD, 2010,Thornton *et al.*, 2015). Plant competition is influenced by seasonal shifts in water availability (Polley *et al*., 2013). Primary productivity in pastures may be increased due to changes in species composition if temperature, precipitation, and concurrent nitrogen deposition increase (IPCC, 2007).Quality of feed crops and forage may be affected by increased temperatures and dry conditions due to variations in concentrations of water-soluble carbohydrates and nitrogen. Temperature increases may increase lignin and cell wall components in plants (Polley *et al*., 2013, Sanz-Saez *et al*., 2012), which reduce digestibility and degradation rates (IFAD, 2010, Polley *et al.*, 2013), leading to a decrease in nutrient availability for livestock (Thornton *et al*., 2009). Extreme climate events such as flood, may affect form and structure of roots, change leaf growth rate, and decrease total yield (Baruch and Mérida, 1995).

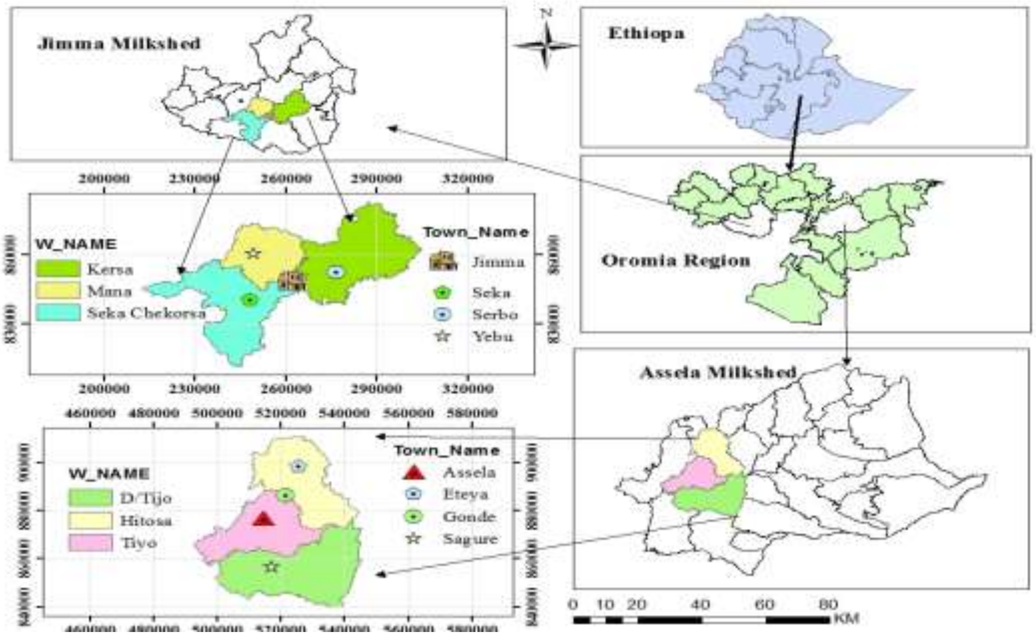
Impacts on forage quantity and quality depend on the region and length of growing season. The length of growing season is also an important factor for forage quality and quantity because it determines the duration and periods of available forage. Therefore, if forage quality declines, it may need to be offset by decreasing forage intake and replacing it with grain to prevent elevated methane emissions by livestock (Polley *et al.*, 2013).

3. MATERIALS AND METHODS

3.1. Description of the Study Areas

This study was conducted in Assela and Jimma milk sheds that were selected from the four milk sheds found in Oromia Regional State based on access, potential of milk production and supply to the market (Brandsma *et al.*, 2013). The Adama - Assela milk shed is the largest in the country in terms of the potential volume of raw milk production as well as the number of milking cows and share about 7,750 tons of milk in Ethiopia. It is found 175km along the southeastern direction of Addis Ababa. This milk shed is characterized by a well-developed infrastructure to access the large Addis Ababa market and other small towns using new express roads. The area also has high potential for roughage production and access to feed from nearby feed factories and factory by products. Additionally, the number of crossbreds and exotic cows are relatively high and comparatively AI services are functioning well (Zijlstra *et al.*, 2015)

Jimma is located 352 km southwestern of Addis Ababa, capital city of Ethiopia and is located at 7°4′N latitude and 36°50′E longitudinal and situated at an altitude of 1704m above sea-level. The area has sub-humid tropical climate with average annual rainfall ranging from 1200 to 2000 mm, having a bimodal pattern. The average annual minimum and maximum temperatures are 25 to 30 °C, respectively (CSA, 2012). In Jimma milk shed annually 4340 tons of milk was produced, even if this amount of milk was produced, high demand of dairy products was there, the farmers make their livelihoods from cash crops like chat and coffee, and it will be hard for milk to compete with these crops and it is provoked by the low availability of fodder due to intensive cropping (Zijlstra *et al.*, 2015).



W = woreda

Figure 1.Map of study area

3.2. Sampling Techniques and sample size determination

3.2.1. Household sampling

Multistage sampling technique was used to select the representative household for this study. Assela and Jimma milk sheds were purposively selected from eight milk sheds identified in Ethiopia. From the selected milk sheds, four towns each found surrounding in the Assela and Jimma milk sheds were also purposively selected based on the milk production potential and accessibility with support of information from respective Zonal Livestock and Fishery Resource Development Office. The selected towns include Assela, Itaya, Sagure and Gonde from Assela milk sheds; Jimma, Kersa, Yebu and Sekka from Jimma milk sheds. The representative sample size was computed according to Yemane (1967).

$n = N/ (1+N (e)^2)$

Where

n =sample size

N=number of farmers per strata

e = level of precision (0.09)

Using the above formula from the total milk producer populations identified in the milk shed (45215 in Assela and 52484 in Jimma milk shed), 246 dairy producers from both milk sheds were randomly assigned for formal survey of this study (Table 1). The other value chain actors like feed dealers and feed processors were selected as they exist. Accordingly, 15 feed traders and one feed processor were interviewed in Assela milk shed, while 4 (four) private feed traders, one cooperative were interviewed from Jimma milk shed. After a formal survey was undertaken, those randomly selected interviewed milk producers were stratified (grouped) again in to urban and peri-urban milk producers.

Table 1 Sample size for the survey and experimental feed sample

Category of the study	Assela milk shed (N = 123)				Jimma milk shed (N = 123)			
	Assela	Itaya	Gonde	Sagure	Jimma	Yabu	Seka	Serbo
producer's survey	25	35	32	31	31	30	31	31
Feed sample	3	3	3	3	3	3	3	3

3.2.2. Feed sampling

Major livestock feeds were identified from the farmers' interview. Feed samples from the major feeds were collected according to the preference rank given by the respondents regarding their relative abundance in the area or used by dairy producer. The feed sample from both roughage and concentrate feed were taken from 3 dairy producer from each town. In total, 12 dairy producer were purposively selected from each milk shed and pooled by its type then the sub-sample of pooled feed were taken for laboratory analysis.

3.3. Data collection methods

3.3.1. Secondary data

The secondary data were obtained from the Zonal Livestock and Fishery development Offices of both milksheds. The information obtained from Woreda Livestock office were total number of dairy producer; number of dairy animals; milk production potential of cows per day/lactation; distance from main road as well as from the other town in that milk shed, organization (Government and NGOs) found to provide feed and other input, number of feed processing plants and the number of actors/feed dealers and potential feed resource existing in the milk shed were obtained.

3.3.2. Primary data

The primary data were using semi structured questionnaire for the respondent who participated in dairy production as well as the other actors participated in the dairy feed marketing like private dealer and cooperatives.

3.3.2.1. Key informant interviews

The key informants identified for this study were Development Agents (DAs), Zonal and Woreda livestock expertise, the Cooperative Promotion Office, leaders of cooperatives and unions, leaders of feed processor plant and Zonal Livestock and Fishery resource leader. By Key Informant Interview (KII) Rapid market appraisal was conducted to map core functions and actors involved in the dairy feed value chain.

3.3.2.2 Survey

Before households were interviewed, rapid appraisal techniques or preliminary observation was undertaken. For this survey questionnaire were prepared for each value chain actors operating within the two milksheds (Appendix I). The questionnaire was pretested before the actual survey and refined for the formal survey. Survey results from a questionnaire were used to collect data on feed production, feed marketing (buying or selling), and means of feed transportation, cost of feed and transportation cost by interviewing individual farmers at their farm stead. The important data from feed dealer and from feed processor also obtained by interviewed.

3.3.2.3 Distribution of costs and margins

Major marketing costs of feed starting from the producers and the different actors were identified. At each stage in the chain, the value of the product from producer up to end users was estimated. The buyer/ consumer price is then the base or the common denominator for all marketing margins. Computing the Total Gross Marketing Margin (TGMM) is always related to the final price or the price paid by the end user and expressed as a percentage.

The concept of Market margin analysis helps to see how much of the total price paid by the consumers is shared among market participants and finally compare the amount of margin obtained and the value additions or other productive activities by each participant so as to recommend for elimination or control of the unproductive market participant which in turn contribute for the efficiency of the market chain (Scarborough and Kydd, 1992)..

Net Marketing Margin (NMM): In marketing chain the net marketing margin of a particular marketing agent, as an indicator of the efficiency of the channel, is defined as the percentage over the final price earned by the intermediary as his net income once his marketing costs are deducted the estimation of market actors' net marketing margin was estimated according to Mendoza (1995).

$$TGMM = \frac{\text{Consumer price} - \text{Farmer's price}}{\text{Consumer price}} \times 100$$

$$GMMP = \frac{\text{Price paid by consumer} - \text{Total gross marketing margin}}{\text{Price paid by the consumer}} \times 100$$

$$NMM = \frac{\text{Gross Margin} - \text{Marketing Costs}}{\text{Price paid by consumers}} \times 100$$

Where:

TGMM = Total Gross Marketing Margin,

GMMP = Gross Marketing Margin of Producers

NMM = Net Marketing Margin

Estimate the quantity of available feed resource

The quantity of feed in dry matter obtained annually from different land use types were calculated by multiplying the hectares of land under each land use type in the year obtained from the producer by its respective conversion factors set by FAO (1987), hence the conversion factors for barley, wheat and teff (1.5), for maize (2) and for sorghum (2.5) tone per hectare were used. From general production assuming about 10% of crop residues would be wasted during utilization (Tolera, 1990).

3.3.2.4. Chemical composition of feeds

The feed sample was collected for the determination of chemical composition. Chemical analyses of feed samples were analyzed in laboratory of Animal Nutrition and Post-harvest and Food Science of College of Agriculture and Veterinary Medicine, Jimma University. The feed samples were dried at 65°C for 72 hours in an oven dry to remove the moisture content of the feed. Ash, NDF, ADF, ADL and EE contents were determined according to the methods described by Association of Official Agricultural Chemists ***(***AOAC, 2000). Nitrogen (N) content was determined by Kjeldahl method after which Crude Protein (CP) was calculated as N*6.25.

3.3.2.5. Estimation of gas emission by using Life Cycle Analysis system boundaries

In the Life Cycle Analysis (LCA) systemic boundary three types of stream were there (Figure.2). Those are upstream; on farm feed production and Downstream. Among the three streams the study focused on upstream and on farm feed production to determine the gas emission through feed supply chain. The red color shaded and bounded in this LCA showed estimation of gas emission due to feed supply for dairy including producing, processing and transportation.

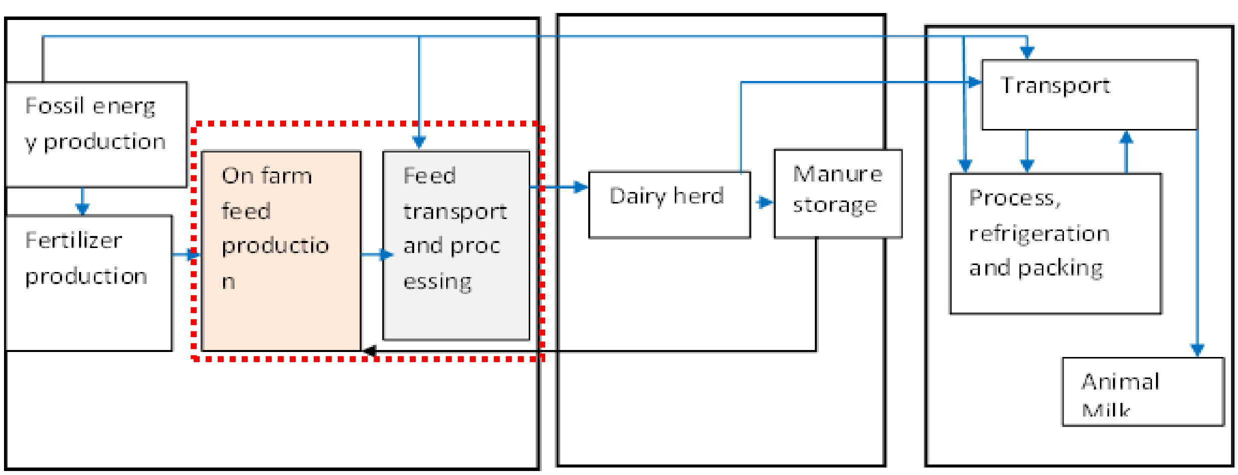


Figure 2: .Life cycle Assessment (LCA) of Ethiopian dairy chain

Adopted from De Vries *et al*., (2016)

a. Gas emission from on-farm feed production

Emissions from feed input (Fertilizer application)

Direct and indirect methods were used to estimate total anthropogenic emissions of N_2O from managed soils. Tier 1 approach of IPCC (2006) is used to compute both direct and indirect emission of N_2O from managed soils. Direct emission from crop production can be determined by direct emission of N_2O from synthetic and organic fertilizer application. Direct N_2O emissions occur via combined nitrification and de-nitrification of nitrogen contained in the fertilizer. The following formula is adopted from IPCC (2006) guideline to compute direct N_2O emission from feed production from managed soils considering fertilizer application as an emission source.

$N_2O\_ND = N_2O inputs$

$N_2O\ inputs = [[(F_{SN} + \mathrm{F_{ON}}) * EF1]] * \frac{44}{28}$

Where:

N_2O -N D =Annual direct N_2O –N emissions produced from managed soils, kg N_2O –N per year

N_2O inputs =Annual direct N_2O-N emissions from N inputs to managed soils, kg N_2O-N per year

F_{SN} = Annual amount of synthetic fertilizer N applied to soils, kg N per year

F_{ON} = Annual amount of organic fertilizer N applied to soils, kg N per year

EF1 = Emission factor for N_2O emissions from N inputs, kg N_2O –N per (kg N input).

Indirect emissions result from volatile nitrogen losses that occur primarily in the forms of ammonia and NOx. Emissions of N_2O take place through two indirect pathways; i.e. volatiliza tion and leaching.

Volatilization, N_2O (ATD)

The N_2O emissions from atmospheric deposition of N volatilized from managed soil is estimated using the equation below according to IPCC (2006) approach of Tier 1

$N_2O\ (ADTN)\_N = [(FSN * \mathrm{Frac}_{(GASF)}) + (FON * Frac_{(GASM)})] * EF_4 * \frac{44}{28}$

Where:

N_2O (ATD)–N = Annual amount of N_2O –N produced from atmospheric deposition of N

Volatilized from managed soils, kg N_2O –N per year,

F_{SN} = Annual amount of synthetic fertilizer N applied to soils, kg N per year

F_{ON} = Annual amount of organic fertilizer N applied to soils, kg N per year

$Frac_{GASF}$ = Fraction of synthetic fertilizer N that volatilizes as NH3 and NOx, kg N volatilized Per (kg of N applied)

FracGASM = Fraction of Organic fertilizer N that volatilizes as NH_3 and NOx, kg N volatilized

Per (kg of N applied)

EF4 = Emission factor for N2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N– N_2O per (kg NH3–N + NOx–N volatilized)]

Emission from Leaching/runoff

The N_2O emission from leaching was estimated using the following equation

$$N_2O\ (L)\_N = (F_{SN} + F_{ON}) * Frac_{LEACH}\_(_H) * EF5 \ \ *44/\ 28$$

Where:

N_2O (L)–N = Annual amount of N_2O –N produced from leaching and runoff of N additions to managed soils, kg N_2O–N per year

F_{SN} = Annual amount of synthetic fertilizer N applied to soils in, kg N per year

F_{ON} = Annual amount of organic fertilizer N applied to soils, kg N per year

$Frac_{LEACH-(H)}$ = Fraction of all N added to/mineralized in managed that is lost through leaching and runoff, kg N per (kg of N additions)

EF5 = Emission factor for N_2O emissions from N leaching and runoff, kg N_2O –N (kg N leached and runoff).

The greenhouse gas (GHG) emission were expressed according to IPCC (2007) in carbon dioxide (CO_2) equivalent so for conversion in this common unit multiplied by the global warming potentials (GWP) (for CO_2 = 1 and N_2O = 298).

b. Emission from farm machinery

The second source of GHG emission in the feed production is from farm machines. Emissions that contributed by farm machine (used to plough land and for harvesting) are accounted for the combustion of fuel by the machine. The primary source of GHG emission from farming machine is CO_2.The following equation is adopted from (IPCC 2006) guideline to determine GHG emission from fuel combustion.

$E_{fuel} = Fuel_{cons} * EF_{fuel}$

Where:

E_{fuel} = Emissions of a given GHG by type of fuel (kg GHG)

$Fuel_{cons}$ = Amount of fuel combusted (L)

EF_{fuel} = Emission factor of a given GHG by type of fuel (kg gas/L).

The emission factors of CO_2 per liter of fuel consumption in Ethiopia as follows according to FDRE, 2011.

Gasoline fuel = 2.42Kg CO_2/Lit

Diesel fuel = 2.67 Kg CO_2/Lit

c. Emission from Feed transportation

The following method is applied to estimate the carbon footprint of feed transportation. The type of transport used, kilometers travelled, and the quantity of feed transported is determined the

fuel consumption by the vehicle per kilometer and its full capacity of transportation is Consid ered. Allocation of fuel is made to find the quantity of fuel consumed only for a particular kilogram

of feed that is transported was computed. Then, total estimated CO_2 emissions from feed trans port were a product of the distance of feed transported, fuel consumption per kilometer and CO_2 emissions per liter of fuel.

$F_{fuel} = S*L$

$E = Fuel*EF$

Where:

Fuel is the total liters of fuel consumed by the vehicle to transport the feed to a certain distance (liters).

S=Is the distance that the feed is transported (kilometers).

L= Is the liters of fuel consumed by the vehicle to transport the feed to one kilometer distance (liters)

E= Is the total emission from feed transport

EF = Is the emission factor of CO_2 from fuel consumption

3.4. Statistical Analysis

To analysis the data, all the collected survey data were coded and entered into the Excel computer software. The Statistical Package for Social Sciences (SPSS) software (version 20.0) was used for data analysis. The data collected from the field through survey questioner Socio-economic characteristics of smallholder were analyzed using the descriptive statistical analysis. To calculate the distribution of costs and margins along feed value chains the formula derived by Mendoza (1995) was used. The CO_2 emission from feed production, processing and transportation and the mean chemical composition of feed obtained from both Asella and Jimma milk sheds were analyses by using GLM procedure. Finally, the statistical model bellow was used.

$$Yij = \mu + mi + pj(i) + \varepsilon ij$$

Where: Yij = quality and quantity of feed available as well as CO_2 emission

μ = Overall mean

mi = the effect of i^{th} milk sheds (Assela and Jimma Milksheds)

pj = the effect of j^{th} production system with in milk sheds (Urban and peri-urban?)

εij = random error

4. RESULTS AND DISCUSSIONS

4.1 Socio-Economic characteristics

This sub-section describes the socio-economic characteristics of respondents including sex, age, education level, livestock holding, land holding, farming systems and means of feed trans portation. As presented (Table 2) majority of respondents participating in dairy production were male, with 78% and 90.2% in Assela and Jimma milk sheds, respectively. In Assela and Jimma milk sheds, the majority of respondents participating in dairy production were found under the age of 45-64 followed by 22-44 age .How ever as we have seen from the result, the elder (65age and above) participating in dairy production were few in both milk sheds The educational level of respondents involved in both Assela and Jimma milk sheds were diverse from illiterate to educate. Most of the respondents in both Assela and Jimma milk sheds had attended grade 1-4 and above. But a few numbers of respondents were illiterate in both milk sheds. Comparatively, the high illiterate dairy producer was recorded in Jimma milk shed than Assela milk shed (13% and 6.5%), respectively.

Table 2.House hold characteristics of respondent in Assela and Jimma milk sheds

Household profile	Assela milk shed (%)			Jimma milk shed (%)		
	Urban	Peri urban	Total	Urban	Peri urban	Total
Sex						
Male	76.5	80.0	78.0	81.4	96.2	90.2
Female	23.5	20.0	22.0	18.6	3.8	8.9
Age group of household						
Age 22-44	36.76	45.45	40.65	70.50	43.00	46.70
Age 45-64	61.76	47.27	55.28	29.50	53.20	50.00
65 age and above	1.48	7.28	4.07	0.00	3.80	3.30
Educational level						
Illiterate	5.9	7.3	6.5	2.3	19.0	13.0
Read and write	5.9	1.8	4.1	4.7	6.3	5.7
Grade 1-4	8.8	12.7	10.6	7.0	32.9	23.6
Grade 5-8	22.1	25.5	23.6	23.3	20.3	21.1
Grade 9-10	22.1	36.4	28.5	23.3	17.7	19.5
Other (>11)	35.3	16.4	26.8	39.5	3.8	16.3

4.1.1. Cattle holding

The average number of cows owned by Jimma producers was significantly higher $P \leq 0.05$ than that of Assela producers (Table 3). The mean total dairy cow obtained from Assela milk shed was less than the result obtained by Abera (2018) in Bishoftu and Assela, the variation of both results might be due to the difference in location between the two studies. Generally, the urban dairy producers in Jimma milk shed had the highest number of dairy cows than peri-urban of Jimma and urban dairy producer of Assela milk shed. On the other hand, Tezera and VHL, V. (2018) reported the mean dairy holding by peri-urban producer was higher than urban dairy producer. This difference might be due to the fact that Jimma peri-urban dairy producer faced with the shortage of concentrate feed than urban producer so they minimize the number of dairy herd. The mean holding of heifers and calves owned by Jimma producer were higher ($P \leq 0.05$) than that of Assela dairy producer which could be attributed to the number milking cows kept by producers (3.91 at Jimma producer and 2.94 by Assela producer). In both Assela and Jimma milk sheds there was no significant difference was found in mean number of bull and oxen as well as the mean total cattle holding obtained in both milk sheds. The men total cattle holding recorded in Assela milk shed similar with the finding of Abebe *et al*. (2017) 6.4 but this result is less than the mean cattle holding obtained from Jimma milk shed.

Table 3.Mean cattle holding of respondents in both Assela and Jimma milk sheds

Categories	Assela milk shed		Jimma milk shed		Milk sheds	
	Urban	Peri-urban	Urban	Peri-urban	Assela	Jimma
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Total cow	2.57±0.50[b]	3.31±0.55[ab]	4.77±0.62[a]	3.05±0.46[b]	2.94±0.37[b]	3.91±30.39[a]
Heifers	0.44±0.21[b]	1.29±0.24[a]	1.43±0.26[a]	1.19±0.20[a]	0.87±0.16[b]	1.31±0.16[a]
Calves	1.91±0.26	2.22±0.29	3.18±0.33	2.47±0.24	2.06±0.20[b]	2.83±0.20[a]
Bull	0.10±0.07	0.40±0.08	0.16±0.09	0.53±0.07	0.25±0.06	0.35±0.06
Oxen	0.15±0.11	1.29±0.12	0.05±0.13	1.64±0.10	0.719±0.08	0.84±0.08
Total cattle	5.18±0.89	8.51±0.99	8.16±1.10	7.89±0.82	6.67±0.66	7.99±0.69

SE = standard error
Means with different superscript letters in the same rows are significantly different at (P≤0.05)

4.1.2. Land use

As indicated in (Table 4), the crop land is dominating in both Assela and Jimma milk sheds as compared to other land use patterns. The mean crop land used by Assela producers was significantly higher (P≤0.05) than that of Jimma dairy producers. However, there was no significant difference in crop land holding between the Assela urban and Jimma peri-urban production system. The current result of mean crop land holding is greater than the finding of Abera (2018), which might be due to the location difference where the later was taken only from Assela town. No crop land was recorded for Jimma urban producer during this study. Generally, the mean value of crop land recorded in Assela milk shed was significantly higher than that of Jimma milk shed (1.47ha and 0.45ha), respectively. This is because in Jimma milk shed, most of the land was covered by cash crop than grain crops (Zijlstra *et al*., 2015). The mean land obtained for forage development and grazing land among milk sheds significant difference was not seen from the current result. The Assela and Jimma peri-urban had more grazing land (0.40ha and 0.24ha) than the urban production system (0.04ha and 0.06ha), respectively. According to Wondatir and Mekasha (2013), the grazing land in both Jido-Kombolcha and Dugda Bora districts were 1.3ha and 0.3ha, respectively. This result is greater than the result obtained from both milk sheds and this variation might be due to time, location and the variation of farming system between the two study areas. Generally, the mean total land holding in Assela milk shed (1.82ha) was significantly higher than that of Jimma milk shed (0.92ha). This result is greater than the finding of Abera (2018), the mean total land obtained from Assela and Bishoftu were 0.6ha and 0.48ha, respectively, this variation might be due to the location and the sample taken between the two study areas.

Table 4. Land holding of respondents in both Assela land and Jimma milk sheds

Land use/Ha	Assela milk shed		Jimma milk shed		milk sheds	
	Urban	Peri urban	Urban	Peri urban	Assela	Jimma
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Crop land	0.55 ± 0.09^{bc}	2.39 ± 0.10^{a}	$0.00\pm.00^{d}$	0.89 ± 0.09^{b}	1.47 ± 0.07^{a}	0.45 ± 0.07^{b}
Forage land	0.01±0.02	0.05±0.02	0.02±0.02	0.01±0.02	0.03±0.01	0.01±0.01
Grazing land	0.04 ± 0.05^{c}	0.40 ± 0.06^{a}	0.06 ± 0.06^{c}	0.24 ± 0.05^{b}	0.21±0.04	0.15±0.04
Homestead	0.07±0.01	0.13±0.01	0.06±0.02	0.08±0.01	0.10 ± 0.01^{b}	0.07 ± 0.01^{a}
Other	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.03 ± 0.07^{b}	0.48 ± 0.05^{a}	0.0 ± 0.0^{b}	0.26 ± 0.04^{a}
Total	0.68 ± 0.13^{c}	2.97 ± 0.15^{a}	0.18 ± 0.16^{d}	1.66 ± 0.12^{b}	1.82 ± 0.10^{a}	0.92 ± 0.01^{b}

SE=standard error
Means with different superscript letters in the same rows are significantly different (P≤0.05)

4.1.3. Farming system

Mixed farming system was the dominant farming system in both Assela and Jimma milk sheds from the other farming system (44.7% and 64.2), respectively (Table 5). This means beside dairy production, most of them had cropping land used for crop production Furthermore, Jimma producers significantly participated more in mixed farming system than that of Assela producer. The percentage of mixed farming systems recorded in both milk shed was higher in peri-urban than the urban production system. The current result is agreed with the finding of Sara (2018) in Ziway-Hawassa milk shed. The second farming system practiced in both milk sheds was only producing of dairy cattle. The highest percentage of producing sole dairy cows was recorded in Jimma milk shed than Assela milk shed (31.7% and 19.5%) respectively.

Table 5.The farming system of respondents in Assela and Jimma milk sheds

Farming system	Assela milk shed		Jimma milk shed		milk sheds	
	Urban	Peri-urban	Urban	Peri-urban	Assela	Jimma
Mixed farming	23.5	70.9	0.0	100.0	44.7^{b}	64.2^{a}
Off-farming and livestock	23.5	10.9	9.3	0.0	17.9^{a}	3.3^{b}
Only dairy cattle keeping	35.3	0.0	90.7	0.0	19.5^{b}	31.7^{a}
Other activity	17.6	18.2	0.0	0.0	17.9^{a}	0.0^{b}

Means with different superscript letters in the rows are significantly different (P≤0.05)

4.1.4. Crop residues production and transportation

In Assela and Jimma milk sheds, the crop residue produced and used by dairy producers accor ding to the survey result were wheat straw, barley straw, teff straw, maize Stover and sorghum Stover as presented in (Table 6). The total crop residue produced in DM/tone in both Assela and Jimma milk sheds were 234.02tone/year and116.516tone/year, respectively. In Assela milk shed, high crop residue production was practiced than Jimma milk shed and this variation was due to the difference in landholding allocated for crop production among the two milk sheds. In Assela milk shed, the crop residue produced were wheat straw, barley straw and occasionally teff straw while in Jimma milk shed maize stover, sorghum stover and teff straw were produced. In Assela milk shed the majority of the dairy producer who had a land for crop cultivation produced wheat straw than the other crop in both production systems (217.315tone/year). This crop was widely cultivated in the area and the farmer used combiner for harvesting. This is made a great opportunity to use this straw for animal feed because the combiner properly stored the residue during harvesting. In Jimma milk shed the crop widely cultivated was maize followed by teff (68.45tone/year and 27.10 ton/year) in both production systems. This result is in line with Abera *et al*. (2014) who reported maize stover was more produced in the area followed by teff straw (137.8tone/year and 39.3tone/year), respectively. Unlike Assela the crop harvesting was done by human power. In Jimma milk shed, most of the farmers leave maize and sorghum stover on the field and the farmer feed their livestock directly on the field resulting in large amounts of feed wastage. Due to this reason and other related factors, the Jimma dairy producers faced shortage of feed more than the Assela dairy producers.

Table 6. Crop residue produced ton per hectare and means of transportation in Assela and Jimma milk sheds

Type of crop residu e	Equivalent conversion factor tone dry matter /ha	Assela milk shed			Jimma milk shed		
		Urban	Peri-urban	Over all	Urban	Peri-urban	Over all
Feed production (tone/year)							
Wheat straw	1.5	77.86	139.46	217.32	0	0	0
Barely straw	1.5	3.38	10.97	14.34	0	0	0
Teff straw	1.5	0.68	1.69	2.36	2.13	24.98	27.10
Maize Stover	2	0	0	0	5.31	63.14	68.45
Sorghum Stover	2.5	0	0	0	1.35	19.62	20.97
Over all		81.91	152.11	234.02	8.79	107.73	116.52
Means of feed transportation (%)							
Car (ISUSU, FSR , Land lover and Bajaj		12.2	5.7	17.9	8.1	3.3	11.4
Cart (horse and donkey cart)		15.4	8.1	23.6	8.1	11.4	19.5
Animal back		0	8.1	8.1	0.8	13.8	14.6
Car and cart		17.1	7.3	24.4	11.4	7.3	18.7
Car and animal back		2.4	0.8	3.3	3.3	11.4	14.6
Cart and animal back		8.1	14.6	22.8	4.1	17.1	21.1

The dairy producer found in both milk sheds used various types of vehicles for feed transporta tion (ISUSU, FSR, and Bajaj and land lover), cart (horse and donkey cart), and animal back. In both milk sheds the urban dairy producer dominantly used car and cart for feed transportation while the peri-urban dairy producer used more cart and animal back than the other means of feed transportation (Table 6). In Assela milk shed the urban dairy producer use d more carts than peri urban. Similarly, Tezera and VHL, V. (2018) reported the urban dairy producer used more cart than urban dairy producer (18.22% and 9.3%), respectively to transport different feeds. In terms of economic value and climate-smart, using cart and animal back are the best and encouraged means of transportation compared to other feed transportation.

4.2. Dairy feed value chain actors and their function

The actors participating in both milk sheds includes input supplier, producer (farmers), traders (cooperatives and private trader) and processors (those are agro-processing, feed processing and local grain miller). All actors have their own function in the chain and their activities are discussed below.

4.2.1. Input suppliers

The dairy feed value chain starts from the input supplier. This segment consists of the actors in the chain that supplies the materials as well as provides different services for the proper fun ctioning of the feed value chain. In Assela milk shed, the input suppliers participated in the chain were Government (Woreda Livestock and Fishery resource management), Farmers unio ns,Kulumsa research institute and Non Government Organization (NGOs) like Agriculture Gr owth Program (AGP) and Nederland's Development Organization (SNV). Similarly, Nangole *et al*. (2013) reported the input supplier participated by providing important material for feed production was dairy cooperative societies, government institution and Kenya Farmer Association (KFA). The dairy feed inputs supplied by actors mentioned above include forage seeds, fertilizer used for crop cultivation and crop used for processing and formulating the concentrate feed. Similarly, Geleti *et al*. (2014) and Kitaw *et al*. (2012), reported that the inpu t materials used for feed production were land, forage seed (plant), fertilizer, financial and lab or for varies operations.

The inputs supplier serves the feed producer in both Assela and Jimma milk sheds in variety of ways. In Assela milk shed, the Woreda Livestock and fishery resource development office (WLFRDO) supplied the feed producer with forage seed, improved forage plant and extension services. DAs and Woreda livestock experts gave training on improved forage seed sowing, plantation of forage plants and methods of feed conservation (Table 7). Similarly, Kulumsa Research Institute also provided improved forage seed and forage plant for the farmers. Farme rs Union was participating in the chain by providing fertilizer for the farmers whose produce f ood and forage. Non-government organizations (NGOs) like AGP and SNV were serving the farmer by providing different types of feed seeds and forage plants as well as they gave training for DAs and farmers.

In Jimma milk shed, different organization like Woreda Livestock and fishery Resource Development Office (WLFRDO), Jimma Research Institution (JRI), Agricultural Growth Pro gram (AGP) and cooperative office were responsible in providing inputs. These institutions supplied inputs like forage seed, improved forage plant, extension service and fertilizer used f or crop cultivation mentioned by feed producer. In Jimma milk shed, application of synthetic fertilizer was not practiced because they do not use wide land for forage development so they applied manure instead of applying synthetic fertilizer. This finding is in agreement with Kita w *et al*. (2012), who reported that farmer did not use fertilizer for forage development due to t he cost of fertilizer and farmer perception.

4.2.2. Producer

In the feed value chain, the producer is a farmer who produces a feed like improved forage and having grazing land for the production of hay as well as the farmers who produce crops for their consumption and selling for the next actors for feed processing and produce crop residue which can directly be used for animal feed. The other feed producer was an institution like Jimma airport, schools and other institutions who sale the green and hay grass for nearby dairy producer.

In the dairy feed value chain, feed producer is the basic actors in the chain because this actors supply a feed for the next actors In Assela milk shed, the dairy producer produced feed like native grass, improved forage (elephant grass, desho grass and alfalfa) and crop residue (wheat straw, barely straw, teff straw& maize Stover). According to Geleti *et al*. (2014), in the livestock feed value chain a feed producer produced feed like crop residue, native pasture, improved forage and concentrate feed produced by floor factory. In Assela milk shed 65.5% of peri-urban dairy producers produced a feed for their own dairy while few percent of urban producer were participating on feed production. From the feed produced, 16.4% and 2.9% of peri-urban and urban dairy producer's sale their feed for others in Assela milk shed. Most the farmers participating in feed production in Assela milk shed were used for own livestock and the other farmers were selling their feed directly to the end-user which is for urban and peri-urban dairy producers and some of them selling to trader found around them. Similarly, Nangole *et al*. (2013) reported the producers are a farmer, who grows fodder with an intension to feed their own livestock but also sell when there is excess. Their core function in the chain was to produce and supply the feed and feed material to the next actors or directly to the end-users. They also stored the feed until to sell. The storage condition is different from one farmer to another which means some farmers have cleaned, shade and good feed storage a rea.

The farmers near the town directly sold their feed to urban and peri-urban dairy producer as well as they sold to other farmers nearby and some of them are sold their feed to the feed collector. The service providers participated in both milk sheds include extension services given by Woreda experts, DAs and NGOs; credit service given by different micro finances and information service given by government and social media. In Assela milk shed most of the dairy producers got an extension service as well as information service (74.8% and 52%) respectively but the milk shed received the least number of credit service. The credit provider existed in the study area are Oromia Credit and Saving Institution (OCSI) and Wasasa micro f inance. But most of the dairy producer didn't benefit from this service provider institution. Si milarly, Mesay *et al*. (2013) in Limu-Bilibilo district of Arsi Zone reported even if a credit services is there the farmers were not interested to loan from the credit institution because of many factors like the credit offered specially from micro finance like OCSI and others was too small.

In Jimma milk shed 57% of peri-urban dairy producers produced feed for their dairy and very few sold the feed to others. But the Jimma urban dairy producers only 18.2% produced feed and none of them sold the produced feed to others. From crop residues produced by farmers found in the milk shed, only teff straw was sold to other dairy producers and also for construct ion purposes. The farmer who produces the other straw like Maize and Sorghum Stover has collected and stored around their home and they used during feed scarcity for themselves. The other feed producers out of farmer identified during survey were institution like airport and schools. These institutions sold the grass hay or green grass produced in their institution to urban and peri-urban dairy producer. This is in line with the finding of Tolera *et al*. (2014), where the institutions like church and school produced native pasture and sale to nearby dairy producer.

Table 7 Feed production and sale, inputs and service used by dairy producers in both Assela and Jimma milk sheds

category	Assela milk shed%		Jimma milk shed%		milk sheds%	
	Urban	Peri-urban	Urban	Peri-urban	Assela	Jimma
Do you produce feed Yes	30.9	65.5	18.2	57.0	46.3	43.1
No	69.1	34.5	81.8	43.0	53.7	56.9
Do you sale feed for others Yes	2.9	16.4	0.0	8.9	8.9	5.7
No	97.1	83.6	100.0	91.1	91.1	94.3
Types of input used						
Fertilizer and crop seed	20.6	50.9	4.5	59.5	34.1	39.8
forage plant	13.2	9.1	13.6	3.8	11.4	7.3
Fertilizer, crop seed, grass seed and forage plant	7.4	23.6	4.5	8.9	14.6	7.3
did not use any input	58.8	16.4	77.3	27.8	39.8	45.5
Type of service						
Extension service Yes	70.6	80.0	36.4	70.9	74.8	58.5
No	29.4	20.0	63.6	29.1	25.2	41.5
Credit service Yes	2.9	0.0	6.8	0.0	1.6	2.4
No	97.1	100.0	93.2	100.0	98.4	97.6
Information service Yes	57.4	45.5	40.9	31.6	52.0	35.0
No	42.6	54.5	59.1	68.4	48.0	65.0

Like Assela dairy producers, the Jimma producers used different inputs like fertilizer, crop seed, forage seed and forage plant to produced feed for their livestock. More peri-urban dairy producers used inputs than urban producers. This difference became due to most of the urban dairy producers have no land to produce feed for their dairy. Unlike Assela dairy producer, the weakness of different services was seen in Jimma milk shed. In some extent the peri-urban had got more extension and information service than urban production system but the credit service was recorded only by urban production system. The credit service provider identified in Jimma milk shed during the study was OCSI, Wasasa and Harbu microfinance but Jimma dairy producers were not offered a loan from this credit institution. Generally, the service provided by different bodies for the Jimma dairy producer was not efficient. In both milk shed s, less than 50% of producers were producing feed for their dairy though better practice is rec orded from Assela dairy producers than Jimma. Similarly, the Assela dairy producer are better advanced than Jimma producer in using different inputs and service provided. This variation might be due to lack of NGOs found in Jimma milk sheds which serve the dairy producer and lack of commitment of different government bodies like DAs and Woreda experts.

4.2.3. Processor

In the Assela milk shed, one feed processing plant and four Agro-industrial factories were identified. These are Galama farmers union formulated feed processing, Chilallo agro-industrial processing plant, HG food processing factory, Itaya PLC food processing and Local grain miller. The Galama formulated feed processor produced concentrated feed for dairy and chicken. This processing plant has a capacity to produce 80ton per day and now it produces 60 tons per day. This processing plant has collected the raw materials from farmers nearby and from other agro-industrial processing plants like Itaya and Chilalo Agro-industrial factori es. Similarly, Fekede *et al*. (2014) reported that the raw materials used for processing units we re collected from the surrounding smallholder farmer and from other processing units. It has used only electrical power for processing and it consumed averagely 58 kWh power per month. The other processing identified was wheat bran and grain miller waste (floor) which was not purposively for animal feed but its by-product was used by dairy producer. The agro-industrial processing plants mentioned above processed flour for human consumption and selling its by-product for dairy producer nearby.

Figure 3 Galama feed processing machine

In Jimma milk shed there is no any feed processing plant which processes a feed and sale for the around dairy producer. This is faced the dairy producer used widely concentrate feed for their dairy. Similarly, Samireddypall *et al*. (2014) and Kitaw *et al*. (2012 reported the lack of processing unit as one constraint identified in their study area which forced the trader had to travel long distances to buy feed.

4.2.4. Trader

In the value chain, these actors are linked to the producer and end-user or consumer (Adisu *et al*., 2012). In the Assela milk shed different private feed traders or dealers were identified. Most of these private traders purchased concentrate feed directly from the feed processing plant that is Alemacoudal from Bishoftu (Debrezeite), formulated feed from Galama processing plant and a by-product of agro industrial processing plants found in Assela town. I n the milk shed, the activities of the private feed dealers identified were the similar except very few traders who collected the crop residue from the farmer and sale to dairy producer. They purchased and collected the straw when the farmers harvest their crop at the farm get by hip or estimated totally on the harvested land, then they collected and stored around their home for sale during feed shortage. But the other trader was directly selling the collected feed to the end-user.

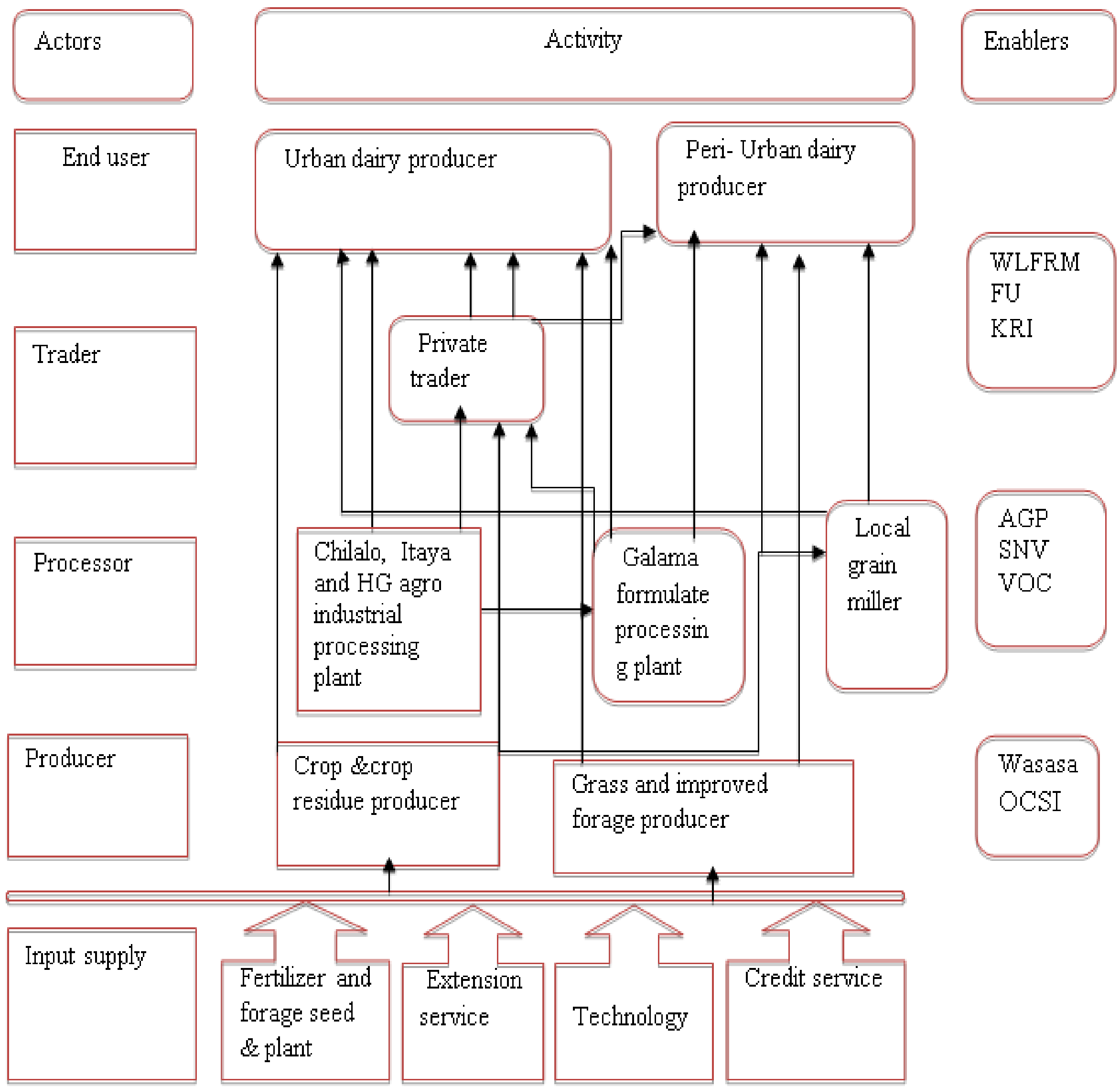


Figure 4 Assela Dairy feed value chain ma

In Jimma milk shed, the trader identified during the study were, private trader involved as con centrate feed and straw feed dealer and dairy producer cooperative. In Jimma milk shed, one d airy cooperative has been established by Jimma town dairy producer member and has a mandate to collect the milk from its member, purchased feed and distribute for them. This cooperative purchased a feed from different areas like Hosana, Kaliti and Debrezeite. Its activities was limited which means it purchased a feed two times per month and distribute for only its member, so out of its member it cannot be sold the feed and collect milk from them.
A type of feed it provides for its members were only wheat bran and concentrate feed. The dai ry producer cooperatives organization served its member by providing concentrate feed from

different areas by affordable price as well as giving those feed by credit for its members. Simi larly, Gebremedhin *et al*. (2009); Kitaw *et al*. (2012 and Diriba *et al.* (2014) reported the farm ers' cooperative serve dairy producer by providing feed in the form of credit and also provide other inputs for its member. In Jimma milk shed the private trader identified purchased processed feed from different processing plants and sold to the dairy producers and the remaining trader purchased crop residue on the farm gate during crop harvested and stored or directly sold to dairy producers. But Gizawu et *al*. (2017) reported that there is no formal feed dealer in Jimma zone. This might be due to the time variation between the two studies. Those feed trader/dealer purchased a feed from Debrezeite, Hosana and Kaliti. In the Jimma milk shed the agro-industrial feed and concentrate feed dealer was existed only in Jimma town. So the dairy producer found out of Jimma town obligate to feed more roughage feed than concentrate feed. Due to this, they were not more profitable from their activity.

4.2.5. Consumer/End user

Consumers in the feed value chain context refer to the livestock producer that utilizes feed for their livestock (Samireddypall *et al*., 2014). So this is the last chain identified from the dairy feed value chain actors and in the context of this study, the end-users were urban and peri-urban dairy producers. All urban dairy producers found in both milk sheds purchased feed whether directly from the feed producer or bought from feed trader in addition to produce a small amount of feed around their farm. Few of them were produced crop residue and improved forage around their farm but they purchased a feed for their dairy throughout the year. Above 50% of the peri-urban dairy producer identified in both milk sheds produced feed for their dairy and at the same time purchased a processed feed from trader.

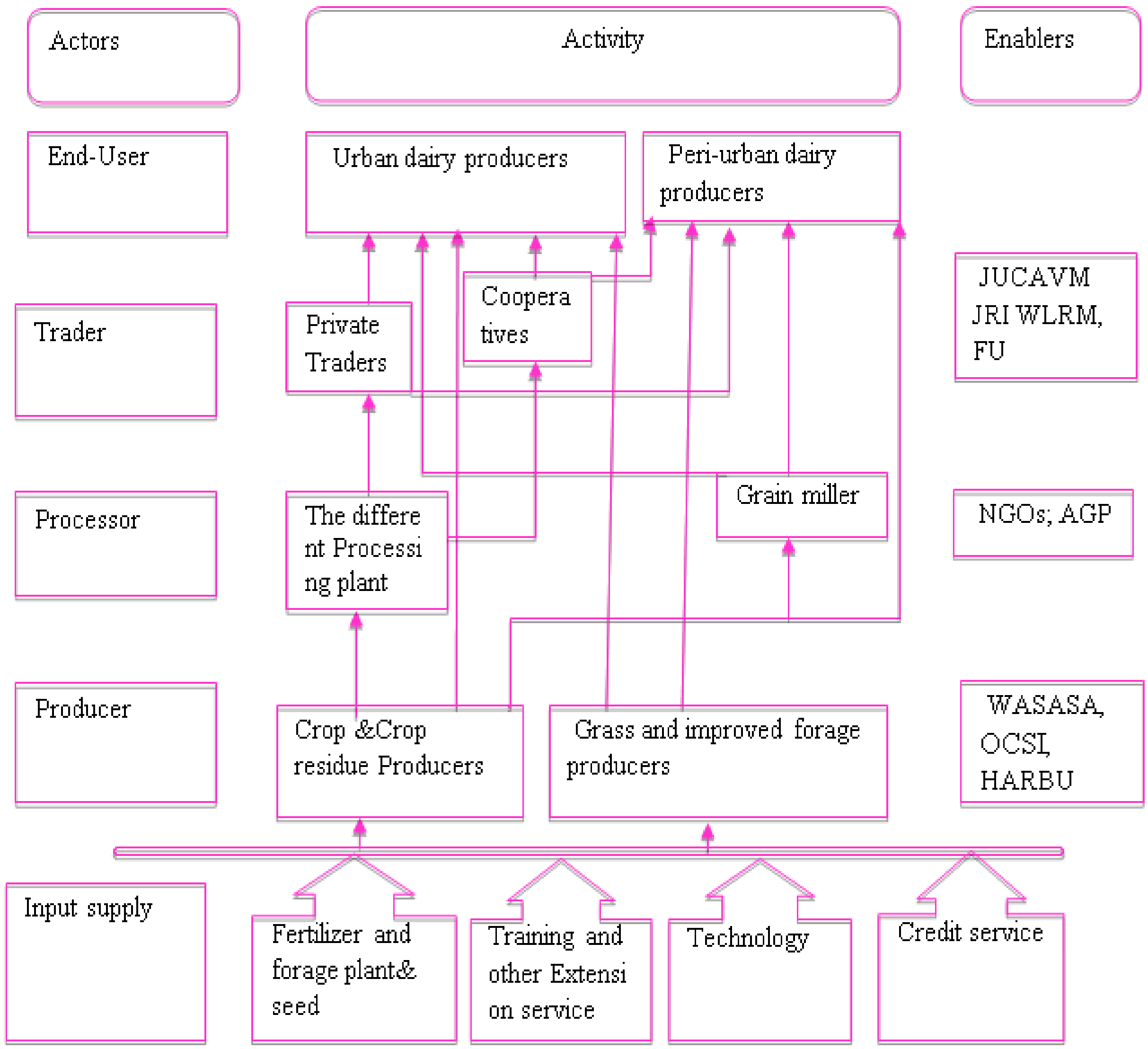


Figure 5.Jimma Dairy feed value chain map

In Assela milk shed most of the urban and peri-urban dairy producers purchased a feed like concentrate, wheat bran, wheat straw, and native green grass or grass hay. The dairy producer found in Assela milk shed had the opportunity to use agro-industrial by-product and formulated feed directly from the processing plant. Even if they do not purchase directly from the factory, the access of food by-product and concentrate feed was there from the dealer found around them. But in Jimma milk shed the dairy producers suffered by feed scarcity throughout the year and mostly during dry season. Because in Jimma milk shed there is no plant for making concentrate and Agro-industrial processing. Due to this, the price of processed feed was higher than that of Assela. The feed trader/dealer had to travel long distance (60-400 km) to purchase processed feed, which makes the price of feed costly for end-users due to added cost of transportation on it. Most of dairy producers who had a small number of dairy cows in Jimma milk shed used a mill by product and mixing with others for their dairy

4.3. Constraints and opportunity in the dairy feed value chain identified in both m ilk sheds

4.3.1. Constraints

Some of the major factors affecting the dairy sector were shortage of concentrate feed, high cost of feed, cost of feed transportation, lack of feed inputs, lack of extension service and financial problem as presented in (Table 8). In both milk sheds, the major constraints to hi nder milk production were the cost of feed and inaccessibility of feed (concentrate feed). Similarly, Diriba *et al*. (2014) and Adugna *et al.* (2014) reported the producer faced by the high cost of concentrate feed to feed their livestock than other constraints.

Jimma dairy producers were more affected than the Assela producer due to lack of feed proce ssing plant in the area. Extension service is an important activity to improve the awareness of producers and also aids to enhance milk production and productivity. But the Jimma producers were not well served from extension worker especially on feed conservation. This result disagrees with the finding of Fekede *et al*. (2014) where the farmer found in Birbirsa and Melka village has got 92.3% and 90.9% of advisory service by extension worker. The variation of this result might be due to the difference in sampling area and commitment of the worker between the two study areas.

The Assela dairy producers were more challenged by financial scarcity than Jimma producer probably due to low prices of milk and lack of additional income. Similar to that of producer the feed traders also faced by different factors. Among them inaccessibility of feed, cost of feed transportation, feed spoilage, financial problem and lack of credit services. In both Assela and Jimma trader inaccessibility of feed and financial problem was the highest percent (40%, 60%, 26.7% and 20%) were hindering the activity of traders. During the study one feed processor was identified in both milk sheds. The problem raised by this processor was lack of inputs and in efficient electrical power. Especially the feed inputs used for processing were a great factor for a processor. Due to input supply gap for the processing plant they are working under their capacity.

Table 8.The constraints influencing the producer and trader in Assela and Jimma milk sheds

Constraints	Assela milk shed		Jimma milk shed	
	Frequency	%	Frequency	%
Lack of access to concentrate feed	22	17.89	32	26.01
High cost of feed	30	24.39	34	27.64
Cost of feed transportation	13	10.57	9	7.32
Lack of feed input/forage seed and plant	14	11.38	12	9.76
Lack of extension service	12	9.76	17	13.82
Financial problem	32	26.01	19	15.45
Constraints faced feed trader				
Inaccessibility of feed	6	40.0	3	60.0
High cost of transportation	1	6.7	1	20.0
Spoilage of feed	1	6.7	0	0.0
Financial problem	4	26.7	1	20.0
Lack of credit crevice	3	20.0	0	0.0

4.3.2. Opportunities

Accessibility of processing plant, access to road and other infrastructure, high demand for milk, support to stakeholder and access of roughage feed in one or in both milk shed were listed as opportunities to milk production in the two milk sheds. In Assela milk shed access of processing plant to process and provided concentrate feed was a great opportunity for Assela dairy producer, while this is not work for Jimma milk shed. Similarly, Adugna *et al.* (2014) reported that accessibility of concentrate feed in different kebeles of Diga district is an opportunity identified for livestock producer but the potential of accessibility was great difference among them like Assela and Jimma milk sheds. Cereal crop is a leading crop produced in Assela milk shed among them wheat and barley crop were widely cultivated;

therefor the dairy producer got an opportunity to used its residue for their animal. The Assela producer has got inputs like forage seed and improved plant, milk material, and other services from different Non-Government Organizations (NGOs) found around them. Well, road and other infrastructure are also additional opportunities for the Assela dairy producer than Jimma. As presented in (Table 9) the great opportunity identified in Jimma milk shed was that the demand for milk increased from time to time as well as the crop by product like maize and teff straw is as an opportunity for dairy producer. Similarly, Brandsma *et al. (*2013) stated that there is high demand of milk in Jimma milk shed so this is as an opportunity for the dairy producer in the milk shed. However, access of concentrate feed and support of stakeholder was not an opportunity for the Jimma producer unlike Assela producer. For both Assela and Jimma feed trader listed high demand of feed by livestock producer as a leading opportunity and followed by a strong support from other stakeholder and non-interference of broker.

Table 9.The opportunities identified for dairy producer and traders in Assela and Jimma milk sheds

Opportunity	Assela milk shed		Jimma milk shed	
	Frequency	%	Frequency	%
Access of feed processing plant around the dairy producer	39	31.7	0	0
Access of road and other infrastructure	13	10.6	3	2.44
Support of government and other NGOs by supplying feed inputs	24	19.5	19	15.45
High demand of milk	13	10.6	69	56.1
Access of roughage feed(hay and crop residue)	34	27.6	32	26.01
An opportunity for feed trader				
High marketing demand	8	53.3	3	60.0
Strong support by different stake holders	3	20.0	1	20.0
No interference of broker	3	20.0	1	20.0
Offering of credit service	1	6.7	0	0.0

4.4. Gross margin and value share

Below (Table 10) summarizes total costs, gross margin and Net marketing margin of actors for wheat bran marketed both in Assela and Jimma. The higher gross marketing margin (GMM) was obtained by Jimma trader and the lowest GMM was recorded by cooperative in Jimma milk shed. The values of Gross Marketing Margin obtained by producers in both milkshed were the same. The net marketing margin share of the producer was high in both Assela and Jimma milk shed (158Birr and 163Birr) respectively. Similarly, the percentage Net marketing margin (NMM) of producer from wheat bran marketing was high on behalf of producer. This result is in line with the finding of Beneberu *et al.* (2012) high net marketing margin was recorded by producer than other actors from wheat bran marketing. The lowest Net marketing margin percentage was obtained by cooperative in Jimma milkshed followed by Assela trader (9.14% and 10.81%).

From the (Table 11) below indicates marketing of formulated feed in Assela and Jimma milk sheds. From the result, the gross margin of this formulated feed on the level of producer was higher than that of a private trader in the Assela milk shed but in Jimma milk shed the private trader earned high gross marginal share than that of producer and cooperatives.

Table 10. Summary of wheat bran marketing costs and benefits sharing of actors along the value chain in Assela and Jimma milk sheds

Item birr per 100 kg	Asella milk shed		Jimma milk shed		
	Producer	Trader	Producer	Cooperative	Trader
Purchasing cost	-	683	-	670	684
Production cost	505	-	499	-	-
Marketing cost	20	10	15	35	50
Total cost	*525*	*693*	*514*	*705*	*734*
Selling price	***683***	***777***	***677***	***784***	***864***
Gross margin	178	94	178	114	180
Net marketing margin	*158*	*84*	*163*	*79*	*130*
% Net marketing margin	***20.33***	***10.81***	***18.87***	***9.14***	***15.05***

Likewise, the percent Net marketing margin share of the producer from concentrate marketing was high in Assela but low earned share in Jimma. The trader in Jimma milk shed was earned higher percentage share than producer and cooperatives (*21.63*%, 10.51%, and 9.04 %) respectively. But this this result is not agreed with the finding of Adisu *et al*. (2012) who reported that the trader shares low percent of Net marketing margin than producer from concentrate marketing. This result shows like wheat bran the end-user or dairy producer has no any alternative to get this product except purchasing from the trader. The cooperatives got a lower share of profit in the chain because cooperative were organized to collect the milk from its client and at the same time it provides the feed by low price for its client.

Table 11 Summary of marketing costs and benefit shares of actors along the value chain of formulating/concentrate feed in Assela and Jimma milksheds

Item Birr per 100kg	Assela milk shed		Jimma milk shed		
	Producer	Trader	Producer	Cooperative	Trader
Purchasing price	-	1051	-	920	1081
Production cost	826	-	835	-	-
Marketing cost	25	50	45	60	70
Total cost	***851***	***1101***	***880***	***980***	***1151***
Selling price	1051	1230	1001	1084	1400
Gross margin	225	179	166	164	319
Net marketing margin	200	129	121	104	249
% Net marketing margin	***16.26***	***10.49***	***10.51***	***9.04***	***21.63***

Wheat straw is a common feed on Assela milkshed and the producers to use it more efficiently. During harvesting time, most of the farmers used the combiner to harvest the crop so this helped the producer to harvest and store properly without wastage and sell during feed scarcity's (Table 12). The gross margin share of producer in Assela was lower as well as the Net marketing margin also low over other actors (11Birr and 8Birr) respectively. This result is in line with the finding of Beneberu *et al.* (2012) the Net marketing share of producer from crop residue marketing was lower than the other actors. Few collectors enter into the chain resulting shares of 30.43 % percentage Net marketing margins from producer. This is in line with Nangole *et al.* (2013) where the trader shares 33.33% Net marketing margin from Boma Rhodes hay marketing.

Teff straw is produced and marketed in Jimma milkshed. The producers sale teff straw directly to the neighboring trader on the farm gate and don't get more profit from the product. As shown in Table 12 the produce almost equal share of Gross margin with local trader (19Birr and 16Birr) respectively. The high Net marketing margin was recorded by producer than trader likewise the percent of Net marketing margin also obtained by producer than trader (45.24%). This result is agreed with the finding of Adisu *et al*. (2012) the producer shares a high percent shares of Net marketing margin from teff straw marketing. Teff straw was used for dual purposes which are used for animal feed and mud house construction. Most of the urban and some of peri-urban dairy producer around Jimma do not use teff straw for dairy feed. Teff straw was much needed for house construction around the area forcing rise in price from time to time. The teff crop producer got an opportunity sale the straw weather to dairy producers or other people used for other purposes.

Table 12.The marketing costs and benefit sharing of actors along the value chain for wheat straw and teff straw in Assela and Jimma combined milk sheds.

Item Birr per sack	wheat straw		Teff straw	
	Producer	Trader	Producer	Trader
Purchasing price	-	28	-	26
Production cost	17	-	7	-
Marketing cost	3	4	0	7
Total cost	***20***	***32***	***7***	***33***
Selling price	28	46	26	42
Gross margin	11	18	19	16
Net marketing margin	8	14	19	9
% Net marketing margin	***17.39***	***30.43***	***45.24***	***21.42***

There is no complex channel for both concentrate and straws feed since the end-user purchased directly from the producer or the trader purchased from the existing food or feed processing plant and sale to end-user. Similarly, Kitaw *et al*. (2012) reported that two types of channel were identified those were channel I and II to provide feed for livestock producer in the study area. This has made a marketing channel easy and short-chain for the product. As presented in (Table 13) below, the total gross marketing margin (TGMM) of wheat bran in both Assela and Jimma milk sheds were 0%, 12.1%, 14.54%, and 20.83% respectively which shares among private traders and cooperatives. The highest result was recorded on the channel II (producer ► trader ► end-user) of Jimma trader 20.83% followed by channel I 14.54 % (producer ► cooperative ►end-user). The Total Gross Marketing Margin (TGMM) on Channel II (producer ► trader ► end-user) at Assela was lower than that of Jimma. This might be due to the dairy producer have the option to buy directly from the processing plant so the feed dealer is obligated to sell the feed by affordable prices to them. The highest result Gross Marketing Margin (GMM) of producer was recorded in Assela both at channels I (producer ► end-user) followed by II (producer ► trader ► end-user) (100% and 87.9%) respectively. This result is in line with the finding of Ouma (2017) reported that the Gross Marketing Margin (GMM) shares of producer from grass seed marketing was (100%, 88.1% and 87%) in channel 1,4 and 7 respectively. In the marketing channel, 100% of the marketing margin means no actor has participated and shared the value from the product of the producer and added price value on end-user. This is not recorded in the Jimma marketing channel because there is no agro-industrial processing plant found in the area and the end-user/ dairy producer were not getting a chance to purchase directly from the factory.

The Gross Marketing Margin (GMM) of producer estimated to be low in Jimma on the market channel II. Channel II means a private trader and there was a profit-oriented rather serves the society and they sold by high prices for dairy producer than cooperatives. The channel I of Jimma was a cooperative established by dairy producer members found in Jimma town. They purchased feed and sold to their members by affordable prices so that the end-user of this member was not vulnerable to inflation in feed cost.

Table 13 The Total Gross Marketing Margin (TGMM) and Gross Marketing Margin (GMM) of producer on Wheat bran and concentrate feed in different market channels in Assela and Jimma milk sheds

Actor	wheat bran				Concentrate			
	Assela milk shed		Jimma milk shed		Assela milk shed		Jimma milk shed	
	Channel I	Channel II	Channel I	Channel II	Channel I	Channel II	Channel I	Channel II
TGMM	0	12.1	14.54	20.83	0	14.55	15.13	22.79
GMMp	100	87.9	85.46	79.17	100	85.45	84.87	77.21
GMMcop			14.54				15.3	
GMMprtr		12.1		20.83		14.55		22.79

Like the marketing channel of wheat bran, the concentrate/dairy ration didn't have a complex channel. The highest Total Gross Marketing Margin (TGMM) of concentrate/formulated feed was recorded in Jimma milkshed on channel II (22.79%) and the least Total Gross Marketing Margin (TGMM) was obtained on the channel I of Assela milkshed (0%). Like wheat bran marketing channel, the dairy producer the Assela milk shed has got a chance to purchase concentrate feed directly from the processing plant. Most of the Assela trader purchased feed from the processing plant found around them so they paid minimum cost for transportation due to this reason they sold a feed to dairy producer by affordable prices than Jimma private trader and cooperatives due to this the Total Gross marketing Margin (TGMM) in the Assela milk shed channel II was shares only 12.1% from producer product. The producer shares high Gross Marketing Margin (GMM) in Assela on channel I followed by channel II 100% & 85.45% respectively. Like wheat bran, on concentrate feed the Gross Marketing Margin (GMM) of producer in Assela milk shed earned 100% shares on channel I this means the end-user/dairy producer purchased the feed for their dairy directly from agro-industrial processing plant. From both marketing channels, the highest GMM of producer was recorded on channel I at Assela milk shed and the minimum value was recorded on the channel II in Jimma milk shed. similarly, Ouma (2017) reported the highest and lowest GMM shares of producer from grass seed marketing was recorded on the channel I and VI (100% and 70%)

respectively. Generally from the above result showed to us if the linkage between the feed producer and dairy producer is strong which means if they link themselves the producer more profitable and the end-user/dairy producer paid for feed affordable prices for this confirmation we have seen in the Assela milk shed on channel I for both wheat bran and concentrate feeds. Generally, the producers as well as the end-user of Assela were profitable from both wheat bran and concentrate feed.

Where: MM=Marketing Margin

TGMM=Total Gross Marketing Margin

GMMp=Gross marketing Margin of Producer

GMMcop=Gross Marketing Margin of Cooperative

GMMprtr=Gross Marketing Margin of private trader

Assela channel I = Producer ⟹ End-user

Jimma channel I = Producer ⟹ Dairy cooperative ⟹ End-user

Assela and Jimma channel II = Producer ⟹ Private Trader ⟹ End-user

4.4.1. Feed marketing and price variation among actors

The (Figure 6) bellow overviews the different market channels and the price sharing among the actors. The feed marketing in both Assela and Jimma milk sheds were dairy ration/concentrate, wheat bran, teff straw, and wheat straw. The wheat bran price at the producer level was 6.8Birr/Kg. The selling price was the same for traders and dairy producers when directly purchased from the producer/processor company. But the trader sold the purchased feed for both urban and peri-urban dairy producer at 8.2Birr/Kg. But the formulated feed sailing price varied among union, producer and trader (9.2Birr/Kg, 10.3 and 10.81Birr/Kg respectively. This price variation might be due to the reason of the union purchased feed for its organization by searching the least cost from different suppliers and commonly by from a customer and negotiation with processing plant. On the other hand, the d airy producer purchased directly from producer/processing plant as clients by affordable prices. Both the wheat and teff straws were low when purchased from the producer, but double in prices when they purchased from the trader 2.6Birr/Kg & 2.8Birr/Kg) producer price and (4.2Birr/Kg and 4.6Birr/Kg) trader prices. The trader purchased this type of feed on a farm gate found around the farmer by cheap prices.

Currently, the price of teff straw was highly rising to 4.6Birr/Kg. But according to Dejene (20 14), the price of teff straw ranged from 0.8 Birr/Kg to 2.5 Birr/Kg since 2009/10 and Birhanu.*et al.* (2009), also reported that the price of teff straw were 0.65/kg on-farm gate and 2.00 Birr/kg on the trader level this price variation might be due to the variation of time and area between the two studies. The price of wheat bran was 6.7Birr/Kg and 6.8Birr/Kg when directly purchased from producer but it increased to 8.2Birr/Kg when the dairy producer purchased from trader this prices not in line with most literature like Tolera *et al*. (2014), Kitaw *et al.* (2014) and Fekede *et al*. (2014) 3Birr/KG, 3.4Birr/Kg and 2.5Birr/Kg respectively. The mean price of concentrate was 10.1Birr/Kg this price is the mean value from the producer, cooperative and trader this price of concentrate relatively in line with Solomon *et al. (*2014) which is 8Birr/Kg but disagree with reported by Kitaw *et al.* (2014) 5Birr/Kg. When different actors enter into the chain and as the chain is longer the price of feed became too costly for end-user but when the feed producer and dairy producer link themselves and exchange their commodity both of them were profitable as we have seen from the Figure 5.

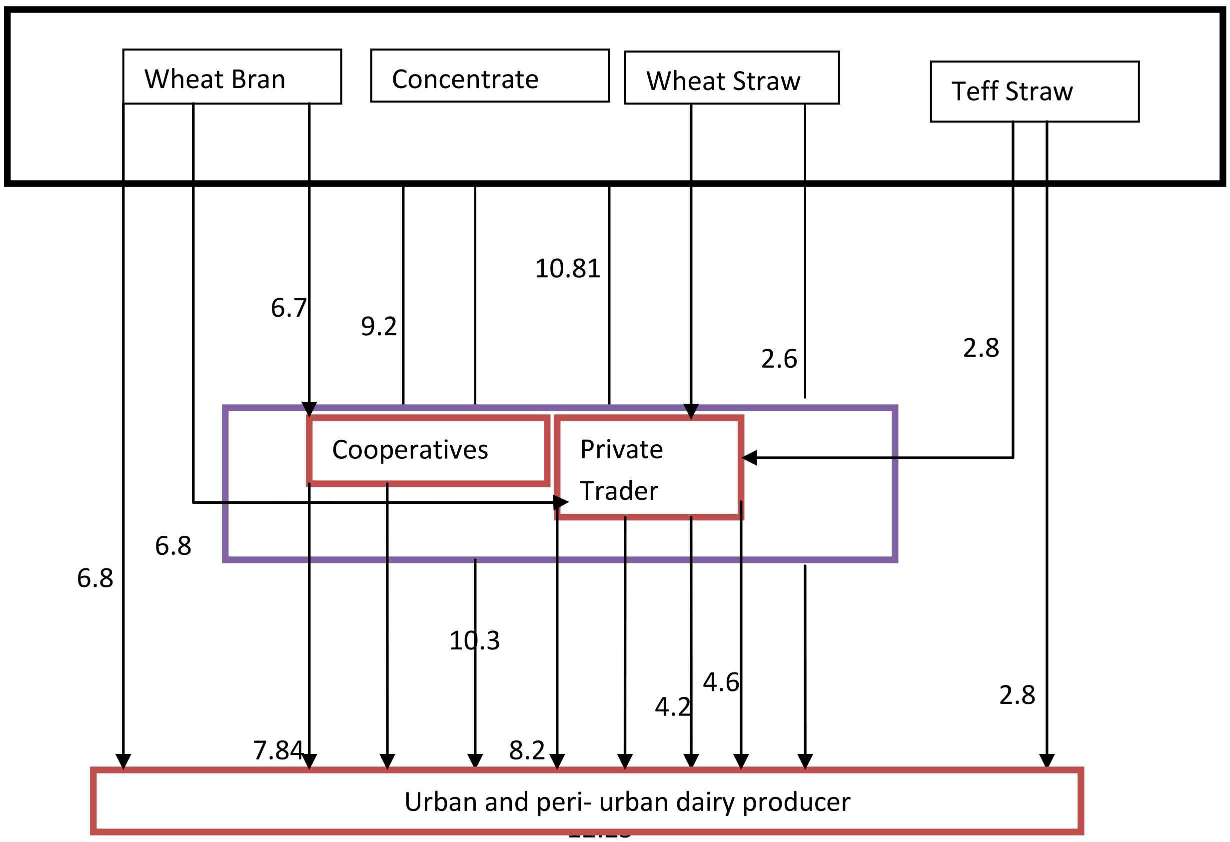


Figure 6**.** Market channel and price shares of Wheat bran, formulated feed, wheat straw and teff straw among actors

4.5. Chemical composition of available feed

The chemical composition of the existing feed used by dairy producers both Assela and Jimma milk sheds are discussed in (Table 14). The mean values for compositions of DM, fiber (NDF, ADF, ADL), ether extract and ash contents showed no significant difference (P>0.05) between the two milk sheds except hay and NSC was seen significant difference on NDF, ADL and EE respectively. The mean CP content of natural grass, alfalfa, hay, concentrate, and wheat bran obtained from Assela milk shed was significantly higher ($P \leq 0.05$) than that of Jimma milk shed. The finding of Bogale (2004) showed that the mean crude protein (CP) content of natural grass 9.6% which is higher than the crude protein (CP) obtained from Jimma milk shed but lower than the result recorded from Assela milk shed. Generally, the natural grass above 7.2% of CP content can support the ruminant maintenance requirement (ARC, 1980). In the current study, hay preparation is not well-practiced in Jimma milk shed, hence directly harvested after it was dried on the field unlike the Assela milk shed. Similarly, Adugna *et al.* (2014) reported that grass hays commonly used by animals are late harvested and drying on a stand. The mean CP content of hay from Assela and Jimma milk shed was 5.93% and 4.53%, respectively. The result obtained from the current study disagrees with the Worku (2014), was reported the mean CP content of grass hay from different locations was 15.97%. The mean result of CP of dairy ration/concentrate feed from Assela and Jimma milk shed was 18.91% and 17.05% respectively. This value is in line with Tesfaye (2016) but lower than the finding of Chalchissa *et al*. (2014), who reported the CP content of dairy ration to be 22.7%. The variation between the results might be due to the material which the feed prepared from, stage of maturity and the management condition. The variation in CP content of concentrate obtained from Assela and Jimma milk sheds might be due to the processing material and storage condition of the feed. The current CP content of wheat bran from Assela (16.72%) is similar with the finding of Chalchissa *et al*. (2014), but higher than the result obtained from Jimma (13.58%).

The highest CF content (49.19%) of feed under this study was recorded from hay followed by alfalfa (46.77%) in Jimma milk shed. But the lowest CF content of the feed was obtained from linseed cake (6.2%) in Assela milk shed. The mean CF content of natural grass/green grass, alfalfa, elephant grass, grass hay and wheat bran obtained from Jimma was higher ($P \leq 0.05$) than the mean CF obtained from Assela. The reason of the high CF content of different feed in Jimma milk shed it might be due to climate condition, type of grasses, soil conditions and stage of harvesting.

The highest NDF content was recorded from grass hay (66.01%) in Jimma milk shed followed by native green grass (65.67%) in Assela milkshed. According to Singh and Oosting (1992), roughage feeds containing NDF below 45%, 45-65% and more than 65% categorized under high, medium and low quality feeds. Accordingly, the mean NDF content the grass hay obtained from Assela can be categorized under medium quality while the Jimma grass hay is categorized under low quality. In Jimma milk shed the hay, was poorly prepared due to longer stay in the field. The mean NDF content of NSC in Assela was significantly higher $P \leq 0.05$ than that of NSC from Jimma. The values of NDF from the current study from both milk sheds were fall under good quality feed.

The highest ADF and ADL contents were obtained from grass hay and elephant grass in Jimma milk shed. According to McDonald *et al*. (2002), the ADF content of feed and digestibility of feed has a negative correlation. So roughages contain less than 40% of ADF are categorized under quality feed and roughages contain greater than 40% falls under low quality feeds (Kellems and Church (1998). So the quality of feed from both milk shed when evaluated in terms of ADF content, 50% was categorized under high-quality feed and the rest was under low quality feeds as per (McDonald *et al*., 1995). According to Reed *et al*., (1986), if the ADL content of feed exceeds 7%, it limits the dry matter intake. So from the total feed, 50 % of feeds have above the maximum level for ADL which can inhibit feed intake.

The mean EE content of native grass hay in this study was similar to the finding of Worku (2014). The ash content of roughage feeds in the study area ranged from 3.96% - 9.66% and from the processed feed ranged from 4.47% -11.02%. From the roughage feed, the highest ash content was obtained from grass hay and NSC in Assela milk shed. This result is similar to the findings of Chalchissa (2014) who reported the ash content of NSC to be 10.92% and Worku (2014) reported that the ash content of grass hay from different sites was obtained 10%.

Table 14.Chemical composition (Mean ± SE) of different feed from Assela and Jimma milk sheds

Feed type	Location	DM	CP	CF	NDF	ADF	ADL	EE	ASH
Green Grass	Assela	88.69±0 .3	10.91±0.57[a]	27.01±0.61[b]	65.67±1.6	29.45±1.8[b]	6.48±0.43	1.44±0.04	5.45±0.47
	Jimma	89.17±0.68	8.33±0.34[b]	30.78±0.84[a]	64.41±1.4	34.41±1.06[a]	6.56±0.37	1.26±0.09	6.7±0.56
Alfalfa	Assela	88.37±1.60	21.23±0.66[a]	43.89±0.47[b]	50.03±0.08	36.71±0.75[b]	9.96±0.48	2.61±0.31	12.49±0.7
	Jimma	88.45±1.30	17.5±0.69[b]	46.77±0.29[a]	51.47±1.05	46.41±1.4[a]	8.88±0.70	2.09±0.20	12.78±0.59
Elephant grass	Assela	91.69±0.76	12.17±0.71	31.38±1.08[b]	60.89±1.9	35.24±1.17	9.147±0.57	1.2±0.21	6.08±0.47
	Jimma	91.81±1.20	11.94±0.21	35.53±0.5[a]	63.45±1.4	33.82±2.23	11.55±1.12	0.94±0.03	6.48±0.37
Hay	Assela	96.00±0.29	5.93±0.12[a]	38.91±1.5[b]	56.68±1.3[b]	50.59±3.91	6.93±0.05[b]	1.86±0.10[a]	9.66±0.25
	Jimma	96.21±0.39	4.53±0.29[b]	49.19±1.44[a]	66.01±1.2[a]	56.58±1.4	9.86±0.46[a]	1.16±0.08[b]	8.59±0.61
Teff straw	Assela	95.67±0.39	4.39±0.29	38.02±1.40	38.4±1.28	50.24±1.4	7.61±0.46	1.32±0.08	7.71±0.61
	Jimma	96.54±0.30	4.54±0.31	40.39±1.03	39.25±1.20	51.99±1.01	7.03±0.08	1.65±0.13	8.48±0.32
formulated feed	Assela	91.42±1.20	18.91±0.13[a]	14.15±0.74	43.8±1.80	18.76±1.08	5.33±0.24	2.07±0.12	6.84±0.52
	Jimma	93± 0.92	17.05±0.53[b]	14.52±1.10	44.6±3.50	19.51±1.6	4.71±0.36	1.66±0.27	4.57±0.35
wheat bran	Assela	92.7±0.33	16.72±0.52[a]	30.55±1.10[b]	44.91±0.59	14.31±0.96	5.08±0.52	2.97±0.35	4.47±0.82
	Jimma	93.1±1.13	13.58±0.43[b]	35.07±1.10[a]	44.2±0.87	15.32±1.08	4.23±0.44	3.06±0.17	3.96±0.39
NSC	Assela	88.45±1.46	29.09±1.1	16.4±1.7	38.85±2.1[a]	13.05±1.19	2.93±0.49	5.93±0.44	11.02±0.95
	Jimma	90.55±1.10	28.45±1.07	15.36±0.45	34.36±1.4[b]	12.38±0.55	2.75±0.2	4.06±0.40	8.23±0.41

Means with different superscripts in the column for the same parameter are significantly ($P \leq 0.05$) different

DM =dry matter, CP = crude protein, CF = crude fiber, NDF = neutral detergent fiber, ADF = acid detergent fiber, ADL = acid detergent lignin, EE = ether extract, SE = standard error

4.6. Greenhouse gas emission from on farm feed production

4.6.1. Greenhouse Gas emission from fertilizer used

Farmers used input like fertilizer (synthetic and organic) to produce feed for their dairy. This input has the potential to produce N_2O by direct and indirect form of emission, one N_2O had a potential of 298 $KgCO_2$ eq emissions by global warming potential (GWP) (IPCC, 2007 and Forster *et al*., 2007). From (Table 15) below the direct and indirect (volatilization and leaching) emission from fertilizer used was computed at urban and peri-urban dairy producers who applied either synthetic or manure or both. The dairy producer found in both Assela and Jimma milk sheds used synthetic fertilizer (DAP and UREA) as well as animal manure for crop and crop residue production. The overall mean of CO_2 emission from fertilizer application was significantly higher in Assela milk shed than Jimma milk-shed (236.08 $KgCO_2$ eq and 75.72 $KgCO_2$ eq) respectively. In Assela milk shed cereal crop is a major crop cultivated in the area and farmers used high quantity of fertilizer for crop production than Jimma farmers. Bouwman (1996) reported that N_2O emissions occur naturally via nitrification and de-nitrification of the application of excess N increases the rate of N_2O emission.

In both milk sheds, the higher emission was seen both directly and indirectly in Assela peri-urban. The lowest CO_2 emission (Table 3) was counted in Jimma urban production system due to luck of or few land for crop production but the Assela peri-urban had wide land and used high fertilizer. Unlike urban farmers in Jimma, the urban dairy producers in Assela have a land for crop production so they used high rate of fertilizer and emit CO_2 equal to Jimma per-urban farmers. Even if the Jimma producer has a small land, they used synthetic fertilizer and manure for crop and crop residue production. But the variation observed between milk sheds was the type of crop cultivation and rate of fertilizer application per hectare. In Jimma milk shed the dairy producer cultivated crops like maize, sorghum, and teff while Assela farmers produced wheat, barley and teff. To produce one quintal of crop residue, 9.26 $KgCO_2$ eq and 6.35 $KgCO_2$ eq were emitted in Assela and Jimma milk sheds, respectively. This result is less than the world gas emitted reported by Gerber *et al*. (2013) the lowest N_2O emission in South Asia (0.12 Kg N_2O eq) and the highest emission recorded in W.Europ (0.53 Kg N_2O eq) from feed production. This emission is equivalent to 35.76 $KgCO_2$ eq to 157.94 $KgCO_2$

eq of global warming potential (GWP). In both milk sheds, the potential gas emission was higher in peri urban than the urban dairy production system. But this disagrees with a result of Tezera and VHL (2018), who reported the urban dairy producer, had higher gas emission than that of peri-urban. This variation might be due to the location and rate of fertilizer application between the two studies. The Jimma dairy producer mostly peri-urban dairy producer used their land for other purposes like coffee and chat as we have discussed above so this production directly not used for animal feed due to this reason the land used for animal feed was very small. In addition, unlike Assela farmer, the Jimma farmer used more manure for crop cultivation in addition to synthetic fertilizer. But in Assela milk shed most of the producers used organic fertilizer for other purposes rather used for as a fertilizer leading the farmer to use high rate of synthetic fertilizer to produces crop residue. Synthetic fertilizer has the potential to produce more GHG emission than organic fertilizer (Gerber *et al*., 2013). The overall result also showed that high GHG emission incurred in Assela milk shed than Jimma milk shed from on-farm feed production due to the above reason. This finding also agreed with (Tongwane *et al*., 2016) who reported high emission from synthetic fertilizer was obtained as a result of the high application rate for the sake of improves productivity.

Table 15. The carbon dioxide (CO_2) emission (Mean ± SE) from fertilizer used in Assela and Jimma milk sheds

CO_2 emission from fertilizer used	Assela milk shed		Jimma milk shed		Milk sheds	
	Urban	Peri-urban	Urban	Peri-urban	Assela	Jimma
Direct emission	109.29 ± 22.6^{b}	246.84 ± 37.76^{a}	9.94 ± 3.79^{c}	104.11 ± 15.0^{b}	170.79 ± 21.81^{a}	70.42 ± 10.53^{b}
Volatilization	11.02 ± 2.28^{b}	24.89 ± 3.79^{a}	1.06 ± 0.39^{c}	10.67 ± 1.52^{b}	17.23 ± 2.19^{a}	7.23 ± 1.07^{b}
leaching	24.59 ± 5.09^{ab}	55.54 ± 8.5^{a}	2.24 ± 0.85^{c}	23.42 ± 3.38^{b}	38.43 ± 4.91^{a}	15.85 ± 2.37^{b}
overall emission	144.9 ± 29.19^{bc}	327.27 ± 32.46^{a}	13.24 ± 36.29^{d}	138.2 ± 27.08^{c}	236.08 ± 21.83^{a}	75.72 ± 22.64^{b}
Kg CO_2 emit/q of feed pro.	6.71 ± 1.22^{b}	12.40 ± 1.90^{a}	1.99 ± 0.83^{c}	8.78 ± 0.96^{ab}	9.26 ± 1.11^{a}	6.35 ± 0.74^{b}

SE = Standard error
Means with different superscript letters in the rows are significantly ($P \leq 0.05$) different

4.6.2. Green House Gas Emission from machine used

The type of farm machines used in Assela milk shed were tractor for land cultivation and combiner for crop harvesting. The greenhouse gas emission incurred from farm machinery due to the fuel consumed by tractor to cultivate land and combiner to harvest the crop. According to Gebre (2016) and FDRE (2011), the emission factor was computed for diesel fuel was 2.67 KgCO_2/lit and for Gasoline type of fuel was 2.42 Kg CO_2/lit. The (Figure 7) below showed as the mean CO_2 emission from tractor and combiner both in urban and peri ur ban of Assela milk shed was 63.56Kg CO_2 eq/year and186.16 Kg CO_2 eq/year, respectively. The peri-urban production system has emitted three times CO_2 from machine used than urban production system because few of the urban dairy producers had land for crop cultivation. This result is similar to the finding of Tezera and VHL, V. (2018) from both tractor and combiner the gas emission were higher in peri-urban than urban production system. Unlike Assela, in Jimma milk shed no machine was used by dairy producers either to cultivate or harvest the crop. All of the respondents used the animal power to cultivate the land and used human power to harvest the crop, implying no fuel was consumed and there is no gas emission is expected.

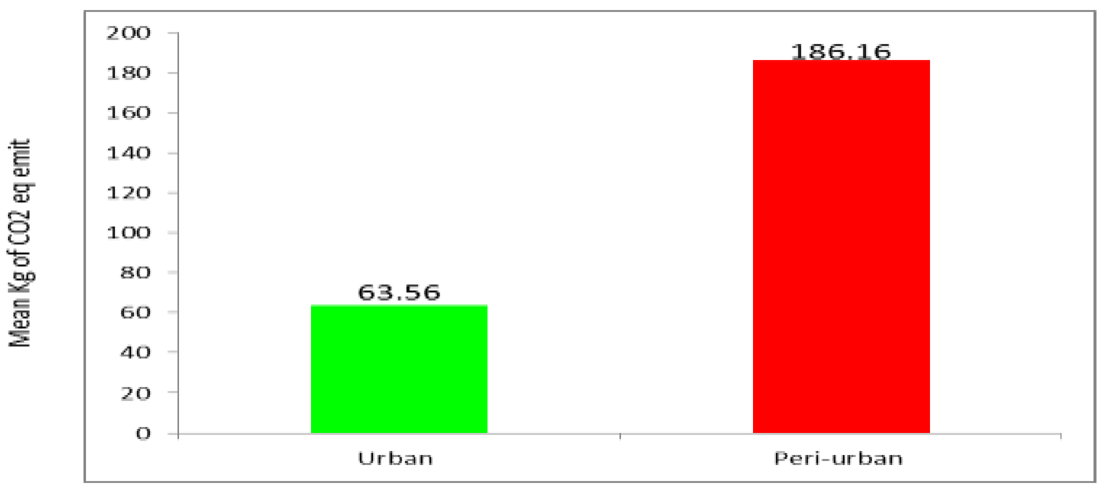


Figure 7. Carbon dioxide (CO_2) emission from machine used by Assela dairy producer

4.6.3. Carbon dioxide (CO_2) Emission from feed processing and feed transportation in Assela and Jimma milk sheds

The gas emission from feed processing estimated from the amount of feed provided to dairy and multiplied by emission factor 1.36 Kg CO_2/Kg of feed processing (Table 16) were derive d as per Weiler *et al*., (2014). The mean CO_2 emission from feed processing in Assela milk shed (68.93Kg CO_2 eq/year) was significantly higher ($P \leq 0.05$) than Jimma milk shed (30.59 Kg CO_2 eq/year). The result shows that, the Assela milk shed had double CO_2 emission than Jimma milk shed which might be due to the availability of more processing plants in Assela milk shed. In both milk sheds, the CO_2 emission in urban was higher than that of peri-urban dairy prouder, since most of urban dairy producers unlike peri urban dairy producers who secured feed by purchasing processed feed. Similarly, Tezera and VHL, V. (2018), reported that in Ziway-Hawassa milk-shed the gas emission from feed processing was higher in urban than peri-urban dairy producer. The highest mean CO_2 emission was obtained in Assela urban (90.42 Kg CO_2 eq/year) and the lowest mean CO_2 emission was recorded in Jimma peri-urban (15.02 Kg CO_2 eq/year). From CO_2 emission due to processed feed and provided for dairy in Assela milk shed 26% was emitted inside milk sheds and the rest percent was processed outside of milk shed, mainly from Addis Ababa and its surrounding feed processing units but in Jimma milk shed totally the concentrate feed was processed out of milk shed. Generally, the dairy producer in both Assela and Jimma milk shed received the feed for their dairy more outside of the selected milk shed so the CO_2 emission from feed processing plant was high out of milk shed than inside CO_2 emission.

The CO_2 emission from feed transportation was obtained from fuel consumed by the vehicle. The mean CO_2 emission from feed transportation at the Assela dairy producer (33.99 Kg CO_2 eq/year) was significantly higher than that of Jimma dairy producer (5.37 Kg CO_2 eq/year). Most of the Assela dairy farmers purchased the processed feed directly from the processing unit in Assela itself while the Jimma dairy producer purchased only from feed dealer because there is no any feed processing unit around Jimma. Due to the above reasons, the Assela dairy producer emited high CO_2 than Jimma dairy producer. Even if a significant difference was seen between Assela and Jimma milk sheds, there was no significant difference among the production system. However, the Jimma urban dairy producer had higher CO_2 emission (8.72

Kg CO_2 eq) than peri-urban (3.51 Kg CO_2 eq) since the majority of peri-urban dairy producer used the animal back and cart for feed transportation. The current result also agreed with Tezera and VHL, V. (2018), where most of peri-urban dairy producer used animal back and cart for feed transportation due to this low gas emission was recorded in peri-urban than urban dairy producer. As presented in (Table 5) above most of peri-urban dairy producers used higher percent cart and animal back for feed transportation than a car but the urban dairy producer used more cars for feed transportation. From the current result displayed in the table below, the higher intensity of CO_2 emission was seen by Jimma dairy producer to purchase one quintal of feed. This variation was recorded due unavailability of feed dealer around small town or peri-urban dairy producer who travelled up to 25Km to purchase small amount of feed for their dairy.

Table 16: Carbon dioxide (Mean ± SE) emission from Off-farm (feed processing) and feed transportation in Assela and Jimma milk sheds

CO_2emition source	Assela milk shed		Jimma milk shed		Milk sheds	
	Urban	Peri-urban	Urban	Peri-urban	Assela	Jimma
feed processing	90.42 ± 5.24^{a}	42.37 ± 3.94^{c}	58.54 ± 4.38^{b}	15.02 ± 1.97^{d}	68.93 ± 4.01^{a}	30.59 ± 2.75^{b}
feed transportation	32.35 ± 6.44^{a}	36.02 ± 7.69^{a}	8.72 ± 1.57^{b}	3.51 ± 0.57^{b}	33.99 ± 4.93^{a}	5.37 ± 0.70^{b}
intensity of feed transportation/Q	0.38 ± 0.09^{c}	0.94 ± 0.15^{ab}	0.59 ± 0.12^{bc}	1.14 ± 0.13^{a}	0.63 ± 0.09^{b}	0.94 ± 0.10^{a}

Means with different superscripts in the rows are significantly ($P\leq0.05$) different

SE = Standard error

4.6.4. Gas emission from feed transportation by feed trader in both milk sheds

The feed dealer in both milk sheds used vehicles like FSR and ISUSU for feed transportation from its production to the end users. They purchased feed from different processing plants found around them and out of the milk shed, especially by the Jimma trader who moved a long distance. The vehicle which the trader used has consumed fuel during feed transportation which is a source of gas (CO_2) emission. For diesel and gasoline fuel type 2.67 and 2.42

emission factors were used according to Gebre (2016) and FDRE (2011). As shown from the (Figure 8) below, the mean CO_2 emission from all vehicles to transport feed by both Assela an d Jimma trader's poduced 254.98 Kg CO_2 eq/year and 2881.46 Kg CO_2 eq/year, respectively. The result indicated that the mean CO_2 emission by Jimma trader was significantly higher than that of Assela trader. The reason for high gas emission by Jimma trader was due to long distance travelled (60-400 Kms) to purchase feed from feed processing plants mainly around Addis Ababa. But the Assela trader had an option to purchased feed from the nearby processing plant and the maximum distance they traveled was up to 175Km. Hailu *et al.* (2018) reported that the CO_2 emission from the transportation sector has been showing an increasing manner from 2009 to 2015 (384.97Gg CO_2eq to 710.63Gg CO_2 eq), respectively in Dire Dawa. But the Ethiopian climate resilient green economy planned (CRGE, 2011) for reducing GHG emission from the transportation sector up to 10MtCO_2e in 2030 from total GHG emission. Therefore, the result obtained from Jimma trader was not compatible with those plans. So to reduce the gas emission to get feed, cooperatives or a private sector has to be encouraged to establish feed processing unit in Jimma town is more effective as it can also serve not only the dairy sector but also other livestock production like poultry and at the same time minimize cost of production.

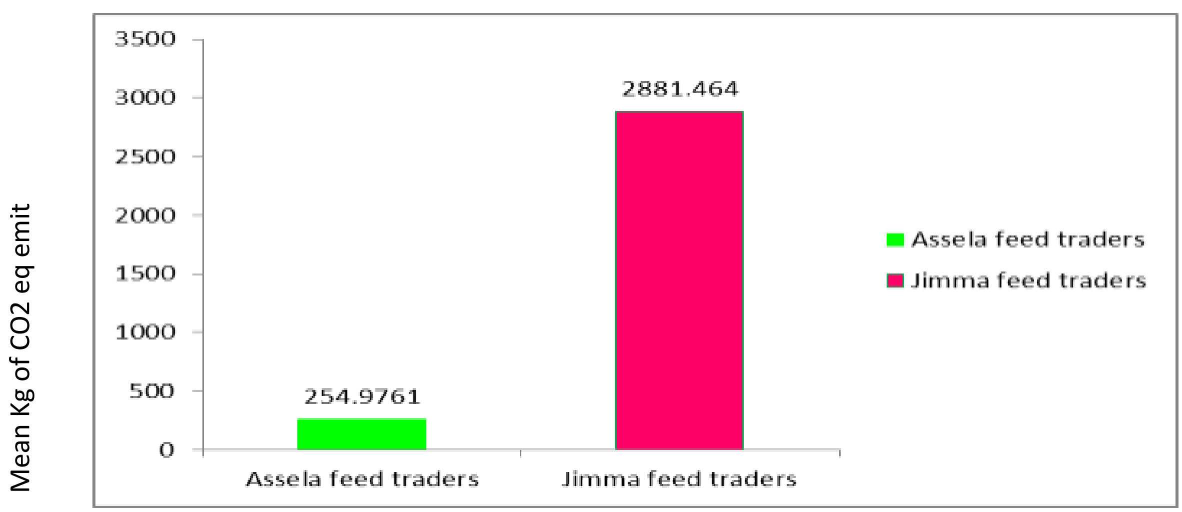
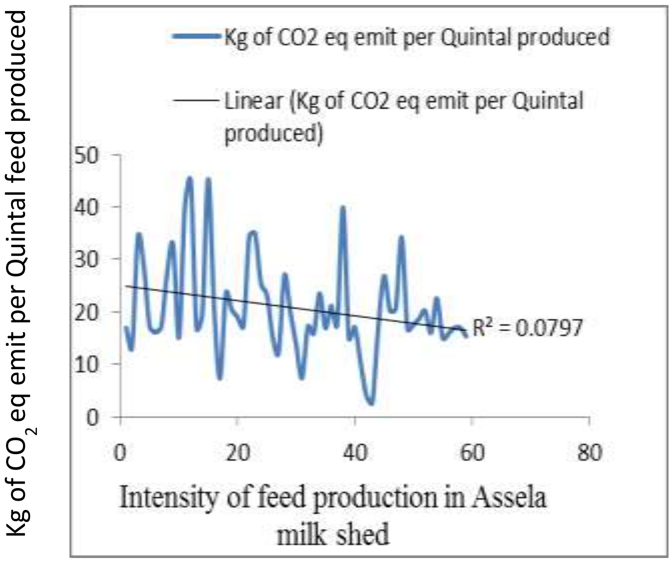


Figure 8. Emission of CO_2 during feed transportation

In Ethiopia Greenhouse gas (GHG) emission from the transport sector is showing increasing manner from time to time however when we compared to worldwide contribution of GHG emission from feed transportation which is only 3 % (Paul, and Weinthal, 2019). The current study showed a feed trader traveled to purchase feed where it existed. But the distance traveled to purchase feed from one to another trader has great variation. With increasing distance traveled to purchase feed the CO_2 emission was increasing. So the CO_2 emission raised by 45% at Jimma traders compared to 10 % increase by Assela traders due to traveling long distance to purchase one quintal of feed.

4.6.5. The intensity of carbon dioxide (CO_2) emission to produce feed per quintal in Assela and Jimma milk sheds

To produce a feed, the dairy producer used inputs like fertilizer (organic and synthetic) and land used for cultivation. This input has a potential to produce feed as well as contribution to gas emission. As can be seen in the (Figure 9) below in both milk sheds, increasing of feed productivity is associated with decreasing CO_2 emission. Hence, in Assela milk shed increasing one quintal of feed production resulted in decreasing CO_2 emission by 7% while in Jimma milk shed increasing of feed production by one quintal decreased CO_2 emission only by 1%. According to FAO and NZAGGRC *et al*. (2017) reducing the intensity of gas emission through improving quality and quantity of feed range from 8-24% in intensive and semi-intensive dairy system in Kenya and 27% in mixed farming system in Ethiopia. The majority of Assela dairy farmers produced below 20 quintals of feed and at the same time more than 20 Kg CO_2 eq emission while the Jimma dairy farmers produced above 20 quintals of feed by emitting less than 20 Kg CO_2. Increasing synthetic fertilizer rate is not improving soil fertility but it used for crop uptake and immediate response for producer. So instead of applying the high rate of synthetic fertilizer on cropping land in terms of improving soil fertility, economical wise and climatically smartens using both organic and synthetic fertilizer is the best solution. Similarly, Tongwane *et al*. (2016) reported that decreasing of synthetic fertilizer application rate on field crops and promoting organic fertilizer is the best solution for reducing gas emission.



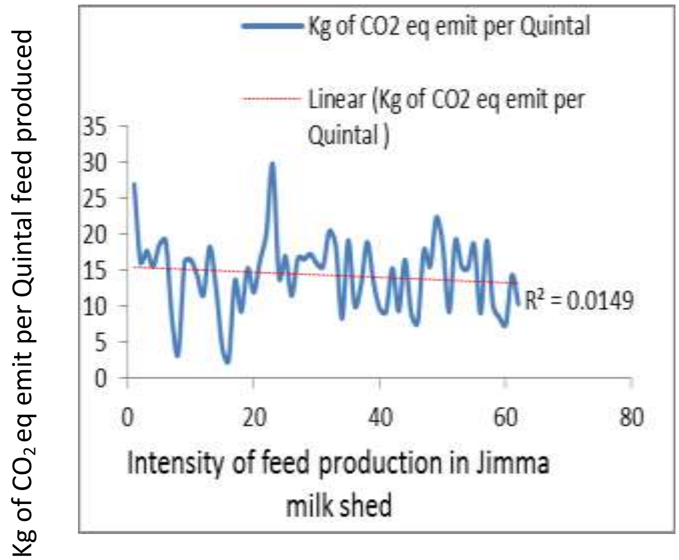


Figure 9**:** Intensity of gas emission to produce /Quintal of feed in Assela and Jimma milk sheds

The Jimma dairy producers practiced the above possible solution than Assela producers. Generally, increasing the productivity is the best associated with decreased gas emission from on-farm feed production as shown in graph above.

In Ethiopia total mission in 2016 was 10438855ton CO_2 with the share of 0.03% from world greenhouse gas emission (Worldmeter, 2016). In this study the total CO_2 emission from the total activity to supply feed for dairy starting from feed production up to the end user was 58.90 ton CO_2 and 30.33ton CO_2 emission in Assela and Jimma milk sheds respectively. So the Assela and Jimma milk sheds shared from the country CO_2 emission 0.0000057ton CO_2 and 0000029ton CO_2 emission respectively. Hence the result recorded in both milk sheds, the GHG emissions (0.09ton CO_2 and 0.046ton CO_2/p in Assela and Jimma, respectively) was less than the per capital CO_2 emission at national level (0.1ton CO_2/p).

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The study was planned to analysis of dairy feed value chain, chemical composition and computing Greenhouse gas emission in Assela and Jimma milk sheds**.** The value chain actors participating in both milkshed include input suppliers (government as well as NGOs, famers unions, financial services, etc.), producer (farmers), traders (cooperatives and private trader) and processors (agro-processing plants, feed processing and local grain miller). However, the contribution and share of these actors may vary between the milksheds. In Assela milk shed, feed producer shares higher profit than other actors while in Jimma milk shed, the feed producer shared lowest profit than other actors. On other hand, the Assela dairy producer were economically profitable while the Jimma dairy producer had to pay high cost for feed due to lack of processing plant in the area. Jimma milkshed suffers most from low extension support and luck of feed processing plant in the area.

The mean values for compositions of feeds for DM, fiber (NDF, ADF, ADL), ether extract and ash contents showed no significant difference ($P>0.05$) between the two milk sheds but variation existed among feed ingredients for all chemical compositions. The mean CP content of natural grass, alfalfa, hay, concentrate, and wheat bran obtained from Assela milk shed was significantly higher ($P \leq 0.05$) than that of Jimma milk shed.

In terms of CO_2, emission from the total activity (from feed production, feed processing and transportation), the Assela dairy producer had higher CO_2 emission than that of Jimma producer. The overall CO_2 emission during feed production emanating from direct emission, Volatilization and leaching from Assela milk shed are two to three times more than that of Jimma. But CO_2 emission by Jimma traders was ten folding than the Assela trader due to longer distance travelled to transport the feed. In both milk sheds, increasing of feed productivity is associated with decreasing CO_2 emission. Hence, in Assela milk shed increasing one quintal of feed production resulted in decreasing CO_2 emission by 7% while in Jimma milk shed increasing feed production by one quintal decreased CO_2 emission only by 1%.

5.2. Recommendations

Based on the above conclusion, the following recommendation is forwarded.

- Jimma dairy producer was not more profitable due to high cost of feed especially for concentrate feed purchased from long distance because of lack of feed processing plant in the area. To reduce the gas emission to get feed and be more profitable, establishing feed processing unit in Jimma town through cooperatives or a private sector has to be encouraged as it can also serve not only the dairy sector but also other livestock production like poultry and at the same time minimize cost of production
- In Assela milkshed even if the access of feed processing plant is available, the linkage between dairy producer and the processing plant was very weak. Due to this reason, most of the dairy producer goes to long-distance to purchase feed for their dairy. Therefore establishing a strong linkage between them will reduce the cost as well as reducing gas emission in relation to feed transportation.
- The rate of synthetic fertilizer used in Assela was higher than Jimma resulting in high amount of N_2O emission. Similar to Jimma dairy producer, practicing partial use of animal manure can help them to minimize the amount of inorganic fertilizer and subsequent gas emission.

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7. APPENDIXS

7.1. Appendix I questioner

General information for producers/farmers

Date of interview _______ District __________ Kebele ________ Village__________

Section 1 Profile of household head

1.1. Name _____________________ Sex ____________ Age _________________

1.2. Marital status a) Married b) Single c) Divorced d) Widowed

1.3. Family Size i. Total ____ ii. Female ___ iii. Male ___ iv. children under 12 years

1.4. Religion a) Orthodox b) Muslim c) Protestant d) Catholic e) Other

1.5. Educational level a) Illiterate b) Read & write c) Grade 1-4 d) Grade 5-8 e) Grade 9-10 f) Other

1.6. Occupation a) Farming both crop & livestock b) Off-farming & livestock c) Only livestock d) Only dairy cattle e) Feed production f) Feed production & dairy cattle g) Others___

Section 2: General farm information

2.1. Land assets [**Tenure system Code:** 1=title deed**,** 2=owned but not titled 3=public land, 4=rented, 5=others

Ownership Code:1=male**,** 2=female**,** 3=joint**,** 4=other relative**,** 5=others]

Land used pattern	Size of land per units	Tenure system (code)	Ownership (code)
Total land area			
Land used for crop cultivation			
Land used for forage development			
Land used for grazing			
Land used for homestead			
Others(like chat, coffee, avocado etc.			

2.2. Is there any change in the size of land you have? _______on which situation? a) Decrease b) Increase

2.2.1. If you say increase, for which purpose did you increase the land? a) Crop production b) Grazing land c) Forage development d) Dairy activities e) Other activities (specify) _________________________

2.3. Livestock ownership (type of livestock Number owned)

Livestock	Total No. of animals	Owner of	No. of	Cash income from	Reason for

species and its product			the Animal (Code)	livestock sold in this year	sale (Br)	selling (code)
	Local	Cross	Exotic			
Cattle	Milking Cow					
	Heifers					
	Calves	F				
		M				
	Bulls					
	Oxen					
Sheep	Lamb					
	Mature					
Goats	Kids					
	Mature					
Donkeys						
Horses						
Mules						
Poultry	Egg					
	Bird					
Bee colony (bee hive)						

Code for reason for selling:1=to get additional income**,** 2=low productivity**,** 3=low feed input (feed shortage)4=diseased animal (unhealthy), 5=low in reproductive performance, 6=others

Code for Livestock owner:1=household male**,** 2=household female**,** 3=jointly**,** 4=other

Section 3. Information on Feed value chain

I. Feed resources and feeding systems

1. What are major feeding systems you use? 1. Free grazing 2. Rotational grazing 3. Tethering / Stall feeding 4. Cut and carry 5. Others __________________
2. What is the source of feed for your animals? 1. Pasture / grazing land 2. Crop residue 3. Improved forage 4. Formulated /concentrates feed 5.Agro industrial by product 6. others _
3. Do you produce feed for you cattle? 1.Yes 2.No

II. Forage production did you produce forage for your dairy cattle? 1.Yes 2.No

1. If yes, what are they?
2. If yes do you used machine to plough and harvest the forage ?1) yes 2) no
3. If yes what type of machine you used ?________________ and the time consumed per ha time and fuel consumed per time _________________lit
4. If no, why____
5. Did you store forage? 1. Yes 2. No
6. If yes, where did you store? 1. under shed with bed under it___ 2. Outside in a conical shape with bed under it 3. on the field without care 4. others _____________________

7. Inputs / services used for forage production? 1. Yes ___ 2. No ____

7.1. What are the major inputs (seed, fertilizer, etc?)for forage production?

No.	Input / services		Source of input (code)	Name of NGOs	Price per input(..)
1	Seed / Stem / Seedlings				
2	Fertilizer	Industrial fertilizer			
		Compost			
		Manure			
3	Forage production training				
4	Forage harvesting training				
5	Forage storage training				
6	Financial services				

Source of input: 1= NGO, 2= woreda / district livestock and fisheries office, 3= research centers 4= universities, 5= own experience, 6=others

8. Do you get feed market information on forage production? 1. Yes 2. No

8.1. If yes, who is your source of market information? ___________________

9. **Forage Marketing**

10. Do you sell forage? 1Yes 2.No **If yes, please fill the table**

No	Type of forage	To whom do you sell (code)	Place of selling	When did you sell (1= dry season 2= wet season	Price per selling (birr per load/hector /
1	Grass				
2	Legumes				
3	Tree or shrub				
4	Others				

To whom do you sell: 1=to traders, 2=to cooperatives, 3=to agro industrial factory, 4=to other/ neighbor farmers, 5=others

11. Do you buy forage? 1. Yes 2. No, **If yes, please fill the table**

No	Type of forage	From whom do you buy	Place of buying	When do you buy (1= dry season 2= wet season	Price per purchase (birr per load/hector
1	Grass				
2	Legumes				

3	Tree or shrub				
4	Others				
from whom do you buy: 1=to traders, 2=to cooperatives, 3=to agro industrial factory, 4=to other/ neighbor farmers, 5=others					

10.1 How far the forage market is? ____Km or time to reach there____________

10.2 How do you transport forage? 1. By human power 2) By animals back 3) By vehicles (car, bicycle, motor bicycle 4. others ______________

10.3 Cost of transportation from your area to the market for selling? ________

10.4 Cost of transportation from the market to your area to buying? _________

10.5 What are the major constraints in forage production in order of their priority and suggested solutions?

Major constraints	Rank (1= high priority, 2= medium, 3=low priority)	Suggested solutions
Seed / stem shortage		
Shortage of training how to produce, harvest, treat and feed		
Shortage of land		
Low productivity of forages		
Shortage of water for year round production (dry season)		

12. What are the potential opportunities in forage production? ____________________

13. Do you produce crop residue from crop production? 1. Yes 2.No **If yes, fill the table.**

No.	Type of crop residue	Amount produced	Measuring unit	Reason for crop residue production
1				
2				
3				

14. Did you used fertilizer in crop production / crop residue? 1 Yes 2. No

13.1. If yes, what type of fertilizer did you used?

No	Type of fertilizer used	Units	Amount used	Rate of application/ha
1	DAP	Kg		
2	UREA	Kg		
3	Manure	Quint		

13.2. Do you use machine for crop production? 1) Yes 2) no **.**If say yes fill the table blow

No	Activities	Type of crop	Type of machine	Time	Type of fuel used	Volume of fuel used /litr

1	Ploughing	Teff				
		Wheat				
		Barley				
		Rice				
		Maize				
		Sorghum				
		Others				
2	Harvesting	Teff				
		Wheat				
		Barley				
		Rice				
		Maize				
		Sorghum				
		Others				

1. Did you care for crop residue after harvesting? 1. Yes 2. No

14.1. If yes, what type of care did you do? ________________________

14.2. If no, why? ____

15. Did you store crop residue? 1. Yes 2. No

15.1. If yes, why? ____

15.2. If yes, where did you store? 1. Under shed with bed under it 2. Outside in a conical shape with bed under it 3. On the field without care 4.others_____________________

15.3. If no, why?____

16. Did you treat crop residue? 1. Yes 2. No

16.1. If yes, what type of treatment did you used? 1. Chopping 2. with molasses 3.with oil cakes and water 4.others

16.2. If no, why? ____

17. Do you sell crop residue? 1. Yes 2. No **If yes, please fill the table**

Type of crop residue	To whom you sell (code)	Place of selling	When did you sell (1= dry season 2= wet season	Amount of selling/ kg/kunt/ha	Price per selling (birr per load/ per hector / kg.)	For what purpose did your customer use? (code)
To whom do you sell: 1=to traders, 2=to cooperatives, 3=to retailer, 4=to other/ neighbor farmers, 5=others **Purpose of crop residue:** 1=animal feed, 2=home construction, 3=mulching/ seedling bed, shed, 4= other						

17.1. What proportion of your crop residues do you sell? ___________________________

18. If you don't produce crop residue, do you buy crop residue? 1. Yes 2. No **If yes, please fill the table**

Typ	From	Place	When you buy	Amount of purchased	Price per purchasing

es of crop resid ues	whom do you buy (Code)	of buying	(1= dry season 2= wet season)	/month/quarter/year	(birr/load/hector/kg/quinta l

from whom do you buy: 1=traders, 2=cooperatives, 3=from retailer, 4=from other/ neighbor farmers, 5=others

19. Did you have grazing land utilization habit? 1. Yes 2. No

19.1. If yes, which type of grazing land? 1. Communal 2. Private 3. Rented 4. others____

19.2. If you use communal grazing, did it have management system in utilization?1.Yes2.No

19.3. If no,for the above question, why?____ ____

8.6 If you have private grazing land how much hectare is it? 1)0.1 2) 0.25 3) 0.5 4) 0.75 5) 1 6) 2 7) 3-5

19.3.1. Do you manage your grazing land? 1. Yes 2. No

19.4. If yes, what type of management is used? 1. Rotational grazing 2. Rehabilitation mechanism through plantation 3. Commercial fertilizer application 4. Compost/ manure dung application 5. Others ______

19.4.1. If you used fertilizer (commercial) what is the rate of application? _____________

19.5. Did the area of the communal land in increasing manner? 1 Yes 2. No

19.5.1. If yes, How? ____

19.5.2. If no, why? ____

19.6. If you used rented grazing land, how did you get it? ______________________________

How much did it cost? ____________Per hector

What are the factors to use rented grazing land? _______________________

What are opportunities of using rented grazing land? ___________________

20. Do you formulate concentrate ration at home? 1) Yes 2)No

20.1. If yes, How?

Raw material Used	Treatment on preparation	Ratio	Place of preparation	When did you prepare (1= dry season 2= wet season	Price per formulation (birr per load)

20.2. If no, do you buy concentrate feed for your animals? 1. Yes 2.No

20.2.1. If yes, please fill the table

Source of concentrate/name of processing plant	Place of buying (code)	When did buy (1= dry season 2= wet season	Means of transportation	Cost of transport	Amount of purchased/kg/ quint.	Price per purchasing (birr per load)
Place of purchasing: 1=from traders, 2=from cooperatives, 3=from processing plant (name), 4=from other/ neighbor farmers, 5=others						

20.3. To which animals do you provide concentrate feeds and other feed resource? 1)cow 2)oxen 3)bull 4 calves 5) others

20.4. What are the major constraints in concentrate feeds marketing in order of their priority?

Major constraints	Rank (1= high priority, 2= medium 3=low priority)	Suggested solutions

21. Did you buy agro industrial by products? 1. Yes 2. No

21.1. If yes, please fill the table

Type of ago industrial by product	Place of buying (Code)	When did you buy (1= dry season 2= wet season	Amount of purchased quintal/month or year	Price per purchasing (birr per load or quintal)	Means of transportation	Transportation cost
Place of purchasing: 1=from traders, 2=from cooperatives, 3=from agro industrial factory (name), 4=from other/ neighbor farmers, 5=others						

21.2. Did you store agro industrial by product? 1. Yes 2. No

21.2.1. If yes, where did you store? ____

21.3. What are major constraints in agro industrial by product feed?

Type of agro industrial by product	Major constraints	Rank (1= high priority, 3=low priority)	Suggested solutions

21.4. What are the potential opportunities in agro industrial by product marketing? __________

22. Did you use other non-conventional feeds? 1. Yes 2. No

22.1. If yes, what are they?

No	Type of non-conventional feed	Did you produce? 1. Yes 2. No	If you didn't produce, Place of buying (code)	When did you buy (1= dry season 2= wet season)	Price per purchasing (birr per load)
1					
2					
3					
4					
Place of purchasing 1=from traders, 2=from cooperatives, 3=from agro industrial factory, 4=from other / neighbor farmers, 5=others					

23. Do you have a group/association/ cooperative for feed production? 1. Yes 2.No

23.1. What is the role of group/association/ cooperative in feed input supply and product ma rketing_________________________

23.2. Do you have long standing customers (buyers or sellers) for feed? 1) Yes 2)No

23.3. Who usually determines price for feeds in the market? _______________________

23.3.1. How do you evaluate the bargaining power of farmers in forage/feed markets?_______

23.3.2. What market regulations are impeding your forage/feed marketing?___________

23.3.3. What market regulations should be in place to facilitate your feed marketing? ____

23.3.4. Challenges and opportunities

Do you faced by any constraints in your dairying practices? 1. Yes 2. No

If your answer is yes please fill the table below.

Type of constraints/challenges	
Lack of feed access	
High cost of feed	
Cost of feed transportation	
Lack of feed input	
Lack of extension service	
Financial problem	

Others if any	

Do you have any opportunities which aids in your dairy production?1. Yes 2. No
If your answer is yes please fill the table below.

Type of constraints/challenges	
Access of feed processing plant around the dairy producer	
Access of road and other infrastructure	
Support of government and other NGOs by supplying feed inputs	
High demand of milk	
Access of roughage feed(hay and crop residue)	
Access of feed processing plant around the dairy producer	
Others if any	

For Feed collectors/trader

1. Questionnaire Code:_________ Date of interview _______________ village_____________
2. Sex 1. Male ____ 2. Female ____
3. Age ________
4. What is your education level? 1. Illiterate _____ 2. Read and write ______ 3. Grade 1-4 _
   4. Grade 5-8 __ 5. Grade 9-10 ______6. Other (specify) _____________________
5. What is your experience in feed trade/collection business? ________ Years
6. Is feed trade/collection business the only source of your income? 1. Yes ___ 2. No ____
   6.1. If no, what are your additional income sources? _____________,
   6.2. If yes, what is your main reason for engaging in feed collection/trading business?
      1. No other alternative ___ 2.Tradition/hobby ___ 3. Best money-making alternative 4. Others ____
7. Do you have legal license to operate the business? 1. Yes 2. No
   7.1. If no, why? ____
   7.2. If yes, what is the price to have a license? ______ ETB per _____(Year or Month)
   7.3. Is that difficult to get a license? 1. Yes 2. No
   7.4. If yes, how much time it take to get the license? ________
8. Please indicate the involvement of gender in your business unit and justify the reason;

S. No.	**Activities**	**Answer (**use code)	**Reason**

		For feed Collectors	**No.**	**For feed Processers**	**No.**	
1	Purchasing of feed					
2	Transportation of feed					
3	Reception					
4	Selling feed					
5	Processing					
6	Cleaning					
7	Quality control					
8	Packaging					
1= female from family; 2= male from family; 3 = male employee; 4 = female employee						

9. If you hire same one, what is the price of employee per month? ________
10. Is there a problem of obtain a labor? 1) Yes 2) No
11. If yes, how did you solve it? ________________
12. From where do you collect feed? 1. Directly from producer 2. From other trader/collectors 3. From feed brokers 4. Others __________________,
13. What is the means of transportation during feed collection? 1. bydonkey 2. On foot 3. Public transport 4.Own transportation truck
14. Please indicate specific place of feed source, respective amount, distance and means of transportation on the following table:

S. No.	Feeds	Amount of feed(Quintal / pack(100/50 kg))	Purchasing price/Quintal/ pack(100/50 kg)	Distance (Km)	Means of transport	Other costs (transportation, labor…) on average
1						
2						
3						
4						

15. What is feed procurement strategy? 1. Contract 2. Incentive-based system 3. Creating fair value share 5. Trust 6.Others ____
16. Do you test the quality of feed during procurement? 1. Yes 2. No

16.1. If Yes, what type of test do you use _______________

16.2. If yes and the quality is not good, what do you do? 1. Reject 2. Purchase by reducing the price 3.Others ___________________,

16.3. If no why? ________________, _________________,______________________

17. For whom do you sell your feed? 1. Cattle producer/farmers/Consumers 2. Other collectors/traders 3. Processors4) Wholesalers 7. Cooperatives _____

18. What is the distribution system of feed to customers? 1. By their own car 2. Donkey 3. On foot 4) public transport

19. Who is responsible for distribution of feed from your center to receiver customers? 1. Myself 2. Purchaser

20. Please indicate your feed selling history, corresponding volume, distance and means of transportation on the following table:

S. No.	Purchasers place	**Amount of feed (Quintal or pack(100 or 50))**	**Selling Price / Quintal or pack(100 or 50)**	**Distance (Km)**	**Means of transport**
1					
2					
3					
4					

21. Do you have storage facility in your collection point? 1. Yes 2. No

21.1. If no, Why? ___________________, _____________________, _____________

21.2. If yes, please fill the following information on the following table

S. No.	**Storage facility**	**Specialty of the storage facility**	**Power consumption of storage facility**	**Remark**
1				
2				
3				

21.3. If yes, what is the source of power for your storage facility?

1. Generator2. Electricity 3. Both

21.4. If the answer is both, on average for how many hours do you use generator per day_____________(hrs.) and Electricity_(hrs.)

21.5. How many litter of fuel the generator consumed per hour?___

22. What is the average electricity consumption (Kwh)per month or year?____________

23. How often do you turn of flights and power when not required? 1. Always 2. Frequently 3)Sometimes 4.Never

24. Do you have encountered spoilage/loss of feed? 1.Yes 2.No

24.1. Ifyeshowoftendoyouencountered?1)always2)sometimes3)Rarely

24.2. If yes, in case of rotting detected, how much of feed is spoiled from the total collected feed? ______________________________

24.3. If yes, what is the reason of rotting? 1)poor hygienic practice
2) lack of storage facility 3)Rodents 4)in accessible market / long time storage5) Moisture/rain/ 6)others, specify

If yes what do you practice to reduce rotting?___________________________________,

Please, give your general suggestion to improve feed collection and distribution procedures in your area

For Feed processors

Questionnaire code:_____________Date of interview_____________village_______________

Sex 1. Male ___ 2. Female ___ Age?_________________

1. What is your education level? 1. Illiterate _ 2. Read and write __ 3. Grade 1-4 __ 4. Grade 5-8 5. Grade 9-10 6. Other (specify) ____________________
2. What is your experience in feed processing business? _____Years
3. What are the main activities in your business? 1. Processing only 2.transporting and proce ssing 3.collecting, transporting and processing 4. Processing and wholesaling 5. Processing and retailing
4. From where do you bring (source) feed? 1.owncollectioncenter 2. Any feed traders 3. Directly from producers 4. Others,_____,____________
5. Pleaseindicateabouthowyouorganizethetransportingandprocessingoffeed:

S. No.	Feed type	Amount of feed transported	Means of transportation	Loading capacity	Distance travelled (km)	
1						
2						
3						
4						

6. Pleaseindicatetheprocessedtypesoffeedproductsandassociatedcoststructure:

S. No.	**Feed type**	**Average amount of feed collected/day**	**Purchasing price/Quintal/pack(100/50kg)**	**Cost of processing, labor & transport/ Quintal/pack(100/ 50kg)**	**Processed products/day**	**Selling price/ Quintal/pack(100/50kg)**	**Remark**

7. For whom do you supply your products? 1. Whole salers2. Supermarkets
4. Directly to consumers _____
8. Whatisyourpowersources?1.Generator2.Electricity 3.both

11.1. If the answer is both, on average for how many hours do you use generator per day ______(hrs)and Electricity____(hrs)?

11.2. How many ltrs of fuel the generator consumes per hour?______

What is the install processing capacity of the factory? ________

What is the current processing capacity of the factory?_

What is feed procurement strategy? 1) contract2) incentive-basedsystem3) creating fair value share 5) trust 6) if others specify___,______,______

What is feed products distribution strategy? 1) contract with wholesalers/retailers2) by using owner tailing go wholesalingshop3) contract with hotels/cafeteria4) others, specify___

Pleaseindicatethepowerutilizationofyourfactoryonthefollowingtable:

S. No.	**Feed type**	**Types of processed feed products**	**Amount of feed required/unit of processed products**	**Processing time /product (hr.)**	**Power consumption ofthe machine/hr.(Kwh)**	**Remark**
1						
2						

9. Do you know the effect of climate change?1)yes2)No
10. If yes, what measures do you take to reduce the effect of climate change from your business perspective? ____

Please, give your general suggestion to improve the processing efficiency of factory?____

7.2 Appendix II summary of ANOVA Table

Appendixes in Table 1: Summary of ANOVA table CP content of green grass

Source	DF	sum of square	mean square	F value	P>F
Model	1	9.95881667	9.95881667	32.87	0.0046
Error	4	1.21187819	0.30296955		
Corrected Total	5	11.17069485			

Appendixes in Table 2Summary of ANOVA CF content of green grass

Source	DF	sum of square	mean square	F value	P>F
Model	1	36.99173400	36.99173400	28.37	0.0060
Error	4	5.21584533	1.30396133		
Corrected Total	5	42.20757933			

Appendixes in Table 3 Summary of ANOVA ADF contents of green grass

Source	DF	sum of square	mean square	F value	P>F
Model	1	21.32010401	21.32010401	10.17	0.0332
Error	4	8.38527761	2.09631940		
Corrected Total	5	29.70538162			

Appendixes in Table 4 Summary of ANOVA CP content of Alfalfa

Source	DF	sum of square	mean square	F value	P>F
Model	1	20.49801667	20.49801667	14.71	0.0185
Error	4	5.57374467	1.39343617		
Corrected Total	5	26.07176133			

Appendixes in Table 5 Summary of ANOVA CF content of Alfalfa

Source	DF	sum of square	mean square	F value	P>F
Model	1	12.40418817	12.40418817	26.61	0.0067
Error	4	1.86491629	0.46622907		
Corrected Total	5	14.26910445			

Appendixes in Table 6 Summary of ANOVA ADF content of Alfalfa

Source	DF	sum of square	mean square	F value	P>F
Model	1	141.1902954	141.1902954	36.05	0.0039
Error	4	15.6643723	3.9160931		
Corrected Total	5	156.8546677			

Appendixes in Table 7 Summary of ANOVA CF content of Elephant grass

Source	DF	sum of square	mean square	F value	P>F

Model	1	25.69284267	25.69284267	37.18	0.0037
Error	4	2.76439955	0.69109989		
Corrected Total	5	28.45724221			

Appendixes in Table 8 Summary of ANOVA CP content of Hay

Source	DF	sum of square	mean square	F value	P>F
Model	1	2.94700417	2.94700417	19.92	0.0111
Error	4	0.59163267	0.14790817		
Corrected Total	5	3.53863683			

Appendixes in Table 9 Summary of ANOVA CF content of Hay

Source	DF	sum of square	mean square	F value	P>F
Model	1	158.5895682	158.5895682	24.19	0.0079
Error	4	26.2228627	6.5557157		
Corrected Total	5	184.8124308			

Appendixes in Table 10 Summary of ANOVA ADF content of Hay

Source	DF	sum of square	mean square	F value	P>F
Model	1	130.4865954	130.4865954	63.45	0.0013
Error	4	8.2267079	2.0566770		
Corrected Total	5	138.7133033			

Appendixes in Table 11 Summary of ANOVA ADL content of Hay

Source	DF	sum of square	mean square	F value	P>F
Model		12.89874788	12.89874788	39.55	0.0033
Error		1.30457733	0.32614433		
Corrected Total		14.20332521			

Appendixes in Table 12 Summary of ANOVA CP content of Concentrate

Source	DF	sum of square	mean square	F value	P>F
Model		5.18940000	5.18940000	8.80	0.0413
Error		2.35867799	0.58966950		
Corrected		7.54807799			

Total					

Appendixes in Table 13 Summary of ANOVA CP content of Wheat bran

Source	DF	sum of square	mean square	F value	P>F
Model		14.75801667	14.75801667	21.52	0.0097
Error		2.74358867	0.68589717		
Corrected Total		17.50160533			

Appendixes in Table 14 Summary of ANOVA CF content of Wheat bran

Source	DF	sum of square	mean square	F value	P>F
Model		30.62752267	30.62752267	8.23	0.0456
Error		14.89476867	3.72369217		
Corrected Total		45.52229133			

Appendixes in Table 15 Summary of ANOVA NDF content of NSC

Source	DF	sum of square	mean square	F value	P>F
Model		39.82186913	39.82186913	33.83	0.0043
Error		4.70792909	1.17698227		
Corrected Total		44.52979822			

7.3. Appendix III Different types of fertilizer used and carbon dioxide emission in Assela and Jimma milksheds

Appendixes in Table 16. Assela and Jimma milk sheds fertilizer used for crop production

type of fertilizer used	Asella milk-shed		Jimma milk-shed	
	Amount used/Kg	Total N/Kg	Amount used/Kg	Total N/Kg
DAP	10463	1883.34	3712	668.16
UREA	5575	2564.5	2462	1132.52
MANURE	273	38.22	350	49
over all	**16311**	**4486.06**	**6524**	**1849.68**

Appendixes in Table 17 Summary of carbon dioxide emission from fertilizer used

Milkshed	Source of emission	Total N used	N_2O emission	When convert to CO_2	Conversion factor N_2O ► CO_2	Reference
Assela	Direct	4486.06	70.495	21007.57811	1= 298	IPCC 2007
	Valorization	4486.06	7.110	2118.656	1= 298	IPCC 2007
	Leaching	4486.06	15.861	4726.705	1= 298	IPCC 2007
Jimma	Direct	1849.68	29.066	8661.787	1= 298	IPCC 2007
	Valorization	1849.68	2.984	889.125	1= 298	IPCC 2007
	Leaching	1849.68	6.53994	1948.902	1= 298	IPCC 2007