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CHARACTERIZATION OF CATTLE FATTENING AND MARKETING SYSTEMS
AND NUTRITIONAL QUALITY OF SORGHUM STOVER ENSILED WITH
EFFECTIVE MICROORGANISMS (EM) AND UREA IN WEST HARARGHE, ETHIOPIA

PhD Dissertation

By

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Addis Ababa University, College of Veterinary Medicine and Agriculture
Department of Animal Production Studies

PhD program in Animal Production

March, 2018
Bishoftu, Ethiopia

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A Dissertation Submitted to the College of Veterinary Medicine, Addis Ababa University
in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in
Animal Production

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PhD Thesis

Addis Ababa University (2018)

ABSTRACT

The study was carried out in Chiro, Gemechis, Habro and Tullo woredas of West Hararghe Zone, Oromia Regional State, Ethiopia from 12 March, 2015 upto 25 March, 2016. The objective of the study was to characterize the cattle fattening and marketing systems and investigate the nutritional quality of sorghum stover treated and ensiled with Effective microorganisms (EM) and urea. To obtain quantitative and qualitative data, survey questionnaire, focus group discussion, key informant interview, personal observations and secondary data collection were done. A total of 160 household respondents; 81 from four highland and 79 from four mid-altitude rural kebeles each respondent having at least one fattening cattle at the time of study were interviewed. The survey result indicated that crop and livestock production was the major source of income in the study woredas. Feeding and watering, cleaning the shelter, health care and marketing were the routine cattle fattening activities performed primarily by husband and wife; wife and children; and husbands, respectively. Thinning of maize and sorghum, grass and weeds in wet season and maize and sorghum stover in the dry season were the major feed resources. Storing crop residues were the main coping mechanism during the critical feed shortage months. Feed shortage, shortage of grazing land, water shortage, low selling price and diseases were ranked as major constraints of cattle fattening practices in the study areas. Dried and chopped sorghum stover each weighing 5kg was treated with urea, EM (Effective microorganism) and urea and EM mixture solutions and ensiled in plastic bags for 21 days. Each treatment was replicated 3 times. The ensiling, in-vitro and in-sacco experiments were conducted using completely randomized design (CRD).

The nutritive quality analysis of sorghum stover showed that the pH values of the treated stover were 4.17, 4.30 and 4.27 for EM treated (T2), Urea treated (T3) and EM plus urea treated sorghum stover (T4), respectively. In all treated stover, fungus development was not observed. The organic matter (OM) and NDF values of all treatment types decreased (90.83, 91.7 and 91.67%) and (73.83, 72.23 and 75.00%), respectively but the CP (5.33, 12.97 and 8.73%) and Ash (9.17, 8.30 and 8.33%) increased for T2, T3 and T4, respectively compared to control sorghum stover (T1). The in vitro DMD values showed that treatments T2, T3 and T4 had significant variation with the control, however, T3 showed the highest in vitro DMD value. Ensiling sorghum stover with these additives generally improved the nutritive value. However, T3 had significantly increased CP and in vitro DMD values. The in sacco DM degradability parameters increased by the additives treatment as compared to T1. Urea treatment showed the highest soluble (36.53%), insoluble but potentially soluble (49.51%), potential degradability (86.04%) and effective degradability (63.39%) fractions than the other treatments. The DM degradation increased with increasing the incubation time across all treatments. The rate of degradation decreased in the order of T3 > T4 > T2 > T1. All the treatments had improved the nutritive value of the sorghum stover. However, the urea treatment was more effective in improving the chemical composition and degradability of sorghum stover. In general, legal protection, technical support and credit facility should be available to the major market participants at woreda level. In addition, treatment of sorghum stover with urea for dry season feeding of cattle is recommended.

Key words: *Cattle fattening, Dry Matter, Effective Microorganisms, In vitro Digestibility, In Sacco Degradation, Sorghum Stover, Urea*

STATEMENT OF THE AUTHOR

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

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DEDICATION

This dissertation manuscript is dedicated to my beloved brother Melaku Girma, my wife Tsiyon Mengistu, my daughters Ruth Daniel, Sosina Daniel and my son Natan Daniel for their love, encouragement, patience and support in the success of my life.

BIBLIOGRAPHICAL SKETCH

I, the author of this work was born in Harar town, Hararghe Administration Region in August 1970 GC. I attended primary education at W/o Yeshimebet Elementary School and High School at Junior Secondary School, and joined the then Alemaya University of Agriculture in 1987. I was awarded with BSc degree in Animal Science in July 1990. After graduation, I joined the Ministry of Agriculture and was assigned in West Hararghe Zone, Chercher Awraja, Hirna town. I served as Animal Husbandry and Forage Development Expert and at different positions until 2004. Then in 2005, I joined Chiro Agricultural Technical Vocational and Educational Training (ATVET) College (currently Oda Bultum University) as Senior Instructor. In July 2007, I joined the post-graduate program at Haramaya University to pursue my Msc degree in Animal Production. Immediately after graduation, I was assigned as lecturer and continued the teaching activity in Haramaya University Institute of Technology for Agro-industry and Forest Development until July, 2013. Then I joined Addis Ababa University, College of Veterinary Medicine and Agriculture (Department of Animal Production Studies) in September 2014 to pursue my PhD study in Animal Production. I am married and a father of two daughters and one son.

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LIST OF ABBREVIATIONS

AAU	Addis Ababa University
ADF	Acid detergent fiber
ADL	Acid detergent lignin
ANOVA	Analysis of variance
AOAC	Association of official Analytical Chemists
APNAN	Asia-Pacific Natural Agriculture Network
CP	Crude protien
CSA	Central Statistics Authority
DM	Dry matter
EE	Ether extract
ECOWAS	Economic Community of West African States
EM	Effective Microorganisms
ESAP	Ethiopian Society of Animal Production
ETB	Ethiopian Birr
ESGPIP	Ethiopia Sheep and Goat Productivity Improvement Program
FAO	Food and Agricultural Organization of the United Nations
FGD	Focus group discussion
FIS	Feed Innovation Services
GTP	Growth and Transformatin Plan
Ha	hectare
IBC	Institute of Biodiversity Conservation
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
ITK	Indigenous Technical Knowledge
IVDMD	In vitro dry matter degradability
LDMP	Livestock Development Master Plan
LMA	Livestock Marketing Authority

LIST OF ABBREVIATIONS (*Continued*)

Mcal	Mega calori
ME	Metabolisable Energy
MJ	Mega Joule
MM	Mineral matter
MoA	Minstry of Agriculture
MoARD	Ministry of Agriculture and Rural Development
OM	Organic matter
NEg	Net Energy gain
NEm	Net Energy maintenance
NEPAD–CAADP	New Partnership for Africa’s Development – Comprehensive Africa Agriculture Development Programme
PEDBRSO	Planning and Economic Development Bureau of the Regional State of Oromia.
Rks	Rural kebeles
SAS	Statistical analysis system
SD	Standard deviation
SE	Standard error
SNNPR	Southern Nations and Nationalities and People Region
SPSS	Statistical packages for social sciences
UNECA	United Nations Economic Commission for Africa
WHZFEDO	West Harerghe Zone Finance and Economic Development Office.
WHZLDHO	West Harerghe Zone Livestock Development and Health Office.

1. INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa. A large number of livestock genetic diversities were reported. Studies estimated that about 25 breeds of cattle exist in the country though the livestock characterization is non-exhaustive (IBC, 2004). Ethiopia has diverse agro-ecological zones suitable for livestock production. Agriculture in the country is characterized by pastoralism in low land area and mixed farming systems in mid and highland areas (Arse *et al.*, 2013). Cattle and sheep are in highland areas and camels and goats are the prominent domestic animals in the pastoral lowlands (Ayele *et al.*, 2003). The total cattle population for the country is estimated to be about 56.71 million (CSA, 2015). During the years 2007/08 to 2016/17, there was a 25.1% growth in the number of cattle (CSA, 2008 and CSA, 2017).

In general, the livestock sector has been contributing considerable portion to the economy of the country and still promising to rally round the economic development of the country (CSA, 2011). Livestock provided 45% of the agricultural output in 2008-09 in Ethiopia (Policy brief series, 2013). The total value of livestock and their products stands at about 20 % of all national exports (IGAD, 2013). Livestock contributes 20% of total GDP (Addisu *et al.*, 2012) and 35 to 49% of agricultural GDP and 37 to 87% of the household incomes. In 2008, livestock accounted for approximately \$150 million in formal export earnings (live animal, meat, hide and skin), making up 10% of formal exports (Birara and Zemen, 2016).

At the household level, livestock play a critical economic and social role in the lives of pastoralists, agro-pastoralists, and smallholder farm households. Livestock fulfill an important function in coping with shocks, accumulating wealth, and serving as a store of value in the absence of formal financial institutions and other missing markets. In the case of smallholder mixed farming systems, livestock provides nutritious food, additional emergency and cash income, transportation of farm outputs and inputs, and fuels for cooking food (Asfaw *et al.*, 2011). Thus livestock remain the most important source of income livelihood in Ethiopia (UNECA, 2012).

Officially in 2012/13 Ethiopia exported 680,000 heads of live animals and 16,500 tons of meat. This is significantly higher than the official export of 200,000 heads of livestock reported by Yacob and Catley (2010). However, an estimated 325,800 cattle, 1,150,000 sheep and goats, 300,000 skins and 150,000 hides go through illicit cross-border trade from Ethiopia (LMA, 2001). Workneh also (2006) reported that annual illegal flow of livestock through boundaries to be as high as 320,000 cattle. In addition, Mohammad *et al.* (2007) noted that estimated informal trade in 2005–06 stood at 328 thousand cattle and 1.1 million sheep and goats. This loss of exportable surplus has affected the country through loss of foreign exchange; income taxes and its impact on legal livestock trade (Belachew and Jemberu, 2003). In Ethiopia, cattle fattening production system is not market-oriented and fattened cattle produced by smallholders are primarily used for local market consumption purpose (Mulu, 2011). This is due to the majority of producers use the male cattle for plowing purpose and according to (Tsegay and Mengistu, 2013) castrated and female cattle werenot used for export market. In addition, the performance of live animal and product marketing has remained low in Ethiopia due to the poor link among production, marketing, processing and delivery to the consumer (Workneh, 2006).

Although the country is endowed with a high livestock population, they are characterized by low productivity, at least in terms of conventional products such as meat and milk (Addisu *et al.*, 2012). Cattle are usually sold when they are too old for these purposes, or drought or cash shortages force people to sell. Oxen are usually sold after the plowing season when they are in poor condition. Meat yield is low, the beef is poor quality and producer returns are often inadequate to buy a replacement ox (MoA, 2002).

According to the development roadmap (2015/16–2019/20) regarding red meat /milk and cattle feedlot systems in Ethiopia include various challenges. The challenges related to feed include poor quality of grazing lands, lack of knowledge of better use of crop residues and poor availability of concentrates and other feed supplements. Challenges related to genetic potential like use of inferior bulls for breeding, low genetic improvement extension

coverage, poor recording scheme, inadequate local semen collection and processing and AI delivery (Shapiro *et al.*, 2015). Concerns related to animal health services at production level include poor animal health extension advice, inefficient animal health services, inadequate supplies and qualities of vaccines and drugs and poor quality control of drugs and supplies. The other concern is absence of policy. This include absence of breeding policy, the enforcement of land use policy, loss of land to alternative investments outside livestock and a need for protective trade policy (Shapiro *et al.*, 2015).

With regard to shortage of feed, poor nutrition results in slow growth rate in growing animals and low production and reproduction performance. The quality of the beef becomes far from satisfactory. Feed utilization is very inefficient as most of the feed (about 85%) is used for body maintenance. In such a system there appears to be a tremendous potential for improvement (Adugna, 2008). The potential feed resource availability and quality in Ethiopia showed that, the major type of feed type is cereal straw/stover (48.17 %) followed by pasture grazing (17.24 %). Aftermath, fallow land and wood land grazing are used as animal feed comprising 13.42, 10.83 and 2.45 %, respectively. Enset is utilized by animals and adds a 3.1 % whereas, pulse crop haulms contribute 2.24 %. Byproducts of root, fruit, *khat* and coffee is totally 0.98 % and oilseed straws and vegetable wastes 1.46 % from the total. Others contribute less than one percent of the total (Adugna, 2007).

Crop residues particularly cereal straws and maize or sorghum stover are the major feed resource during the prolonged dry season in Ethiopia (Kidane, 1993; Adugna, 2007). In improving the red meat-milk production in GTP-II in Ethiopia, the total increase in the number of cattle from overall production zones is expected to grow from 56 to 62 million in 2020 (11% increase). To make this a reality, among other factors, the need for greater knowledge on the use of crop residues was taken as a challenge to the GTP-II plan and this could be well addressed through introduction of better use of crop residues. These include proper storage, supplementation and treatments by chopping and urea application (Shapiro *et al.*, 2015). This could be easily implemented through the use of physical and chemical treatment of crop residues (Alemu, 2008). Crop residues are generally high in fiber, low in digestibility and low in crude protein (Charles *et al.*, 2012). Thus, both physical and

chemical treatment are specially important in small farms of developing countries where crop residues form the principal feed of ruminant livestock during dry seasons (Elnazeir and Suaad, 2013).

In general, feed shortage, disease prevalence, marketing problem, and shortage of land and water are major problems of cattle production in West Hararghe (Abdi *et al.*, 2013). The major cattle feed sources in this area were crop residues, natural pasture hay and commercially available industrial byproducts (Estefanos *et al.*, 2014; Tsigereda *et al.*, 2016). Although in previous times, there were a very few studies done on cattle fattening practice limited to two woredas, the current study tried to investigate the existing practices and marketing system which is dominated by brokers influence by selecting four prominent and representative woredas in the Zone in a better approach. Among the crop residues, maize and sorghum stover are the major ones but sorghum stover is the most available feed that could be available up to late dry season. But because of its low quality and consumption by cattle, wastage is very high thus the left over is either used as fuel wood or left in the field for composting with dung. Eventhough traditionally, farmers chop and mix stover with other feeds, studies such as treating sorghum stover with Effective micro-organism (EM), urea and EM plus urea to improve the nutritional value has not been reported so far in West Hararghe. Thus, these problems necessitates and draws attention for this research intervention because sorghum is one of the major crop in the area and producers will have a chance to use treatment of crop residue for better utilization.

Therefore, in this research, assessment of the current socio-economic and demographic features of producers and characterizing the cattle fattening system were done. The indigenous thecnical knowledge was understood, the role of gender and related factors in the fattening system was studied, the cattle marketing system was assessed. In line with these, experiment was conducted to add up to the limited information about the different aspects of beef cattle fattening practices of the area with the following objectives:

General Objective

To characterize cattle fattening and marketing systems, and analyze the nutritional of sorghum stover treated and ensiled with effective microorganisms (EM) and urea in West Hararghe Zone.

Specific Objectives

- To characterize cattle fattening system in selected *woredas* of West Hararghe Zone;
- To assess the marketing system of fattened cattle in four *woredas* of West Hararghe Zone;
- To investigate the chemical composition, *in vitro* DM digestion and *in sacco* digestibility of sorghum stover treated and ensiled with effective microorganisms (EM) and urea.

2. LITREATURE REVIEW

2.1. Livestock Production Systems in Ethiopia

Livestock production systems are determined by many factors. Among these are agro-ecological zone (including rainfall, temperature, soil type and length of growing season), the amount of land owned or farmed per household, the types of crop grown, the livestock species and numbers reared and their economic importance to the producer and the degree of integration of crops and livestock. Five production systems have been defined and these include pastoral, agro-pastoral, mixed crop-livestock farming, urban and peri-urban dairy farming and specialized intensive dairy farming systems (LDMPS, 2007). There are two major production systems within Ethiopia: the highland crop-livestock system, and the lowland pastoral system (Sintayehu *et al.*, 2010).

2.1.1. *The highland mixed crop-livestock farming system*

The Highland crop–livestock mixed farming system encompasses nearly 40 percent of the country’s (Ethiopia) land surface and is located above 1,500 m.a.s.l. It is featured by a mixed farming system where crop cultivation and livestock production are undertaken side-by-side complementing each other. From the total national livestock holdings, about 80 percent of cattle, 75 percent of sheep and 25 percent of goats are found in this production system. Livestock plays a pivotal role in the highland settings through provision of draught power for crop production, manure for soil fertility and fuel, and serves as source of supplementary family diet and source of cash–income (that is from sale of livestock and livestock products) particularly when markets for crops are not favorable (NEPAD-CAADP, 2005).

In this system, where food and cash crop growing is the main agricultural activity, farm size ranges from 0.5–1 ha. Livestock are for draught, seasonal milk and meat production and a source of food and income. Cattle are the main stock. Feed resources are natural pasture, crop residues and to lesser extent improved pasture and forages. Milk yield is 1 litre/day and average land area 0.25 ha per animal (Alemayehu, 2006). Provision of draught power, although rarely accounted for in financial or economic terms, is the most important

function of livestock in the mixed farming systems of the highlands. In the mixed farming areas herds are much smaller being 5.7 head in East Harerghe, 8.6 in Illu ababora and 11.8 in the Central Highlands. In large parts of the mixed crop-livestock farming areas the cattle herds are unable to maintain themselves - that is they are not self-sustaining - and oxen need to be imported from the lowlands to supply the power deemed necessary for cultivation (LDMPS, 2007).

2.1.2. The lowland pastoral and agro-pastoral livestock system

The pastoral population is estimated at 12–15 million. Among the most notable pastoralists are the Borana, Somali and the Afars around the southern, eastern and northeastern parts to the country, respectively. Pastoralists exploit grazing land in arid and semi-arid areas. Livestock is for subsistence and seasonal milk production. Livestock include cattle, sheep, goats and camels (Alemayehu, 2006). The system is thought to account for about 20 percent of the Ethiopian cattle. They are nomadic communities and largely sedentary agro-pastoralists but nearly all own cattle in herds typically of 10-15 cattle and about 7 sheep and/or goats. Cattle are used primarily for dairy for household consumption, with the result that the majority of the herd is female (Sintayehu *et al.*, 2010). Yield/cow/day is 0.5–1 litre. The average land area per animal is from 5 to 10 ha (Alemayehu, 2006). Average distance to market is about 90 kilometers (Sintayehu *et al.*, 2010). These areas sell young bulls to highland farmers (for traction) through exchange for cereals (mainly maize), and also contribute the highest number of animals for export (Alemayehu, 2006). In a good seasons in the lowlands, pastoralists sometimes fattened cattle feeding the natural pasture but in average or poor season, they often sell their cattle in poor condition at low prices (MoA, 1996). According to the report of IBC (2007), range development and improved access to water are important to improve livestock production. In recent years, there has been a move away from the nomadic system to cropping in areas with sufficient water. Low moisture is the major production constraint particularly in the arid zone. In this zone, there is a high potential for irrigated agriculture, especially for production of fiber crops, sugar cane, oil seeds, horticultural and forage crops for export.

2.2. Common Breeds of Cattle in Ethiopia and Hararghe

Major indigenous cattle breeds of Ethiopia thus far identified are Sheko, Begayit, Boran (Borena), Abigar, Afar, Horro, Fogera, Arado, Jidu, Arsi and Red Bororo. In addition very heterogeneous mixtures of Zebu sub-types (Black Zebu or Jem-Jem, short horn zebu and small zebu) have been described under the name Abyssinian Zebu (IBC, 2004). Furthermore, report by FAO (1999) indicates that the presence of zebu-sub-classes (Adwa, Ambo, Bale, Goffa, Gurage, Harar, Smada, Mursi and Hammer) cattle types in different parts of the country.

In common with other species of domestic livestock of Ethiopia, cattle are adopted to survival under the harsh climatic conditions, severe disease challenge, poor nutrition and indifferent management. They are thus usually considered as being “unproductive” although some special characteristics are attributed to particular types. The Boran and Afar, for example, can withstand prolonged droughts whereas the Abigar and Fogera are tolerant of prolonged flooding with the Abigar also exhibiting some tolerance of trypanosomosis (MoARD, 2007). Major cattle breed types of Oromia include Arsi, Boran, Guji, Konso, Ogaden, Bale, Dega, Jilbeguro, Salea, Karayuu, Chefe, Oboo, Anniya, Doba, Issa, Somali, Sidamo, Buche, and other crosses. According to the livestock breed survey of Oromia regional state, the dominant cattle breed type found in West Hararghe are Arsi, Ogaden and Doba. Buche and Somali are found in small number. Other crosses of exotic (Holstein Friesian) and local breed types and different local crosses are found in the zone. Among the crosses, the major ones include Holeystein Ferisian, Jamusi, Baltu, Etu and Aroji (Van Dorland *et al.*, 2003).

Cattle in West Hararghe zone are kept in a mixed crop-livestock production system. Cattle have a multi-function in the zone helping as source of draft power, milk and meat production. During the production and fattening farmers focus on traits like height to wither, body width, and coat color in selection of breeds. Feed shortage, disease, market problem and grazing land and water problem are the major identified problems and constraints of cattle production in this area (Abdi *et al.*, 2013). With regard to the supply

of cattle to Hararghe highlands, Bale lowlands are considered as source of supply for cattle (both for domestic and export markets). The major destinations for Bale cattle are Bale Robe and its surrounding, Hararghe highlands, and Dera and Adama. Traders from Hararghe come to Melka-Oda and Seweina markets (Bale lowlands) and buy young bulls. These animals are trekked for about eight days to Hararghe and sold to farmers as replacement for draft purpose for certain time and for fattening later on (Getachew *et al.*, 2008).

2.3. Growth and Development of Cattle

Growth is defined as increase in size of an organism, either by an increase in cell size or much more usually, by an increase in cell number whereas, development is the change in proportion of various parts of the body (Peter, 2005). Growth is also defined as an increase in tissue mass. Mass increases by hyperplasia early in life and hypertrophy later in life, although hyperplasia of adipose tissue continues throughout life. The growth curve, being mass or cumulative weight plotted against age, is sigmoid, consisting of a prepubertal accelerating phase plus a postpubertal decelerating phase (Owens *et al.*, 1993).

2.3.1. Factors affecting growth and development

Genetic factors or traits which are heritable in meat animals are economically important. Environmental factors such as heat regulation is important factor in that low temperatures tend to prolong animal development and high temperatures tend to retard it. Nutritional factors especially the amount of protein provided, is also an important factor regulating animal growth and development (UK Essays, 2015). Weight, condition, frame and sex are also factors affecting cattle growth (Bruns and Robbi, 2003). Young bulls produce the leanest carcasses, followed by culled cows and steers, with heifers on average producing the fattest (Irshad *et al.*, 2012).

Besides heredity which dictates the maximum amount of growth and development possible, nutrition along with other environmental factors governs the actual rate of growth and extent to which development is attained. Fast rate of growth is attained by high plane

of nutrition and this can lead to an earlier onset of fattening phase of growth. However, the nature of the diet is an important growth regulating factor. Thus, when the protein/energy ratio is increased, the fastest-growing animals may become leaner (Irshad *et al.*, 2012). As indicated by MLA (2011), to gain one kilogram of weight, cattle need between 35 and 45 MJ ME above that required for maintenance, depending on the stage of production. Younger cattle need lower ME because they need less energy for growth than fat accumulation in mature ones.

The other important phenomenon currently important to consider is the climate change especially global warming which may highly influence production performance of farm animals throughout the world. Heat stress affects reproductive performance, change in rainfall and temperature change distribution and abundance of disease causing vectors (Kassahun, 2016). The other negative influence is on the production of pasture crops. In fact, the effect of heat stress can be partly addressed by nutritional strategies, such as replacing rapid fermentable carbohydrates with saturated fatty acids and the feeding of more by-pass protein and dietary electrolytes (Scholtz *et al.*, 2013).

According to the summary of AVMA (2014), castration is a common practice throughout the world. Despite the fact that it inflicts pain on the animal, brings slow growth rate and poorer feed efficiency, it has a number of advantages in that it reduces aggressiveness, and sexual activity by lowering testosterone level and modifies carcass characteristics- higher quality grade, more consistent, more marbled and high tender meat. Moreover, carcass from bulls command lower prices at market when compared with carcass from steers.

2.4. Multi-Functionality of Livestock Production

Livestock can provide a steady stream of food and revenues and help to raise whole farm productivity. Livestock are often the only livelihood option available to the landless because they allow the exploitation of common-property resources for private gain. In addition, at the smallholder level, livestock are often the only means of asset accumulation and risk diversification that can prevent a slide into abject poverty by the rural poor in marginal areas. Livestock ownership also tends to increase consumption of animal protein

and micronutrients, and creates employment opportunities beyond the immediate household (Henning, 2003). Livestock products account for almost 30 percent of human protein consumption (Steinfeld *et al.*, 2006).

Livestock production can play an instrumental role, for example, in supporting sustainable rangeland management, preserving wildlife and other forms of biodiversity. Research showed that cattle grazing improves the quality of seasonal rangeland forage available to elk during critical periods of nutritional stress, enhancing soil fertility and nutrient cycling, and in directly promoting the amenity value of particular landscapes to other users (Robin, 1996).

The poor people owning livestock have the opportunity to increase the income from the livestock by changing the production system to a more income generating system. The present livestock production systems are developed and optimized based on the existing opportunities and on the threats that have existed in the country over time (Jørgen *et al.*, 2007).

2.5. Future Trends of Livestock Production

Human population growth, increasing urbanization and rising incomes are predicted to double the demand for, and production of livestock and livestock products in the developing countries over the next 20 years. Urbanization is generally associated with higher average household incomes and changing lifestyles with more food consumed outside homes. Livestock production is growing faster than any other agricultural subsector, and it is predicted that by 2020, livestock will produce more than one-half of the total global agricultural output in value terms. This process has been referred to as the “livestock revolution” (Delgado *et al.*, 1999). Important global livestock sector trends reflecting this revolution are: 1) a rapid and dynamic increase in consumption of livestock products in developing countries; 2) A geographic shift of livestock production from temperate and dry areas to warmer, more humid and disease-prone environments; 3) a change in livestock production practices from a local multipurpose activity to an increasingly market-oriented and vertically-integrated business; 4) increasing pressure on,

and competition for, common property grazing and water resources; 5) more large-scale industrial production units located close to urban centers, potentially causing severe environmental damage and posing public health risks; 6) decreasing importance of ruminant vis-à-vis monogastric livestock species; and 7) a rapid and large rise in the use of cereal-based feed (Henning, 2003).

2.6. Characterization of Cattle Fattening System in Ethiopia

Characterization includes the systematic documentation of the information gathered so as to allow easy access. Characterization activities should contribute to objective and reliable prediction of animal performance in defined environments, so as to allow a comparison of potential performance within the various major production systems found in a country or region. It is, therefore, more than the mere accumulation of existing reports (FAO, 2007). According to Ashenafi *et al.* (2014), characterization of a given production system could provide an overview of the farming system and identify the major livestock production challenges, opportunities and possible potential interventions with special emphasis on livestock feed and related aspects for the improvement of livestock production and productivity in the target districts. In general in Ethiopia, there are three types of cattle fattening systems (MOA, 1996).

2.6.1. The traditional system of fattening

The traditional system of fattening cattle is characterized by cattle keeping mainly for draft power, milk and manure production and are usually only sold when they are too old for these purposes or drought or cash shortages force people to sell. Oxen are usually sold after the plowing season when they are in poor condition (MOA, 1996). Meat yields are low, the beef is of poor quality and farmers' returns are often inadequate to buy a replacement ox. In low lands where pastoralists do not use cattle for draft, cattle are sometimes fattened on natural pasture in good seasons. However much body weight is lost during long distance trekking to Addis Ababa and the animals may reach market in little better condition than culled highland stock. In average or poor seasons, the pastoral lowland cattle are rarely fattened and often have to be sold in poor condition at low prices (MOA, 1996). However,

currently in rural areas in Ethiopia, smallholder cattle fattening is emerging as an important source of income (Harko, 2015).

2.6.2. *By-product based fattening*

By-product fattening system is mainly based on agro- industrial by-products such as molasses, cereal milling by- product and oilseed meals (MOA, 1996). Tsegay and Mengistu (2013) reported that pastoralists were the potential supplier of livestock followed by smallholders to feedlot industries in Adama, Methara and Mojo towns found in east Shoa Zone, Oromiya Regional State, Ethiopia. There is a continuing growth of the feedlot sector in Ethiopia in order to meet the projected increase in demand from both export and domestic market. Commercial feedlots finished relatively large number of animals at a time than small scale fattening. Accordingly, most of these commercial farms use *teff* straw predominantly among other crop by products and agro-industrial by-products and salt.

Crop residues are becoming increasingly important as sources of roughage in feedlots. Major field crops produce large quantities of crop residues (straws, stovers and haulms) in addition to their main product- grain. These include cereal straws (e.g. tef, wheat, barley, maize, sorghum etc.), grain legume haulms (e.g. haricot beans, field peas, chickpeas, lentils, groundnut etc.). Sweet potato and cassava tops and vines, sugarcane tops and enset by-products are also becoming very important in small scale fattening (Adungna, 2007). Studies conducted in three areas of East Shoa showed that 87.5 % of the respondents indicated that the fattening duration in feedlot was 3 to 4 months. The majority of respondents replied that both roughage and concentrate were provided every day throughout the fattening period. Most of the time feed was provided as a roughage concentrate mix but there was no roughage treatment. Practically there was no ratio of concentrate to roughage mix and the amount of concentrate given was ranging from 3 to 12 kg (Tsegay and Mengistu, 2013).

2.6.3. *The Harerghe fattening system*

This system is an excellent example of how to profitably fatten cattle using forage and crop residues. The main features of this system include farmers buy young oxen from the adjacent lowland pastoral areas, use them for draft for several years, and then fatten and sell them before they get old and emaciated (MoA, 1996). Lowland pastoralists are not castrating nowadays because it was the uncastrated bulls which were fetching better price than those castrated (Dejene, 2014). This system of fattening is based largely on cut-and-carry feeding of individual tethered animals. Grazing is rare, and there is virtually no grazing land in most areas. Although farm sizes are amongst the smallest in Ethiopia (MoA, 1996 and Mengistu *et al.*, 2016) which is 0.6 hectare (World Bank, 2004), farmers are able to fatten oxen using crop thinning, weeds removed from crops, leaves stripped from sorghum and maize plants and small amounts of pasture hay. The major types of weeds used for feeding fattening cattle are summarized in Appendix 7. Few concentrates or supplements are used, but oxen in excellent fat condition can be consistently produced. These receive premium prices and keenly sought on the local market as well as being trucked to Addis Ababa and exported to Djibouti. The marketing system is well developed and ensures that there are always buyers for fat oxen and traders bring in an adequate supply of young replacement stock from the lowlands (MOA, 1996).

Fekadu and Alemu (1999) reported that among the most common feed types used for fattening in Hararghe, thinning, leaf strip and part of maize and sorghum plants are major feeds offered to fattening cattle during the main and early dry seasons. This tradition is seasonal undertaking to utilize seasonally available feeds. During abundant feed supply, the animals are offered in ad-libitum. Farmers extend animal's daytime feeding up to nighttime and supplement the animal with common salt or locally available mineral licks twice a week. The night time feed offering is used to supplement the amount of daytime dry matter consumption and to compensate under supply of feed during daytime as in the case when the farmer is away from his house. During short rainy season, they allow their oxen to graze at the edge of farm plots or roadsides for 1.5 to 2 hours every morning before sunrise. In the cases where the farmer has more than one ox, he transfers the second one to

his relative or person in the same village to feed for him after using for traction (Fekadu and Alemu, 1999).

2.7. Poor Livestock Nutrition and Feed Shortage in Ethiopia

Poor nutrition and feed shortages are the root causes for the poor performance of the livestock sector in Ethiopia. Natural pastures are the main source of livestock feed. However, they cannot fulfill the nutritional requirements of the animals, particularly during the dry season due to poor management and their inherent low productivity and quality. While the population of livestock is increasing, the area of grazing land is decreasing from year to year because of increasing cultivation. In general, poor nutrition is the major impediment to the development of the country's livestock sector (Adungna, 2007). Crop residues are generally poor in their nutritional value however, they are found to be major feed resources for the livestock both in the high and mid-altitude areas particularly during the dry season when the biomass of the natural grazing land is very minimal (Funte *et al.*, 2010). The amount of crop residue and other feed sources are depicted in Table 1. Generally crop residues are low in quality, high in fiber content, low in digestibility therefore, as a result livestock productivity decreases due to malnutrition with a consequence of reduction in disease resistance (Malede and Takele, 2014).

Table 1: Quantity of different feeds (tone DM) available in Ethiopia

Types of feeds	DM (tone)	%
Cereal straws/stovers	29,155,077	48.2
Pulse crop haulms	1,357,621	2.2
Oilseed straws	787,448	1.3
Vegitable wastes	94,094	0.2
Root crop by products	414,383	0.7
Fruit crop by products	81,538	0.1
<i>Khat</i> and coffee byproducts	99,012	0.2
Sugar cane tops	29,724	0.05
Enset	1,903,672	3.1
Aftermath grazing	8,121,471	13.4
Pasture grazing	10,436,493	17.2
Fallow land grazing	6,556,682	10.8
Wood land grazing	1,486,960	2.55
Total	60,524,175	100

Source: Adugna (2007)

2.8. Feed Resources in the Highland Mixed Farming System of Hararghe

In Hararghe, most farmers give priority to their animals. The major feed resources are sorghum and maize stover, straw, maize and sorghum leaves, thinned maize and sorghum seedlings and sterile plants, maize tassels, sweet potato leaves, haricot bean leaves and weeds grown in crop fields. Cattle, sheep and goats are observed tied with rope near crop fields or *khat* fields. All feeds are taken to the animals. Communal grazing areas which are used for cut and carry system need to be improved with more productive forages. Existing grass types on the communal grazing lands indicate over grazing. Thus, these areas could be good for forage development intervention demonstration. Grasses like Napier grass can provide high biomass of grass and can be harvested two to three times a year if properly managed. Thus, planting Napier grass could be an alternative for high forage biomass harvest (Gebregziabher and Gebrehiwot, 2011).

Excluding 3 pastoral districts in the lowland, the total hectareage of farmland covered by annual crop in the eleven districts of the West Hararghe zone is 277,460 ha from this sorghum covers 98,965.28 ha (35.67%) and this can give a potential stover yield of 544,309.04 tons based on average yield of sorghum 22 qt/ ha in the zone (WHZLDHO, 2014; Adugna, 2008). The amount of sorghum stover potentially produced in 2014 from the four study woredas was illustrated in Table 2. Abdi *et al.* (2013) reported that in west Hararghe zone, small holder farmers use different feed types. The report summarized that sorghum and maize stover, barely straw, legume haulms, sweet potato vine and tuber are the major feeds available for cattle production in the study districts. Crop residues such as maize and sorghum stover account 45.1% followed by cereal straw and sweet potato vines and tubers accounting for 18.3%. Similarly, Azage *et al.* (2010) reported that sorghum, maize, haricot bean and sweet potato production in Mieso district (a district in West Hararghe zone) cover 73%, 22%, 3% and 1%, respectively of the arable land. According to (Antonio and Silvia, 2010), the increasing pressure on land and the growing demand for livestock products makes it more and more important to ensure the effective use of feed resources, including crop residues.

Table 2: Land covered by sorghum production and amount of sorghum stover potentially produced (ton) in the study woredas

Study Woredas	Total land Area (ha)	Grazing land (ha)	Cultivated land (ha)	Land covered by sorghum (ha)	Potential production of sorghum stover (ton)
Chiro	70,962	482	26,807.274	10,599 (39%)	58,294.5
Gemechis	77,785	6185	29,812	11,585 (39%)	63,717.5
Habro	72,270	316	10,132.9	2424 (23.9%)	13,332
Tullo	58,950	253.3	13,280	4141 (31.2%)	22,775

Source: WHZLDHO (2014); 22 quintal/ha was taken for average production of sorghum in the zone. Crop residue production is estimated by multiplying crop production data with established conversion factors for each crop. Accordingly, the conversion factor for sorghum stover is 2.5 (Adugna, 2008)

Efforts have been made to familiarize EM technology to farmers that are practicing in fattening of cattle in Chiro woreda. Farmers in Nejebas and Chiro kela PAs use EM to ferment wheat bran and grass hay separately by mixing 1 liter EM, half liter molasses or alternatively half kg sugar by 10 liters of water and covering in a plastic bag for 24 hrs and then supplying for animals. By doing this they have increased the palatability of the feeds (Esayas K. Personal communication).

2.9. Indigenous Technical Knowledge of Cattle Fattening

There is a new interest among researchers in the potential contribution of indigenous knowledge to find solution for sustainable development. Indigenous Knowledge has been defined as a systematic body of knowledge acquired by local people through accumulation of experiences, informal experiments and intimate understanding of the environment in a given culture (Rajasakeran *et al.*, 1992). Survey conducted in Keneya (Nyando *et al.*, 2013) indicated that indigenous technical knowledge (ITK) plays a significant role in the adoption of agroforestry technologies that help in management of fuel wood, fodder, soil and weeds. Alemayehu (2006) indicated that in Ethiopia, farmers involved in small-scale fattening do cut-and-carry and hay (from natural pasture and crop residues) feeding. Residues of local grain by-product and beverages are mixed with salt and given to milking cows, ploughing oxen and fattening animals. Teshager *et al.* (2013) indicated that in Illu Abba Bora zone farmers use a unique management tool by separating animals for fattening from other herd and providing shelter and relatively quality feed and adequate water. They also restrict movement of animals by tethering them; thereby prevent loss of energy for search of feed and water.

Adugna (2007) reported that there are commonly adopted feeds offered to livestock including fattening cattle some woredas of SNNPR. These include chopped sugar cane leaves mixed with Bole (mineral soil), sweet potato vine, warm water, chopped pumpkin, chopped enset leaves, sugar cane tops, haulms of haricot bean, horse bean and field peas and by-products of local alcoholic liquor (*ye areke atela*). In Tigray farmers feed livestock spiny cactus cladodes after removing the spines with knife or burning with fire. They prefer

the spiny cactus for fencing back yard and crop fields. The spineless cactus is planted in the backyard to protect from being browsed by animals (Gebregziabher and Gebrehiwot, 2011). According to the report of Tsigereda *et al.* (2016) respondent households in Fedis and Habro woreda of Hararghe use either yeast, fenugreek (*Trigonella foenumgraecum*) flour and fermented dough or their combination during feeding of fattening cattle as a feed source.

2.10. Improving Poor Quality Roughage

Crop by-products are in general, fibrous plant materials left behind after harvesting human food crops and are available in many areas where crop agriculture is practiced. They are generally high in fiber, low in digestibility and low in crude protein. On small farms in developing countries they form the principal feed of ruminant livestock during dry seasons. Crop residues include straw and chaff from cereal grains (rice, wheat, barley, and oats), stover (maize, sorghum), maize cobs, bean haulms, and sugar cane tops and bagasse. Crop residues are characterized by their high fiber content (>700 g of cell wall material/kg DM), low metabolized energy (<7.5 MJ/kg dry matter), low levels of crude protein (20-60 g of crude protein/kg DM) and mineral nutrients and low to moderate digestibility (<30-45% organic matter digestibility) (Elnazeir and Suaad, 2013). Crop by-products have common characteristics. Generally they are poor in palatability, low in crude protein (mostly below 6%), high in cellulose and other structural carbohydrates (crude fiber), low digestibility, low in calcium and phosphorus and low in vitamin A content (Charles *et al.*, 2012). However, cereal straws normally contain at least 70% carbohydrates and are therefore, a potential source of energy for livestock, which can be utilized through microbial fermentation in the rumen (Mahesh and Madhu, 2013).

One approach to improving the feeding value of poor quality roughages is through treatment of roughages, either physically or chemically which is aimed at rendering the structural constituents more accessible to microbial digestive enzymes in the rumen (Alemu, 2008). However, chemical treatment has received the most attention. Chopping straw to 5 cm or a little longer before feeding is a common practice. Scientific tests have

shown that chopping does not improve straw digestibility, but it does increase intake, reduce wastage and make it easy to mix the straw with other feed components. There is also the salting method, in which chopped straw is soaked in a dilute salt solution before feeding. Although this method has not been scientifically tested, many farmers practice it, considering it effective (Charles *et al.*, 2012).

Supplementation of crop residues with grasses, legumes or concentrate feeds significantly improves feed intake and animal performance. In dryland farming systems where forages are scarce, crop residues are supplemented with concentrate feeds. Supplementation of the basal diet with good-quality forage or concentrates helps to overcome the problem of low palatability (Charles *et al.*, 2012).

Urea mixed with moist straw releases ammonia. Facilitated by bacterial action, the process is rapid at high temperatures and is thus more suited to subtropical and tropical conditions than to temperate climates or subtropical winters. Because it releases ammonia, urea treatment has a similar effect on straw as anhydrous ammonia (Suttie, 2000). Within the range of temperature of 20 to 45 °C the ureolysis can be completed after one week or even 24 hours. Ureolysis is an enzymatic reaction that turns urea into ammonia and subsequently the ammonia creates an effect on the cell wall of forage (Chenost, 1987). However, at ambient temperature, the duration of treatment may range from one week to eight weeks (Chenost, 1995).

Urea treatment should be timed to fit in with crop-harvesting operations and wherever possible done before the straw or stover has already been stored or stacked, to avoid double handling and extra labour. This will also help ensuring that the straw is in good condition; dirty, mouldy or rotten straw must never be treated as the end-product would be a poor and potentially dangerous feed (Suttie, 2000). The urea treated low quality roughage will be higher in digestibility and crude protein than the untreated material. Therefore, some farmers will feed urea-treated low quality roughage to their animals with the highest nutritional requirements, such as lactating or fattening animals. Other farmers will feed

limited amounts of the treated low quality roughage as a supplement, with the remainder of diets being untreated low quality roughage or grazed forage (Girma and Goetsc, 2008).

The outcome of urea treatment of low quality straw is influenced by a series of factors which include dose of urea applied, initial quality and moisture content of the material treated, duration of the treatment and temperature conditions under which the treatment is applied (Cañeque *et al.*, 1998). The urea by the action of urease enzyme through the process of ureolysis changes to ammonia. The ammonia thus released under favorable environmental conditions gives rise to the modification of the ligno-cellulosic bonds, which in turn increases its nutritional value (Cañeque *et al.*, 1998). Smith (2002) explained that urea treatment has been found effective with all the major sources of crop residue (barley, rice and wheat straws; maize, millet and sorghum stover) in Africa increasing the dry matter intake and digestibility of animals.

2.11. Sorghum Stover as a Fodder

The primary demand for sorghum and millets is for food in Africa, especially in the dryland regions where these are the principal crops. This continuing demand is reflected in the trend for increasing area under sorghum and millets in Africa over the last fifty years but crop productivity has not kept pace with this increasing demand (Harold, 2015). It is a hardy, drought-resistant crop adapted to environmental conditions which is too harsh for the production of maize. It needs less water and can survive dry conditions and then continue to grow when moisture becomes available (Peter, 2005). Sorghum is the fifth most important cereal crop grown worldwide after rice, wheat, maize and barely (Food Security Department, 1999). Sorghum and maize dominate the crop production with some oil crops, wheat and tef in Ethiopia (IBC, 2007). It is the third most important crop (CSA, 2016). Sorghum (*Sorghum bicolor* L. Moench) is one of the most important cereal crops widely grown for food, feed, fodder, forage and fuel in the semi-arid tropics of Asia, Africa, the Americas and Australia. Stover is an important source of dry fodder for dry season maintenance rations for livestock (Reddy *et al.*, 2010).

Stover is the leaves and stalks of corn (maize), sorghum or soybean that are left in a field after harvest. It can be directly grazed by cattle or dried for use as fodder. Stover has attracted some attention as a potential feed source because of their palatability and biomass for fermentation or as a feedstock for cellulosic ethanol production (Yayneshet, 2010). Sorghum stover may be grazed in the field, stored as dry roughage or ensiled. It is commonly fed to beef cattle. Attention should be given after harvest because sorghum will send up new shoots if the moisture is favorable. The prussic acid content of these shoots may be toxic to grazing animals (ESGPIP, 2008).

The bulky and fibrous nature of coarse feeds results in poor nutrient supply and reduced intake. Such feeds have to remain in the rumen/stomach for extended periods of time before they are sufficiently digested in the rumen/stomach and allow more feed consumption. It is common for animals to lose weight and condition, produce less and even have difficulty breeding when fed on these low quality roughages (Alemu, 2008). Similar to the other roughages, sorghum stover contains lingo-cellulosic materials. The degree of lignification shows the barrier that prevents enzymatic attachment of ruminal microorganisms on cellulose and hemicelluloses (Selma, 2001).

2.12. The Nutritive Quality of Sorghum Stover

Important traits reported from Ethiopian sorghum include cold tolerance, drought resistance, resistance to sorghum shoot fly, disease and pest resistance, grain quality and resistance to grain mould, high sugar content in the stalks, and high lysine and protein content (IBC, 2007). Unlike in maize where the ears can be harvested and utilized when still green, the sorghum heads have to be fully mature before they can be harvested and sun-dried for threshing (Otieno *et al.*, 1990). Therefore, the feeding/nutritive value of sorghum crop residue is generally poor and it provides sub-maintenance levels of nutrients. The limited adoption of improved sorghum varieties has been mainly attributed to the lower nutritional value of their crop residue (Kelley and Rao, 1994). The dried leaves and stems of sorghum form useful roughage for cattle and horses while the well matured plant can be used as green fodder or silage. It is however, unsafe to feed the young green plant since

they contain dhurrin, a cyanogenic glycoside which on hydrolysis yields hydrogen cyanide (Etuk *et al.*, 2012).

Assessment of the digestibility of intercropped sorghum stover with groundnuts legume revealed that there was an increase in the rate of digestibility inter-cropped stover fed with supplement. This could be due to high nitrogen content available to ruminal bacteria in the intercropped stover and supplements, which was not in the sole grown stover. Based on this result, the authors recommend the intercropping of sorghum with groundnuts to improve low nutrients value and digestibility (Quala *et al.*, 2011). Chemical composition and nutritional values of sorghum stover for ruminants studied in Tanzania, Uganda and Burundi showed that it has organic matter (OM), crude protein (CP), ash, crude fat, crude fiber, and digestible organic matter 922, 64.3, 77.7, 21, 311 and 472 g/kg DM, respectively (Dy Ness *et al.*, 2013). Reddy *et al.* (2010) reported that the nitrogen, neutral detergent fiber (NDF), *in vitro* digestibility (all in % of dry matter), mega joule (MJ) of metabolizable energy content, voluntary feed intake and changes in live weight of bulls fed sorghum stover was 0.45%, 70.2%, 50.5%, 7.30 Mmj/kg, 2.31 kg/d, 13 g/d/kg, -0.38kg/d, respectively. Table 3 shows nutritional values of cereal straws in different areas of Ethiopia.

Table 3: Nutritive value of feeds commonly available in various parts of Ethiopia (with potential for use in feedlots).

	DM	OM	NDF	Lignin	CP	Ca	P	IVD MD	ME	NEm	NEg
Feed types	%	% DM						%	Mcal/kg DM		
Barely straw	91.4	91.7	74.4	6.9	4.4	0.36	0.14	50.4	1.82	0.98	0.43
Wheat straw	91.8	89.0	74.7	6.2	3.1	0.25	0.08	51.3	1.74	0.90	0.36
Tef straw	91.9	91.4	72.3	5.4	4.8	1.18	0.31	53.2	1.97	1.12	0.57
Oat straw	92.2	92.1	61.9	5.2	5.7	0.25	0.18	57.9	2.12	1.26	0.69
Rice straw	93.4	81.2	NA	NA	2.8	0.24	0.36	NA	NA	NA	NA
Finger millet straw	91.2	91.5	69.5	4.0	3.3	0.55	0.22	55.5	1.97	1.12	0.56
Maize stover	91.0	92.1	73.5	4.7	4.0	0.31	0.10	56.1	2.10	1.25	0.68
Sorghum stover	91.3	87.7	68.9	6.1	5.6	0.55	0.25	59.5	2.02	1.17	0.61

Adapted from: Feed resources and feeding management: A manual for feedlot operators and development workers, Ethiopia (Adugna, 2008). NA- data not available.

2.13. Effect of Feeding Treated Sorghum Stover for Farm Animals

Chemical treatment has been reported as the most promising treatment to breakdown or disrupt the amount of lignin present in various byproducts thus increasing their digestibility (Selma, 2001). Sorghum stover is one of the major crop residues in Africa (Smith, 2002). Sorghum stover like other byproducts containing high fiber, respond to various treatments. The objectives of treating residues are to increase the proportion of their gross energy available to the animal as metabolizable energy and to raise intake. Urea treatment has been found effective with all the major sources of crop residue (barley, rice and wheat straws; maize, millet and sorghum stover) (IAEA, 2002). Urea treatment had enriched the nitrogen content, the dry matter digestibility (DMD) and the dry matter intake (DMI) of sorghum stover from 6.7, 470 ± 50 and 50 ± 6 in the control to 23.4 g/kg DM, 650 ± 30 g/kg and 68 ± 3 DM g/kg^{0.75}/ day after treatment, respectively (Smith, 2002). In fact the use of urea calls for resources and some degree of education, the lack of which has hindered the adoption of this approach (IAEA, 2002).

Urea ammonization of maize stovers significantly improved the chemical composition, daily feed intake and live weight gain of N'dama calves (Egbu, 2014). Sugar-cane bagasse treated with urea used in fattening diets at three levels. The result showed there were no significant difference between treatments in average daily gain, final body weight and total body weight gain, but these parameters were superior in the treated groups than in the control (Mohammed *et al.*, 2014).

2.14. The Nature and Use of Effective Microorganism

Effective Microorganisms (EM) is a culture of coexisting beneficial microorganism predominantly consisting of lactic acid bacteria, photosynthetic bacteria, yeast, fermenting fungi and actinomycetes cultured according to a specific method in liquid form (Higa and Parr, 1994; Renuka and Parameswari, 2012). EM contains about 80 species of microorganisms which are able to purify and revive nature. The main species involved are normally the *Lactobacillus plantarum*, *Lactobacillus casei* and *Streptococcus lactis* (lactic acid bacteria), *Rhodospseudomonas palustrus* and *Rhodobacter spaeroides*, (photosynthetic bacteria), *Saccharomyces cerevisiae* and *Candida utilis* (yeasts), *Streptomyces albus* and *Streptomyces griseus* (actinomycetes), and *Aspergillus oryzae*, *Penicillium* species and *Mucor hiemalis* (fermenting fungi). Some of the benefits claimed to accrue from the use of EM include improved meat and manure quality, improved animal health, reduction of foul smells and absence of toxic effects on bird growth (Philips and Philips, 1996). All of these are mutually compatible with one another and can coexist in liquid culture. The original use of EM was for agriculture. Hence EM was first applied to enhance productivity of organic or nature farming systems. Agricultural uses include greater release of nutrients from organic matter when composted with EM, enhanced photosynthesis and protein activity (Renuka and Parameswari, 2012).

Long term application of EM reduced the adverse characteristics of waste water. The quality of the treated water was high, which indicated its potential use for reuse without health hazards. It also enhanced crop growth as measured by its effects on cucumber. Application of EM products to tap water also eliminated the ill effects generally found in

chlorinated water. The treated city water was more effective in promoting plant growth. Application of EM to sewage sludge enhanced its value as a fertilizer. Plant growth was enhanced in contrast to application of untreated sludge, which had toxic effects. The value of EM in sanitation programs and the potential of recycling wastes after treatment for nature farming at a low cost is presented on the basis of these studies (Okuda and Higa, 1995).

In an experiment grass silage was treated with EM-silage, the result showed a significantly higher propionic acid production and a significantly lower acetic acid production compared to the control silage. This resulted in a decrease of the calculated methane production based on the volatile fatty acid production and a (not significantly different) decrease in the measured methane production by gas analysis. An increase in the production of propionic acid has positive effects on milk and milk protein production (FIS, 2003).

Chamberlain *et al.* (1996) conducted an experiment in which the growth rates of sheep and lambs grazing on EM treated pasture and drinking water were compared in a separate trial. EM lambs had higher live weight gains for the first three and last weighing and has a higher overall live weight gain. There was no significant difference between the ewe live weights. Additionally internal parasite faecal egg numbers were lower in the EM treated lambs.

2.15. Effect of Effective Microorganisms

Studies have already shown that the use of probiotics and Effective microorganisms could improve growth parameters: feed intake, weight gain, feed conversion ratio in broilers (Chantsawang and Watcharangkul, 1999). Silages treated with microbial inoculants such as EM showed improvement in chemical composition (Gordon, 1989; Steen, 1989) by signifying this effective micro-organisms (EM) could better be used as biological inoculants to improve the nutritive quality and value of conventional (high fiber feed stuffs) and non-conventional feed stuffs (high anti-nutrition content and fiber) like coffee pulp, husk, cassava and most root and tuber crops, etc (Yonatan *et al.*, 2014). Use of EM in Africa is a new innovation and novel idea (Safalaoh, 2006).

EM Bokashi is a necessary supplement feed for animals and is made from 1 to 2% multiplied EM, 1% molasses and 98% water, which is then added to organic feed materials which could be wheat bran or rice husk. It has various applications, but is mostly used as a form of animal feed (APNAN, 1995).

2.16. Activating the Effective Microorganisms

EM is available in a dormant state and requires activation before application. Activation involves the addition of 7 L of chlorine free water and 1.5 kg of brown sugar to 3 L of dormant EM one week prior to application. These ingredients were mixed together in either a 15 L or 20 L container and stored in area with minimal temperature fluctuations. A major influence on the survival of microorganisms is the temperature of their environment, with significant temperature fluctuations impacting upon their survival. The pH is also a determining factor. It was indicated that the pH of the EM should be approximately 4.5 (Renuka and Parameswari, 2012).

This activated EM must be allowed to ‘brew’ for a minimum of 7 days in an airtight fermentation tank which has a warming element. A fermentation process allows the activation of the micro-organisms whereby an optimal amount of beneficial bacteria is obtained. The EM-A needs to be then diluted with water (1: maximal 100), and can then be used for many different applications. Once the EM-A solution is prepared, it must be used within 48 hours. The EM-A before dilution can be kept for a month in an airtight vessel (Renuka and Parameswari, 2012).

2.17. Livestock Marketing and Marketing Structure in Ethiopia

Marketing includes moving products from producers to consumers and involves exchange activities of buying and selling, the physical activities designed to give the product increased time, place and form utility and the associated functions of financing, risk bearing and dissemination of information to participants in the marketing process (Jabbar *et al.*, 1997). Livestock marketing involves the sale, purchase or exchange of products such as

live animals and livestock products of milk, meat, skins, wool and hides for cash or goods in kind (ILCA, 1990).

Conventionally, many livestock markets in Ethiopia are categorized into primary market, secondary market and terminal market. The basis of such classifications is mainly number of animals that attended the market per market day and the number of market participants in the market. In terms of number of animals, primary, secondary and terminal markets are those in which less than 500 heads, 500-1000 heads, and greater than 1000 heads of animals attend the market per day, respectively. In terms of market participant, primary markets are those in which the main sellers are producers and the main buyer local assemblers and secondary markets are those in which the main sellers are local assemblers and main buyers are big traders. In terminal market the main sellers are traders and main buyers are butcheries and restaurants (Getachew *et al.*, 2008).

Generally, the livestock marketing structure follows a four-tier system. The main actors of the 1st tier are local farmers and rural traders who transact at farm level with very minimal volume, 1–2 animals per transaction irrespective of species involved. Some traders may specialize in either small or large animals. Those small traders from different corners bring their livestock to the local market (2nd tier). Traders purchase a few large animals or a fairly large number of small animals for selling to the secondary markets. In the secondary market (3rd tier), both smaller and larger traders operate and traders and butchers from terminal markets come to buy animals. In the terminal market (4th tier), big traders and butchers transact larger number of mainly slaughter type animals. From the terminal markets and slaughterhouses and slabs, meat reaches consumers through a different channel and a different set of traders/businesses (Ayele *et al.*, 2003).

Livestock markets are generally under the control of local authorities. Market locations in primary and secondary markets are usually not fenced. There are no permanent animal routes and no feed and watering infrastructures. Yet buyers and sellers are subjected to various service charges by the local authorities as well as other bodies (Ayele *et al.*, 2003). Market information is crucial to producers, wholesalers and consumers to help them make

decisions on what and whether to buy and sell. In general, information is required on prices, traded or available quantities, forecasts of future supplies and demand, and general market conditions. Information must be relevant, accurate and timely and reflect all sectors of the market, especially consumer demand (ILRI, 1995). Nearly in all parts of the country, there is no regular market information on prices and supplies, nor formalized grades and standards of cattle, sheep and goats (Kebede and Ray, 1992; Ayele *et al.*, 2003). Markets are dispersed with remote markets lacking price information.

Generally, there is excess supply of animals beyond demands which effectively suppresses producer prices since the more mobile trader is better informed on market prices, while better information combined with excess supply places the trader in a better position during price negotiation. Livestock are generally traded by 'eye-ball' pricing (subjective judgment), and weighing livestock is uncommon. Animals are sold on a per-head basis and price agreement reached by a long one-on-one bargaining between a seller and a buyer. Under such circumstances, prices paid will reflect buyers' preference for various animal characteristics (weight, sex, age, condition, breed, color), the purpose of animals purchased (for resale, slaughter, fattening or reproduction), the season of the year (occurrence of religious and cultural festivals) and the bargaining skills of buyers and sellers (Kebede and Ray, 1992; Ehui *et al.*, 2000; Ayele *et al.*, 2003).

2.18. Problems Related to Marketing

Livestock marketing is based on quality standards. Prices paid will reflect buyers' preference for various animal characteristics. These quality attributes include e.g. sex, weight, age, condition, breed and color (ESAP, 2003). Animal selection is purely based on eye-appraisals and exchange takes place on bargaining. There is no reliable source of information neither on export demand nor on domestic supply situations. Thus, producers, traders, exporters and support giving institutions are constrained by shortage of market information to rely on for enhancing production, marketing and exports. Effective export requires knowledge of the client's requirement, producing according to needs and creation of awareness on availability of products to the clients (Belachew and Jemberu, 2003).

So far, little effort has been undertaken to strengthen demand in the clients' countries and creating segments in other counties, by publicizing the special features of our products. Active participation of private sector is required to enhance production and promote export. However, currently there are few livestock exporters and a few meat processors and exporters. These firms have relatively low capital as well as inadequate knowledge of international trade. To enter the international markets, well-equipped livestock quarantine stations are required. However, under our conditions these facilities are not in a place (Belachew and Jemberu, 2003).

Concerning the improvement of red meat in Ethiopia, the challenges of marketing and processing include poor market infrastructure and roads, poor technical knowledge of value chain actors, especially processing technicians, inadequate market information and poor linkages between producers, processors and export abattoirs. These challenges could be overcome through capacity building and by building infrastructure (Shapiro *et al.*, 2015).

2.19. Challenges and Opportunities of Livestock Marketing in Ethiopia

2.19.1. Challenges of livestock marketing in Ethiopia

The challenges of livestock marketing in Ethiopia can be roughly grouped into internal and external challenges.

Internal challenges

Because of inadequate information on available resource, the country's livestock number, annual off-take, productivity and consumption levels are not adequately known. Prevalence of diseases not only affects the efficiency of production but also hampers export market development as a result of frequent bans by importing countries. Archaic traditional production system is the other problem because pastoralists consider their livestock as means of saving or capital accumulation. Livestock are sold when need arises for cash

income or when shortage of feed and water occurs (Belachew and Jemberu, 2003). In Ethiopia animals are trekked for long distances, (for a period of 1-3 days) without adequate resting/shading, watering and feeding facilities along the supply chain. The trekked animals, therefore, are prone to predators; deaths of up to 5-10 per cent and 10-15 per cent sickness from stress; and 8-13 per cent body weight losses. These animals more often are sick, dehydrated and emaciated resulting in some being condemned at ante-mortem/post-mortem inspection and generally poor carcass quality (UNECA, 2012).

Illegal export trade is the other problem. The sources of this illegal export are Afar and Somali Regions, Borena and East Hararghe Zones in Oromia and South Omo of the SNNP. The immediate destinations for such exports are Djibouti, Somalia and Kenya. The livestock are mostly for re-export to the Middle East Countries from Somalia. The Djibouti's and Kenyans` re-export after meeting their domestic consumption. This loss of exportable surplus has affected the country through loss of foreign exchange; income taxes and its impact on legal livestock trade. The traditional herd management system is not adequately supported through introduction of improved breeding and feeding system. The local breeds are not differentiated and improved for particular purpose. Infrastructures like livestock markets, stock routes, resting places, quarantine stations are poorly developed in the pastoral areas. Therefore, there is no easy access to traders for assembling and transporting livestock. Export standard slaughterhouses are located in central areas far from surplus producing areas. In addition, transport facilities that allow adequate flow of livestock and meat are not adequately employed (Belachew and Jemberu, 2003).

External challenges

The external challenges are easily manifested by competition. Many countries compete for livestock and products markets in the Middle East. The main competition for Ethiopia comes from Somalia, Sudan, South America, Australia, New Zealand, Eastern Europe and the European Union. Available information indicates that Somalia exports up to 2 million heads of sheep and goats and 10,000 heads of cattle a year. Its major source of supply is

believed to be the Ethiopian Somali Region, Eastern Hararghe and parts of Bale zones of Oromia (Belachew and Jemberu, 2003).

The European Union is a surplus producer of livestock and livestock products. Their Exports are competitive due to the export subsidies adapted to maintain a reliable domestic production. However, because of FMD and Mad cow disease their market share in the Middle East has relatively declined. As compared to others, Ethiopia has certain advantages on its competitors which it can capitalize upon. These are the preferred animal types, location and stable supply. The Ethiopian livestock (cattle, sheep and goat) are the preferred breeds in the Middle East, as they are organically produced and the meat is of good tastes. The proximity of the country to the Middle East has also cost advantage due to lower transport costs. However, importing countries frequently ban imports of meat and livestock from the horn as a result of outbreaks of livestock diseases. Currently, the Djibouti port is the only port for exporting livestock to the Middle East countries. However, the port is ill-equipped for handling large number of livestock. The livestock-resting place is too small. It has no sufficient fencing and there is no compartment for handling different categories of livestock and isolation of sick animals (Belachew and Jemberu, 2003).

2.19.2. Opportunities of livestock marketing in Ethiopia

High demand of animals by the local abattoirs, increasing official exports and increasing domestic meat consumption are the opportunities that will enhance the system (Malede and Yilkal, 2014). According to Ethiopian revenues and customs authority's meat and live animal export performance data, meat export volume increased from 870 tons in 2000/01 to 7,468 tons in 2008/09. The country's export performance reached its peak in 2005/06 by exporting 7,917 tons of meat. In addition, during the nine months, July 2009–March 2010, USD 85.5 million was earned from export of 7,018 tons of meat and 259, 247 head of live animals (Trade Bulletin, 2010). Domestic consumption of bovine, sheep and goats, pig and poultry meat in 1998-2000 and 2010 (projected year) in Ethiopia shows 0.5 and 0.7 million tons, respectively (LDMPS, 2007). Small scale cattle fattening enterprise will create

employment opportunities for rural unemployed and landless people (Sarma and Ahmed, 2011).

Huge numbers of livestock of several species, very large areas of land for production of feed, abundant crop residues and agro-industrial by-products for use as feed, rapidly rising world-wide demand for products of animal origin, government well-disposed to sector and willing to improve policies and increase budgetary allocations, reorientation of government towards creating an appropriate enabling environment and liberalization of economy and privatization trends are summaries of analysis of strength, weaknesses, opportunities and threats of the Ethiopia livestock sector (MoARD, 2007).

Moreover, generating significantly more participation by the private sector in production and service delivery, use the existing district-based information system as a basis for developing a national livestock management information system, modifying the already improved land tenure situation for smallholder farmers and extensive pastoralists alike to encourage them to invest in activities that would have beneficial effects on the environment and contribute towards sustainable production, improve access and reduce bureaucracy in attaining credit, ensuring that existing and planned developments in the livestock sub-sector complement rather than compete with each other (MoARD, 2007).

2.20. Beef Consumption Habit of the Rural Society

The trend of meat consumption in Sub-saharan Africa is expected to increase from 11 in 2000 to 22 kg/person/year in 2050, respectively (FAO, 2009). While Ethiopians remained slightly below the meat intake of all low-income countries consuming 9 kg per capita annually (FAOSTAT, 2004). The result of the study by Shawel and Kawashima (2009) showed that the response of meat consumption to income was higher in urban than in rural areas. Rural meat consumption made significant improvement between 1996 and 2000 but lost the momentum between 2000 and 2004. In urban areas, on the contrary, there was continual improvement throughout this period. The result of economic analysis revealed that urbanization and income have been found to be positively and significantly influencing

meat consumption in Ethiopia. In special occasions and holidays, Ethiopian people have a cultural ceremony for slaughtering Infertile cows or oxen, not any other animals and sharing among the group, called *kircha* (A group of 10 to 20 people buy a live animal, slaughter and divide the beef among them) which is a very common option of the rural areas where access of meat is challenging (Semeneh *et al.*, 2013).

3. MATERIAL AND METHODS

3.1. Description of the Study Area

West Harerge Zone is one of the 17 Zones in Oromia National Regional State, geographically located between $7^{\circ} 52' 15''$ - $9^{\circ} 28' 43''$ North latitude and $41^{\circ} 03' 33''$ - $43^{\circ} 34' 13''$ East longitudes. West Hararghe is bordered to East Shewa in the north, East Harerghe and the Somali region to the east, Arsi zone in the west and Bale zone in the south. The capital town of the Zone is Chiro, which is located at a distance of 326 km East of Addis Ababa. The study districts are depicted in Figure 1.

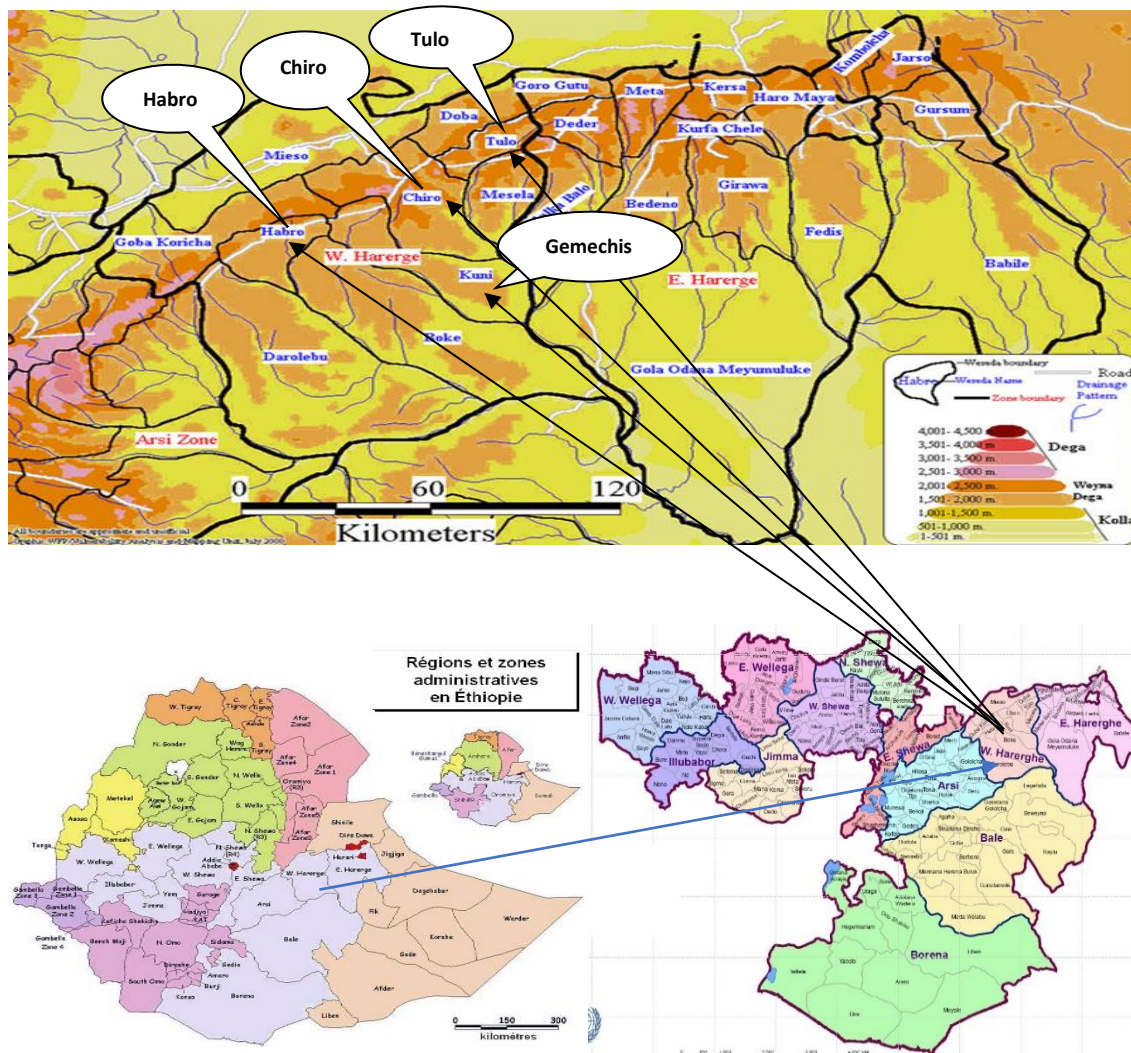


Figure 1: Location map of study districts (Source: <https://www.google.com.et/search>)

The area coverage of the Zone is 1,723,145 ha (17,231km²), comprising of 14 districts (3 of them agro-pastoralists and pastoralists) with a combined population of 1,871,706 of whom 912,845 are women. About 160,895 (8.59%) are urban inhabitants, and 10,567 (0.56%) are pastoralists. Average number of members in the household is 5 (WHZFEDO, 2007). In Western Hararghe Zone, mixed farming of crop and livestock is a common practice in the highland and mid-altitude areas, while in the lowland area of the zone agro-pastoralists and pastoralists rear livestock as the major activity. Agro-ecologically, West Hararghe zone is classified into three namely: highland 12.49%, midland 38% and lowland 49.51%. The topography of the Zone includes 57% mountain, 25% plain and 18% undulating. The main crops grown in the Zone are mainly sorghum, maize and haricot bean and the main animal feeds include crop residues, grass, and some improved forages. Excluding 3 agro-pastoral and pastoral districts in the lowland, the total hectares of farmland covered by annual crop in the 11 districts of the Zone is 277,460 ha. (WHZLDHO, 2014).

The ecological zones are set based on the differences in altitude variation ranging between 500 up to 3500 masl. Lowland (*Gamawojji*) (500- 1500 masl), midland (*Badda darre*) (1500 – 2300 masl) and highland (*Baddaa*) (2300 - 3500 masl). Rainfall is dispersed throughout the year into two rainy seasons *Belg* or short rain falling in February-April and *meher* or main season rains fall from June-September with small showers in dry months. Annual rainfall averages range from below 700 mm for the lower '*Kola*' to nearly 1,200 mm for the higher elevations of '*Woina dega*' and '*Dega*' areas (PEDBRSO, 2010 and Alemayehu, 2006). The general description of the Zone and the study woredas is presented in Table 4.

Table 4. General description of West Hararghe Zone and the study woredas

Description	Woredas				West Hararghe Zone
	Habro	Gemechis	Chiro	Tullo	
Area (ha.)	NA	NA	70,963	58950	1,723,145
Altitude (mt.)	1200-2590	1300-2400	1500-2800	1500-2797	1200-3060
Rainfall (mm)	650-1050	850	900-1000	800	700-1200
Temperature (0C)	20-22.5	15-30	27-38.5	26	16-28
Human population	214,931	184,238	206,771	147384	1,871,706
Livestock population					
Cattle	77,440	89,251	91,274	125,915	1,179,638
Sheep	9615	19138	36,857	13177	181,959
Goats	23,168	77,699	65,983	37,973	952,611
Equines	16163	24591	15,595	6517	227,477
Camel	13	8,488	576	NA	1,429,655
No. of livestock markets	6	7	4	2	NA
No. of Kebeles (PAs)	32	35	39	30	NA

*Source: *CSA (2011) and WHZLDHO (2014).*

3.2. Sampling Procedure, Data Collection and Analysis of the Survey Work

3.2.1. Sampling procedures

Among the 14 districts in the Western Hararghe Zone, 11 districts are areas of mixed crop livestock production system and 3 are agro-pastoral and pastoral woredas. Four woredas from mixed crop livestock production areas namely; Chiro, Tullo, Gemechis and Habro were identified and selected for this study based on their potential and abundance of cattle fattening practices in consultation with West Hararghe Zone Livestock Development and Health Office. From the four districts selected, a total of eight rural *kebeles* (RKs) (the small administrative units), that is 2 representative RK per woreda, one from highland and the other from mid-land within the woreda were selected purposively based on their

prominence for cattle fattening relative to the other surrounding RK. Sample size was determined based on the formula recommended by Arsham (2007) for survey studies:

$$N = 0.25/SE^2$$

Where N is sample size and SE stands for standard error. With the assumption of 4% standard error, a total of 156 households were taken for the study but four relevant respondents were added and totally 160 respondents were participated in the survey. Accordingly, among the 160 respondent farmers, 81 from four highland and 79 from four mid-altitude Rks were selected. The study woredas and kebeles were selected using purposive sampling method. First a list of farmers who practiced fattening in the Rk (sampling frame) were identified from a list of HHs living in the *kebele* and then respondents were selected using systematic sampling method which involves a random start and then proceeds with the selection of every Kth element from then onward. In this case, $K = \text{Population size (N)}/\text{sample size (n)}$ where ‘K’ stands for Kth order on the list, ‘N’ for size of population and ‘n’ for desired sample size (Olive and Virginia, 2009). In this manner, the number of respondents were 40 from Habro, 39 from Gemechis, 45 from Chiro and 36 from Tullo woreda based on the available number.

3.2.2. Data collection

A preliminary visit to the study areas was done to have first impression on cattle fattening practices of smallholder farmers and the marketing situation. The survey questionnaire was developed and pretested on sample households to develop a structured questionnaire. A separate questionnaire was prepared in Afan Oromo to serve as a guide for interviewing respondents. Eight enumerators were hired and orientation about the objective of the survey and the interview technique was given. The enumerators were development agents (DAs) and there was close follow up and cross checking by the researcher. Primary data including qualitative and quantitative information were collected through personal interviews by trained enumerators using the survey questionnaire starting from 12, March, 2015 up to 15, May, 2015. The data included the socio-economic and demographic features

of the producers, land size, number of livestock species, cattle herd composition, marketing of fattened cattle, sources of income, feed and feeding, health management. Moreover, secondary data obtained from West Hararghe Zone and Woreda Trade and Market development offices, West Hararghe Zone and Woreda Livestock Development and Health Offices and West Hararghe Zone Finance and Economic Development Office were utilized in the study. The secondary data collected from zonal and district concerned offices collected were used to generate baseline information on fattening and marketing practices of cattle in the study area.

Personal observation

Personal observation by a single farm and livestock market visit was made to support the data about feeding, watering, housing, healthcare of the cattle, utilization of resources and management of communal grazing land, feed conservation systems, feed resource situation of the households and livestock marketing and marketing situations.

Focus group discussion (FGD)

Focus group discussions were conducted and facilitated in the selected districts using a checklist prepared for this purpose (Appendix 2). A group of 10 participants per *kebele* in each woreda were involved for this purpose to gather qualitative data. The group was intended to include men and women, young and elderly representing all the wealth groups in the area having knowledge and experience about cattle fattening practices. Issues such as the historical background of cattle fattening practice, indigenous knowledge for cattle fattening, feed types, the grazing land condition, the marketing condition, technical support and opportunities and challenges of the work and other issues were raised for discussion to collect relevant information.

Key informant interviews (KII)

Key informant interviews were conducted with influential producers, cattle and feed traders, brokers, development agents, *woreda* and Zone experts with checklists at their

respective sites. Their purpose, involvement and problems encountered in the value chain were assessed.

3.2.3. Livestock market categorization

Conventionally many livestock markets in Ethiopia are categorized into three and the basis of such classifications is mainly number of animals that attended the market per market day or the number of market participants in the market. Accordingly:

1. *Primary markets* are those in which less than 500 heads of animals attend the market per day or those in which the main sellers are producers and the main buyer are local assemblers. Market centers are found in rural areas.
2. *Secondary markets* are those in which 500-1000 heads of animals attend the market per day or those in which the main sellers are local assemblers and main buyers are big traders. Their locations are regional towns.
3. *Terminal markets* are those in which greater than 1000 heads of animals attend the market per day or the main sellers are traders and main buyers are butcheries and restaurants. Their locations are principal cities, according to Ayele *et al.* (2003) and Getachew *et al.* (2008).

3.3. Preparation of Stover and Treatments

Sample of sorghum stover was collected from the four study woredas of Highland and Mid-altitudinal agro ecology areas of West Hararghe namely: Habro, Gemechis, Chiro and Tullo and transported to Chiro town. The local varietal name for the sorghum crop (*Sorghum bicolor* L. Moench) include *Chefere, Dasle, Goronjo, Gebabe, Harka bas, Muyra, Wegere* and *Zengada* according to FGD participants. The sorghum stover was the harvest of December 2016 from a sample of eight farm fields from the four woredas. The standing stover was mowed by sickle (*Shelebi: type of angular cutting two-three nodes above ground*) and collected from the field immediately after harvesting of the seed head and transported to experiment site. Since, most of the sorghum crop in the study woredas was usually attacked by stock borer pest, this had changed the color of the inner sheath,

outer stalk and leaf parts from creamy white to deep red color and in addition it hardened the stalk sheath making the chopping process difficult. Thus, the highly pest affected stover was removed from the sample while the healthy one (with all intact leaf, leaf sheath and the stalk) was chopped manually at approximately 3 cm size using locally made axe (*softu*). The stalk was crushed at the nodes in between internodes to facilitate easy drying and better exposure of the stalk pith for chemical wetting. The chopped stover was exposed for sunlight on a plastic sheet for 5 days and manually turning timely to keep uniformity in drying. Finally, the dried sample was measured with a calibrated hanging balance and put in plastic bags pending for chemical treatment. Composition of the ensiled material is illustrated in (Table 5).

The EM solution was prepared according to the norm that is one liter of activated EM was mixed with one kg of molasses and 18 liters of chlorine free water in the ratio of 1:1:18. To make this effective, the chlorinated /tap/ water was left for overnight before mixing with EM and molasses. Chlorine free water was needed because microorganisms are very sensitive to chlorine and it could kill them before they commence their activities. Molasses was added and mixed with EM at equal proportion in order to initiate the microbial (EM) multiplication and metabolism (Yonatan *et al.*, 2014).

Once the solution was made, the chopped stover was sprinkled at the rate of 900 ml of the solution to one kg of chopped stover. The stover was mixed with the solution by hand and the treated material left for sometime until the stover absorbs the solution. This was done to properly wet the sorghum stover so that fermentation could be effective (Mulugeta A., 2015). Accordingly, three duplicates of 5 kg of the stover were measured and put separately on plastic sheet managed for wetting the stover and each treated individually with 4.5 liter of the EM solution. For the second treatment preparation (Urea treated sorghum stover) the same procedure was applied but the stover was treated with fertilizer grade urea-water mix at the ratio of 20:1:20 (water: urea: stover). About 0.75 kg of urea mixed was with 15 liters of water and this was used to treat 15 kg of stover (Girma and Goetsc, 2008). Accordingly, three replicates of 5 kg chopped stover each were sprinkled separately with 5 liters of the urea-water mix solution.

The third treatment was the EM-Urea solution which was prepared by combining 2.25 liters of EM solution and 2.5 liters of Urea solution for each treatment. These were then combined together in order to treat 5 kg of stover. The solution was poured on the stover using a plastic can. While pouring the solution on the dried stover, turning and rubbing it manually had facilitated uniform wetting of the stover.

Finally, the treated sorghum stover was separately put in a transparent plastic bag (size: 90 cm length by 58 cm width) and pressed by hand so as to avoid air space. This is the easiest method of silage making known as Plastic bag silo recommended for feeding up to ten animals (Seiichi *et al.*, 2005). And individual containers were knotted at the top by a sisal rope to block entrance of oxygen and finally the bag was inserted into another plastic bag (size: 93 cm length by 60 cm width) to assure anaerobic fermentation and protection. The same weight of untreated stover (control) in three replications was put in plastic bag with the same management. All the bags are kept in a clean room with cement floor covered by plastic sheet. The room was closed to facilitate the anaerobic fermentation.

3.4. Experimental Design and Treatments

The ensiling experiment was carried out using a completely randomized design to compare the treatment effects. Each of the three types of the treatments (T2=EM, T3=Urea and T4=EM+Urea,) and the untreated stover (T1 = Untreated stover) were replicated three times. The experimental treatments including the kind and amount of additives was shown in Table 5.

Table 5. Experimental treatments of chopped sorghum stover

Treatments	Amount of stover (kg)	Additives	Amount of additives (Liters)
T1	5	-	0
T2	5	EM solution	4.5
T3	5	Urea solution	5
T4	5	EM + Urea solution	4.75

EM= Effective microorganisms

3.5. pH Measurement, Sensory Evaluation and Chemical Analysis

3.5.1. pH measurement and sensory evaluation

The feed quality of treated stovers was evaluated visually, smell, texture and pH value. The pH values of the treated sorghum stover samples were determined by Bench top Digital pH meter of the extract (Playne and McDonald, 1996). The pH of the treated feeds was determined by soaking 20 g of the materials overnight in 100 ml of distilled water. This was then divided into three portions, filtered and pH determined using a pH meter (Otieno *et al.*, 1999).

The treated stover was ensiled for 21 days. The pH measurement was done by taking 20 g of the ensiled material from each sample experiment bag. Sampling taking was done cautiously by grabbing the silage material by hand and soaking it in beakers and as much as possible minimizing entrance of air in the main silage bag. The sample was allowed to be soaked in a 100 ml distilled water for overnight. Then the soaked sample was thoroughly mixed and stirred up properly to get the juice and finally filtered with an ordinary sieve and the solution was divided equally and poured into three glass tubes and pH measurement was done and the mean value was taken. Finally the color, smell and touch with-hand parameters were assessed in comparison with the control treated stover and the result of each test was recorded (Yonatan *et al.*, 2014). Two individuals including the researcher had participated in evaluating the sensory evaluation parameters to avoid bias.

3.5.2. Chemical analysis

A representative sample of 300 g were taken from the top, middle and bottom part of each plastic bag and sealed immediately and put in ice box containing ice bars to arrest the fermentation process and finally the sample was transported to National Veterinary Institute (NVI) laboratory and there it was sub-sampled, weighed, put in laboratory tray covered with white paper, coded for identification and was put in partial drying oven at 55 °C for 72 hrs for partial DM determination.

The samples were grounded to pass through 1mm sieve in Wiley mill. Accordingly, the samples were analyzed for dry matter (DM), crude protein (CP), Ash and Crude fat (CFat) or Ether extract (EE) according to AOAC (1990). The OM was determined by subtracting the Ash value from 100%. The detergent analysis was conducted at Holeta Agricultural Research Center (HARC). Neutral detergent fiber (NDF), Acid detergent fiber (ADF) and Acid detergent lignin (ADL) contents were analyzed according to Van Soest and Roberston (1985).

3.6. In vitro DM Digestibility Procedure

In vitro dry matter digestibility (IVDMD) was determined according to procedures of Tilley and Terry (1963). The dried materials were grounded to pass through 1 mm sieve for *in vitro* dry matter digestibility. About 0.5 g of the samples was incubated in 125 ml flasks containing rumen fluid-medium mixture for 48 hours in a water bath maintained at 39 °C. This was followed by a 24-hour acid-pepsin digestion phase at 39 °C, under anaerobic conditions. The rumen fluid was obtained from rumen fistulated steers kept at the Holeta Agricultural Research Center. The steers were offered natural pasture hay under maintenance diet, water and mineral block ad libitum, and concentrates. The IVDMD was calculated according to Galyean (2010) as follows:

$$\text{IVDMD \%} = 100 \times [(\text{initial dry sample wt} - (\text{residue} - \text{blank}))/\text{initial dry sample wt}]$$

3.7. Ruminal *in sacco* DM Degradability Procedure

Sun dried samples were ground using Wiley mill to pass 2 mm screen to determine *in sacco* DM degradability by incubating about 3 g of sample in a nylon bag (40 to 60 μ (micron) pore size and 4.5 x 18 cm dimension) in three rumen fistulated steers found at Holeta Agricultural Research Center. The fistulated animals were F₁ Boran Friesian cross bred with mean \pm SE weight of 500 \pm 30 kg kept in individual pens. The animals were fed standard diet formulated to maintenance diet. The feed included hay ad-libitum and 2 kg concentrate per head per day. The 2 kg concentrate was composed of 50 % wheat bran, 1% salt and 49 % Noug seed cake (NSC). The samples were incubated for 0, 6, 12, 24, 48, 72 and 96 hours. For each sample, two bags were used for each incubation time and repeated in three fistulated animals. The bags were inserted sequentially and removed at one time not to disturb the rumen eco-system. Upon removal from the rumen, bags were washed in running tap water while rubbing gently between thumb and fingers until the water becomes clear. This was done to take out the degraded feed from the bags. Zero time disappearance (washing losses) was obtained by washing un-incubated bags in a similar fashion. The washed bags were then dried in an oven at 60°C for 48 hours. The dried bags were then taken out of the oven and allowed to cool down in desiccators and weighed immediately to determine the dry weight of the incubation residues.

The degradability of DM is expressed as percentages and was determined for each bag using the following formula (Osuji *et al.*, 1993):

$$\text{Dry matter disappearance (DMD)} = \frac{((\text{BW}+\text{S}) - (\text{BW}+\text{RW}))}{(\text{S} \times \text{DM})} \times 100, \text{ where;}$$

BW = Bag weight

RW = Residue weight

S = Sample weight in DM basis

DM = Dry matter content of the original sample (%)

Data for ruminal disappearance characteristics of DM were fitted to the exponential equation following the procedure described by Ørskov and McDonald (1979).

$Y = a + b(1 - e^{-ct})$, where:

Y = Degradability of DM at time t

a = soluble fraction

b = insoluble but potentially degradable fraction

c = degradation rate constant of the b fraction

t = degradation time (0, 6, 12, 24, 48, 72, and 96 h)

e = (2.7182) base for natural logarithm

The nonlinear parameters a , b , and c were estimated using non-linear procedures of SAS (Statistical Analysis System, Version 9.3, 2010).

The potential degradability (PD), $PD = a + b$; whereas: Effective degradability (ED) was calculated following the method of Ørskov and McDonald (1979) assuming a passage rate of 4 %/h. Assumption of passage rate is based on the feed intake level of animals (Daniel *et al.*, 2012).

$ED = a + bc / k + c$;

Where:

a = soluble fraction

b = insoluble but potentially degradable fraction

c = degradation rate constant of the b fraction

k = passage rate

3.8. Statistical Analysis

Data gathered from the field through FGD, key informant interview and personal observations were analyzed after categorizing and narrating based on the research objectives using a thematic analysis approach. Thematic Analysis is a type of qualitative analysis. It seeks to discover using interpretations. It consists of three link stages namely;

data reduction, data display and data conclusion-drawing/verifying (Alhojailan, 2012). The data collected through structured questionnaire were coded and entered into Microsoft Office Excell computer software and analyzed using statistical package for social sciences (SPSS, 2006) version 20. Some of the survey results were summarized using descriptive statistics like mean, range, standard error of mean and percentage values of various parameters.

Standard livestock-unit conversion factors (head to TLU) employed by ILCA (1986) (for camel 1.0, cattle 0.7, sheep 0.1, goats 0.1 and Donkeys 0.5) was used to show animal or group of animals that will eat the same amount of feed as a 250 kg bovine (Richardson and Smith, 2006). Conversion to TLU was used to see TLU livestock holding per house hold of the highland and mid-altitude of each study woredas.

Chi-square (socio-demographic variables), Index ranking (purpose of rearing cattle, selection criteria, preference for fattened cattle, major constraints, factors determining fattening cattle price) and means±standard error (number of cattle per fattening period, fattening duration, frequency of fattening per year, age of fattening) were employed.

Index was computed (for Objective of rearing, major constraints of cattle fattening practices, factors determining fattened cattle price, selection criteria of cattle for fattening and preference of type of cattle for fattening) by employing the principle of weighted average (Musa *et al.*, 2006):

$$\text{Index} = \frac{R_n * C_1 + R_{n-1} * C_2 + \dots + R_1 * C_n}{R_n * C_1 + R_{n-1} * C_2 + \dots + R_1 * C_n};$$

Where R_n = Value given for the least ranked level (example if the least rank is 7th rank, Then $R_n=7$, $R_{n-1}=6$ and ... $R_1= 1$). C_n = Counts of the least ranked level (in the above example, the count of the 7th rank = C_n , and the counts of the 1st rank = C_1).

All data obtained from chemical analysis of the experimental feeds including *in vitro* dry matter digestibility and *in sacco* DMD were analyzed using the general linear model

(GLM) procedure of the statistical analysis system (SAS, 2010) with the following model. The least Significant Difference (LSD) procedures was followed to separate the means when the F value shows significant differences. The model for analysis of the chemical composition, *in vitro* and *in sacco* dry matter digestibility data was:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where;

Y_{ij} = Response variable

μ = Overall mean

T_i = Treatment effect

e_{ij} = The random error

4. RESULTS

4.1. Socioeconomic Characteristics of Interviewed HH

4.1.1. Household characteristics

The socio-economic characteristics of interviewed farmers are shown in Table 6. In general, sex, marital status and family size of respondents had no significant difference ($P > 0.05$) in the study woredas. Whereas age and education level had significant association ($P < 0.05$) with the study woredas. In the study woredas, out of the total households ($N=160$) involved in fattening of cattle, 97.5% of the households were male headed but only 2.5% were female headed HHs. The mean \pm SD for age was 41 ± 11 . Higher number of respondents in the age range of 20 to 31 were found in Habro and Tullo. In addition, the highest number of respondents in the age range of 32 to 43 and 44 to 55 were found in Habro and Chiro, respectively. The overall household age of interviewed farmers was 20-31 years (24.4%), 32-43 years (35.6%), 44-55 years (30.6%) and 56-70 (9.4%). All respondents falling in these age groups were directly participating in the cattle fattening activity at the time of the interview. Respondents who were in the age group of 32 to 43 were the highest in number and they were mostly supported by family labor. Whereas, respondents in the age range of 56 to 70 were the smallest because of older age since cattle fattening requires relatively intensive labor for feeding and other management activities. In terms of marital status of the house hold heads 91.2 % married, 6.2 % single, 1.2 % widowed and 1.2 % divorced. The mean \pm SD family size was 5 ± 2 and the majority (53.8%) was in the range of 4 to 6.

The overall education level of household heads included 31.9% illiterate, 22.5% reading and writing, 25.6% elementary school, 5.6% junior secondary school, 11.9% secondary school, 1.2% above secondary school complete and 1.2% spiritual education. Fattening practice is lucrative in the study woredas thus, the 11.9% respondents were mostly drop outs from high school education and engaged in cattle fattening. The majority of respondents (68.1%) had started fattening in the past ten years.

Table 6: Socio-demographic characteristics of respondents (%) in the study woredas

Variables	Woreda					Overall N=160	X ²	P-value
	Habro N=40	Gemechis N=39	Chiro N=45	Tullo N=36				
	%							
Sex	Male	97.5	97.4	100.0	94.4	97.5	2.53	0.469
	Female	2.5	2.6	0.0	5.6	2.5		
Age	20-31	35.0	15.4	15.6	33.3	24.4	25.91	0.002*
	32-43	52.5	35.9	26.7	27.8	35.6		
	44-55	12.5	30.8	44.4	33.3	30.6		
	56-70	0.0	17.9	13.3	5.6	9.4		
Marital status	Married	82.5	94.9	97.8	88.9	91.2	16.57	0.056
	Single	15.0	5.1	2.2	2.8	6.3		
	Divorced	0.0	0.0	0.0	5.5	1.2		
	Widowed	2.5	0.0	0.0	2.8	1.3		
Family size	1 to 3	17.5	17.9	17.8	16.7	17.5	5.07	0.534
	4 to 6	47.5	61.5	60.0	44.4	53.7		
	7 to 10	35.0	20.6	22.2	38.9	28.8		
Education	Illiterate	17.5	35.9	46.7	25.0	31.9	45.50	0.000*
	Read and write	25.0	20.5	33.3	8.3	22.5		
	Elementary school	20.0	35.9	4.4	47.2	25.6		
	Junior secondary school	12.5	2.6	4.4	2.8	5.6		
	Secondary school	20.0	5.1	8.9	13.9	11.9		
	Above High school	5.0	0.0	0.0	0.0	1.3		
	Spiritual education	0.0	0.0	2.3	2.8	1.2		

Level of significance at P<0.05; N=Number of respondents

4.1.2. Sources of income for households

In West Hararghe Zone, mixed farming of crop and livestock was the dominant and common practice in all study woredas. As presented in Figure 2, when looking the overall respondents of the study woredas, the major sources of household income (96.3 %) was from crop and livestock production as income source. With the shortage of grazing lands, cattle fattening activity is highly linked with crop production. According to personal observation and discussion with focus groups, women in the study woredas generate income from sale of agricultural products such as fruits, vegetables and cereals, *Khat* (*Catha edulis*) and sheep and goats. Fuel wood sale and engaging in daily labor work in the nearby towns is common phenomenon in times of food scarcity serving as income in the study area.

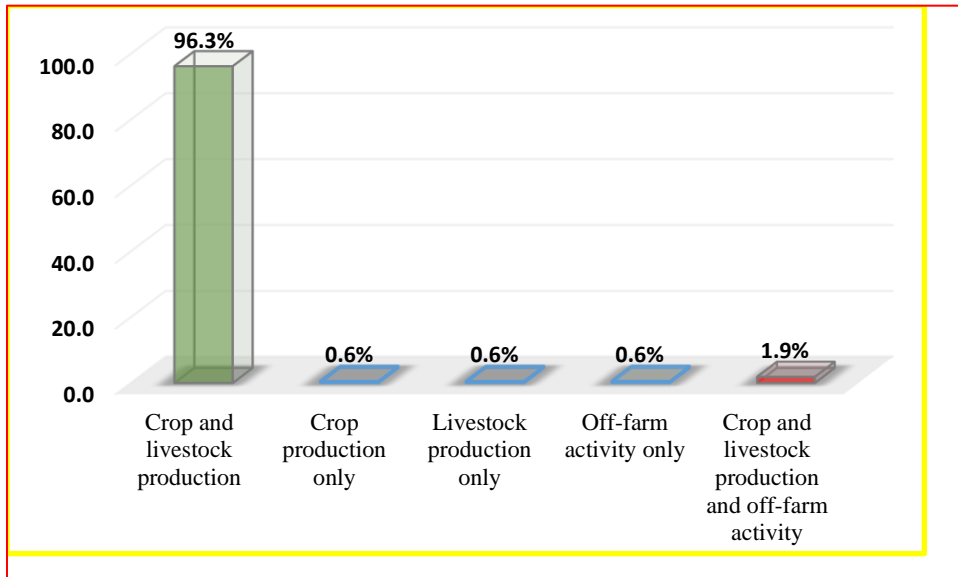


Figure 2: Source of income of respondents in the study woredas

4.1.3. Land holding and utilization

Average crop land size of small holder farmers in the study woredas is described in Table 7. Food crops include maize (*Zea mays*), sorghum (*Sorghum bicolor*), wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), tef (*Eragrostis tef*), broad bean (*Vicia faba*), haricot bean (*Phaseolus vulgaris*) and chick peas (*Cicer arietinum*) and major cash crops and vegetables were *khat* (*Catha edulis*), onion (*Allium cepa*) and tomato (*Solanum lycopersicum*). Personal observation to the study *kebeles* revealed that practically there was no grazing land seen in some the study *woredas* particularly in Habro and Chiro. But in Gemechis *woreda*, there is 60 hectare communal grazing land which is swampy area in the center especially during the rainy season and in Tullo *woreda*, there are small patches of private grazing lands on the border of croplands. In addition, according to FGD, there was no land dedicated for improved forage development due to the shortage of cultivable land for cereal production and cash crops mainly *khat*. Therefore, maize and sorghum in Tullo *woreda* were produced in between rows of *Khat* and undersowing of haricot bean in maize fields was a common practice. But in some areas of Tullo and Chiro *woredas* soil bunds in between the crop lands in plain and hilly areas were covered by elephant grass. During the discussion with focus groups, high population growth lead to incorporation of grazing lands into crop lands which caused thier dwindling.

Table 7: Average crop land size of small holder farmers in the study woredas (ha).

	Habro		Gemechis		Chiro		Tullo	
	HL	MA	HL	MA	HL	MA	HL	MA
Mean	0.7	0.7	0.7	0.8	0.5	0.6	0.6	0.6
SD	0.03	0.02	0.05	0.03	0.2	0.2	0.2	0.3

SD=Standard deviation; HL=Highland, MA= Midaltitude

The average land holding of respondent in highland and mid-altitude *kebeles* of the studied *woredas* was depicted in Table 8. More or less, the land used for crop and more specifically

to food crops is similar. However, the grazing land in the highlands was smaller than the midaltitude areas of the study areas.

Table 8: Average land holding based on agro-ecology in the study areas

Land use	Agro ecology	Mean \pm SE
Crop land holding	HL	0.64 \pm 0.04
	MA	0.68 \pm 0.04
Food crops	HL	0.44 \pm 0.04
	MA	0.39 \pm 0.04
Cash crops	HL	0.11 \pm 0.03
	MA	0.20 \pm 0.03
Grazing land	HL	0.12 \pm 0.04
	MA	0.30 \pm 0.16
Forage land	HL	0.13 \pm 0.00
	MA	0.13 \pm 0.05
Private forest land	HL	0.13 \pm 0.05
	MA	0.08 \pm 0.02
Rented land	HL	0.33 \pm 0.13
	MA	0.18 \pm 0.08
Others	HL	0.15 \pm 0.04
	MA	0.25 \pm 0.00

HL=Highland; MA= Midaltitude

Whereas Table 9 shows cereal production per respondent of the study areas (Mean \pm standard error). Similarly the mean \pm SE of the land covered by main cereal crops of the overall study woredas showed that maize, sorghum, wheat, haricot bean, chick peas and others (including finger millet, *khat*, onion, tomato) was 0.25 \pm 0.01, 0.24 \pm 0.01, 0.23 \pm 0.01, 0.23 \pm 0.01, 0.22 \pm 0.00, 0.15 \pm 0.01 ha., respectively. According to personal observation in some of the interviewee farmer crop fields, maize and sorghum were produced mixed, broad bean was produced under maize and chick peas and *teff* were produced as relay crop after maize harvest.

Out of the 160 owners of fattening cattle, 90.6, 87.5, 22.5, 19.4, 11.4 and 31.3% produced maize, sorghum, haricot bean, *teff*, barely and other crops, respectively. But still some other farmers produced maize and sorghum separately. The overall average yield of maize

and sorghum in the highland and midland of the study areas was 22.3 and 20.9 quintal /ha, respectively at the time of this study.

Table 9: Land utilized for major types of cereal crops (Mean and standard error) (ha).

	Maize	Sorghum	Wheat	Barely	Tef	Faba bean	Haricot bean	Chick peas	Others
Mean	0.25	0.24	0.23	0.12	0.15	0.15	0.23	0.22	0.15
SE	0.01	0.01	0.01	0.01	0.01	0	0.01	0	0.01

4.1.4. Family labor distribution

Almost all members of household in the study woredas were partaking in different activities of cattle fattening in West Hararghe zone. Responsibilities of family members is depicted in (Table 10). Feeding and watering of the fattening cattle was in one way or another the responsibilities of the majority of family members (41.9%) however, husband and wife (24.4%) were more dedicated to the work than other family members. Whereas, wives (22.5%) and wives and children (25.6%) were more involved in the cleaning of manure and collection of leftover feeds from the shelters. The responsibility of selling and purchasing of fattened and replacement cattle, respectively was the responsibility of husbands (86.9%) in the family. This was especially so in the marketing of fattened cattle however, according to focus group discussion, women were mostly involved in marketing of calves, heifers, infertile cows, goats and sheep in the study areas. Members of household in multiple response include husband, wives, children and partners that involve in routine fattening activities alternatively.

Table 10: Responsibilities of family members in the routine fattening activities (%) (N=160)

Family members	Feeding and watering	Cleaning	Healthcare	Selling
Husband	5.6	15.0	64.4	86.9
Wife	9.4	22.5	0.6	0.0
Children	5.0	15.6	1.20	1.0
Partner	0.0	0.0	0.0	0.6
Single	1.8	3.8	5.0	5.6
Wife & children	6.9	25.6	0.0	0.0
Husband & wife	24.4	10.0	16.9	4.0
Husband & children	5.0	0.0	0.0	1.9
Multiple answer	41.9	7.5	11.9	0.0

Concerning the seasonality of labour availability, in general 91(58%) of the whole respondents confirmed that there was shortage of family labour for managing fattening cattle during certain months of the year. But the situation varied in each study woreda in that 68, 53, 68, and 42% of respondents interviewed in Habro, Gemechis, Chiro and Tullo woredas, respectively indicated that there was no sufficient family labor that help them the fattening work. Most of them reasoned out that there were peak months of the year when they desperately needed the family and additional labor to look after the fattening cattle. Generally, months of April, May and June were peak months of the year when respondents and family members were kept busy in plowing, sowing and cultivating in the cropland so every family member whose age reached for work gave more emphasis for crop cultivation to use the rainy time effectively. Therefore, during this time in addition to the feed shortage, fattening cattle lack due emphasis in their management. This was further confirmed in the FGD held in each woreda, some of the participants indicated that they buy bulls for plowing mostly in June and July months because during this time there is no enough fodder so the price of bulls was relatively cheap in the market.

4.2. Cattle Fattening Practices

4.2.1. Experience of cattle fattening

The fattening experience of respondents showed that 55%, 29%, 10%, 3% and 3% of the respondents had 1-8, 9-17, 18-26, 27-35 and 36-40 years, respectively (Figure 3). The majority of respondents (55%) had started fattening in the past eight years.

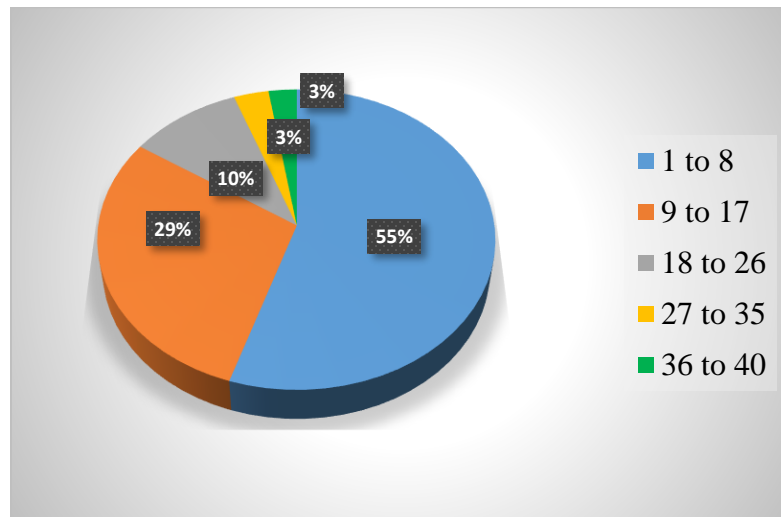


Figure 3: Experience of cattle fattening (years)

The fattening experience of respondents mean \pm SD was 10 ± 8 years (Table 11). The majority of the respondents (55%) had 1 to 8 years of experience which might show how the number of producers increased in recent years. The majority (55%) of the respondents had 1 to 8 years of fattening experience and this shows a large number (88) of farmers had been involved in the fattening work during the recent past eight years. However, a few of the respondents (3%) traced back to 36 to 40 years of fattening experience. There was a 53% increment in the number of producers involved in the fattening work during these years. In general, cattle fattening practice in West Hareghe had a long time history. Discussion with the elders of the community and FGD, revealed that cattle fattening started in this area long time ago. At around 1975, there were a couple of individuals in Tullo woreda who used to buy fattened cattle and trek the animals up to Miesso, 72 km far away

from capital of Tullo woreda-Hirna town, where there was a train access in Miesso and they were able to transport the fattened cattle to Addis to sell at profit. The impact of this was more and more farmers were attracted to the work thus farmers started to tether and feed their cattle for achieving premium price in the market. Tethering to feed animals especially cattle during fattening is actually due to lack of grazing lands and expansion of cropping lands which had been increasing from time to time.

Table 11. Household experience of cattle fattening

Experience in fattening (Years)	Woreda					X ²	P-value
	Habro N=40	Gemechis N=39	Chiro N=45	Tullo N=36	Overall N=160		
	%						
1 to 8	70	41	55.6	52.8	55	22.26	0.035*
9 to 17	22.5	43.6	28.9	22.2	29.4		
18 to 26	2.5	5.1	8.9	25	10		
27 to 35	2.5	5.1	4.4	NA	3.1		
36 to 40	2.5	5.1	2.2	NA	2.5		

Level of significance at P<0.05; N=Number of respondents; X² = Chi-square goodness of fit test
NA= Data not available

4.2.2. Livestock herd size

The herd size for the two agro ecological settings of the study woredas showed is showed in Table 12. Cattle had the higher TLU value than the rest of livestock species. The highest TLU per HH value was reported in the highland kebele of Habro and the lowest value for the midland kebele of Gemechis. This showed that respondents in Habro had better access for cattle from the lowlands of pastoral areas than the other woredas. Higher TLU values for cattle was observed in the highland agro-ecological setting than mid-altitude counter parts. The TLU values for sheep and goats were not consistent for comparing the two agro ecologies and across the study woredas. However, sheep are a little bit more dominantly found in the highland agroecology than goats. The higher number of cattle and donkey showed how these animals were valuable for the rural society in the study areas. This

situation could be associated with the adaptation, alternative function and feeding habit of of these species of livestock.

Table 12: Livestock herd size in TLU per HH in the study woredas.

	Habro		Gemechis		Chiro		Tullo		Overall	
	HL	MA	HL	MA	HL	MA	HL	MA	HL	MA
Cow	1.09	1.4	1.11	0.98	0.73	0.85	1.05	0.93	0.98	1.04
Oxen	0.63	1.23	0.99	0.98	0.73	1.07	1.24	1.05	0.89	1.08
Bulls	1.33	0.21	0.41	0.28	0.13	0.37	0.27	0.16	0.53	0.26
Heifers	0.35	0.21	0.48	0.18	0.29	0.12	0.43	0.39	0.38	0.22
Male calves	0.77	0.63	0.66	0.00	0.35	0.24	0.58	0.43	0.58	0.32
Female calves	0.63	0.42	0.44	0.04	0.60	0.27	0.35	0.43	0.51	0.29
<i>Cattle total</i>	<i>4.80</i>	<i>4.10</i>	<i>4.09</i>	<i>2.45</i>	<i>2.83</i>	<i>2.92</i>	<i>3.93</i>	<i>3.81</i>	<i>3.83</i>	<i>3.20</i>
Sheep	0.10	0.18	0.11	0.01	0.13	0.10	0.20	0.06	0.13	0.08
Goats	0.13	0.16	0.04	0.06	0.08	0.13	0.11	0.11	0.09	0.11
Donkey	0.63	0.53	0.26	0.10	0.27	0.41	0.31	0.44	0.37	0.36
<i>Total</i>	<i>5.66</i>	<i>4.97</i>	<i>4.50</i>	<i>2.62</i>	<i>3.31</i>	<i>3.56</i>	<i>4.55</i>	<i>4.42</i>	<i>4.42</i>	<i>3.75</i>

HL=Highland, MA=Midaltitude, TLU=Tropical livestock unit, HH=Household

4.2.3. Purpose of rearing cattle

This study showed that the almost all respondents (94.4%) in all study woredas had kept fattening cattle mainly for selling purpose (Table 13). All the respondents (100%) practice cattle fattening before selling. Nighty respondents (56.3%) rear cattle primarily for security (saving) purpose. The main objective of rearing cattle in the study area was selling eventually to enjoy the premium price in the livestock market. Since food crop production is one main feature of mixed crop-livestock production, using cattle for their meat and milk was taken as the last resort so ranked last in this study.

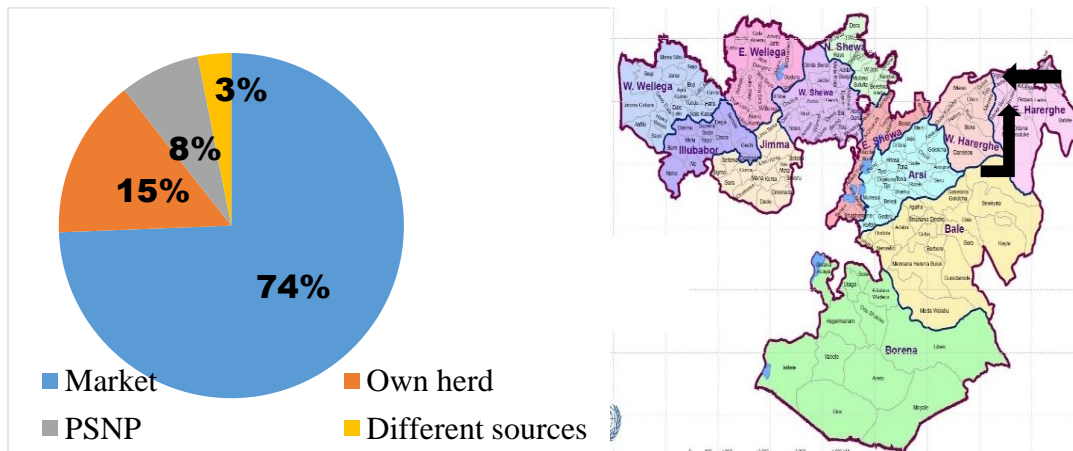
Table 13: Objective of rearing cattle in the study areas

Objective of rearing	Objective category			Total		
	Primary (N)	Secondary (N)	Tertiary (N)	weight	Index	Rank
Selling after fattening	151	8	0	469	0.251	1 st
Security (saving)	90	55	12	392	0.209	2 nd
Draft power	80	73	3	389	0.208	3 rd
Manure production	38	94	25	327	0.175	4 th
Food source (Meat and milk)	36	78	28	292	0.156	5 th

N= number of respondents; weighted value for each objective of rearing based on rank (3 for 1st, 2 for 2nd and 1 for 3rd)

4.2.4. Source of cattle for fattening

The majority of respondents 119 (74%) bought replacement bulls or steers directly from the market in all studied woredas. However, 24 (15%) of them got from their own herd and still 12 (8%) of the farmers got their source from Ministry of Agriculture office through productive safety net program (PSNP). The rest, collectively 5 (3%) respondents got replacement animals from relatives, from other organizations and by buying from their neighbors (Figure 4). In the focus group discussion held in each woreda participants indicated that in addition to the local sources, replacement cattle were dominantly coming from Bale and Somali region lowlands. Giner and Gasera are areas in Bale where these cattle were coming from. So the bulls come from these areas by traders through Kasheja, Gololcha, Bedessa and Boke lowlands and reach to Habro and Gemechis livestock markets.



PSNP= Productive saftyenet programme

Figure 4: Source of cattle for fattening

Babile is a district in East Hararghe bordering the Somali region lowlands where replacement cattle especially bulls were coming to Tull woreda by traders. The cattle were medium horned, slightly black around the head but the rest of the body was white, long legged with wide chest and thick neck. They are locally named as Ogaden and/or Boran breed. However, farmer also use their own local type of cattle for fattening. The local cattle are horned, commonly grey (*dalecha*), red, white and red and a few black colored, relatively short legged and smaller dewlap as compared to the Ogaden types. And these local types of cattle were more common in Gemechis livestock market.

4.2.5. Sense of ownership and characteristics of fattening cattle

Sense of ownership and characteristics of fattening cattle is illustrated in Table 14. Ownership of the fattening cattle in the study woredas showed that both husband and wife had shared ownership in Chiro (57.8%) and Tullo woreda (66.7%). In Gemechis woreda, all family members had equal sense of ownership. Unlike the other three study sites, in Habro woreda, the majority (57.5 %) of ownership went to the husband. Overall the study woredas, joint ownership sense of spouses was the highest in number (49%) than the other types. Generally, the majority of respondents (88.1%) preferred to fatten male cattle because they said fattened bull or ox attracts more buyers than female cattle. The respondents (96%) in the study areas had a strong ambition to continue fattening in the future but the rest 4% needed to stop it however, they had different reason for their decision. Thus, 55% of those decided to continue said because cattle fattening is their means of subsistence and profitable work, while 35% said it is profitable and don't going to stop it, and the last 6% told it is thier means of subsistence for living. Lack of money, shortage of feed and not being more profitable were reasons forwarded by those (4%) that intended to stop fattening in the future.

In Gemechis, Chiro and Tullo woredas the majority of respondents 69.2, 91.1 and 97.2%, respectively recommended castration before fattening justifying that even if fattening castrated bull requires relatively longer time, since the size of the fattening cattle becomes bigger after castration than uncastrated ones, it can be sold with a relatively higher price.

Focus group discussants mentioned that nowadays fattening is not only based on multiplying the number of cattle by rearing and picking one for this purpose instead most producers focused on fattening of bulls buying directly from the market to save time and get some income within a short period of time. Mostly the trend of fattening is producers buy a bull, use it for draught power for at most a year and then castrate and feed it for fattening. In fact this is done as a norm for local bulls. Because most respondents believe that without castration, the local bulls show an aggressive behavior and difficult to manage them, they bellow throughout the night and one cannot get the expected fattening result. But if they are castrated, they get docile and reach a good market size after some time as per the feeding management of the owner. So, the duration of fattening is usually from three to six months. However, the scenario in Habro woreda was different in that most of the respondents (75%) recommended fattening of intact (non-castrated) bulls. They noted that uncastrated bulls mostly coming from the lowlands of Somale region and Bale areas take shorter time to fatten than castrated ones. Mostly the average age for starting fattening of a home-born male cattle was four years. Respondents mentioned that if it is born at home, it will be used for draught power for a longer period of time before starting fattening.

This was further confirmed by experts from the Habro woreda livestock and fishery resource development office in that almost five years has passed since most cattle fatteners stopped castration of their bulls and oxen but bring uncastrated fattened bulls to the market. They justified that the time to fatten intact bulls is shorter than that of castrated ones. The experts added that the need for uncastrated bull was geared by the source of these cattle either from lowland or their own stock, the demand of the export trade and to some extent to the inclination of domestic market for lean meat. Personal observation to the livestock market confirmed this fact (Figure 5). Color preference to start fattening showed that most of the respondents' reply fall into red and white and multiple answer. However, overall most respondents (37.5%) gave multiple answer.

Table 14: Sense of ownership and characteristics of fattening cattle in the study woredas (%)

	Habro (N=40)	Gemechis (N=39)	Chiro (N=45)	Tullo (N= 36)	Overall (N=160)
Sense of ownership					
Husband	57.5	5.1	4.4	19.4	21.3
Wife	2.5	0.0	0.0	5.6	1.9
Both	30.0	43.6	57.8	66.7	49.4
Family	0.0	48.7	35.6	5.5	23.0
Other (single)	10.0	2.6	2.2	2.8	4.4
Choice of fattening cattle					
Steers and bulls	92.5	64.1	100.0	94.4	88.1
Cows/Heifers	0.0	2.6	0.0	2.8	1.3
Both	7.5	33.3	0.0	2.8	10.6
Castrated/ Non-castrated cattle					
Castrated	20.0	69.2	91.1	97.2	70.2
Non castrated	75.0	12.9	8.9	2.8	25.6
Both	5.0	17.9	0.0	0.0	4.2
Starting age of fattening (Years)					
One and two	0.0	10.3	0.0	25	8.1
Three	22.5	43.6	4.4	25.0	23.1
Four	30.0	41.0	42.2	38.8	38.1
Five	12.5	5.1	22.2	5.6	11.9
Six	32.5	0.0	28.9	5.6	17.5
Seven	2.5	0.0	2.2	0.0	1.3
Choice of color of fattening Cattle					
White	15.0	41.0	2.2	25.0	20.0
Red	17.5	33.3	57.8	27.8	35.0
Creamy white (<i>Dalecha</i>)	15.0	2.6	0.0	13.9	7.5
Dark	0.0	0.0	0.0	0.0	0.0
More than one color	52.5	23.1	40.0	33.3	37.5

N=Number of respondents



Figure 5: Uncastrated fattened bulls in Gelmso market, Habro woreda

4.2.6. Number of animals and duration and frequency of fattening

It was observed that the mean number of animals per fattening period, fattening duration and frequency of fattening and the age to start fattening if the animal was born at home varies based on highland and mid-altitudinal agro-ecology in the study areas (Table 15). The mean \pm SE value showed, these parameters were higher in the midaltitude than highland study sites. Similarly, the same parameters had different mean values when comparing the study woredas. The mean value of each variable in Habro woreda showed that respondents in this area fatten cattle more frequently than other woredas. Following Habro woreda, the frequency decreases in Chiro, Tullo and Gemechis, respectively. The duration of fattening almost goes in line with the frequency in this study because when the duration decreased, the frequency of fattening increased.

The ever increasing demand for fattened cattle in the market and the high price and income accrued from this sector had attracted more and more respondents from the two agro-ecologies. According to the discussion made with the key informants, currently producers utilize crop residues, cereals and agro-industrial byproducts to be able to sell after a few months of feeding. To make this effective, producers buy replacement bulls that are coming from lowlands and use them mostly for one term plowing and then fattening. Therefore, during personal visit especially in Habro and Tullo livestock markets, it was revealed that most of sellers in the market were ready to sell intact uncastrated fattened bulls. Regarding the age of cattle, producers could estimate by looking on the eruption of incisor tooth so young animals have small incisor teeth whereas old ones have broad erupted, wide and cracked tooth. Farmers also look on the condition of their horns so younger animals have smooth horns while older ones have 3-4 circular ridges indicating more than 6 years of age.

Table 15: Mean±Standard error for number of animal per fattening period, fattening duration, frequency of fattening per year and age of fattening.

		Number of cattle per fattening period	Fattening duration (months)	Frequency of fattening per year	Age (years) for fattening
	N	M±SE	M±SE	M±SE	M±SE
Agro eco- logical zone					
Highland	79	1.57 ± 0.09	4.84 ± 0.17	1.54 ± 0.08	3.76 ± 0.13
Mid-land	81	1.62 ± 0.08	5.16 ± 0.17	1.65 ± 0.07	4.47 ± 0.13
Woreda					
Habro	40	1.78 ± 0.12	3.35 ± 0.18	1.93 ± 0.10	4.67 ± 0.16
Gemechis	39	1.36 ± 0.12	6.36 ± 0.18	1.15 ± 0.95	3.36 ± 0.17
Chiro	45	1.60 ± 0.11	5.20 ± 0.17	1.62 ± 0.09	4.75 ± 0.16
Tullo	36	1.64 ± 0.12	5.44 ± 0.19	1.61 ± 0.10	3.42 ± 0.17

M=Mean; N=Number of respondents; SEM= Standard error of mean; base year 2015.

4.2.7. The selection criteria of animals for fattening

The selection criteria of cattle for fattening is illustrated based on ranking (Table 16). Accordingly, the first thing that draws the attention of respondents to buy cattle for

fattening is the conformation of the animal. This includes the shape, outline and form of the animal. They indicated that they were attracted by wide chest and breast bone, long back and wide abdomen that could carry a lot of feed. Color has got greater impact on attracting the buyers. White, grey (*dalecha*) and red colored animals were more attractive in the market for buying than dark colored animals. Short and dwarf cattle were not chosen for fattening so respondents thirdly gave more attention to the height of the cattle. They prefer to fatten long legged and long backed cattle to carry lots of flesh. They look additionally on the size of the body of animal and the hump because large hump is prominent and can easily attract buyers. Short horned cattle were manageable for fattening. But in the study areas, personal observation and discussion made with farmers revealed that respondents don't give much emphasis about the size of the horn as long as the former conditions are met. However, other respondents in Tullo woreda indicated that long horned cattle will not fatten in a short period of time because traditionally people believe that the feed goes to the growth of the horn. They don't prefer polled animals even because tethering them is difficult without horn but they chose to buy medium horned cattle because it is easy to tie/tether at the horn and manage the animal. To make this reality, participants in FGD discussion in Tullo woreda indicated that they preferred to buy young bulls that were coming from pastoral areas mostly through Babile town, East Hararghe which is neighboring the Somali Regional State (Figure 6). The cattle type is locally known *babile* type and they are long in their stand, have broad chest, long back, prominent hump and thick neck with long hanging dew lap characteristic of lowland cattle.



Figure 6: Intact bulls coming from Somali region for fattening.

However, if by chance a home born cattle become horny, owner will fatten and sell in the market because he has no any other alternatives. Thus, the local fatty and horny animals are known as Dobba type.

Table 16: Rank of selection criteria of cattle for fattening

Variables (N=160)	1	2	3	4	5	6	7	Total weight	Index	Rank
Color	9	47	37	51	10	0	1	765	0.185	2
Height	17	34	58	25	10	7	0	757	0.183	3
Horn	14	2	6	4	20	63	2	344	0.083	5
Conformation	111	18	16	9	0	2	0	1005	0.243	1
Size	9	52	32	36	17	2	0	734	0.178	4
Others	4	4	1	1	0	1	1	64	0.015	6

N=number of respondents; weighted values for each variables for selection criteria for fattening based on rank (7 for first; 6 for second; 5 for third; 4 for fourth; 3 for fifth; 2 for sixth and 1 for the seven). Others include condition of teeth and health aspects

4.2.8. Preference of type and decision of end of fattening

The preference of type of cattle for fattening based on ranking is illustrated in Table 17. Mature oxen and young bull were the first and the second priority of selection in all study woredas in West Hararghe. Because of the accessible market supply in the study woredas, it was customary to use a young bull for plowing purpose commonly for a year and start fattening right after it using the available feeds and once the animal gets fattened, the farmers would bring it to the market. There were farmers who buy the already fattened bull after examining closely if there is an additional room for continuing fattening and selling at a better price. During the survey, personal visit and discussion time, respondents mentioned that currently young and uncastrated fattened bulls were more supplied in the market than castrated mature ones. This is in connection with the relatively shorter time needed to fatten young and uncastrated ones than castrated bull. They said fattening

castrated bull takes more than a year but uncastrated bull 4 to 6 months only. However, mature and fattened oxen still get relatively higher price than young fattened bulls.

Sterile cows, heifers, old oxen and cows were sequentially third up to last resort to be fattened. Respondents indicated that cows and heifers could be fattened when they get pregnancy /sterility problem. If the owner of these type of cattle observed this problem, he immediately shift his objective and starts to fatten these animals by providing supplementary feeds. These type of female cattle are known locally as *Meshena* that is to describe them sterile. Therefore, they would be sold at a better price for domestic consumption by local butchery men. Practically speaking, one could barely find old oxen as there is a high demand in the market for cattle at young and mature age. However, it is customary to sell old cows and buy replacement stock. Thus, when the farmers need to sell cattle of any age apart from calves and breeding heifers and cows in the market, they usually fatten or put on some weight to enjoy good income from the market.

Table 17: Rank of preference of type of animals for fattening

Variables (N=160)	Weight frequency						Total weight	Index	Rank
	1	2	3	4	5	6			
Old oxen	3	5	44	19	13	2	304	0.105	5
Matured oxen	85	67	3	1	0	0	860	0.298	1
Young bull	68	64	20	4	0	0	820	0.284	2
Old cow	2	1	3	3	7	48	100	0.035	6
Unproductive cow	2	21	68	25	10	1	485	0.168	3
Heifer	2	3	14	55	32	2	314	0.109	4

N=number of respondents; weighted values for each variables of preference of type of cattle for fattening based on rank (6 for first; 5 for second; 4 for third; 3 for fourth; 2 for fifth; and 1 for sixth).

The decision to make the end of fattening period for cattle (Figure 7) was directed by many factors among these body size change brought about by the animal by feeding

supplementary feeds, anticipating current and future better price, feeding length and the other factor was the demand of cash for immediate purpose. Almost half of the respondents 81 (52%) replied that they decided to sell guided by the body size increment of the cattle. When they believed, the animal had finished fattening and no more size increment comes, they decide to sell because staying the animal any longer on the one hand, it could not bring any additional change in body size and secondly feed which could be stored for others could be finished. The other 32 (20%) of the respondents wait for the time until the price escalates so even if the fattened cattle had enough body size to be sold, they wait until a better price could be achieved. The third group of respondents 26 (17%) were of more opportunistic in the fattening of cattle because they start fattening when feed is abundantly available and sell at the time when the feed started to diminish. The last group of respondents 18 (11%) indicated that they had forcibly decided to sell their fattening cattle when they had desperately needed money for fulfilling their urgent needs or when they had to pay for community service or other credits.

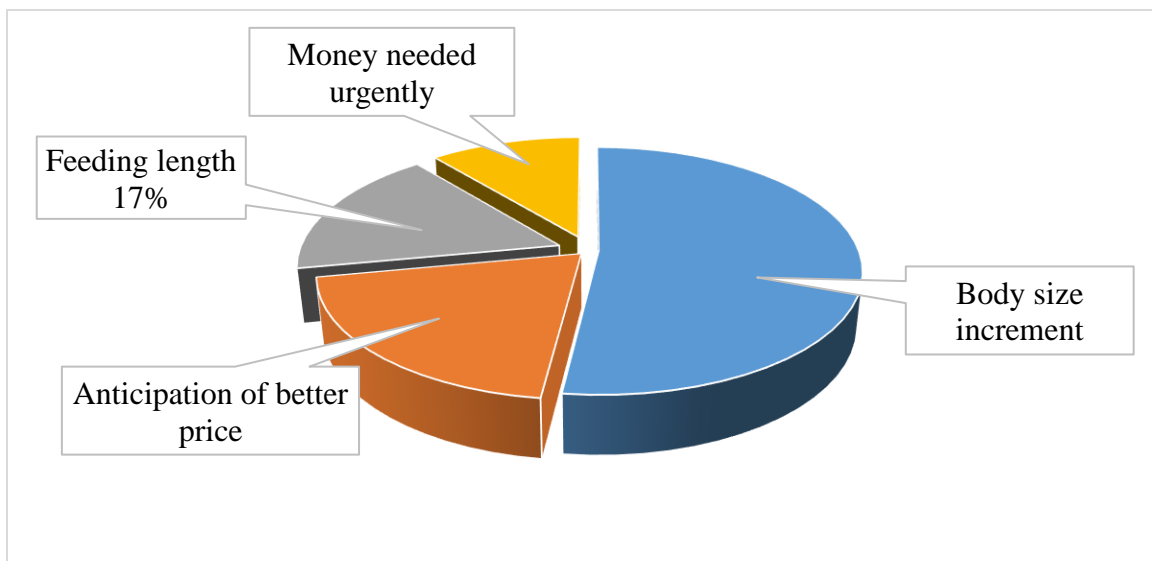


Figure 7. Decision to make end of fattening for all woredas

4.2.9. Technical support

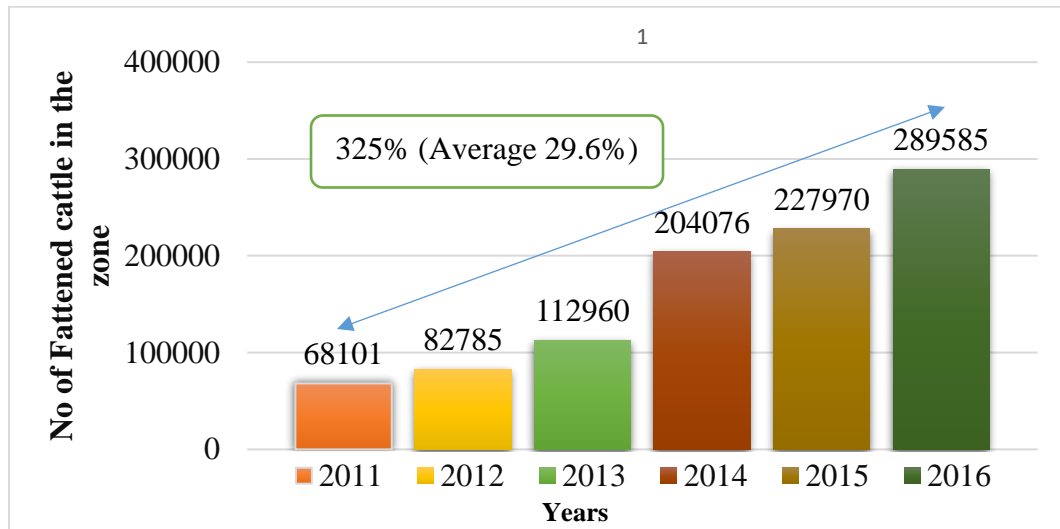
There were different sources of technical support for cattle fattening in West Hararghe Zone as observed in the study areas. It was revealed that 34, 34, 28, 3 and 1% of the respondents indicated that the office of agriculture, fellow farmers, parents and relatives, conferences of administration and newspaper and television, respectively, were their sources of technical support. However, most of these respondents (76%) said the technical support was not sufficient to easily adopt new technologies and innovative practices. Only 24% of them declared they were beneficiaries of the technical support obtained from different sources. The issues of technical support the respondents needed mainly focused on cattle feeds (49%), marketing (37%), health (7%) and breeding (7%) but there were no respondents on cattle product utilization. Producers noted that there were efforts to grow elephant grass on backyard and soil bund, elephant grass and other grass splits on soil bunds. Oats, cowpea, pigeon pea and vetch seeds were distributed for these farmers to develop and use as a supplement for their cattle.

Thirty seven percent of the respondents needed technical support on marketing issues that is about up to date price situation in the central market, how to organize themselves to deliver their cattle to central markets, to organize themselves and bring agro-industrial by-products and get it at a reasonable price. Seven percent of the respondents needed support on breed improvement through artificial insemination to get larger sized bulls to use for fattening. In this regard, the livestock and fishery resource development offices in the study woredas had launched a program on estrus synchronization for mass artificial insemination (AI). The objective is to improve the genetic make-up of the local breed so that enhancing milk and meat production. Among the respondents only 11% indicated they had used bulls obtained from AI service and used for fattening purpose. Whereas, 89% of the respondents indicated they had not used AI in general. This might indicate the need for further strengthened extension because majority of them even had no information.

4.2.10. Future expansion of the number of fattening cattle

The respondents who needed to expand cattle fattening in the study area were much higher (96%) than those who wanted to maintain as it is (4%). This is highly associated with the market availability in the area and taking as a coping strategy to generate income due to repeated failure of cereal production caused by erratic, late or complete failure of rainfall starting from 2014. Regarding the opinion of the family on the future number of the beef cattle, all the respondents (100%) replied to increase the number of fattened cattle although there was financial constraints and feed shortages. All respondents replied the trend of beef cattle production and productivity was increasing from time to time because more and more youths were attracted to the business utilizing agro-industrial by-products and maize flour especially during the feed scarce/dry season. Crops whose growth interrupted because of shortage of rainfall were used to be fed for fattening cattle. Along with this fact, all of the respondents in the study areas replied the cash income generated from sale of fattened cattle made them to incline to cattle fattening because of the increasing demand for fattened cattle in the livestock market from year to year.

According to the report obtained from West Hararghe zone livestock and fishery resource development office annual reports (2003-2006), the number of fattened cattle was increasing from year to year. Generally there is a 325% increment in the number of cattle fattened in the zone (Figure 8) in the past six year time. On average there was a 29.6% increase in the number of fattened cattle each year starting from 2011 to 2016. The major factors contributing to this change is the attraction of farmers for cattle fattening because of the growing market demand although the challenge of feed and other marketing problems remain there.



Source: West Hararghe zone Livestock and Fishery Resource Development office

Figure 8: Number of fattened cattle in the zone in different years

4.3. Cattle Feed Resources

4.3.1. Cattle feed resource during the wet season

The major feed resource available for fattening cattle during feed available season include crop thinning of maize and sorghum crops, grass and weeds which account for 85 and 70, 96 and 70 and 80 and 69 %, respectively in the highland and mid-altitudinal areas, respectively as reported by respondents of the study woredas (Table 18). It is customary for farmers of the study areas to broadcast a lot of seed in the cropland and at the time of the first tillage (*bekbako*) and then weed out those crop which were densely grown and weak in their stand and offer for cattle. In some cases, they sow maize deliberately for the sole purpose of feeding their fattening cattle. Personal discussion with some of the interviewees in Tullo woreda revealed this fact that some farmers sow maize purposely for feeding their fattening cattle because they believe they could incur more money in selling the fattened cattle than the cereal produced.

The main source of grass in the study areas were basically the hills and mountains covered by forests and kept excluded nowadays from livestock and human interference. Thus every community member has the opportunity to buy the grass from the kebele office. Therefore, these areas were becoming an ideal source of forage during its harvest time. The other source is small land near the crop fields purposely left and fenced for pasture production. However, in Gemechis woreda there is a large grazing land owned by the kebele office which is estimated to be 60 hectares. The site was excluded during the main rainy season from animals and human and later on the grass is sold at the time of harvest but then after, the grazing land was used communally during the entire dry season. There were private owners of grazing land in this woreda and these farmers sell the pasture after the main rainy season. Weeds and stubble feeding were common to all study districts.

4.3.2. Crop residues and grass for dry season feeding

From the results of this study, it could be possible to infer that maize and sorghum stover and pasture hay had substantial share of dry season feed resources of the area (Table 19). Sorghum stover being a residue which was found piled mostly in the field during late dry season used for feeding without any chemical treatment both in the highland and midaltitude agroecologies. Almost all respondents in the four districts of West Hararghe zone made use of stover and pasture hay largely as compared to other alternative feeds. The overall percentage of respondents that utilized the different alternative feeds in the study area showed that larger number of farmers in the mid altitude areas (95, 90 and 37%) utilize sorghum, maize stover and *teff* straw than their highland counterparts (92, 84 and 24%). This might attribute to the relatively suitable topographic condition of the mid-altitude areas for the production of these crops as compared to the rugged and hilly unsuitable terrain of the highlands. However, more respondents in highland areas (84%) used pasture hay than those living in the mid-altitudinal areas (65%) respondents in the highland were favored of the pasture grown in the nearby mountains which has currently obtained legal protection to be stock excluded areas and harvested finally for sale by kebele authorities in the study areas. Respondents living in the highland kebeles (25%) produced more barely and used the straw for feeding their fattening animals in the dry season than those in the mid-altitudinal kebeles (10%).

Table 18: Feed resources of the study areas during the wet season of the year (% of respondents)

	Habro		Gemechs				Chiro				Tullo				Overall					
	HL		MA		HL		MA		HL		MA		HL		MA		HL		MA	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Thinning	19	95	20	100	15	79	18	90	21	95	3	13	12	67	16	89	67	85	57	70
Maize stalk	16	80	1	5	7	37	19	95	1	5	15	65	8	44	2	11	32	41	37	46
Sorghum stalk	13	65	4	20	9	47	18	90	0	0	18	78	3	17	2	11	25	32	42	52
Grass	19	95	15	75	18	95	20	100	22	100	5	22	17	94	17	94	76	96	57	70
Weeds	20	100	19	95	10	53	19	95	21	95	4	17	12	67	14	78	63	80	56	69
Stubble feeding	1	5	1	5	1	5	0	0	0	0	0	0	1	6	1	6	3	4	2	2
Others*	2	10	2	10	2	11	0	0	0	0	2	9	7	39	4	22	11	14	8	10

*N=Number of respondents; HL=Highland; MA=Mid-altitude; * Others = haricot bean leaves, sweet potato vine, elephant grass
Stubble refers green seed covering and stems harvested while the crop is still green at the field*

Table 19: Feed resources of the study areas during the dry season of the year (% of respondents)

	Habro		Gemechis				Chiro				Tullo				Overall					
	HL		MA		HL		MA		HL		MA		HL		MA		HL		MA	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Teff straw	10	50	0	0	2	11	20	100	2	9	0	0	5	28	10	56	19	24	30	37
Barely straw	0	0	0	0	5	26	4	20	10	45	4	17	5	28	0	0	20	25	8	10
Maize stover	20	100	18	90	9	47	20	100	21	95	22	96	16	89	13	72	66	84	73	90
Sorghum stover	20	100	19	95	14	74	20	100	22	100	20	87	17	94	18	100	73	92	77	95
Pasture hay	19	95	14	70	14	74	18	90	17	77	6	26	16	89	15	83	66	84	53	65
Others*	13	65	10	50	7	37	2	10	7	32	0	0	16	89	4	22	43	54	16	20

*N=Number of respondents; HL=Highland; MA=Mid-altitude; * others = finger millet straw, wheat straw, pulse crops straw*

4.3.3. Major types of crop residues for dry season feeding

Crop residues are plant materials remaining after harvesting. All the 160 respondents (100%) of the study areas stored crop residues for dry season feeding of their fattening cattle. Larger number of respondents in the mid-altitudinal study areas stored *teff* straw, maize and sorghum stover (33, 88 and 98%) than those living in the highland agro ecology (22, 87 and 96%). The result was summarized in Table 20. From all study woredas, 155 (97%), 140 (88%), 44 (28%), 22(14%) respondents stored sorghum, maize stover, *teff* straw and other cereal crop residues, respectively.

Table 20: Number of respondents who store crop residues for dry season feeding

Crop residues	HL		MA		Overall	
	N	%	N	%	N	%
<i>Teff</i> straw	17	22	27	33	44	28
Maize stover	69	87	71	88	140	88
Sorghum stover	76	96	79	98	155	97
*Others	20	25	2	2	22	14

*N=Number of respondents; HL=Highland; MA=Mid-altitude; * others = finger millet straw, barely straw, wheat straw, pulse crops straw*

In general, crop residues of mainly sorghum and maize stover, *teff*, wheat and barley straw were stored stacked outside in the field (54.4 and 74%), stacked under shade (39.2 and 24%) and stacked both outside and under shade (6.4 and 2%), respectively in the highland and mid-altitude agro-ecologies of the study areas.

4.4. Feeding Practices of Fattening Cattle

Out of the 160 respondents from all woredas, 151 (94.4%) used cut and carry system of feeding but only one respondent (0.6%) use semi grazing because this owner in highland of Gemechis woreda had his own plot of grazing land near his home and 6 (3.75%) respondents in the highland and mid-altitude agro-ecology of the study area use stubble feeding by letting the animals directly feeding in the crop land after harvest. Whereas 2 out of 160 respondents (1.25%) used both cut and carry and stubble feeding in the Chiro

woreda. In focus group discussion, almost all of the participants agreed that, producers do not let their fattening animals to graze because they were afraid of injury by other animals and did not have the belief that cattle intended for fattening reach expected body gain through grazing. However, feeding of industrial by products mainly wheat bran and oil cakes and locally prepared concentrates such as maize flour, boiled haricot bean seed by mixing tef straw with wheat bran, maize flour and water (mostly a home-made ration) in order to increase the palatability of the straw were frequently observed systems of feeding during personal visit.

Out of 79 respondents in the highland, 78 (98.8%) and 81 respondents in the mid-altitude 79 (97.5%) treat feed before offering it to the fattening cattle (Table 21). However, only one and two respondents in the highland and lowland agro-ecology did not treat feed before offering to cattle. Regarding to the type of treatment of feed, out of 79 and 81 respondents in the highland and mid-altitude agro-ecology, 29 (37.2%) and 21 (26%), respectively chop maize and sorghum stalks and stover for easy and better consumption by cattle. In the Highland and mid-altitude agro-ecologies, 35 (44.8%) and 42 (52%) respondents, respectively chop stover and as the same time wetting stover with salty water to enhance palatability. With regard to other methods, 14 (18 %) of the respondents in the highland and 18 (22 %) in the mid-altitude used cooking of haricot bean seed; wetting with water and adding salt to increase palatability of the stover, wilting haricot bean leaf in the sunlight to avoid bloating and diarrhea. However, there was no respondent that used chemical treatments such as urea in the study woredas.

Respondents made use of used oil jerry can cut, wide plastic and metal dishes (utensils), vessels made of old tires (these are all local feeding troughs) and wood fenced area in the shelter (*girgim*) for feeding their fattening cattle. In fact the first three were used to feed supplementary feeds such as home-made wheat bran, maize flour, boiled haricot bean, and other locally available supplements whereas, the *girgim* is used solely for feeding chopped green stalks, stover, straw, haulms and grass hay.

Table 21: Feeding practices of fattening cattle % (n)

Types of feeding practices	Agro-ecology		
	Highland	Mid-altitude	Overall
Treatment before offer	98.8 (78)	97.5 (79)	98.0 (157)
▪ Chopping stalks/stover	37.2 (29)	26.0 (21)	31.3 (50)
▪ Chopping and moistening with salty water	44.8 (35)	52.0 (42)	48.1 (77)
▪ Cooking, wilting, wetting	18.0 (14)	22.0 (18)	20.0 (32)
Early night time feeding	90.0 (71)	95.0 (77)	92.5 (148)
Supplementary feeding	97.5 (77)	97.5 (79)	97.5 (156)

Once the cattle isolated to be fattened is, early night time feeding was a common strategy in the study areas which is intended to help the animal fatten within a short period of time. From all the respondents 71 (90 %) and 77 (95%) in the highland and mid-altitude kebeles, respectively experience of feeding early night time however, the rest did not have this experience. The purpose of early night time feeding was to compensate the time lost during the day when the cattle is trying to avoid fly bites and disturbance by human and other animals noises. Although there is some variation, usually the fattening cattle were fed concentrates in the morning and at dusk, grass and different weeds in the day and maize or sorghum stover in the early night time.

All respondents in the study areas buy additional supplementary feeds mostly agro-industrial origin from market. In the two agro-ecologies of all studied woredas, 77 (97.5%) and 79 (97.5%) in the highland and mid-altitude bought supplementary feed from the local market. Only the rest 4 (2.5%) respondents replied they did not buy feed from the market instead used the crop residue and other locally available and left over feed from their home.

4.5. Feed Shortage, Seasonality and Coping Mechanisms

There is feed shortage in general but it was aggravated during the dry season of the year in the study areas (Table 22). Respondents of this survey work 100, 96, 90 and 75 % from Tullo, Chiro, Gemechis and Habro woreda, respectively in general confirmed that there was high feed shortage but it was serious during the dry season of the year. However, some respondents (20%) in the highland of Habro woreda, replied that the feed shortage was seasonal for them. From the focus group discussion held in each woreda, most of the participants agreed that the feed shortage is critical starting from February up to June and April up to June in the highland and mid-altitude sites, respectively of the study areas.

Table 22: General condition of feed shortage for cattle in the study areas

		Habro	Gemechis	Chiro	Tullo
HL	Yes	12 (30%)	17 (44%)	21 (47%)	18 (50%)
	No	0	2 (5%)	1 (2%)	0
	Yes but seasonal	8 (20%)	0	0	0
MA	Yes	18 (45%)	18 (46%)	22 (49%)	18 (50%)
	No	2 (5%)	2 (5%)	1 (2%)	0
	Yes but seasonal	0	0	0	0
Overall	Yes	30 (75%)	35 (90%)	43 (96%)	36 (100%)
	No	2 (5%)	4 (10%)	2 (4%)	0
	Yes but seasonal	8 (20%)	0	0	0

HL=Highland; MA=Mid-altitudinal areas; N (%) = Number of respondents (%)

Respondents in the different woredas had their own means of coping mechanisms concerning the dry season (February up to June) feed shortage (Table 23) through storing feeds such as grass hay and crop residues. Higher number of respondents in all study woredas used storing feed as the major means of mitigation of the dry season feed deficit. Crop residues mainly maize and sorghum were fed to fattening cattle starting from the field at their harvesting stage after collecting the ear and head and at the final harvest by stacking in the field or under shelter. To compensate the feed shortage still farmers producing fattening cattle purchased feed mainly wheat bran, maize flour and oil seed cakes from market. In Habro and Gemechis woredas, respondents indicated that they used to offer

leaves of multipurpose fodder trees such as Oda (*Ficus basta*), Welensu or Gorgo (*Erythrina abyssinia*), Wedesa (*Cordia africana*), and Gerbi (*Acacia albida*) because these trees are green during dry season.

Table 23: Coping mechanisms during critical feed shortage months

	Habro (N=40)	Gemechis (N=39)	Chiro (N=45)	Tullo (N=36)	Overall (N=160)
Coping mechanisms	N (%)				
Rely on stored feed	36(90)	21(54)	42(93)	27(75)	126(79)
Rely on crop residue	15(38)	19(49)	35(78)	6(17)	75(47)
Rely on multipurpose fodder trees	16(40)	11(28)	0(0)	0(0)	27(17)
Send animals to other areas	2(5)	0(0)	0(0)	0(0)	2(1)
Rely on purchased feed	14(35)	17(44)	14(31)	22(61)	67(42)

N= Number of respondents. A respondent chose more than one alternative

Wheat brans, cotton seed cake, noug seed cake, linseed seed cake and maize flour were agro-industrial by-products purchased and utilized by the respondents in the study areas. Most of the respondent 148 (92.5%) in both agro-ecologies used wheat bran solely for supplementing their fattening cattle but 21(13%) out of 160 respondents prepare a home-made ration with one of these oil seed cakes mix with maize flour and wheat bran and even with tef straw to offer to their animals. Six to 7 kg of wheat bran and a handful of miaze flour mixed with salt and tef straw or without tef straw was offered twice per day before offering crop residue or grass hay (which was nearly 12 kg per day). The average price of wheat bran of all studied woredas was 569.50 birr per quintal according to interviewed feed traders at the time of the data collection.

4.6. Indigenous Technical Knowledge (ITK) of Fattening Cattle Feeds and Feeding Systems

There are indigenous feeding systems for fattening cattle in all study woredas. According to the participants in the FGD, these local knowledge of fattening were aimed at fattening within a short period of time, saving money to compensate for the escalating price of agro-industrial by-products especially the oilseed cakes, enhancing feeding values of some of the crop residues as a drought season feed shortage mitigating strategy. According to

respondents and participants of the FGD, through course of years, they had developed means of minimizing the negative effect of some of the concentrate feeds while feeding. Feeding fenugreek (*Trigonella foenum-graecum*) seed soaked, boiled or in the form of flour mixing it with sugar was highly accustomed in most of the study areas. They feed it purposively expecting it help for further fattening of beef cattle and makes the hair and skin of the animal to shine at the end of fattening period and that is highly needed in the market. Sometimes buyers rub the skin of the fattened cattle with their fingers to detect whether it has an oily nature or not and that is taken as a good sign of fattening. Because of its lucrative nature, some respondents were specializing to cattle fattening even if they have cropland. They produce maize and sorghum and feed the whole plant at seed filling stage to get a good result within a short period of time. Table 24 and Appendix 7 shows the indigenous feeds and system of feeding used by respondents in their respective woredas. The scientific names of the feeds listed in the table are Beet root (*Beta vulgaris*), Cow pea (*Vigna unguiculata*), Chick peas (*Cicer arietinum*), Enset (*Ensete ventricosum*), Fenu greek (*Trigonella foenum-graecum*), Welensu (Gorgo) (*Erythrina abyssinica*), Pumpkin (*Cucurbita*), Sugar cane (*Saccharum officinarum*), Sweet potato (*Ipomoea batatas*), Yeast (*Saccharomyces cerevisiae*) and Wedessa (Wanza) (*Cordia africana*).

The rugged terrain topography of most of the land which is unsuitable for crop cultivation, shortage of grazing lands, increase in population number which dwindled the average crop land holding per individual farmer, long time experience of fattening, road access to central market and availability of good market, and access to neighboring lowlands for constant supply of cattle stock are all contributing to the expansion of fattening and enhanced the utilization of developing ITK in feeding and other management practices of fattening cattle. Details of the locally available feeds and their scientific names, feeding system and remark is presented in Appendix 7.

Table 24: Indegenous technical knowledge of feeding fattening cattle in the study areas

Habro	Gemechis	Chiro	Tullo
-Fenugreek flour and wheat bran and slightly added water -Yeast (<i>Saccharomyces cerevissa</i>) mixed with wheat bran and water	- Broad bean and lentil haulm -Barley straw wetted with salty water	-Maize seed as it is or cooked -Chopped sorghum stover wetted with salty water	-Boiled fenugreek seed with sugar at the end of fattening period -Chopped sweet potato slightly aerated before feeding -Soaked maize seed with salt and warming it up
-Chopped sugar cane -Maize flour mixed with wheat bran or sole	-Sweet potato vine -Grinded maize seed	-Water mixed with sugar - Common salt mixed with water	-Feeding wilted haricot bean plant at seed filling stage -Feeding pounded and wetted sorghum stover mixed with wheat bran -Feeding boiled sorghum stover stalk left on the field after harvest
-Boiled maize seed with salt -Feeding ear of maize at dough stage -Boiled cowpea seed with salt or feeding the whole plant at seeding filling stage	-Boiled sorghum seed -Fenugreek flour mixed with water and sugar -Chopped beet root with salt - Chopped sweet potato -Chopped local pumpkin with salt	-Leaves of sweet potato (<i>sara mitatisa</i>) -Flour left over from mill houses -Licking Amole (local common salt)	-Feeding of chick peas crop at full flowering time
-Feeding weeds of different plants	-Chopped <i>Enset</i> root	-Chopped sugar cane planted for cattle	-Mixing <i>teff</i> straw with wetted wheat bran to initiate feeding more <i>teff</i> straw -Wetting the bed area to initiate forced feeding - Chopped maize stover wetted with salty water
-Mixing wheat bran with tef straw, salt and water enhance utilization of straw	-Boiled haricot bean with its soup.	-Water soaked fenugreek seed mixed with sugar -Wetting the bed area to initiate feeding of crop residue during the night time	- Boiled haricot bean with salt -Grinded Haricot bean and sorghum seed mixed with wheat bran and salt for short period (1-2 months) of fattening
-Sole sugar feeding/licking -Feeding <i>Erythrina abyssinica</i> and <i>Cordia africana</i> and leaves of different <i>Acacia</i> trees during dry season. -Small amount of urea added on wheat bran and salt -Leaf and bark of Wolensu (<i>Erythrina abyssinica</i>) tree	-Feeding haricot bean leaves at seed filling stage - Thinnings, Leaves stripped from maize and sorghum	-Pounding dry sorghum stover and mixing with wetted wheat bran	

4.7. Watering

The main source of water identified in the highland and mid-altitudinal agro-ecology of the study woredas were mainly springs and rivers. However, in the highland kebeles of Habro, Gemechis and Chiro woredas, owners of fattening cattle fetched water from springs whereas in the mid-altitudinal areas, the principal source of water is rivers. Other sources of water used for fattening cattle included mechanical (tap) and hand pumped water, ponds and a combination of two or more than two of these sources (Table 25).

As fattening was practiced by tethering and feeding the cattle at backyard or near the cropland, provision of water was done at the spot by carrying it by donkey or manually from the source to the place of feeding/shelter. In almost all districts of the study area, most farmers engaged in cattle fattening offer water once in a day at noon time. They believed this time is the time when the fattening cattle become more thirsty and make them to consume until they become satisfied or limited to one Jerrycan (20 liters) once per day or one and half jery can (30 liters) two times per day in accordance to the availability of water in the area. However, in this system of fattening, owners of fattening cattle donot let their animals to go to the water source. This is mainly because of fear of breakage of legs during their show-off bucking behavior and infliction of injury on their body during fighting with other cattle. Regarding associated problems with water sources, respondents reported lack of sufficient water in the highlands of Habro (80%), Tullo (61.1%) and to some extent (26.1%) in the mid altitude areas of Chiro.

Table 25: Source of water, frequency of watering and associated problems (%)

	Habro		Gemechis		Chiro		Tullo		Overall	
	n= 40		n= 39		n= 45		n= 36		n= 160	
	HL	MA	HL	MA	HL	MA	HL	MA	HL	MA
Sources										
<i>Spring</i>	75.0	10.0	63.0	20.0	63.6	34.8	27.8	33.3	58.2	24.7
<i>River</i>	10.0	45.0	16.0	80.0	0.0	52.2	44.4	55.6	16.5	58.0
<i>Pond</i>	0.0	0.0	0.0	0.0	0.0	8.7	27.8	0.0	6.3	2.5
<i>Tap water</i>	15.0	45.0	10.5	0.0	9.1	0.0	0.0	0.0	8.9	11.1
<i>Pump water</i>	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	2.5	0.0
<i>Multiple answers</i>	0.0	0.0	0.0	0.0	27.3	4.3	0.0	11.1	7.6	3.7
Frequency of watering										
<i>Once a day</i>	100.0	100.0	100.0	100.0	90.9	100	88.9	100.0	95.0	100.0
<i>twice a day</i>	0.0	0.0	0.0	0.0	9.1		11.1	0.0	5.0	0.0
<i>Once in two days</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water associated problems										
<i>Yes</i>	80.0	15.0	5.3	10.0	3.6	26.1	61.1	27.8	39.2	19.8
<i>No</i>	20.0	85.0	94.7	90.0	96.4	73.9	38.9	72.2	60.8	80.2

n= number of respondents, HL=Highland; MA= Mid altitude

Respondents further raised the problem of lack of water during the dry months of the year because some of the springs in their areas had dried out and they were forced to fetch water from far places and/or buy from mechanically/manually assisted pipe water sources. In all study districts, locally available materials were being utilized for water provision. The majority of respondents used edible oil plastic Jerrycan (20 liter capacity) cut on the top for ease of drinking, plastic vessel, aluminum vessel, vehicle tires and steel barrel designed for this purpose.

4.8. Housing

The type of housing system in the study woredas (Table 26) included dominantly homestead and farmyard shades however properly facilitated barns were not found. According to respondents these kind of barns were found around towns with individuals that keep more than two to three fattening cattle at a time. Multiple answer refers to those respondents that used both homestead and farmstead shades at the same time. Shades were constructed using corrugated iron or plastic sheets covered roofs in all agro-ecologies

however, the sides were usually open or slightly covered by tree branches in mid-altitude agro-ecology. In the highland kebeles, the sides were covered with plastic sheets or corrugated iron sheets to keep fattening cattle warm. Most respondents believed that creating warmth inside the shade improves fattening of cattle.

From the overall usage of the type of housing, farmyard shades (40.5 and 51.9%) (Figure 10) and the backyard shades (36.7 and 46.9%) (Figure 11) were nearly equally important in the highland and mid-altitude agro-ecologies, respectively. However, practice of fattening in living room with family members and in well suited barns were rarely seen except in Chiro woreda where one of the study kebele is near the town to employ a better small scale fattening. In Tullo woreda, fattening a bull inside a house constructed adjoining the main house was practiced by few farmers.

Table 26: Type of housing system in the study areas

	Habro n=40 (%)		Gemechis n=39 (%)		Chiro n=45 (%)		Tullo n=36 (%)		Overall n=160 (%)	
	HL	MA	HL	MA	HL	MA	HL	MA	HL	MA
Backyard shades	0.0	70.0	73.7	10.0	27.3	26.1	50.0	88.9	36.7	46.9
Farmyard shades	100.0	30.0	26.3	90.0	4.5	69.6	33.3	11.1	40.5	51.9
In living room with family members	0.0	0.0	0.0	0.0	4.5	0.0	5.6	0.0	2.5	0.0
Barn	0.0	0.0	0.0	0.0	27.3	0.0	11.1	0.0	10.1	0.0
Multiple answer	0.0	0.0	0.0	0.0	36.4	4.3	0.0	0.0	10.1	1.2

n= number of respondents, HL=Highland; MA= Mid altitude

Discussion with the focus groups revealed that, owners of fattening cattle used backyard shades mostly when their crop land is near to their home so that they can easily manage their fattening cattle; dispose the manure easily in the cropland and could easily protect their fattening cattle. When their home is far away from the cropland, they prefer to construct a shade in the middle of the cropland in order to easily feed the fattening cattle with crop residues and dispose the manure in the crop land. In the highland study area of Gemechis woreda some respondents used dried manure for smoking and warming the

fattening cattle inside the shade. They practiced this to prevent the animals from flies bite and give warmth against the cold.



Figure 9: A fattening bull inside a house constructed adjoining the main house, Kirakufis, kebele, Tullo woreda.



Figure 10: A fattening ox in the farmyard shelter, Cheffe kebele, Tullo woreda



Figure 11: A fattening ox inside a shelter at the backyard, Kuni segeriya, Gemechis

4.9. Major Diseases and Health Management of Fattening Cattle

Regarding the occurrence of disease in fattening cattle of the study woredas (Figure 12), 89 (55.6%) of the respondents replied there was incidence of cattle disease whereas, 33 (20.6%) experienced there was no disease prevalence of their fattening cattle. Thirty (18.8%) of the respondents experienced fattening cattle disease however, the disease was seasonal in nature. The rest 8 (5%) replied multiple answers. Those that replied ‘no’ further explained that fattening cattle cannot be easily exposed for disease once they achieved better body condition so get ability to withstand diseases. Moreover producers usually deworm cattle before starting fattening. But sometimes, they might experience bloating from excess feeding of concentrate feeds.

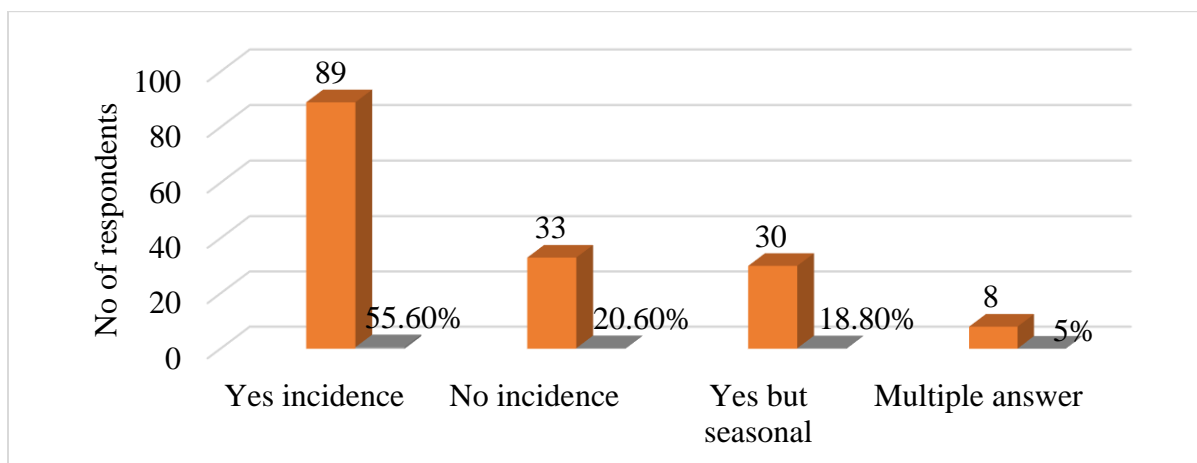


Figure 12: Occurrence of diseases in fattening cattle

However, discussion with woreda animal health workers indicated that fattening cattle could be encountered with diseases. The major diseases of fattening cattle in the study areas were Black leg, Pasteurellosis, Lumpy skin disease (LSD), Acidosis and Internal (liver flukes and nematods) and external parasitism predominately ticks. Black leg occurs mostly before and after the main rainy season. The microbes require stress condition of the animal when there is feed shortage in the drought season, when there is a change of feed such as during new emergence of grass after the rainfall or this disease emerges because of long time stress during trekking even. Based on the discussion with focus groups, traditionally producers treat blackleg by piercing the swelling area on the leg and exposing the wound for air. Pasteurellosis occurs during the dry season, LSD (Lumpy skin disease) is another economically important and fastly transferable disease which is threatening the fattened cattle in study woredas. Acidosis is caused by excess feeding of concentrates. Some producers upon returning their unsold fattened cattle back home, sometimes the cattle dies and the reason could not be identified. Locally producers agreed that it is caused by evil-eyed people. But veternerians unravelled that it could be because of stress due to long distance trekking of extremely fattened cattle. Because during the whole fattening period, the cattle had been stationed (tethered) mostly in one place. The other reason they indicated was feeding of much concentrates just before coming to the market place to have a large belly and virtual large size in the market place.

When there was disease incidence, most of the respondents used government owned animal health clinics 92 (57.5%). The other 43 (26.9%) of them used private veterinarians (health technicians), government clinics and traditional medications. Twenty five (15.6%) of them used mobile private animal health workers because clinics were found far from their home.

Average annual expense for medication of fattening cattle was 257 birr and the average expense for medication per trip to the health clinics was 61 birr. However, when using private health technicians, the average annual expense amounted to 190 birr but for single trip medication, they used to pay on average 59 birr. However, respondents who were taking advantage of government, private technical assistant and traditional medication, which costed them an average 228 birr annually and 59 birr for single trip expense.

4.10. Major Constraints of Cattle Fattening Practices

The major constraints of cattle fattening practices in the study areas were indicated in Table 27. Accordingly, lack of feed during the fattening time was ranked first both in the highland and mid-altitudinal areas of the study. Shortage of grazing land was the second major constraint in both agro-ecologies. Low selling price was highly associated with the interference of brokers in the market place because they involve in the bargain of selling process and block the full benefit of the producer until the bargain satisfied their intended benefit. Disease incidence and high purchasing price were ranked last for fattening cattle were not often easily exposed to disease because mostly they were dewormed initially and get periodic vaccination and isolated during the whole fattening time from the other herds and in a state of good body condition that made them resist diseases. High purchasing price as indicated by the respondents was to mean interference of brokers in the market transaction when they wanted to buy a bull for draught power and consequent fattening or when buying an ox or a bull which had not yet finished fattening. The advantage of being neighbors to pastoral lowlands helped most respondents in some of the study woredas to gain an easy access for replacement cattle for fattening. In fact there were traders in this regard that bring cattle from lowlands to the livestock markets.

Table 27: Rank of major constraints of cattle fattening practices in the study areas

Variables	Weighted frequency						Total weight	Index	Rank
	1	2	3	4	5	6			
Highland (N=78)									
Shortage of grazing land	17	32	18	8	1	2	362	0.213	2
Shortage of water	10	9	6	9	14	30	214	0.126	4
Feed shortage	46	24	7	1	-	-	427	0.251	1
Disease incidence	1	1	15	27	21	13	207	0.122	6
Low selling price	11	14	12	14	25	2	278	0.164	3
High purchasing price	1	4	23	15	13	22	211	0.124	5
Mid-altitude(N=82)									
Shortage of grazing land	29	30	7	9	4	3	390	0.221	2
Shortage of water	2	12	7	22	21	18	226	0.128	4
Feed shortage	36	19	15	9	2	1	403	0.228	1
Disease incidence	1	2	26	7	25	21	212	0.120	5
Low selling price	15	18	17	16	16	-	328	0.186	3
High purchasing price	4	11	6	13	16	32	206	0.117	6

N=number of respondents; weighted values for each variables of major constraints of cattle fattening practices based rank (6 for first; 5 for second; 4 for third; 3 for fourth; 2 for fifth; and 1 for sixth). High or low purchasing price is for cattle.

4.11. Types of Livestock Markets

Generally there were six important sites of livestock markets in the study area where taxation of the sold and purchased livestock is common to all (Table 28). The name of market place, the number of livestock coming to the market, their types, the infrastructures found, the location of the markets and the days of marketing in each study area vary.

4.11.1. Kuni primary market

Kuni livestock market is primary market located 343 km east of Addis Ababa. It is found in Kuni town, the capital of Gemechis woreda. The potential market in Gemechis is the Kuni livestock market however there are other small markets in the woreda. There is one market day per week -Monday in which cattle, sheep, goats of different sex and age groups and donkey were found for sell. In this market camel, horses and mules were not traded. Even though fattened cattle come from different places, but dominantly they were coming

from Sororo and Kuni Segerya kebeles and this was because these kebeles had enough pasture and water for the fattening animals according to information from woreda experts.

The livestock market lied on half hectare land and it was fenced with eucalyptus poles. But there were no weighing scale and watering trough and other necessary facilities. According to the woreda trade and town development office weekly assessment report, the number of livestock coming to the market per week was estimated to be less than 500. The number of fattened cattle reached up to 250 upon arrival of holidays. The office used eye-ball estimation to categorize fattened cattle based on their body size as large, medium and small fattened cattle. The price of fattened cattle was 20 to 25 for large fat cattle, 15 to 20 for the medium and 8 to 14 thousand ETB for the small one when this data was taken in 2015. There was a problem of illicit market where traders were buying calves and transporting them to Somali region but currently it had stopped.

4.11.2. Debesso primary market

Debesso primary market is located 344 km east of Addis Ababa on the main road to Harar and Dire dawa. It is a small town administered by its own municipality and found in Tullo woreda. There is one market day per week, Monday in which transaction of cattle, goats, sheep and donkey takes place excluding camel, horses and mules. In one market day less than 500 different types and age groups of livestock gather in the market place. Discussion with fattened cattle traders (KII) revealed that the supply of fattened cattle decreases during Orthodox Christians fasting time and increases in non-fasting months.

The market place was just behind a village. There were no infrastructure like fence, feeding and watering trough, gates, convenient road and shelter in the market place at all. Government assigned workers collect tax both from sellers and buyers. When the cattle enters into the market place known locally 'Jeldhaba', they pay 10 birr and when the buyers comes out of the market, they pay 20 birr for cattle. If it is for small ruminants 5 birr when it enters but nothing would be paid while they came out of livestock market. For donkey it was 10 birr. People preferred Debeso market because the market place was beside the

asphalt road of Addis to Harar and so it was easy for transportation. One can have many alternatives for buying cattle. The influence of brokers is a little bit lower than that of Hirna town livestock market.

4.11.3. Belbelitti primary market

Belbelitti is found 415 km east of Addis Abeba and 87 km away from Chiro, the capital of West Harerghe zone and 12 km away from Gelemso. The market lied on 0.4 ha area and the place had no perimeter fence. Cattle, Sheep, goats and donkey were the species of livestock seen in the market. It is a potential livestock markets in Habro woreda where 400 to 500 animals gather each week. The market was held two times per week- Thursday and Sunday. The main market is held on Thursday. Belbellitti livestock market is a recipient of Mechara and remote lowland areas.

4.11.4. Gelemso secondary market

Gelemso is found 401 km east of Addis Abeba and 75 km away from Chiro, the capital of West Harerghe zone. The market was found in the middle of the town. The market day was once per week and it was held every Tuesday. In Gelemso livestock market each week, up to one thousand different species of livestock gather for sell. The market place lied on 1 ha land and it is stone walled and found south of the city. But like the other markets in West Hararghe, this market had no weighing scale, no other facilities. The types of livestock available in the market place were cattle, goats, sheep and donkey. It is estimated that about 15 Isuzi vehicle full of fattened cattle were delivered to the central market each week and this number could increase during festival times.

The Gelemso livestock market is a recipient of fattened oxen (*Sanga*), fattened bull (*Korma*) and fattened infertile cows (*Meshena*) that came from places of Milkay, Belbelitti, Gadullo, Sekina, Guba Koricha, Darolabu, Odda bultum, Bokke, Wachu, Karra and from all kebeles around Gelemso town. For Wacchu market, Bokke and Oda bultum markets are suppliers. From remote areas fattened cattle might trek one up to two days to reach Gelemso market. Replacement young bulls came from Darobilika (Bale) 94 km far away from

Gelemso by trekking, then to Micheta, Mechara, and Gelemso. So the main suppliers are the neighboring Bale lowland and the Somali regional state. Data on the number and prices of livestock is collected each week in the market by the woreda trade and town development office. Based on this data, fattened cattle were categorized into large, medium and small sized. At the time of this data collection, large, medium and small fattened cattle had an average value of 30, 22, 7 thousand ETB, respectively in Gelemso livestock market.

4.11.5. Chiro secondary market

Chiro market is a big market in West Hararghe zone and it is the capital town of the zone. It is located 326 km east of Addis Ababa on the main road to Harar and Dire dawa town. The market lied on 3000 meter square area. Chiro town has one market day- Thursday where up to 1000 different species and age groups of livestock are collected in the market. The market is being stone fenced in the time of field visit and accessible for vehicles but there were no additional facilities like weighing balance, feeding trough, watering tanks, latrine etc. The types of livestock in the market included primarily fattened oxen, calves, infertile cows (*Meshena*), goats and sheep of different age groups, and donkey. Sellers and traders preferred Chiro market because of the influence of brokers was relatively less than the other markets. Traders buy fattened cattle on Thursday from Chiro and travel the same day night to reach on Friday for sell in Adis Ababa market.

4.11.6. Hirna secondary market

Hirna secondary market is found 372 km east of Addis Abeba and 47 km east of Chiro town. Hirna is the capital of Tullo woreda. The market was found in Hirna town which is found on the main road from Addis Ababa to Harar thus accessible for truck services. However, currently the market place was situated in the middle of a village on the northern periphery of the town and placed almost on 1 ha area of land. The area was loosely fenced - barbed wire but there were no livestock market facilities. There was no weight balance, watering point, strong fence, resting place and feeding facilities even the tax collecting workers had no office to perform their work. There were three entrances and exits for

livestock. These gates were additionally used to collect tax upon entrance from sellers and exit from buyers. The town municipality office collected 10 birr per every type of cattle and 5 birr per sheep and goats. The buyers pay 20 birr per cattle of every type upon exit from the market. When this data was collected, it was a Christian fasting month and the number of fattened cattle arrived in the market were small in number as compared to the non-fasting months.

There were different species and types of livestock dominantly there were fattened cattle, fattened rams, and bucks. In addition, there were also bulls, cows, heifers, calves, ewes, lambs, infertile does, does with kids, male and female donkeys. There was no camel in the market and the sell of mules and horses was a rare case. The number of fattened cattle were estimated to be 150 to 180 per market day. Sellers and buyers prefer Hirna secondary market because it was a big market and helped them to get a choice of fattened cattle. Different types and species of livestock come to market from many routes. Fattened cattle came from Burka area, Doba and Mesela woreda trucked by vehicle but others were trekked from almost all kebeles around Hirna town. At the time of this data collection, the price of young uncastrated young bull, uncastrated adult male bull, fattened ox and fattened infertile cow or heifer was 7 to 8, 20, 25 to 30 and 15 thousand birr, respectively. Fattened cattle were destined to Addis Ababa city, Adama, Hawasa, Dire Dewa and Harar town according to the woreda livestock market experts.

Table 28: Summary of types of livestock markets in the study area

Woreda	Town	Distance from Addis Ababa (km)	Market type	No of livestock per market day	Market day	Area (ha)	Fence type
Habro	Belbeliti	415	Primary	<500	Thursday	0.4	
	Gelemso	401	Secondary	500-1000	Tuesday	1.0	Stone walled with two gates
Gemchis	Kuni	343	Primary	<500	Monday	0.5	Loose wooden fence, one gate
Tullo	Debesso	344	Primary	<500	Monday	0.5	
	Hirna	372	Secondary	500-1000	Saturday	1.0	Barbed wire fenced, one gate
Chiro	Chiro	326	Secondary	500-1000	Thursday	0.3	Stone walled with one gate

Sources: Woreda experts and own visit. Market types (Getachew et al., 2008 and Ayele et al., 2003) Livestock species: Cattle, Sheep, Goats and Donkeys in all livestock markets.

4.12. Fattened Cattle Market Participants

In the livestock markets of the study woredas, dominantly there were market participants such as: producers, farmer traders, traders, brokers, broker traders, tax collectors, trekkers, and butchers according to woreda livestock and fishery and livestock market development experts.

4.12.1. Producers

These were mostly farmers who were found at the grass root level and participate in mixed farming system both in highland and mid-altitudinal areas. The scarcity of grazing land in Western Hararghe highland and mid altitudinal areas forced farmers to tether their cattle and practice cut and carry system of feeding for fattening their cattle. Recently some producers preferred to sell their fattened cattle at farm gate. They preferred to do this because they fear the forceful and illegal involvement of brokers in the bargaining process in the market place and in a rare case, very fattened oxen can take long hours to reach market and when producers lack their expected price, they had to trek back and often the

animal fall on the rough terrain road and expose to leg breakage, loss of hooves or sometimes sudden death.

4.12.2. Farmer traders

Besides involving in the crop-livestock production activity, this kind of traders buy fattened cattle from remote market places of the zone and bring to accessible markets to fetch some profit in different markets found in the same zone. Sometimes they competitively buy and sell in the same market and to enjoy the profit. According to woreda livestock marketing experts in Gemechis woreda, the farmer traders includes females but they were few in number. They trek cattle from Kuni to Chiro market which is 7 km distance to get profit. In Gelemso town livestock market, there were around 30 women who buy and sell sometimes bulls for drought power but mostly heifers and calves from one market to the other. The number of females involving in farmer trader activity was increasing from time to time because they can generate an income for their livelihood.

4.12.3. Traders

These were relatively few in number but prominent in the study area markets. They had their own agents and had strong ties with the brokers. They could buy and collect fifteen to twenty fattened cattle per market day and directly transport to terminal markets. They pay 400 ETB per oxen for trucking animals from Chiro to Addis Ababa with Isuzu car, which has a capacity for loading 10 fattened oxen or the same price for FSR vehicle which has loading capacity of 20 fattened cattle. These traders travel as far as to Adama and Addis Ababa livestock markets. In Hirna market, there were seven traders who had legal permission licence but generally their number could reach up to 20 according to experts of district livestock and fishery resource development office.

In Gemechis woreda, according to woreda livestock marketing experts, there were traders both legally registered and illegal ones. The legal registration allows every trader to make business everywhere in Ethiopia. There were four legally registered and six unregistered traders known in the woreda during the data collection time. The legally registered ones truck the animals to Adama and Addis Ababa. Once the number of fattened cattle were checked during loading on Isuzu vehicle, they pay tax and receive pass permit paper having the name of the trader, the date and the number of animals and their destination place registered on it. The illegal ones were who don't have legal permit and don't pay tax. They simply buy fattened cattle using their broker agents. The composition of traders were from everywhere but mostly they came from Bosot woreda (Bishoftu), Adama and Addis Ababa. Efforts were made to categorize traders based on their capital and the tax they paid and accordingly, there were 55 class A and 50 Class B traders and these traders pay tax for Gemechis woreda.

4.12.4. Brokers

These are individuals that involve in the price bargaining process in livestock market. They are meant to easily facilitate the transaction and take a reasonable commission from the seller and/or buyer sides. But in the West Hararghe context, brokers mostly take commission from the buyer's after negotiating the price with the producer and finally request an unfair and exaggerated commission from the buyer side. Therefore, because of their deceitful and confusing influence, producers usually lose premium price. However, in a rare case producers urge brokers to sell their fattened cattle and this time they act as a mediator and earn double commission from both sides.

According to woreda livestock market and trade office experts in Gemechis woreda previously efforts were made for brokers to be legally registered and organized and put a hanging ID card to be easily noticed in the market, however, this did not work and they were currently disintegrated because of unwillingness to pay tax and submit to government rules. Thus, currently they were not legally supported to work but they work in the area. The question they raised was lack of employment so they move in different markets to

perform their work. Because of the influence on producers, the government brought a solution either to organize themselves in micro-enterprise, take credit and start their own cattle fattening in group or engage themselves individually in the cattle fattening work. The other intervention the woreda made was to control and supervise the marketing area with a police force.

The problem caused by brokers in Hirna livestock market was aggravating from time to time. These individuals usually earn more money than traders. Through the bargain they try to reduce 2 to 3 thousand from a producer and earn 1 to 2 thousand from the trader per sell of a fattened ox. Brokers claim from 1000-3000 birr as a commission from sell of one bull. The other groups of brokers were paid 400 birr per one Isuzi or FSR vehicle for facilitating truck. The brokers were embezzling the producers. Producers complained that there was a loose control mechanism in the study areas. There were different types of brokers based on their financial capacity and prominence to the public. Looking at their composition, there were men, women and youngsters who were farmers, jobless student, youngsters living near-town rural kebeles, drop outs from highschool, jobless university graduates, bankrupted traders government workers and other brokers who were at the same time brokers and traders of other goods like khat, onion and other vegetables. The last type occasionally came and work on market days. The majority of brokers that came from rural areas were farmers. They serve the 'big' brokers by providing information or mediate between the producer and the market 'big' brokers.

They were many in number and this work is becoming an open job opportunity for everybody. In fact they need to have acceptance among the traders and the local people. They did not have any limited range of work place so they move to every market in the zone, even go to the lowlands of Somali region and some of them even occasionally travel to Addis Ababa livestock market to do the same job. If they don't get commission, they disturb the trader, producer, and all the transaction process and even try to create physical conflict. Unless they get commission, the traders cannot buy. Efforts had been made to organize them by micro-enterprise but currently every broker work privately. If the

government creates a system of control, the market would stabilize and the situation will subside.

4.12.5. Broker traders

These types of traders were prominent in the cattle market and have enough money to buy fattened cattle through forceful negotiation with the producers. Some of them have up to 100,000 birr capital for the transaction. Once they started the price negotiation process, nobody will approach to buy the fattened cattle in fear of emerging conflict. They control the situation and buy the animal with a cheap price later on. After this process, they transfer the animal to the traders and earn a high commission.

4.12.6. Butchers

These were individuals whose trade is cutting up and selling meat in their shop. In the West Hararghe zone, they were found in both small and big towns. In small towns like Debeso and Kuni, they slaughter cattle in a traditional way in the backyards but in big towns of the study area—Hirna, Habro, and Chiro—cattle were slaughtered in government-owned abattoirs. In the Gemechis woreda Kuni market, the butchers were coming from Bedesa and Chiro and buy 1 to 3 fattened cattle and trek to Bedesa and Chiro. In Gemechis there were 2 Christian and 3 Muslim butchery houses. There is no abattoir but cattle were slaughtered in their backyards.

In Tullo woreda, Hirna town there were 4 Christian and 2 Muslim butchery houses. There is one abattoir partitioned for the slaughtering of cattle for Christian and Muslim people. These people buy fattened cattle from Hirna, Debeso and Chefe Banti livestock market but mostly they depend on the Hirna market because in this market they have a range of choice of cattle and could save money paid for trekking or trucking if it were from Debeso and Chefe Banti. They buy and slaughter younger fattened cattle at abattoir. The Christian butchers buy male oxen to slaughter because slaughtering female cattle was not allowed. Infertile female cattle (*Meshena*) were mostly slaughtered in groups at backyard for sharing (*Kircha*) mostly during Christian festivals.

4.12.7. Tax collectors

These were staffs from woreda revenue authority office of the respective capital town of the woreda assigned to collect tax once per week in market day sitting at livestock market gate. They collect tax both from sellers (the producers) and buyers (traders, local butchers and consumers) when the cattles enters into the market and upon exit from the market. They pay 10 birr and the buyers comes out of the market they pay 20 birr. If it is for small ruminants 5 birr when it enters and nothing will be paid while they come out. For donkey 10 birr is paid up on exit. Summary table for all these marketing participants is presented in Appendix 11.

4.13. Fattened Cattle Marketing Channels and Routes

In the study woredas, different cattle marketing channels were found. The producers (cattle fatteners), the different market participants (actors) and the final consumers were found in the marketing bargaining process. In the market we find producers, farmer traders, brokers, tax collectors, trekkers, traders and butchers (Figure 13). But the major route livestock marketing route is the Adama and Addis Ababa terminal/tertiary markets. The main actors identified and involved in the channel include:

- Producers-farmer traders-traders-butchers-consumers
- Producers-traders-butchers-consumers
- Producers-broker traders-traders-butchers-consumers
- Producers-butchers-consumers
- Producers-Consumers

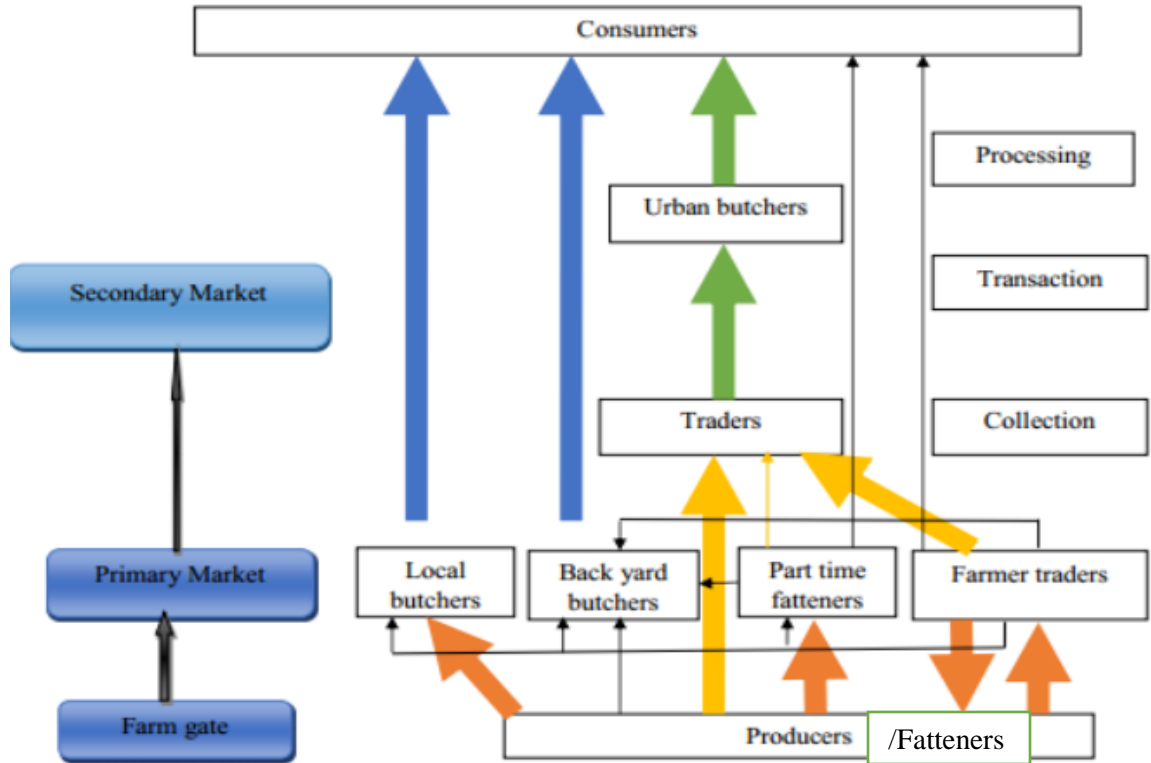


Figure 13: Cattle marketing channel of study areas in West Hararghe zone

4.14. Market Information

Prior collection of market information is an essential tool for successful transaction and obtaining reasonable price both from the seller and buyer side. Almost all respondents 159 (99.4 %) had their own source of marketing information before selling their fattened cattle. Accordingly, 138 (86.3%) of these respondents obtained market information by making their own visit in the market 1-2 weeks prior to coming along with their fattened cattle to the market. Whereas, 12 (7.5%) of them obtained this information from their neighbors but crosscheck it by making visit ahead of decision to sell in market. However, a sum of collectively 10 respondents (6.3% of the total) got information by one or more than one methods of assessing information accesses. These include inquiring their neighbors, asking the price situation from sellers in the same market day they intended to sell the cattle, by asking extension agents, relatives and co-operative officials.

Regarding the preference of the source of market information, 149 (93%) respondents largely preferred their own market visit in their locality because they would be more confident in claiming the price of their fattened cattle. During own market visit, producers search for fattened cattle which were comparable in size and body condition to their own and then ask the price to use it as a yardstick for the coming market sell. While the rest 11 (7%) of the respondents basically conduct personal visit but additionally they inquire price information from relatives, neighbors, cooperative officials and extension agents. The reason for selection of the specified source of market information lied because the information was reliable for 105 (65.6%) of the respondents; it was accessible for 54 (33.8%) and it was both reliable and accessible for the rest 1(0.6%). Regarding the accuracy of the market information, most of the respondents 79 (49%) stated that the accuracy was very high, while 55 (34%) claimed it was high, still the other 25 (16%) said medium however only one respondent declared it was low. Those saying medium and low succinctly reasoned out that they could not believe what their neighbors and others were telling them about the price of fattened cattle without cross-checking it because these people could be bribed by brokers to provide false information. Regarding the frequency of getting up to date market information 71 (44.4%) of the interviewee stated they got information on weekly basis, 46 (28.8%) of them got always by asking from different sources, 27 (16.8%) got sometimes, still 14 (8.8%) of the respondents obtained fortnightly but the rest 2 (1.2%) got the information weekly from the market and always from different other sources if they intend to sell but sometimes in the slack periods.

4.15. Advice on Cattle Marketing Issues

The majority of farmers (67%) in the study districts did not get advice on cattle marketing issues of beef cattle from development/extension agents. However, 33% of them stated that they had been advised by development agents (DAs) and woreda administration staffs on different issues of marketing. Among these, 37, 19, 19, 12, 10 and 3% got advice on issues of quality of cattle to be produced for the market; price of cattle at different markets; on quality of cattle and price; on the time of sale of fattened cattle; on matters related how to keep themselves from brokers and the combination of these, respectively.

4.16. Transportation System of Fattened Cattle

Producers from different directions trek their fattened cattle primarily to the nearest market possible to reach at the exact market time however, if they could not get their expectation price then they were forced to return to the same market the next marketing day. Most respondents go far markets to buy replacement cattle for fattening. They prefer to go far markets to buy the cattle at cheaper price than the nearest ones. The minimum and maximum time taken in general to trek and reach to the near and far markets in the study area is 0:15 minutes and 4:00 hours, respectively (Table 29). Some producers in group rent Isuzu vehicle to truck their fattened cattle paying 150 birr for one way trip per fattened ox. They do this to avoid stress and physical damage of the fattened cattle by the up and downs of short cut all weather roads and in addition to save time.

Table 29: Mean trekking time taken to reach at livestock market (hr.)

Districts	Distance	N	Mean \pm SEM	Minimum	Maximum
Habro	Near	36	0:47 \pm 0:34	0:15	1:30
	Far	36	3:00 \pm 0:06	2:00	4:00
Gemechis	Near	39	1:00 \pm 0:02	0:10	1:30
	Far	39	1:53 \pm 0:03	0:30	4:00
Chiro	Near	45	1:26 \pm 0:03	0:25	3:00
	Far	45	2:19 \pm 0:60	1:00	4:00
Tullo	Near	22	1:00 \pm 0:01	0:30	2:00
	Far	no	no	no	no

N= Number of respondents

The majority of respondents 151 (94.4%) from all surveyed areas trek their fattened cattle to the market while a few of them 5(3.1%) and 4(2.5%) used trucking or alternative means, respectively. However, trekking extremely fattened cattle sometimes caused incidences of unlocking of their hooves and in some cases fatigue and death the animal upon return to home. Regarding the responsibility of trekking fattening cattle to the market, 144 (90%) of the respondents in all study woredas indicated that, they don't give this responsibility to

anybody so they trek their cattle by themselves. While 8 (5%), 4(2.5%) and 4(2.5%) responded that they had trekked by their own and relatives; their relatives and hired labor, respectively. Those respondents who used hired labor used to pay 40 to 50 birr for one trip of trekking fattened cattle to the market place.

According to woreda livestock market experts, there were also individuals who takeover the responsibility of trekking fattened cattle from a livestock market to butchers' compound or they temporarily put in thier backyard taking additional responsibility of feeding and managing the purchased cattle for a few days until brought to the abbatoir. The distance of trekking could be on average range of 1 up to 27 km. For their service, these trekkers were paid 100, 60 and 50 ETB per very fat, medium and relatively small fattened cattle, respectively. Those that guard and manage the purchased cattle from the time of purchase till the owner receives in their backyard is paid 30 ETB per cattle per day.

Trekking from market to the butchery house or temporary shelter creates stress on the body of animals. Animals move without any rest and supply of feed and water and because of this, fattened cattle get stressed and weight loss is inevitable when many cattle moved by few attendants in the night time. Traders make use of local sloppy earthen docks to load fattened cattle in the study areas. They use night time for loading animals and easing the process so that animals get into the vehicle without noticing, however, from the time of loading till unloading at destination place, transporting fattened cattle is stressful in that heads of animals were tied shortly to the body of the vehicle (*sponda*) to avoid disturbance but this forces them stand all the way to their destination.

In general the majority of respondents in all study woredas responded there was no problem of access of roads from their village to the main road or to the market. These included 72 and 80 % in the highland and mid-altitude, respectively of kebeles of the woredas. However, 28% of the highland and 20% of the mid-altitude respondents claimed that there is a road access problem thus respondents in Habro highland kebele needed maintenance of old roads and new construction of roads. Respondents in Gemechis both agro-ecologies needed fence around livestock market and improvement of roads. In Chiro and Tullo,

highland and mid-altitude study areas, respondents demanded improvement of the currently found and new road construction, respectively.

4.17. Alternative Markets and Preferences

All respondents (100%) in Habro woreda brought their fattened cattle for sale in Habro livestock market because respondents in this woreda could not trek to the other potential markets even to their neighboring market in Bedesa because it is 38 km away on which trekking fattened cattle on all-weather gravel road could be dangerous. Since the neighboring Bedesa market is far from their villages, 55% preferred Habro market for its proximity to their village while the rest 45% of the respondents preferred Habro market to get good price.

Gemechis and Chiro woreda respondents had many alternative livestock markets than Habro and even Tullo woreda respondents. Respondents in Gemechis mainly trek their fattened cattle to Bedessa market because it is neighbor and only 23 km away from their site. Whereas, other respondents preferred to sell in Kuni, Chiro and still some others sell at their farm gate. However, to save time and avoid incidences, some of the respondents in Gemechis rent Isuzu vehicle in group and pay 150 birr for each fattened cattle and truck to Chiro market. With regard to their reason to alternative markets, 39% of them trek to different markets for the proximity of the markets but 36% of the other groups used these markets in search of relative advantage of price. The other 15% used these markets to enjoy relative proximity and price advantage simultaneously. Still, 10% of the others stated they used alternative markets to avoid cheatings by illegal brokers.

Respondents from Chiro woreda use Chiro town livestock market in which more traders were available and the influence of brokers was to some extent minimal because Chiro is the capital town of the zone. However, as an alternative, they used to bring fattened cattle to Debeso market which is on the side of Addis to Harar/Dire dawa main asphalt road and still many traders participate in it. A few others used to sell at Kuni market and at their farm gate. Interviewees living in Chiro district study sites 44, 29 and 27% of them used

these markets for obtaining relative advantage of price, for their proximity and for enjoying both good price and proximity at the same time, respectively.

Geographically, the highland study kebele of Tullo woreda is near to Debeso town, a small town where there is livestock market so the respondents preferred to bring to the nearest market rather than long time trekking to Hirna town, which is 12 km away for their location. Whereas, the mid-altitude studied kebele is situated near Hirna town-capital town for Tullo woreda. So respondents in this kebele usually preferred to sell their fattened cattle in this market. Still a few respondents in the woreda sell at farm gate. They used this opportunity as a means to avoid the interference of brokers. In Tullo woreda the majority of the respondents preferred their respective nearest market mainly because of its proximity (75%) and still 17% of them preferred the markets for relative advantage of better price. In this regard, Hirna and Debeso livestock markets have location advantage in common because the main Addis to Harar/Diredawa asphalt road runs through these towns and many traders participate in these markets at different market days. A few respondents (8%) stated that they enjoyed both proximity and relative of better price advantage.

4.18. Market Selling Practices

The majority of respondents sold their fattened cattle to traders (Table 30). These include 92.5, 92, 100 and 91.7% of the respondents from Habro, Gemechis, Chiro and Tullo woredas, respectively. In addition, 7.5 in Habro and 2.6% in Gemechis sold to local butchers while the other 5.4% of respondents in Gemechis woreda sold to traders and local butchers at different times. Whereas, 8.3% of the respondents in Tullo indicated that they sold to individuals whom they did not differentiate.

Table 30: Marketing actors buying fattened cattle (%)

Woreda	Traders	Local butchers	Both	Not Known
Habro	92.5	7.5	0	0
Gemechis	92.0	2.6	5.4	0
Chiro	100	0	0	0
Tullo	91.7	0	0	8.3
Overall	94.05	2.75	1.35	1.85

4.19. Price Determination

Price determination by marketing agents usually based on eye ball estimation. This trend is applicable across all study woredas. Out of the 160 respondents in the study woredas, majority of them (52%) determine price through negotiation between the seller (mostly producers) and the buyer (Table 31). In the first instance, the seller claims the initial price then the bargain continues with the presence of brokers. Thirty percent of the respondents replied that the final decision of price was made by the middle men (brokers) without whom the transaction was virtually impossible. Still 11% of the respondents indicated that they claim the price and remain in firm stand against the brokers bargain and finally sell their cattle. These group had enough approximation of the prevailing price, confident in the body condition of fattened cattle they had brought and even they had a decision to bring back the cattle if they didn't get premium price in that particular market. In fact a few of the respondents (3%) had fallen in the hands of the buyers. They do this when the supply of cattle in the market was relatively higher; when they were in desperate need of money; finished feed to proceed fattening and had no enough information about the existing price beforehand.

Table 31: Marketing agents for price determination in the market (%)

	Habro n=40	Gemechis n=39	Chiro n=45	Tullo n=36	Overall n=160
Seller	10.0	3.0	2.3	32.43	11.0
Buyer	7.0	0.0	0.0	2.70	3.0
Brokers	37.0	41.0	30.2	10.81	30.0
Negotiation between seller and buyer	29.0	56.0	67.4	54.05	52.0
Others	17.0	0.0	0.0	0.0	4.0

n= number of respondents in the study woredas

4.20. Price Variation in Different Markets

The majority of the respondents (66 %) from overall the study woredas indicated that there was fattened cattle price difference across different markets in the zone. This is further confirmed by 60, 77, 55.5 and 73 % of the interviewee in Habro, Gemechis, Chiro and Tullo, respectively (Table 32).

Table 32: Price variation across different livestock markets

	Habro	Gemechis	Chiro	Tullo	Overall
Number (n)	24	30	25	26	105
Percentage (%)	60	77	55.5	73	66

Participants of the focus group discussion in each study woreda strengthened this idea in that the price of fattened cattle in the existing markets was different based on the number of buyers, brokers, sellers and accessibility of the market location in relation to the main Addis to Harar/Diredewa asphalt road. The price of fattened cattle in livestock markets such as in Hirna, Debeso and Chiro was higher than Belbelite, Gelemso and Kuni livestock markets because the former markets were much closer to the main asphalt road than the later ones. For Habro woreda respondents, they enjoyed better price at Habro market than

Belbeliti- a small town in Habro woreda where respondents usually make buying of replacement stock than selling fattened cattle.

Respondents in Gemechis highland enjoyed better price when they bring their fattened cattle to Chiro livestock market where they get access to many traders but another alternative is to sell at their vicinity market in Kuni-capital of Gemechis woreda with relatively lower price than in Chiro. Whereas, the mid-altitude kebele respondents in the same woreda explained they bring their cattle for selling in Bedessa town in which they get better price than Kuni market. For Chiro woreda highland and mid-altitude kebele surveyed participants, primarily Chiro and Debeso markets were places where they enjoy better price for sell of their fattened cattle whereas, they preferred Kuni, Bedessa and to some extent Boke livestock market for buying replacement oxen first for using for draught power and then for fattening. The situation is different for Tullo woreda respondents. They reported that they get better price at Hirna and Debesso market because of presence of many buyers and their location advantage and concurrently they preferred Cheffe banti, Doba, Debeso and even Hirna livestock markets to buy emaciated or unfinished fattening cattle. In general in the four study woredas, price variation was due mainly to differences in the number of traders available in the livestock market (45%), difference in the number of traders and proximity to urban center (23%), due to proximity to urban center (12%); the fourth group of respondents (10%) indicated it was due to difference in road and transportation facilities. The rest of the respondents (10%) indicated degree of influence of brokers, and other multiple responses.

4.21. Seasonal Price Variation

In focus group discussion, participants accounted for the seasonal price variation. Fattened cattle price becomes higher in the months of May up to October and lower from November up to January in Habro woreda. In Gemechis woreda it becomes higher from June up to August and lower from October up to January. In Chiro woreda, price of fattened cattle escalates from February up to June while it lowers from the month of October up to January. Higher price was observed from February up to June whereas, lower price was

observed from October up to January in Tullo woreda. The time trend for price variability is almost similar in all woredas except a slight difference in the number of the months. However, there is no fattened cattle price variability based on agro-ecology of the respondents.

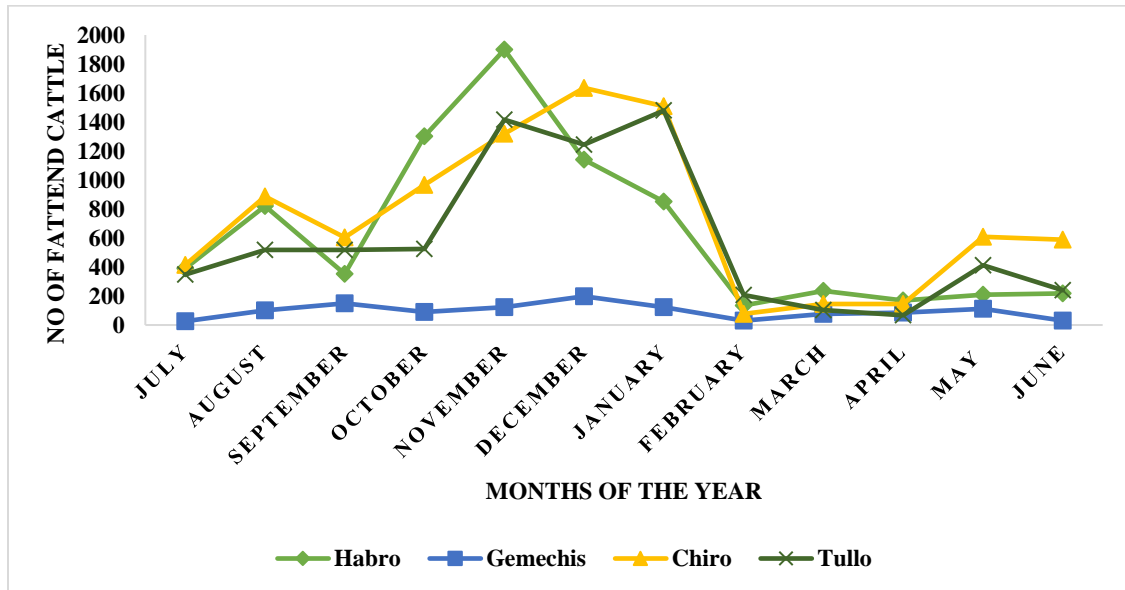
The months of February, March and April were peak times for the study area farmers to highly engage themselves in plowing land for sowing and cultivation of crops for the main *Mehir* season. During this time, most farmers need draught oxen. Consecutively, the demand for oxen would boost the price of in general. In this time, more farmers focus on the plowing activity rather than feeding for fattening. Moreover, from February up to October farmers faced with shortage of feed for livestock but at the same time, there are Christian festivities which calls high demand for fattened cattle. Thus, absence of enough feed decreases the supply of fattened cattle in the livestock market which in turn increases the price. Those that were capable of storing crop residues and could afford to buy supplementary feeds of agro-industrial origin and holding cattle fattening as a side and routine business would highly be favored by the price increment because they were well prepared for the scarcity of feed. Therefore, they could be more benefited from higher price at the end of Christian fasting months (February to March), New Year (September) festivals. However, the months October up to January (Christmas and Epiphany festivals) were characterized by relatively lower price of fattened cattle and this is associated with the availability of crop residue and most respondents focus on fattening cattle by using this ideal time so the number of farmers involved in the fattening activity rises and the supply escalates and at the same time price decreases in comparison with the other times. The result was summarized in Table 33.

Table 33: Seasonal price variation from focus group discussion

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August
Habro	x	x	*	*	*				x	x	x	x
Gemechis		*	*	*	*					x	x	x
Chiro		*	*	*	*	x	x	x	x	x		
Tullo		*	*	*	*	x	x	x	x	x		

Red = Months of higher price; Green = Months of lower price

Figure 14 illustrates the trend of number of fattened cattle delivered to central market in the study woredas. Similar to the result obtained through the survey work, this figure shows and confirms the months of higher and lower supply versus the number of fattened cattle delivered to central market from study woredas. As it is clearly depicted in the figure, from the months of October to January, there is higher supply of fattened cattle for market because of the relatively high feed resource during these months. According to this figure, Tullo, Chiro and Habro woreda supply more fattened cattle than Gemechis woreda livestock market.



Source of data: West Hararghe Zone Trade and Market development office (2016)

Figure 14: Number of fattened cattle delivered to central market from study woredas

The months of February up to beginning of April are Christian fasting months so during these months, the supply and purchase of fattened cattle decreases but after the completion of the fast, the supply to local and deliverence to central market increases eventhough it is not as large in volume as from October to January months.

4.22. Animal Factors Associated with Price

Not only number of traders, the location and the season that influenced price of the fattening cattle in the study wordas but there were also different factors associated with the animal color, age, sex, body conformation and health of the cattle highly affect price during negotiation between the buyer and the seller. Therefore, rank of factors determining price of fattened cattle is illustrated in Table 34. Accordingly, health of the animal was given first priority thus ranked first. Personal discussion with the respondents and market place visit, it was noted that buyer observe the animal when moving here and there to see any leg damage and the cattle must be active looking at the hands of the seller and so the buyer scrutinize every other body parts.

The second factor that highly draws the attention of buyers was the body conformation of the cattle. The height from the feet, the width of the chest and rear side width, the size of the hump, the volume of abdomen, the back and the loin and the tail head and other minor parts would tell an experienced buyer everything about the amount of flesh the fattened cattle carried, the future fattening potential and help for eye ball estimation of price. Once the first two criteria were met, the color of the fattened cattle was the third ranked factor. Respondents believed that naturally white coated fattened cattle can attract the attention of every buyer and in addition these type of cattle easily reveal every effort the producer made to fatten the animal.

Evenif the price of fattened cattle was very high during the months of February to August, there was high feed shortage so in response to this, most of the respondents were forced to fatten cattle during the feed available months of October, November and December up to

January because there is higher amount of crop residues. Therefore, once the cattle is fattened and reached for market, they didn't wait until the price rises in fear of feed dwindling and consequative body loss. In the study woredas, once the owner used the bull for one to two years for plowing, he preferred to fatten and sell the cattle to enjoy the premium price obtained in the market therefore, virtually there was none cattle allowed to stay until they became old, emaciated and start staggering. Thus one can find in the market castrated young ox, uncastrated young ox, castrated adult ox, infertile cow or heifer (*meshena*) and female and male calves.

Table 34: Rank of factors determining price of cattle for fattening

Variables (N=160)	Weighted frequency						Total weight	Index	Rank
	1	2	3	4	5	6			
Color	16	33	56	37	14	4	628	0.18	3
Age	20	38	34	27	18	23	586	0.17	4
Sex	19	15	22	36	38	30	491	0.14	5
Body conformation	48	32	14	27	24	15	648	0.19	2
Health of all body parts	64	22	23	22	16	13	697	0.20	1
Time of sell	1	28	20	14	51	46	416	0.12	6

N=number of respondents; weighted values for each variables of factors determining cattle price at the market place based on rank (6 for first; 5 for second; 4 for third; 3 for fourth; 2 for fifth; and 1 for sixth).

4.23. Perception and Trend of the Prevailing Price

Even though there was high influence by brokers, 17.5, 74, 22, and 75% of the respondent's perception about the prevailing cattle price was very good in Habro, Gemechis, Chiro and Tullo woredas, respectively because there was higher demand for beef, the price of live fattened cattle was higher in the local market. Whereas, the majority (82.5, 26, 78, and 25%) of the respondents in all study woredas had a good feeling about the trend of price of fattened cattle. However, the majority 55, 90, 93 and 92% of the respondents in the same study woredas still blame the negative influence of brokers in the market transaction. While 45, 10, 7 and 8 % of the respondents in Habro, Gemechis, Chiro and Tullo woredas claim there was no influence of brokers in the market place. The latter ones justified that the

presence of brokers in the livestock market transaction simplified the business so that they could easily sell fattened cattle through the facilitation of brokers. The perception and trend of the prevailing price was summarized in Table 35.

Table 35: Perception and trend of the prevailing price of fattened cattle (%)

	Habro	Gemechis	Chiro	Tullo	Overall
<i>Perception of prevailing price</i>					
Very good	17.5	74	22	75	46
Good	82.5	26	78	25	54
<i>Influence of brokers</i>					
Yes	55	90	93	92	82.5
No	45	10	7	8	17.5

However, based on the FGD meeting in the woredas, brokers usually enforce producers to sell at lower price so as to get 400 up to 4000 birr ‘commission’ from a single fattened cattle, disturb the normal market transaction for their own sake, decide the price on behalf of the producers, enforce and tether the cattle without the willingness of the producer, insultion, beating the cattle owner and hitting the legs of the animal to make it lame so owner lose hope and ultimately forced to sell at lower price for their own sake. These were a few of the behavioral corruption manifested by brokers in the market places of the study woredas.

The majority of respondents (97.5%) indicated that the trend of fattened cattle price was increasing from time to time. However, the rest said there was no change and the trend was even decreasing because of the influence of brokers. Out of the whole respondents, 92.5% indicated that they were happy with the prevailing fattened cattle price in their respective area while the rest 7.5% were not happy due to the influence of brokers in the market. The ones who were not happy proposed stopping the involvement of brokers from the marketing system, decrease their number, paying only legally decided commission and government intervention on brokers activity as solutions to improve fattened cattle price and income of the producer in their respective area.

4.24. Reason and Decision of Sell for Fattened Cattle

The reason and decision of sell of fattened cattle for all woredas was summarized in Table 36. For the reason why the respondents sell their fattened cattle, 92% of them indicated that they sold their cattle to earn profit and use the money for fulfilling the needs in their livelihood. While 3% of them used the money for covering medical bill. The rest 5% used sold to earn profit and cover school fee and government debt. On the other hand, almost all of the respondents 160 (100%) sold their cattle when they thought the price was high in the livestock market. About the decision to sell of fattened or purchase replacement cattle in the family, out of all respondents in the four woreda, the majority (59%) indicated the husband reached the decision by negotiating with their wives. This was done to avoid unnecessary argument in the family and to be more transparent because most of their wives had great contribution in the fattening process. While 30% of HHs indicated the decision was made by their own. They remarked no negotiation was needed as long as there was faithfulness among family members. The rest 11% said they raise the issue of selling as a discussion point and collect the view of most of the family members to reach decision. This was because most of the family members spent their time in the fattening work and should fairly benefit from the income.

Table 36: Reason and decision of sell for all woredas

Reason and Decision	Frequency	%
Reason of sell		
- Earn profit	147	92
- Cover medical bill	5	3
- Profit, school fee and government debt	8	5
Decision of sell		
- Husband with wife	94	59
- Own decision	48	30
- With family members	18	11

4.25. Sense of Ownership and Impact after Selling

On the issue of the feeling of ownership after selling their fattened cattle, 67% of the respondents felt nothing because their intention was to sell and they did the right thing (Table 37). While 23% of them were initiated to buy replacement fattening cattle just after selling the cattle. A few of them 5%, 4% and 1% responded that they experienced fear of losing status in the society, fear of losing their money and potentially become poor, intended to raise another, respectively. The majority of the respondents (94%) responded that there was no impact of selling fattened cattle on herd structure in their compound because selling fattened cattle was a long time tradition and lucrative business in the study woredas. But most of them tried to replace even to increase the number of cattle used for fattening before expending the money for other purpose. However, the remaining 6% of the interviewee indicated selling fattened cattle decreased the number of cattle from the herd and sometimes they felt regret and guilty until they bought and replaced another.

Table 37: Sense of ownership and impact after selling

Sense of Ownership	No. of respondents (n)	Percentages (%)
Nothing	107	67
Initiated to buy replacement	37	23
Fear of losing status	8	5
Fear of loss of money and becoming poor	6	4
Intention to raise another	2	1

4.26. Consumption of Beef

All respondents (100%) in Habro and Gemechis, while 60 and 92% in Chiro and Tullo woreda, respectively consume beef. Whereas, 40 and 8% of the respondents from Chiro and Tullo study area did not consume beef. Accordingly, 55 and 45% from Habro indicated they eat only during festivals and anytime, respectively. In Gemechis, 41, 26 and 33, in Chiro 69, 24 and 7, and in Tullo woreda, 75, 19 and 6 %, respectively consume beef only

during their religious festivals, anytime when we get money and during harvest of cereal production from December to January (*Tarri*) in a group (*Kircha*), respectively.

Regarding the frequency of consumption per month, in Habro woreda all respondents replied that they didn't eat in most of the months except on those having festival occasions. In Gemechis 49, 18, and 33% indicated that they eat once or twice in per month but only in months that have festivals; they did not counted how frequent they ate; and the third ones used to consume beef once per two months time, respectively. While in Chiro woreda, 11, 9 and 80% of the respondents said they eat once per month; eat in months that have only festivals and eat once per two month. In Tullo woreda, 25, 19 and 56% told they ate once per month, ate once per months that have only festivals and the third ones did not eat in a month's time, respectively. These results were summarized in Table 38.

Table 38: Habit, reason and frequency of consumption of meat (%)

	Habro	Gemechis	Chiro	Tullo	Overall
<i>Habit</i>					
- Yes	100	100	60	92	87
- No	0	0	40	8	13
<i>Reason</i>					
- Religious festivals	55	41	69	75	60
-Anytime	45	26	24	19	29
- During harvest (<i>Terri</i>)	0	33	7	6	11
<i>Frequency</i>					
-Once per month anytime	0	0	11	25	9
-Once per festival month	100	49	9	19	44
-Once per two months	0	33	80	56	43
-Do not know	0	18	0	0	4

4.27. Challenges of Fattened Cattle Market

4.27.1. Brokers influence

The selling and buying process in livestock market transaction is facilitated by the involvement of brokers without whom the transaction process is difficult and tedious. These brokers mediate the transaction through selecting the type of animal that the buyer needs and how much money he/she affords to pay and asking at the same time the seller the amount of money he is expecting to sell and finally in mediating and convincing the seller and buyer. Then if the market is successful, the broker collects commission from the two parties but mostly from the buyer. Through this traders buy without wasting their time in the market. Most of the time, the fattening cattle producers expect maximum price beyond what they know about the current price of equivalent fattened cattle and not willing to sell the animal directly to the traders. So this time there would be involvement of brokers. Generally there were two types of brokers in the study areas, those with no money and those that have their own money (100-150 thousand birr) especially the latter ones try to make a lot of profit margin by blocking the transaction until the producer agrees to sell for the broker. A number of men, few women and youngsters of different age were involved in this work.

In discussion with the participants of focus groups in the different woredas and KII, they tried to explain the issue that when the fattened cattle arrived at the market, brokers would approach and start dealing with sellers and deliberately promise them to pay 'higher price' which was actually a little bit lower than what sellers at first claimed. Once sellers kept this promise (the 'a hang up price') (*mismar*), they would be ambitious to enjoy this high price and claim this as their baseline and refuse to sell the animal in reduced amount for others and stay long time in the market. The broker at the same time claims as if he had started a deal and ready to buy the cattle therefore nobody dares to approach and buy the cattle. Finally, the seller would be forced to sell at lower price which the brokers needed and determined to pay or opt to return the tired animal back home.

Some of the brokers were not legally allowed to conduct the price negotiation in the livestock market, a case in Gemedchis woreda. However, they still intervene in the bargain and both traders and sellers were fed up with this exaggerated commission because the sellers lose 500 to 4000 in a single market day from sell of a fattened cattle. Intimidation, cheating, physical attack and blocking the normal market dynamics were some of the features of livestock market in the zone. There were times when brokers returned a purchased cattle to the producer in the village and enforced him to pay their lost 'commission'. From the traders' side, these gangster brokers ordered a vehicle full of purchased fattened cattle to return to the market and sold the already bought cattle to other traders who was capable of paying better commission for them. Consequently, this problem forced many traders to return their government permit paper. This was especially so in markets of Chaffe banti, Hirna and Debesso which were overwhelmed by gangster brokers. Sometimes, the brokers in a group of 4 to 5 approach and surround the producer. If for instance, the producer claims the selling price is 15 thousand birr, then these people handle the guy 10 thousand birr to count. Purposely, they brought money having only a 50 birr note and in the mean time without giving enough time to check and count the money, they drug the cattle to their hiding place in the nearby village. Upon disagreement and in trying to return the cattle, sometimes severe physical attack on the owner and consequence disturbance arise in the market. Previously their influence was so intense that some of the brokers (*Delala*) were equipped with weapon and threatens the producer and enforce to sell with the price less than what the market can offer.

The influence of the brokers was multifaceted, often they wait the producers at road side outside of the market place (*Jeldhaba*) before entering to the market. The producers were mostly farmers, who come trekking their fattened cattle and brokers start claiming the fattened animals as their own. Therefore, the producer cannot directly sell to the trader so the farmer lose even the right to sell his animal directly to the trader. There were legally known brokers who were to some extent known by government bodies and pay their tax. The brokers in Chiro livestock markets have their own standards some groups receive 1000, others 500 and still others require 100 birr per sell of one fattened cattle. Even though

producers sell directly to traders which is a rare case if by chance brokers know this, they forcibly earn commission from the traders.

Brokers in West Hararghe had no legal boundary to work, they travel from one market to the other to participate in the transaction. They come to Chiro market from Debeso, and Chefe Banti market and gear the market transaction as they want. It was tried to form legal brokers unity but it was impossible to control them. Sometimes some of the illegal (those that do not pay taxation) were kept by police for punishment but the problem was still persisting. So still the problem associated with brokers requires urgent solution. Although there was a high corruption on the side of the brokers, the local concerned officials did not give due attention and take consequative measure on the condition. The rule, regulation and the law did not work and changed into real practice.

4.27.2. Traders influence

According to discussion with some of the repondents, the influence of traders in the system of marketing was many. Among these, they approach the producer at village level and give false hope to take every responsibility to sell the fattened cattle at a better price at the central market – Addis Ababa or Adama and they would take the animals without any legal written agreement. Through this way, sometimes the traders will disappear from the area without paying the producers money.

The situation was sometimes even worse and aggravated when it comes to producers who tried to truck their fattened cattle and sell in Addis market. The traders who got this information would follow them and announce as if the fattened cattle were their own and decide and negotiate the price on behalf of the seller. When the sellers lose hope of selling at better price, they will be forced to sell at the same price which they refused to sell in the local market. To the traders, this was intentionally done to discourage producers not to dare selling their fattened cattle at better price in the central markets.

Since the demand of meat is increasing from time to time especially in the towns and cities and the need to buy fattened cattle from Hararghe area is high, marketing of the fattened cattle in West Hararghe towns became more lucrative work and draws the involvement of many participants. This could be easily explained by the fact that traders had started sending their agents down to the rural villages and pay an advance payment after dealing with the bargain and determining price on eye-ball appraisal and collect fattened cattle directly from the spot. This had obstructed producers from enjoying premium price since they had already been pre paid to sell at an agreed price.

4.27.3. Infrastructural problems

There was no properly constructed loading and unloading area. Thus in all study areas, traders use temporarily built sloppy soil piled docks. In Tullo woreda- Hirna livestock market was in the middle of a village so has no expansion area, no fence and other facilities. In most of the live stock market with the exception of Chiro and Gelemso, the market place has no fence and other facilities and equipment. Even if a few had stone walled fence, in fear of paying the taxation money, some of the buying and selling activities were carried outside of the market area which would enhance brokers influence and the producers were highly disadvantaged.

4.27.4. Consequence of the problem

Producers were the first complaints of the illegal influence of brokers in the marketing system. Most traders complained that even if they were legally working in the area, government officials demanding to collect tax from the seller and buyers-traders they did not give emphasis to the deep rooted problem brought about by brokers. Cutting price and earning exaggerated commission was one manifestation of corruption. These illegally grouped individuals disturb the market dynamics and work for unwanted inflation. Many traders both in Hirna and Chiro town were forced to return their legal permit paper because of the unnecessary payment of their money.

4.27.5. Illegal routes of cattle in West Hararghe

According to discussion with traders, Adas to Doba and then to Djibouti was an illegal route that take heifers and cows and there were traders that buy uncastrated bulls from Beddesa and bring to Wuchale in Somali Region and then to the neighbouring Somalia for illegal export. In Habro, there was a contraband route of specially traders truck or trade calves and cows-mostly to Somali Region especially in 2015 the problem was visible. Even donkeys were being trekked through contraband routes from this area to Sudan they use for loading purpose. But currently this problem has temporarily stopped through supervision by kebele officials.

4.27.6. Solutions forwarded to the challenges

In all study areas government officials were trying to take measures on the illegal activities of brokers by assigning police men and controlling the market area and even banning brokers from the cattle market. In Tullo woreda, the woreda police, peace and security office, marketing and livestock agency in group had taken measures on the illegal activities of middle men. Livestock market places were intended to be shifted from near village areas to open places with enough space to monitor the movement of animals and prevent hiding areas of illegally or forcibly bought and taken animals in Tullo woreda. In Gemechis woreda the illegal middle men were identified and advised to correct their activities through organizing in micro-enterprises and giving legal recognition and permission. Every broker that participate in the market should be legally known. The office of trade and town development in Gemechis was posting the market price of the previous week to update producers about the prevailing price for awareness creation of the coming week. This information was posted near the market.

In Gelemso repeated meeting was held with farmers to give ideas how to sell safely at market place; announcements were done at market place, task force committee was working against the influence of brokers trying them to organize in micro-enterprise basis. Therefore, at the time of this study, the influences were a little bit lessened. Although still

producers faced with some challenges, some of them choosed to sell the fattened cattle at farm gate. This might protect them from illegal looting of their money by brokers. The villagers tried to unite and prevent the influence of brokers.

Creation of job for the jobless is one means of combating unemployment in the area. When looking at the composition of brokers, there were high school complete students, university graduates and government workers who kept this work as par-time work even. Legally restricting brokers to work in their living areas; legal protection and technical support to the producers and certified traders; urging producers to sell their fattened cattle to central markets in groups; expansion of co-operatives and at the same time mobilizing and organizing producers to participate in it; determine the amount of commission to be paid for brokers per fattened cattle; fencing market places and control every individuals coming in and out of market; make avail fattened cattle market information to producers-through mass media; and capacity building training for producers, traders and brokers were solutions forwarded for the challenges.

4.28. Opportunities of the Fattened Cattle Livestock Market

In discussion with Key informants, population increase, urbanization, change in income of the society all have contributed to the increasing demand of beef from fattened cattle. In addition, Hararghe beef cattle is needed for its good flavor and tenderness. Large number of fattened cattle were available in one market day so that buyers could have many alternatives. Although the volume varies in different seasons, there was uninterrupted supply of fattened cattle to the markets.

Most of the livestock markets were located in an area which is not far from main asphalt road which made it easy for loading and transporting the fattened cattle to different destination. Except for some of the big markets like Chiro and Hirna, relatively peaceful market transaction was found in Habro, Gemechis and Debeso where the number of traders and brokers was relatively smaller. From time to time the number of merchants/traders and producers involved in the transaction was increasing.

Premium price obtained for fattened cattle in West Hararge draws high supply of replacement cattle for fattening from lowland. The market was still good for the producers because they buy with (8,000 to 15,000 birr) and sell after four to six months up to 18,000 to 35, 000 birr. There was relatively higher price paid for exceptionally fattened cattle that reached 40, 000 to 45, 000 birr and this kind of fattened cattle were directly ordered from Addis Ababa for marriage engagement and other special ceremonies. The system of feeding by itself – stall feeding had helped to get fattened cattle that reach for market relatively in a short period of time. Along with the zero grazing system of feeding, lots of indigenous technical knowledges were found among the producers. Job opportunities were created for traders (fattened cattle, feed and veterinary medication), rental vehicles (ISUZU and FSR), brokers, trekkers, small traders of tea, coffee, soft drinks, biscuits etc in the market place and for hotels and restaurants in the towns of the market place. Income from taxation of fattened cattle coming to the market place (*Jeldhaba*), purchased animals and from traders taking fattened cattle to central market.

4.29. Nutritional Quality Analysis

4.29.1. pH measurement and Sensory evaluation of urea/EM treated stover

The effect of urea and EM treatment on pH, sensory appraisals and fungus prevalence of untreated and treated sorghum stover are summarized in Table 39. The mean pH values which are depicted in the Table show that the values for all treated stover types in this study ranged between T2 to T3. At the end of the twenty one days, T2, T3 and T4 had high, low and moderate alcoholic odor. The color of the treated ones were changed from straw to brownish yellow color (T2 and T4) and dark brown (T3). All of the treated silage samples at the end had soft consistency when touched and none of them had sign of fungus. The results of the visual appraisal, color and smell showed all the treatment silages showed

good quality by use of EM, Urea, and EM plus Urea as biological inoculant and chemical additive (T2, T3 and T4).

Table 39: Effects of urea/EM treatment of sorghum stover on pH, sensory appraisals and fungus prevalence

Parameters	Type of silage			
	Untreated (T1)	EM treated sorghum stover (T2)	Urea treated sorghum stover (T3)	EM + Urea treated sorghum stover (T4)
pH	-	4.17	4.30	4.27
Color	Straw	Brownish yellow	Dark brown	Brownish yellow
Smell	Natural	Highly Alcoholic odor	slight alcoholic with pungent smell	Moderately Alcoholic odor
Texture	Hard	Soft	Soft	Soft
Fungus	NM	NM	NM	NM

NM= no mold; + = Slightly moldy; ++ = Heavily moldy

4.29.2. Chemical composition and in vitro dry matter digestibility of silage

Effect of EM and Urea treatment on the chemical composition of the silages are shown in Table 40. Treatment did not significantly ($P > 0.05$) affect the DM and EE components of the T1 and T2 - T4. The ash was highest in T2 and lowest ($P < 0.01$) in T3. The OM content was highest in T1 and lowest ($P < 0.01$) in T2. The CP content was highest ($P < 0.001$) in T3 followed by T4, T2 and T1, respectively.

In general T2, T3 and T4 affected the fiber fraction of treated sorghum stover and showed lowest NDF values than T1 ($P < 0.001$). T2 showed lower ADF value than T1. However, the ADF content of T3 and T4 silage showed higher ($P < 0.01$) value than T1 and T2.

Table 40: Chemical composition and in vitro dry matter degradability (%) of sorghum stover treated with urea and EM

Treatment	DM	Ash	OM	CP	EE	NDF	ADF	ADL	IVDMD
No trt. (T1)	96.23 ^a	7.20 ^c	92.80 ^a	2.93 ^d	1.17	77.77 ^a	54.97 ^b	9.63 ^{bc}	49.83 ^c
EM (T2)	96.43 ^a	9.17 ^a	90.83 ^c	5.33 ^c	1.23	73.83 ^b	51.20 ^c	8.50 ^c	51.07 ^{bc}
Urea (T3)	95.20 ^b	8.30 ^b	91.7 ^b	12.97 ^a	1.33	72.23 ^c	56.60 ^{ab}	11.10 ^a	54.37 ^a
EM+Urea(T4)	95.87 ^{ab}	8.33 ^b	91.67 ^b	8.73 ^b	1.27	75.00 ^b	58.33 ^a	10.10 ^{ab}	51.80 ^b
SEM	0.19	0.24	0.24	1.16	0.06	0.63	0.90	0.33	0.53
Significance	Ns	**	**	***	Ns	***	**	*	***

^{a-d} Means with different superscript letters in a column within a category differ at 5% level of significance; * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$; Ns = Non-significant ; SEM = Standard error of the mean; T1=Sorghum stover; T2=Effective micro-organisms treated sorghum stover; T3= Urea treated sorghum stover; T4= Effective micro-organism plus urea treated sorghum stover; DM=Dry matter; OM=Organic matter; MM=Mineral matter(Ash); CP=Crude protein; EE=Ether extract; NDF=Neutral detergent fiber; ADF=Acid detergent fiber; ADL=Acid detergent lignin. IVDMD= Invitro dry matter digestibility.

The ADL content of T2 is lower than T3 and T4. Treatment 3 and T4 both showed slightly higher ($P < 0.05$) ADL values than the T1. There was significant improvement ($P < 0.001$) in vitro dry matter degradability of T2, T3 and T4. However, IVDMD value was highest ($P < 0.001$) in T3 followed by T4 and T2. The IVDMD value for T1 was the least among all the treatments.

4.29.3. In sacco dry matter degradability

The *in sacco* DM degradability parameters of T1, T2, T3 and T4 are given in Table 41. The lowest and highest values for soluble fraction (a) ranged between T1 – T3 while the highest value was observed in T3 followed by T4. T1 had the lowest value of soluble fraction. The insoluble but potentially degradable fraction (b) ranged between T1 and T3 and all treatments showed significant ($P < 0.001$) variations. T3 had highest value of b fraction and the lowest value was found in T1. In general, the values of the insoluble but potentially degradable fraction were in the order of $T3 > T2$ and $T4 > T1$. Potential

degradability of was the highest in T3 and lowest in T1. The mean values for potential degradability of all the treatments showed significant ($P < 0.001$) variation among each other. The potential degradability value in T3 was the highest followed by T4, T2 and T1.

Table 41: *In sacco* DM degradability of sorghum stover (%) treated with different additives

Treated feeds	a (%)	b (%)	c (%)	PD (%)	ED (%)
T1	29.51 ^c	34.34 ^c	0.041 ^a	64.14 ^d	49.45 ^c
T2	33.99 ^b	45.58 ^b	0.042 ^a	79.57 ^c	60.52 ^b
T3	36.53 ^a	49.51 ^a	0.036 ^b	86.04 ^a	63.39 ^a
T4	35.62 ^a	45.41 ^b	0.037 ^b	81.03 ^b	60.63 ^b
SEM	0.35	0.33	0.001	0.20	0.06
Significance	***	***	**	***	***

^{abcd} means in a column with different letters are significantly different ($P < 0.05$); a = soluble fraction; b = insoluble but potentially soluble fraction; c = rate of degradation; PD = potential degradability; ED = effective degradability. T₁=Sorghum stover; T₂=Effective micro-organisms treated sorghum stover; T₃= Urea treated sorghum stover; T₄= Effective micro-organism plus urea treated sorghum stover; SEM = Standard error of the mean; Significance level *= $P < 0.001$; **= $P < 0.01$; *= $P < 0.05$; NS=Non-significant.

Similar to the potential degradability, the mean values of the ED fraction showed significant variation ($P < 0.001$) and the highest value was recorded for T3 and the lowest in T1.

4.29.4. Ruminal degradability of DM

Table 42 summarized the ruminal degradability of DM (%) from sorghum stover silages. Generally degradation increased with incubation time across all treatments. The ruminal degradability of T1 for the different incubation hours was lower than all the other treated silages (T2, T3 and T4). Generally the rate decreased in the order of T3 > T4 > T2 > T1. In the present study, there was significant ($P < 0.001$) variation in degradability of DM in different treatments at different hours of incubation. Treatment of sorghum stover with

EM, Urea and EM plus Urea for silage had enhanced the ruminal degradability at different incubation hours. Degradability of sorghum stover increased slowly between 12 to 24 and 72 to 96 hours but there was a higher change of values between 6 to 12 and 24 to 48 hours of incubation across all four treatments. The ruminal degradability was the highest in T3 and lowest in T1 at 96 hours of incubation. The graph showing trend of the ruminal degradability of DM (%) of sorghum stover treated with different additives is presented in Appendix 8.

Table 42: Ruminal degradability of DM (%) from sorghum stover treated with different additives

	0	6	12	24	48	72	96
T1	27.86 ^c	38.20 ^c	45.87 ^d	48.20 ^c	58.80 ^c	62.30 ^c	64.20 ^d
T2	32.67 ^b	44.67 ^b	55.10 ^b	60.13 ^b	73.17 ^b	76.97 ^b	79.70 ^c
T3	35.93 ^a	45.57 ^a	56.40 ^a	63.33 ^a	76.77 ^a	82.17 ^a	84.80 ^a
T4	34.67 ^a	44.78 ^b	54.53 ^c	60.10 ^b	73.10 ^b	77.67 ^b	80.27 ^b
SEM	0.94	0.90	1.26	1.74	2.07	2.26	2.35
Significance	*	*	*	*	*	*	*

^{abcd} means in a column with different letters are significantly different ($P < 0.05$);

T₁=Untreated sorghum stover; T₂=Effective Micro-organism treated sorghum stover
T₃= Urea treated sorghum stover; Effective Micro-organism + Urea treated sorghum stover; SEM = Standard error of the mean; Significance level *= $P < 0.001$

5. DISCUSSION

5.1. Household Characteristics

Out of the total 160 sample households interviewed in all study woredas, the majority of respondents (97.5%) were male and the rest 2.5% were female headed (Table 6). This was due to the tradition that fattening of cattle in general and male cattle fattening in particular, was mostly performed by male holders in West Hararghe and the majority of respondents (88%) preferred to fatten male cattle which involved male HHs to make easy handling and control of the animals. The presence of higher percentage of male headed HHs engaged in cattle fattening in the study area was in line with the works of Dereje and Tesfaye (2009). Similarly, all respondents involved in cattle fattening were reported to be male headed HHs in the works of Tsigereda *et al.* (2016). However, more percentage of female respondents 15.6% out of 45 sampled respondents were reported in Somali Regional State, Harshin district who were directly involved in cattle fattening activity (Fikru, 2015). According to Leulseged *et al.* (2015), female holders were mostly involved in the fattening of infertile cows, sheep and goats. There is a clear gender disparity in cattle ownership in Ethiopia, with male holders having a 15 % point higher ownership rate over female holders. In addition, Gurmessa and Daniel (2013) reported among the sampled households including both males and females, only 15.6% of the respondents were female participants in cattle fattening package in the Fentalle district, East Shoa zone, Oromia. Thus, strengthened institutional involvement working on gender equality should be there to capacitate women with technical trainings, avail credit facility and support them to be engaged in the cattle fattening work.

Respondents who were in the age group of 32 to 43 and 44 to 55 were the highest in number and they were mostly supported by family labor and had significant contribution in their respective area because of their long time experience in cattle fattening. Secondly, those with the age range of 20 to 31 years were youngsters who were attracted to cattle fattening because it is lucrative work in the area. Whereas, respondents in the age range of 56 to 70 were few in number because of old age since cattle fattening requires intensive care in feeding and other traditional management activities. In line with the reports of Population

communication (2014), in this result, the majority of respondents were in the working age group of 15 to 64 years old population which in Ethiopia is considered as a working age population. While age groups of 0-14 and 65 and above are considered as child and old age, respectively. In Habro woreda respondents in the age group of 20-30 and 32-43 participated more than other woredas. This might be due to a good access to lowland replacement bulls. Similarly, Shewangizaw (2016) reported that the majority (66.67%) of fattening participants were between the ages of 31-40. Harko (2015) noted that in both rural and urban areas, smallholder cattle fattening was emerging as an important source of income in Ethiopia. According to Tsigereda (2016), 91% of the households who were in the age range of 20 to 80 years were married which might signify participation of family members in the routine cattle fattening activity in Hararghe was vital. Marital status of the household heads found 91.2 % married in this study was comparable to 91.7% (Tsigereda, 2016).

The overall mean \pm SD of family size for the four woredas included in this study was 5 ± 2 which was comparable to 5.42 (Abdi *et al.*, 2013), 5.45, 5.46 and 5.04 average household size of West Hararghe, East Hararghe, and Ethiopia, respectively (CSA, 2014) and a little bit lower than 6.3 and 6.1 for highland and midland agro ecology of Chiro woreda (Bezahegn, 2014). Whereas, much lower than the report by Daniel (2008) which was average of 8 persons per HH in Borena.

The 31.9 and 11.9% of households who were illiterate and secondary school, respectively reported in this study (Table 6) was analogous to the report by Abdi *et al.* (2013) which was 35.2 and 12.1% for illiterate and grade nine and above, respectively. However, the educational background of the respondents in the current study was much better than 58.5 and 3.4% of respondents who were illiterate and secondary school complete, respectively in the agro pastoralist area of South Omo Zone of SNNPR as assessed by Yidnekachew *et al.* (2016). Shewangizaw (2016) found 46.67% of respondents who had completed high school and engaged in cattle fattening in North Gondar Zone. According to Sharada (1999), education has an important role to play in increasing agricultural production in rural Ethiopia. Productivity may be enhanced either through the adoption of more productive inputs and techniques or through improvements in productive efficiency for a given

technology. Therefore, this illiteracy level in the current study draws attention for intervention of adult education so that introduction and adoption of new technologies in relation to cattle fattening and organizing under cooperatives would be easily feasible. The farmer's training centers (FTCs) established in most of the West Hararghe woredas could easily be used for this purpose.

5.2. Sources of Income for Households

In the study woredas, mixed farming of crop and livestock accounts for 96.3% and it was a dominant and common source of income followed by a small percentage (1.9%) of off-farm activity. This report was in agreement with the works of Abdi *et al.* (2013), Estefanos *et al.* (2014) and Tsigereda *et al.* (2016). However, in anomaly with the current report, off-farm income generation was increasing to diversify income among most of the rural population in Ethiopia (Woinishet, 2010). Teshager *et al.* (2013) noted that in Ethiopia in both rural and urban areas, smallholder cattle fattening is emerging as an important source of income. Alemayehu (2006) noted that small to medium scale crop-livestock production is the dominant feature of highland (*dega*) and lowland (*Woina dega*) agro-ecologies zones in Ethiopia where a wide range of crop and many species of livestock are kept for different purposes. According to personal observation and discussion with focus groups, participation of women in petty trading of agricultural products such as fruits, vegetables and cereals, *Khat* (*Catha edulis*) and mainly small ruminant animals is a very common source of income in the study area rural *kebeles*. Fuel wood selling and engaging in daily labor work in the nearby towns is a common phenomenon in times of food scarcity performed by men and women. Therefore, according to ILO (2014), diversification of income in the rural areas helped to reduce poverty, assisted as coping mechanism for price volatility and improved food and livelihood security.

5.3. Land Holding and Utilization

The overall mean \pm SE of cropland holding per HH of the studied woredas was 0.6 ± 0.03 ha is for highland and 0.7 ± 0.21 ha for mid-altitude. This value was a little bit lower than the average cultivable land holding per household (0.86 ± 0.039) ha reported by Abdi *et al.* (2013), 0.85 ha reported by Estefanos *et al.* (2014) and 0.8 ha average crop area per holder report of CSA (2014). The variation was attributed to the difference in the study areas and to the population growth, which diminishes the size of the cropping land from time to time through inheritance. The land occupied by food crop, cash crop and grazing land 0.46, 0.24 and 0.20 ha., respectively was smaller as compared to the land allotted for food production but a bit larger for grazing land as compared to the report by Estefanos *et al.* (2014).

When looking into the land utilized for major types of cereal crops, maize and sorghum obtain the prominent proportion (Table 7). On average 0.25 and 0.24 ha of land was dedicated for maize and sorghum production, respectively. Among the household interviewed in this study, 90.6 and 87.5 %, respectively produce these two cereals as a major crop in the study areas. However, because of land shortage under sowing of haricot bean in maize field and sowing of maize; sorghum in between hedge rows of *khat* and relay cropping of chick peas after maize were common practices in the study areas. The average yield for maize and sorghum in the study area was 24.8, 23.4 and 22.3, 20.9 quintal per hectare for highland and midland agro ecologies, respectively. Similarly CSA (2016) reported in West Hararghe zone, comparable values 23.4 and 24.3 quintals per hectare yield for maize and sorghum, respectively.

5.4. Family Labor Distribution

Husband and wife (24.4%) were more dedicated to the fattening work than any other family members. This was because children were mostly involved in formal education. Similar to this report more number of male and female in the family whose age falls from 31 to 55 years old highly involved in the farm and household activities which rendered their attention and other social welfares in Borena (Daniel, 2008). Whereas, wives (22.5%) and wives and children (25.6%) were taking part in the cleaning of the shelters from manure

and leftover feeds in the current study woredas. Generally, the number of female HHs involved in cattle fattening in this study area was very small (2.5%). Thus, around 87% of the purchase and sell of fattened cattle was performed by male households. Females were mostly involved in the sale of fattened infertile cows and heifers. Regarding the sharing of responsibility among family members, Tsigereda *et al.* (2016) reported that 80 % in Fedis and 83.3% in Habro were husbands who took responsibility in selling of live animal. Gebregziabher and Gebrehiwot (2011) strengthened the current study result by the fact that sale and purchase of cattle for fattening in Hararghe was the responsibility of the male. Mulugeta (2015) noted that purchase and sale of cattle was the sole responsibility of males in Tigray. As opposed to the current study, females in the pastoral areas of Ethiopia were involved in the purchasing of bulls (Rubin *et al.*, 2010).

5.5. Experience of Cattle Fattening

Among all the interviewed farmers, it was found that 3% of them had 36 to 40 years of fattening experience. This might show how much cattle fattening had a long time experience in West Hararghe. In agreement with this report, Teshager *et al.* (2013) emphasized that farmers in Chewaka district had a long history of traditional small-scale fattening. Similarly, Yidnekachew *et al.* (2016) reported that farmers in South Omo Zone had 1 to 30 years of experience in cattle fattening. However, 55% of the respondents had 1-8 years of cattle fattening experience in the study woredas which might suggest in the recent years, increasing number of producers were being attracted to the work in the area. This report was somehow in agreement with Bezahegn (2014) in that the majority of the respondents (46.4%) involved in cattle fattening practice had 5 to 10 years of experience whereas 11.4 % had more than 15 years of experience in the work. In fact, the accessibility of transportation and promising market in central market was the reason why the fattening so long time experience.

5.6. Livestock Herd Size

The higher number of cattle and donkey in TLU/HH showed how these species of livestock and to a lesser extent sheep and goats are valuable for the rural society in the study areas. The situation was associated with the adaptation, alternative function and feeding habit of these species of livestock in the area. In this study, the number of cattle was higher than sheep and goats. The presence of higher number of cattle was indicative that in Hararghe the highland and midland agro-ecology farmers were giving more attention to cattle rearing as draught animal and diversifying their income primarily from cattle fattening. The overall TLU per house hold of cattle and goats in the highland and mid-altitude agro-ecology reported in this study (Table 12) was less than the report of livestock holding in TLU of pastoral and agro-pastoral areas of Mieso woreda (Daniel *et al.*, 2014). The overall mean value of total herd size was higher in the reports of Zewdie (2010) than the results of the current study.

5.7. Purpose of Rearing Cattle

In these study woredas, selling cattle was ranked first by most of the respondents. Selling was mostly done after finishing the plowing season when cattle got fattened (bull and oxen) by stall feeding at backyard/farmyard or if they were heifers and repeatedly failed to conceive or got infertile or cows which become old or the other instance was if the owner was in a desperate need of money. Security (saving), draft power, manure production and use as a food source were ranked second, third, fourth and fifth, respectively. Oxen and bulls were reared primarily (96.8%) for cash generation and draught power in West Hararghe selected woredas (Dereje and Tesfaye, 2009). Tsigereda *et al.* (2016) noted that cattle were the most important component of the mixed crop-livestock subsistence farming system of Western and Eastern Hararghe zone. They provide draught power for cultivation, food and income for the family. Similarly, Abdi *et al.* (2013) reported that the primary purpose of keeping oxen in West Hararghe was for draft power and income generation purpose accounting for 99.4 % of respondents. Similar purposes of keeping cattle was reported in Harshim district of the Ethiopia Somali Region although oxen were primarily

kept for traction and got fattened and sold once they became old enough and no longer useful for traction (Sisay, 2015).

5.8. Source of Cattle for Fattening

The sources of fattening bulls were mainly the livestock markets found in the study areas. However, the supply of the replacement bulls for draft power and fattening were the ones coming from the lowlands of neighboring Somali Region and Bale lowlands. The bulls are locally known Ogaden breed (Dereje and Tesfaye, 2009). According to FGD and information from woreda livestock and fishery resource experts the areas where these animals coming from were specifically Giner and Gasera in Bale and Babile woreda in East Hararghe. So the male bulls were trekked from these areas by traders through Kasheja, Gololcha, Bedessa and Boke lowlands to reach to Habro and Gemechis and the other route starts from Babile by truck to Hirna livestock markets. This was in agreement with the report of Getachew *et al.* (2008) and LDMPS (2007). Aklilu (2008) reported that immatures or young steers from pastoral areas could be finished by small holder farmers through stall/zero grazing or in combination with feeds coming from natural grazing lands in the highlands of Hararghe and Wolayta in Ethiopia. Majority of farmers in Hararghe use oxen for 1 to 3 years for plowing and then fattening (Tsigereda, 2016). In anomaly to the current report, in Tanzania, most of the cattle are raised for beef cattle by pastoralists and agro-pastoralists in arid and semi-arid areas (Mlote *et al*, 2013).

5.9. Sense of Ownership and Characteristics of Fattened Cattle

There was variation in the study woredas in terms of sense of ownership of fattening cattle (Table 14). The majority of households 57.8 and 66.7%, were both husband and wife who exercised ownership equally in Chiro and Tullo woredas, respectively while in Habro, it was the husband (57.5%) that owned the fattening cattle. But in Gemechis 48.7% of the respondents reported all family members had the right on ownership of the fattening cattle. In this regard, Habro woreda was exceptional because ownership went to husbands and the reason might be attribute to the fact that this study woreda is the farthest (78 km) from the zonal capital where issues of gender equity might not be addressed well in rural kebeles so

that majority of cattle ownership was still at the hands of male HHs. Similarly, Estefanos *et al.* (2014) reported that cattle ownership has the highest index (0.21) for household head (husband) than spouse (0.12). Tewodaj *et al.* (2009) indicated that ownership of cattle by women alone is not common in Ethiopia. The trend of ownership in Tullo and Chiro woredas was similar to the presence of joint ownership of spouses found in many regions (Tewodaj *et al.*, 2009). The same authors generalized that women mostly market small livestock and poultry, as well as dairy products and eggs. However, the sale of cattle and other large livestock is for the most part in the male domain. According to Daniel (2008) reported in Borena, with the presence of the husband in the house, the role of the wife as the owner was less, which was only 5%. Although, ownership goes dominantly to the husband side, most family members were engaged in the management of fattening cattle in the current study.

Overall the majority of respondents (88%) preferred to fatten male cattle because they said fattened male bull or oxen attract more buyers than female cattle. This report is in agreement with Tsigereda *et al.* (2016). Harko (2015) mentioned that traditionally, fattening of animals in agro-pastoral and mixed crop livestock production systems concentrates on male animals and on females which are either infertile or have finished their reproductive cycle. Irshad *et al.* (2012) noted that sex has a major influence on fatness and conformation in cattle. Young bulls produce carcasses with the best conformation, followed by steers and then heifers. Males usually grow faster, mature later, and have carcasses that are more muscular and less fat than females. In general, weight, condition, frame and sex are factors affecting cattle growth (Bruns and Robbi, 2003).

In the study area, the trend of cattle fattening was mostly shifting from many years of using the animal for plowing and latter fattening at an old age to the purchase of local or lowland bull or bull from own source and using it for one year plowing season and then start fattening. Focus group discussion participants noted that generally in the study woredas, local bulls are castrated after they are bought because they believe that without castration, cattle do not get fattened within a short period of time. However, the scenario of bulls coming from the lowlands of Somali region was different. They were fattened

intact because farmers believed that the bulls do not recover from the stress within a short period of time if they get castrated before fattening.

In Gemechis, Chiro and Tullo woredas the majority of respondents 69.2, 91.1 and 97.2%, respectively recommended castration before fattening justifying even if fattening castrated bulls requires relatively longer time, the fattened cattle becomes bigger in size and attracts higher price. However, the scenario in Habro woreda was different in that more respondents (75%) recommended fattening of intact (non-castrated) bulls. They reasoned out that uncastrated bulls take shorter time to fatten than castrated ones. However, Tsigereda *et al.* (2016) reported that 50% in Habro practiced castration while majority of the farmers in Fedis woreda-East Hararghe zone (96.7%) did not castrate their fattened cattle. Personal observation in the markets showed that most producers in Tullo and Habro livestock markets brought uncastrated fattened bulls to the market. With the increasing supply of bulls from Babile-East Hararghe zone, the lowlands of Bale and Somali region, so there was a tendency to shift from fattening of castrated to uncastrated bull. The reasons might be involvement of more and more producers, use short period of time for fattening, use less amount of feed and income generation within a short period of time. AVMA (2014) discussed that in general cattle may demonstrate reduced feed intake and average daily gain (ADG) for a period of time after castration but the benefits of castration is that the internal fat and carcass fat content increased and carcass lean content decreased (Zamiria *et al.*, 2012).

With regard to the preference of color to start cattle fattening, most of the respondents' preferred red, white and multiple answer that included red, white, creamy white. However, the overall reply of the respondent in the study areas indicated the majority of respondents (37.5%) gave multiple answer explaining white, creamy white and red colored fattened cattle were more attractive in the market than dark colored animals. In addition, these colors could easily depict every effort the producers made to fatten their cattle. However, experts in the Woreda Livestock and Fishery Resource Development office had shown that local butchers enjoyed this opportunity to buy the rarely brought black fattened cattle at a relatively lower price in the market. Girma *et al.* (2012) indicated people's perception that

black color cattle is more susceptible to trypanosomiasis prevalent in their area. Similarly, Katiyatiya *et al.* (2014) reported black coat color cattle attracts more ticks than others. MLA (2011) further noted that dark-coated cattle, bulls, older cattle and those in poor condition usually attract the heaviest infestations of fly. Similarly, Tsigereda *et al.* (2016) reported all color of animal except black was preferred in Habro woreda while majority of the farmers in Fedis woreda preferred red and white color of cattle. Shewangizaw *et al.* (2014) indicated that light white was the best followed by red color are recommended but black color was not selected for cattle fattening. Similar reports of color preference was reported by Tesfaye (2007). Contrary to the current result, coat color was not a criterion for selection of beef animals in Fogera woreda, Amhara Region (Anteneh *et al.*, 2010).

5.10. Number, Duration and Frequency of Fattening

The slight difference in the mean number of cattle per fattening period, fattening duration and frequency of fattening per year of the two agro-ecologies might be attributed to the availability of grass from the hills and mountains and crop residues of various cereals because of better precipitation. However, Bezahegn (2014) reported that fattening length in highland areas was significantly higher ($P < 0.05$) than those of midland and lowland *kebeles* of Chiro woreda due to less availability of feed and the utilization of more energy to keep their body from the cold environment. During personal visit, some producers keep fattening cattle in the highland by burning dung to give warmth and covering the shelter with plastics. The age to start fattening if the cattle is born at home varies in the two agro-ecological settings thus highlanders start fattening earlier than the mid-altitude producers. This might also be due to the relatively less available crop land in the highland as compared to the more suitable cropland in the midland so male cattle are kept for long time service. The mean number of cattle per fattening period and frequency of fattening per year for highland and mid-land agroecology was similar to the report of Bezahegn (2014).

There were small differences in the mean number of cattle per fattening period, fattening duration, frequency of fattening per year and age to start fattening if the bull was born at home. These mean differences might have arisen generally from differences in the feed resource potential, access for source of replacement cattle for fattening and availability of

traders in the markets. Respondents in Habro *woreda* fatten cattle more frequently than the other *woredas*. This might be related to an easy access of replacement bulls from the Bale lowlands and Somali pastoral areas in addition to the home grown bulls. But the other *woreda* producers mostly relied on home grown and local bulls purchased and castrated for fattening. Aklilu (2008) noted that financial constraints among the small holder farmers limit the number of steers/immatures and/or the amount of supplementary feed that they can buy thus in most cases, they handle one head of cattle at a time.

In the present study *woredas*, 3.36 ± 0.17 to 4.75 ± 0.16 years was the age range of cattle to start fattening which is comparable to the result reported by Tsigereda *et al.* (2016). However, Sintayehu *et al.* (2010) indicated that most cattle fattened by smallholders in Ethiopia are aged 8 years or older. These are draught oxen are fed near-to-zero opportunity cost feeds available in small quantities locally. This was more or less confirmed by Mulu (2011) that in Amhara region smallholder farmers commonly fattened mature and older animals ranging from 5 to 7 years old but for short durations (usually three months). As opposed to this short time fattening experience, farmers in the current study areas fatten in the range of 3.35 ± 0.18 to 6.36 ± 0.18 months. However, the present result of fattening duration was much lower than the duration reported by Teshager *et al.*, (2013) who identified 45.6 and 7.8% of the respondent fattened cattle for 16 and 10-15 months, respectively in Illu Aba Bora Zone of Oromia Region. Three to four months duration in fattening was an exemplary work (Tsegay and Mengistu, 2013) to be followed by small holder farmers given there is an effort of trainings such as feeding management and availing credit facilities both for purchase of cattle and agro-industrial byproduct feeds.

5.11. The Selection Criteria of Cattle for Fattening

In the current study areas, rank of selection criteria of cattle for fattening include body conformation, color, height, size and horn in their order of importance from first to last. Similarly, Abdi *et al.* (2013) stated body width as first criteria, followed by coat color (usually white, red and grey 'dalecha') and height to wither with respective index ranking result of 0.188, 0.161, and 0.11. In addition, Shewangizaw *et al.* (2014) stated that the majority of respondents preferred white followed by red colored cattle. Whereas, Sintayehu *et al.* (2010) indicated that breed and color were what producers and co-operatives emphasized while buying cattle for fattening. Sandip *et al.* (2014) reported that straight back bone and straight legs denote good meat production criteria used for selection of cattle for fattening. However, unlike to the current report, regarding the color these authors indicated that coat color played an important role in selection for functional efficiency of cattle in Arbegona woreda, Southern Ethiopia. Thus respondents preferred black coat color for strong survival in the dry season, do not emaciate and high market access. But as far as cattle fattening is concerned, the respondents in the same woreda preferred to rear cattle with grey coat color which they considered to have beef with high fat percentage. Fisahaye (2016) indicated that white and well-arranged small teeth, an elongated body with small age, broad neck and long legs, wide area between two legs, thick and short tail and regular wear of hooves were important traits used for selection for fattening cattle. In a broad sense of the selection criteria, UASDA-CES (2016) indicated major traits of economic value and influencing productive efficiency when selecting desirable beef cattle include reproductive performance or fertility, maternal ability, growth rate, feed efficiency, body measurements, longevity, carcass merit and conformation or structural soundness. Fachbereich (2012) noted that the function of horn is concerning predator defense and competition in resource competition. It is indicative of healthiness and less parasitic load. The other function is thermoregulation because the roots of the horns originates from sinuses of the head, so horn contributes to nasal heat loss.

5.12. Preference of Type and Decision of End of Fattening

Matured oxen and young bulls were the first and the second priority of selection in all study worded areas. Because of the accessible market supply in the study areas, it was accustomed to use a young bull for plowing usually for a year and start fattening then after. Unproductive cows and heifers, old oxen and cows were sequentially ranked third up to last resort. Respondents indicated that cows and heifers could be fattened when they had pregnancy /sterility problem (*Meshena*). Mlote *et al.* (2012) reported uncastrated bulls are used for fattening in the Lake regions of Tanzania. Contrary to this, none of the farmers fatten female cattle (Shewangizaw *et al.*, 2014). In contrast to the current study again, the study of Sisay (2015) in Ethiopia Somali region, revealed that more steers were used for fattening than bulls because bulls were desperately needed for plowing purpose. However, surprisingly, fattening of cattle was not a common practice for both producers and traders in the agro-pastoral areas of Uganda (Denis *et al.*, 2015). Body size increment and anticipation of better price were the first and second priority to make decision to end fattening. However, Shewangzaw (2016) reported that majority of the respondents (56.67%) decide end of fattening considering the rate of liveweight change whereas, anticipation of the current and future price was considered by 40% of the respondents. Similarly, Shitahun (2009) reported that the majority of respondents (84.97) decided end of finishing period by considering live-weight change of fattening cattle with visual observation based on their feed intake and the rest by anticipating the current and future price (15.03%). Intact male livestock show higher growth, leanness of carcass and feed efficiency than the castrated ones as noted by Needham *et al.* (2017). Castration imposes pain on the animal and causes a period of slow growth rate and poorer feed efficiency there are benefits as well. Castration reduces aggressiveness and sexual activity by lowering testosterone levels, and modifies carcass characteristics (AVMA, 2014).

5.13. Technical Support

The source of technical support were the office of agriculture, fellow farmers, parents and relatives, conferences of administration and newspaper and television, for respondents of

the current study areas in their order of importance. In agreement with this study, Daniel (2008) noted that sources of technical support in Borena zone comes from office of agriculture (40%), fellow pastoralists (34.7%), office of agriculture and fellow men (10.7%), radio, newspaper, television (10.7%) and different NGOs working in the area (4%). Unlike the present findings, in Fogera, Amhara region Anteneh *et al.* (2010) reported that 94.2% of respondents were with out information about improved beef production. While the remaining get it from development agents (DA), parents, and radio. However insignificant number of respondents got from NGO's and trainings.

Issues which required technical support in this study were cattle feeds, marketing, health and breeding but there was none respondent who gave account on cattle product utilization like meat and milk. Similarly Daniel (2008) reported cattle health, feed, production and marketing were their major concern (76.7%) while they needed comparatively less support (10.6%) on fattening and other issues.

5.14. Future Increase of the Number of Fattening Cattle

Regarding the opinion of the family on the future number of the beef cattle, all the respondents (100%) replied they want to increase the number of fattened cattle although there was financial and feed constraints. According to the report of West Hararghe zone livestock and fishery resource development office annual reports (Figure 7), the number of fattened cattle was increasing from year to year. Harko (2015) noted that in both rural and urban areas in Ethiopia, smallholder cattle fattening is emerging as an important source of income. In fact in the rural areas, cattle fattening is based on locally available feed resources. Along with this fact, the majority of respondents were being between the age of 31 to 40 and who had finished their high school education could show how much this activity is attracting educated people to be involved (Shewangizaw, 2016). In addition, the global cattle population may increase from 1.5 billion to 2.6 billion between 2000 and 2050 (Thornton, 2010). This is mainly to satisfy the increasing population number and because

of increased urbanization, and increased livestock and livestock products consumption (Hall *et al.*, 2004).

5.15. Cattle Feed Resources

Based on the results of this study, among the major feed resources of the area, thinnings of maize and sorghum crops, grass and weeds were the dominant ones in the wet season and maize and sorghum stover, *teff* and barely straw and grass hay were available in the dry season of the year. This report was in agreement with the study of Gebregziabher and Gebrehiwot (2011). These authors noted that thinning in Hararghe was done after using high seed rate for maize and sorghum and then thin weak and sterile plants and feed to fattening oxen. Thinning will be done in a way that supports the oxen for a longer period of time. The local grasses known in the current study areas include *Burana* (*Digitaria abyssinica*) and *Serdo* (*Cynodon nelemfuensis*) while some of the weeds include *Wela gabis* (*Commelina bengahalensis*), *Balcha* (*Galinsoga parviflora*) and *Orome* (*Amaranthus hybrids*) (Appendix 7) (Stroud A. and Parker C., 1989).

The utilization of such feed resources manily based on season and availability. This result was in agreement with the report of Tsigereda *et al.* (2016) who showed crop residue, natural pasture hay were available during the dry season for fattening cattle in East and West Hararghe selected woredas. Estefanos *et al.* (2014) similarly indicated that crop residue, natural pasture and weeds were the major feed resource for cattle in Hararghe area.

5.16. Feeding Practices of Fattening Cattle

Formal interview and personal observation in the study areas showed that owners of fattening cattle use in door feeding by chopping maize and sorghum stover, wetting the chopped crop residue with salty water, wilting haricot bean leaf before feeding, buying additional supplementary feeds such as wheat bran, oil cakes, maize flour and providing animals sometimes mixing industrial by products with chaffed tef straw to increase palatability and night time feeding of crop residues especially sorghum and maize stover were feeding practices in this study areas and this report was in agreement with the report

by Tsigereda *et al.* (2016); Fekadu and Alemu (1999) and Gebregziabher and Gebrehiwot (2011). Different from the current report, in Amhara region some areas farmers release their fattening cattle to graze after the harvest of cereal crops so they graze crop stubble and standing forage at the beginning of dry season (Aklilu, 2004). Chemical treatments such as the use of urea were not common in the study woredas. However, use of urea treated low quality roughage increases its digestibility and crude protein than the untreated material. Therefore, lactating and fattening animals can be fed with urea-treated low quality roughage because this feed can satisfy their higher nutritional requirements (Girma and Goetsc, 2008).

5.17. Feed Shortage, Seasonality and Coping Mechanisms

There was feed shortage in general but it was aggravated during the dry season of the year (February upto June) in the study areas. This study indicated that the trend of feed shortage in the high and midland agro-ecology was the similar in the different woredas. Abdi *et al.* (2014) reported feed shortage was the major constraint having the first rank and highest index 0.455 among seventeen constraintsts listed. The seasonal feed shortage condition in East Hararghe and West Hararghe woredas especially during the dry season was also mentioned by Bezahegn (2014); Freweini (2014) and Tsigereda *et al.* (2016).

Relying on crop residues stored in the crop field after harvest, buying of supplementatry feed mainly agro-industrial by-products and use of different multipurpose trees like Oda (*Ficus basta*), Welensu (Gorgo) (*Erythrina abyssinia*), Wedesa (*Cordia africana*) and Gerbi (*Acacia albida*) is a common practice. These trees are green during dry season and owners cut the branches and offer to their fattening cattle. These were good coping strategies worth to be mentioned in these study areas. Similar findings were documented by Tsigereada *et al.* (2016) and Jimma *et al.* (2016).

5.18. Indigenous Technical Knowledge of Cattle Feeds and Feeding Systems

Studying ITKs has been contributing a lot to the sustainable development of the livestock sector in most developing countries including Ethiopia. In the present study woredas, farmers used to practice soaking in water overnight and cooking cereal grains, home made rations such as mixing wheat bran, maize flour and *teff* straw, wilting haricot bean crop before feeding somehow to help reduce the effect of antinutritional factors present in the feeds. According to FAO (1994) document, livestock dealers sometimes use fenugreek to tone animals up and give them a transient good appearance. Soetan and Oyewole (2009) noted that generally wilting of plant parts and cooking in water of cereals reduce antinutritional factors residing in leguminous feed. West Hararghe farmers are well known for their best practices and use of indigenous technical knowledge of cattle fattening (Abdi *et al.*, 2013). Generally the physical, chemical and biological methods of treating crop residues increases intake to a certain degree, reduces feed waste, convenient to transport and easy to store (FAO, 2002). In addition treated feeds show higher CP, EE and ash contents (Yilkal, 2015) and animals fed showed limited to higher digestibility and body weight gain (Egbu C., 2014).

Tethering mostly one and rarely two fattening cattle and feeding on cut and carry system of feeding with a diversified indigenous knowledge of feeding was similar to the report mentioned by Teshager *et al.* (2013). In feeding and supplementation strategies in Southern Ethiopia, mixing crop residues (*teff*, barley, and wheat straw, maize and sorghum stover) with enset, sweet potato vines and banana leaves had commonly been practiced to increase intake and palatability of crop residues and mineral lick supplementation was also an indigenous technical knowledge practiced by farmers in the area (Deribe, 2015). Indigenous knowledge on cattle feeding like chopping of straw, mixing of green grass with straw, feeding tree leaves practiced by the rural farmers in Bangladesh (Ahmed *et al.*, 2010). Nyando *et al.* (2013) reported that communal grazing, use of crop residues, feeding animals along rivers, selected trees for browsing, leaf litter and pod and movement during drought were farmer knowledge of existing ITK in fodder management in India. There were in fact a wide range of feeds being used in the study areas. However, the type of feed,

traditional mixing to make home made rations and the level of incorporation of some of palatable weeds requires technical backup from the concerned organizations in the study woredas.

5.19. Watering

Spring and river were the main source of water identified in the study areas. But in the highland the majority of owners of fattening cattle fetched water from springs whereas in the mid-altitudinal areas, the principal source of water was river. Other sources of water used for fattening cattle included mechanical (tap water) and hand pumped water, ponds and a combination of two or more than two of these sources. Similarly Tsigereda *et al.* (2016) reported the main sources of water to be spring and ponds. Estefanos *et al.* (2014) listed out that river, stream, borehole, pond, tap water and lake were found in East and West Hararghe zone selected study sites. Since fattening cattle in the study areas follows stall feeding system, water was carried by donkey or human power. Most producers offer water for fattening cattle at noon time believing this is the time when the fattening cattle become more thirsty and they allow the animals to consume until they become satisfied, limit one jery can (20 liters) or one and half jery can (30 liters) two times per days according to the availability of water in the area. Water shortage especially during the dry season was a major problem raised by respondents living in both agro-ecologies. Abdi *et al.* (2013) also reported similar problems in his study. Population increment, expansion of cropping lands, deforestation, the intermittent drought, the rugged topography, expansion of urban areas and other infrastructures might all contributed in one or another to water shortage.

5.20. Housing

In the traditional fattening system of these study areas, the housing system for fattening cattle included dominantly backyard and farmyard shades. Housing with family members in living rooms had been stopped nearly in all study areas. However, this report was not in agreement with Estefanos *et al.* (2014) in that he reported stall with floor, family partitioning, veranda and kraal in their order of importance. Still different from the current

work, Tsigereda *et al.* (2016) reported most farmers (93.3%) in Fedis, east Hararghe keep all fattening cattle in the house together with the family. The same authors reported that unlike Fedis, majority of the farmers in Habro woreda (96.7%) keep fattening animals in a separate barn. But during personal observaion in the highland *kebeles* of Gemechis and Tullo, a few producers were found to fatten their cattle inside their house but a separate room and in a shade where its top and sides covered with plastic sheets and dry dung was purposively burned to give warmth for the fattening cattle. This is purposely done to decrease the energy expense to because of cold (Bezahagne, 2014). Farmers in Diga woreda, East Wollega use kraal for night time and periodically shift its location to adjacent sites to maintain cleanliness of the kraal and to distribute the manure in the farmland (Dereje *et al.*, 2014).

5.21. Major Diseases and Health Management of Fattening Cattle

Major diseases of fattening cattle in the study areas were Black leg, Pastuerellosis, Lumpy skin disease (LSD), Acidosis and internal and external parasitism mostly thick. This agrees with the general scenario in the country (Shapiro *et al.*, 2015 and Abdi *et al.*, 2013). To prevent and treat diseases, government owned vet clinics personels, private health technicians, and traditional practioners were means of alleviating disease incidence problems in these study woredas. Among the major constraints of cattle fattening practices in the study areas, disease was less important for the respondents. This is because, according to the woreda vetrenary personels, although the problems are there, most fattening animals get dewormed before the feeding regiem begins and take periodic vaccination by the government animal health clinics. The other reason was fattening cattle are penned in a separate sheter so they are not easily exposed to disease during the fattening time and kept in a good body condition so that they could naturally resist diseases. This report agrees with Gebregziabher and Gebrehiwot (2011) in that reduction in incidence of diseases could be the practice of zero grazing in the area beacause allowing cattle to graze in communal grazing areas exposes them for internal and external parasite infestation, reproductive disease such as brucellosis and other contagious diseases. In addition to this, Bezahegn (2014) reported similar results in that respondents ranked livestock disease last

as a major livestock production constraint in Chiro woreda. Tsigereda *et al.* (2016) noted disease seemed less important factor affecting fattening cattle in the study areas. According to Zemene *et al.* (2016), disease was the third major constraint of cattle fattening in Jimma zone preceded by initial capital and feed shortage.

5.22. Major Constraints of Cattle Fattening Practices

Feed shortage, shortage of grazing land, low selling price, shortage of water, high purchasing price and disease were ranked from second to last, respectively in this study areas. The presence of these constraints were more or less confirmed by (Abdi *et al.*, 2013 and Estefanos, *et al.*, 2014) Similarly, Alemayehu (2006) noted that feed shortages and nutrient deficiencies become more acute in the dry season in both the highlands and lowlands in Ethiopia. The feed shortage both in quality and quantity was also mentioned as a constraint affecting cattle fattening in central Southern region (Shewangizaw *et al.*, 2014). Feed shortage, water scarcity and disease were the most important constraints for Begait cattle production system in Tigray (Mulugeta, 2015). In general poor nutrition that is attributed to low nutrient content of commonly available animals' feeds has been ascribed to be the major factor that compromises beef production of tropical cattle breeds (Yoseph *et al.*, 2011).

5.23. Types of livestock Markets

The livestock marketing in West Hararghe study woredas could be categorized into primary and secondary markets according to Getachew *et al.* (2008) who mentioned the livestock marketing classification based on the number of livestock that attend the market per market day. Although lots of livestock trade takes place in the study woredas, the emphasis given to the market places in fulfilling facilities and infrastructure remained poor and the system of trade exposed producers for illegal and exaggerated commission forcibly taken by brokers. Except the stone walled fence of Chiro and Gelemso (Habro woreda) livestock market, the rest had no fence so marketing of fattened cattle conducted on open area and all of the livestock markets in the study areas have no necessary facilities. Similar to this finding, Shitahun (2009) reported that the marketing system in Bure woreda, Amhara region, was characterized by a large number of highly dispersed markets, which

generally lack basic infrastructural facilities like perimeter fencing, cattle pens, weighing scale, watering, feeding, resting, and quarantine place. In general, inadequate market infrastructure, virtual absence of market information system, absence of market oriented livestock production and excessive cross-border illegal trade are among the major challenges that hinder the smooth livestock trade in Ethiopia (Belachew and Jemberu, 2003).

5.24. Fattened Cattle Market Participants

In the current study, the livestock market participants of West Hararghe were producers, farmer traders, brokers, broker-traders, tax collectors, traders and butchers. Similarly, Belay (2013) reported the market participants in East Hararghe are producers, consumers, legal traders, illegal traders, butchers and brokers (middlemen). He also mentioned that legal traders, illegal traders and middlemen were participants of the livestock market in Haramaya, East Hararghe zone. Different from this area in Ethiopia, the market participants of fattening cattle in Bure, Amhara region, were individuals/group consumers, local butchers and cattle traders only (Shitahun, 2009). According to Daniel (2008), marketing actors in Borena zone include pastoralists/producers, producer/pastoralist traders, part-time traders, fulltime traders, butchers, hotel owners, brokers/commission agents and consumers. Teshager *et al.* (2013) indicated that the market actors were producers, consumers, middlemen, restaurant owners, traders and butchers. Similarly, in selected study areas in Ethiopia the market participants include producers, collectors, feedlot operators, big traders, medium or small traders, cooperatives, brokers and exporters (Getachew *et al.*, 2008). But in general, the beef cattle value chain actors found in Ethiopia include small holder farmers, collectors, feedlots, traders, cooperatives, brokers/middlemen and abattoirs/butchers (Harko, 2015). The variation in the number and kind of livestock market participants might be associated with the accessibility, number, species and body condition of livestock in a specific market place. The roles of marketing actors is summarized in Appendix 11.

5.25. Fattened Cattle Marketing Channels and Routes

The marketing channel presented in this study (Figure 12) was not as intricate as cattle marketing channel depicted by Daniel (2008) because there were commercial fattening, live cattle and processing export abattoirs in Borena zone. Shewangizaw (2016) illustrated the marketing channel of beef cattle starting from farmer, cattle trader, whole seller, retailer/butchers, hotels and consumers. The major livestock marketing route in this study is the Adama and Addis Ababa terminal/tertiary markets where from West Hararghe study areas fattened cattle are transported by Isuzi and FSR vehicles. However, based on the discussion with traders, fattened cattle are stressful starting from the loading all the way to their destination. According to Asfaw *et al.* (2011), most stock routes in Ethiopia are characterized by lack of adequate feed, water, and resting places. Tesfaye (2007) indicated that stressful loading and unloading of beef cattle on ISUZU and FSR vehicles were common scenario in Metema district.

5.26. Market Information

Collecting market information ahead of time is an essential issue for successful transaction and obtaining reasonable price both from the seller and buyer side. In the study woredas, the reliable source of market information was own visit. Thus, overall 93% the respondents largely preferred their own market visit ahead of time because they would be more confident in claiming the price of their fattened cattle in the market. Similarly, Daniel (2008) reported that in Borena zone most of the respondents obtain market information preferably by market visit (36.0%), while the other groups (37.3%) mentioned in addition to market visits, they have multiple information sources such as relatives and neighbors. This was done deliberately to some degree keep themselves away from deceiving behavior of brokers and enjoy the premium price. However, Teshager *et al.* (2013) reported that generally the majority of respondents in Illu Ababa Bora zone had access to market information before sale. The source of this market information are neighbours, development agents and relatives each accounting 71.8, 17.6 and 10.7%, respectively. Malede and Yilkal (2014) noted that markets in Ethiopia are dispersed with remote markets

lacking price information. But in many countries livestock marketing service include provision of market information (Azage *et al.*, 2010).

The current methods of obtaining livestock market information simply based on previous market prices and exposed producers for brokers' deception. In addition Ayele *et al.* (2003) noted that the problem associated with brokers is highly linked to the system of marketing whereby market information is private and non-standardized; thus, brokers facilitate the market transactions for a fixed fee. The Ethiopian livestock market information system (LMIS) provides regular livestock prices and volume information to producers, middle men, and traders in most of the major livestock markets in the country. Information from LMIS is available on request via text messaging, email, and on the Internet (Feed for the future, 2016). However, the LMIS supply had not been expanded and reached to producers and traders of the study districts.

5.27. Advice on Cattle Marketing Issues

Out of all respondents, the majority of them did not get advice on different issues. However, only 33% of them stated that they had been advised by development agents (DAs) and woreda administration staffs on different issues of marketing. Mulu (2011) reported that the involvement of projects such as IPMS of ILRI has brought a positive impact through promoting individual and collective cattle fattening and marketing by providing support in terms of credit supply, providing market information on the prices, technical advice, market linkage facilitation, supply of improved forage seed, facilitating training to experts and farmers and organizing experience sharing tours of experts and farmers in Bure woreda, Amhara Regional State.

5.28. Transportation System of Fattened Cattle

Most producers almost in all study woredas used to trek their fattened cattle to the market. But a few of them rent Isuzu vehicles to truck fattened cattle from Gemechis to Chiro market but this was in anomaly with the report of others. Tesfaye (2007) reported that in

Metema district producers, itinerants and cattle traders trekked their cattle to the market place on foot, mainly because using vehicle for cattle transportation was only given permission for licensed exporters. However, in many countries, livestock marketing services include provision of transport of livestock or livestock products (Azage *et al.*, 2010). Moreover, transporting animals by dedicated trucks avoid stress, injuries, weight loss, and deterioration of body condition and death associated to poor transport (Dugasa and Belachew, 2009).

A few of respondents in this study reported that some producers (5%) who preferred to truck their fattened cattle to the big livestock market like Chiro was primarily to avoid physical damage and save market time. There was no resting place, feed and water points on the road. However, producers provide lots of water and feed initially once they decided to bring to market so that most of the fattened cattle have inflated belly. Alemayehu (2006) noted that marketing of live animals is constrained by inadequate infrastructure and transport facilities. When stock are trekked, the absence of stock routes, resting areas, watering and feed points results in substantial weight losses before they reach consumption or market areas. Similarly Dugasa and Belachew (2009) summarized that sometimes during trekking cattle are forced to trek long distances and this inflicts injury, fail to walk and death due to fatigue when conducted by untrained drovers. Weight loss, deterioration of body condition and death of animals are major shortcomings of trekking. Study of Ayele *et al.* (2003) showed that there was a reduction of weight by 69% when cattle were trekked from Guder to Addis Abeba 129.4 km during the dry season.

In the study woredas, the minimum and maximum time taken in general to trek and reach to the near and far markets was 0:15 minutes and 4:00 hours, respectively. As opposed to the current report, Daniel (2008) reported that in Borena zone cattle were trekking for eight days to cover a distance of 250 kms from Moyale to Dubluk.

5.29. Alternative Markets and Preferences

The markets in the study woredas had different marketing potential based on the number of traders involved and relative distance to the main asphalt road. Thus, in Habro woreda,

producers have only one alternative market at the woreda capital- Gelemso and the other alternative markets are very far away to access. But producers in the other study woredas (Gemechis, Chiro and Tullo) have two or more alternative markets to sell. So they are more advantageous than producers in Habro. In South Omo Zone of SNNPR, beef cattle producers have alternative markets in village, woreda and zonal livestock market which are found on average at 8.21, 16.95 and 43.31 kms, respectively (Yidnekachew *et al.*, 2016).

Hirna and Debeso livestock markets have location advantage in common because the main Addis Ababa to Harar/Diredawa asphalt road runs through these towns and many traders participate in these markets at different market days. A few respondents (8%) stated that they enjoyed both proximity and relative price advantage. Berhanu *et al.* (2007) summarized some potential cattle markets in Ethiopia. Based on their report in Alamata woreda, cattle sales was an important source of cash income making the woreda an important cattle supplier to the regional capital of Mekelle. Fogera woreda is an important supplier of cattle in Amhara Region. Metema woreda shares an extensive border with the Sudan. Therefore, live animal trade to Sudan is an important activity. The same authors noted that Ada'a-Liben woreda is an important supplier of livestock (cattle and shoats) to the surrounding markets, including Addis Ababa. Its proximity to Addis Ababa and its location at the gate of transport to the eastern and southern parts of the country makes it an important livestock market area.

5.30. Market Selling Practices

The majority of respondents in the study woredas sold their fattened cattle to traders. As opposed to this report, both producers and traders are involved in selling of livestock directly to consumers (Berhanu *et al.*, 2007). However, few of them reported they sold for local butchery men. Traders and local butchers were the main buyers of fattened cattle. Berhanu *et al.* (2007) reported that traders may travel hundreds of kms for the business.

5.31. Price Determination

Price determination was done largely through negotiation between buyer and seller (52%) in the study areas. While 30% of the respondents replied that the final decision of price was made by middle men (brokers) without whom the transaction was virtually impossible. In Ethiopia livestock market price is determined through ‘eye-ball’ pricing and weighing livestock is uncommon (Asfaw and Mohammad, 2007). This result was in agreement with Berhanu *et al.* (2007) and Daniel (2008). Belay (2013) stated the involvement of brokers (middlemen) in the marketing systems were considered as the major constraints the farmers faced. However, in Borena zone the majority (73.2%) of the respondents stated that the brokers do not have any influence when they sell their cattle (Daniel, 2008) even more contrasting to the present study, even if producers claim initial price, majority of price was determined by traders in South Omo Zone (Yidnekachew *et al.*, 2016). Still 11% of the respondents in this study indicated that they claim the price and keep in firm stand of the brokers bargain and finally sell their cattle.

5.32. Price Variation in Different Markets

The majority of the respondents (73%) from overall the study woredas indicated that there was fattened cattle price difference across different markets in the zone. This is further confirmed by 60, 77, 55.5 and 73 % of the interviewee in Habro, Gemechis, Chiro and Tullo woredas, respectively. Participants of the focus group discussion in each study woreda emphasized this idea in that the price of fattened cattle in the markets was different based on the number of available buyers, brokers, sellers and accessibility of the market location in relation to the main Addis to Harar/Diredewa asphalt road. According to Tesfaye (2007), generally livestock markets which are far from the main asphalt road benefited less from the sale of fattened cattle because buyers need markets relatively near to the asphalt road for ease of trucking. Teshager *et al.* (2013) reported that price variation for selling cattle across different markets and overall 85% of the respondents agreed the existence of price variation in Becho, Algie and Chewaka livestock markets due to difference in the number of traders, proximity to urban centers and availability of

infrastructure. Therefore, producers who live far away from main asphalt road could possibly benefit from expansion of road construction in their locality.

5.33. Seasonal Price Variation

The seasonal price variation of fattened cattle in the study areas was highly associated with the beginning and end of plowing period, availability of feed and to some extent to presence of Christian festivals. This was in agreement with Getachew et al. (2008) who stated that the livestock markets in most parts of Ethiopia are characterized by seasonality in flow and prices of animals. At the end of the plowing which is mostly in June, farmers in this study area, would divert their attention to fattening activity. Therefore, during the months of October to January, the supply of fattened cattle in the market increased which was automatically reflected by a relative decrease in the price. On the contrary, the months between February and June, are characterized by less feed availability and more emphasis was given to crop production and buying of drought oxen. The trend of season dependent fattening was somehow similar to the report of Shitahun (2009). The seasonality of market price was indicated as a challenge for cattle fattening activity in West Hararghe (Bezahegn, 2014). Many authors (Asfaw and Mohammad, 2007; Gebregziabher and Gebrehiwot, 2011 and Kefyalew, 2011) noted that prices are usually fixed by individual bargaining and depend mainly on supply and demand, which was heavily influenced by the season of the year and the occurrence of religious and cultural festivals. The seasonal variation was expressed in feed availability which has a direct negative impact on cattle production in the area (Estefanos, 2014). In Fogera, Gojam farmers buy oxen during the dry season especially from January to March for traction. After feeding with grass and crop residue, they sell for beef market from May to September so as to gain premium prices (Anteneh *et al.*, 2010). In the current study however, supply increases starting from September to January in line with the availability of feed. Feed scarcity and quality deterioration during the dry season and high feed cost have reduced incentives for feeding regimes resulting in non-uniform supply of beef cattle to the market (Harko, 2015). In contrast to this current report, price in the market rises when there is high amount of feed available in Borena pastoral area because body condition of animals improves and used for milk production for family consumption (Daniel, 2008).

5.34. Animal Factors Associated with Price

In the study areas, factors associated with the animal such as color, age, sex, body conformation and health of all the body parts highly affected price during negotiation between the buyer and the seller at the market. White and red color were given more attention than black. Cattle with the age range of 3 to 4 years were chosen to start fattening. Male oxen were more preferable than females. Additionally long height, wide chest, wide abdomen, prominent hump and active and healthy looking animals were more desired. Tesfaye (2007) similarly indicated age, size and color of cattle were factors affecting the supply, demand and price of cattle marketing. Thus younger age, uncastrated, large frame size and good body condition, as well as colors other than black were highly demanded in Metema cattle market. Anteneh *et al.* (2010) also noted that cattle of good body condition and younger age are preferable on the market, but unlike the present study, coat color was not a criterion for selection beef animals. Prices paid will reflect buyers' preference for various animal characteristics (e.g. sex, weight, age, condition, breed and color), the season of the year, the purpose as to whether the animals are purchased for consumption, breeding, fattening or resale, and buyer's and seller's bargaining skills (ESAP, 2003).

5.35. Perception and Trend of the Prevailing Price

Achieving better price is the first and foremost reason for the majority of respondents in the study areas and this was in line with the report of Yidnekachew *et al.* (2016). Although there was variability in perception of the prevailing price for fattened cattle in the study woredas, the majority of producers agreed that price was attractive in the area because there was an increasing demand for fattened cattle in the market. However, most of these respondents were disappointed with the influence, unethical behavior and misconduct of brokers. Similarly Mulu (2011) reported that the existence of meat outlets and livestock markets offering attractive prices and good marketing arrangements makes it attractive for farmers to invest in cattle fattening. Contrary to this situation, in Lemo and Soro Woredas of Hadya zone farmers prioritize price third among the major constraints fattening cattle practices in the area following feed scarcity and disease (Gezu *et al.*, 2014). The outlook about marketing of cattle in pastoralist areas is different in that these people have limited supply response to prices due to few investment opportunities, resources required for livestock production are free, self-sufficient and thus, there is a short supply of consumer goods. They are more interested in building large herds and flocks for cultural prestige, accumulating wealth, paying dowries (social functions), and as drought coping mechanisms, than building a large herd for increased commercial off-take (Asfaw *et al.*, 2011). But generally in Ethiopia, increased export activity reveals export demand that adds to and supplements the domestic demand for livestock. Any increase in demand, in the presence of a given domestic supply, will increase livestock prices (Hailemariam *et al.*, 2009).

The involvement of brokers/middlemen in every segment of the marketing chain is the special feature in most of the livestock market in Ethiopia to provide the service of matching buyers and sellers and facilitate the transaction (Getachew *et al.*, 2008). However, the majority of respondents of the current study areas were blaming brokers involvement and unfair reduction of price in favor of gaining exaggerated ‘commission’ from each mediation between seller and buyer. Tsedeke (2007) indicated that farmers complain on brokers about the high commission charges, misbehavior, mis-information and repel buyers if not involved.

According to the study made by BCaD (2015), it was revealed that high price is captured along the value chain by the brokers (25-50%) than by those adding more value. It is observed that the channel from producer to final market would include one to three brokers/middlemen. Each successive middleman took a larger fee and added little if any value further escalating the price of the end product-meat. To avert this situation, organizing farmers through cattle fattening and marketing co-operatives can have many advantages over the individual cattle fattening farm (Tesfaye, 2005). Thus introduction of grading system and making available information on price of terminal markets could solve the problem. It was a common practice to classify cattle grades in Ethiopian markets. Estimation of weight from linear body measurements and use of the same for price determination can be initiated in areas of Haraghe where traditional fattening has reached good and promising stage.

5.36. Reason and Decision to Sell Fattened Cattle

In the study areas, the majority of respondents indicated that the reason of sell of fattened cattle is to earn profit and use the the money for supporting their livelihood, while the rest replied paying school fee, cover medical bill and government debt. Anteneh *et al.* (2010) noted that generation of income to meet unforeseen expenses is the main reason for selling livestock in the highlands of Ethiopia. Seid (2012) stated that in mid and highland altitude areas, the most important reasons for selling their cattle are filling food gap, loan repayment and forced sales during dry period and crop planting seasons. While cash need to buy cereal food during the dry season, shortage of feed and disease are main reasons that trigger pastoralists to sell their cattle in the market. Similarly, in the traditional fattening system in North Gonder, cattle are usually only sold when they are too old for these purposes, drought or cash shortages force people to sell (Malede and Yilkal, 2013). In the study woredas the majority of HHs indicated that husbands reached decision by negotiating with their wives, decision made by their own and final decision was reached by family in their order of importance. According to Daniel (2008), in pastoral area of Borena, final decision

for the sale and purchase of beef cattle was reached through negotiation, husband and husband and wife according to their order of importance.

5.37. Sense of Ownership and Impact after Selling

For the majority of the respondents (67%) they did the right thing so they did not feel sympathy after selling. While 23% of them were initiated to buy replacement fattening cattle just after selling their fattened cattle to maintain their ownership status. A few of them 5%, 4% and 1% responded they experienced fear of losing status in the society, fear of losing their money and potentially become poor, intended to raise another, respectively. Similarly, in Borena pastoralist area, Daniel (2008) reported that the majority of respondents mentioned nothing would happen once they sold their beef cattle, but either raise or buy another as a replacement stock. According to Anteneh *et al.* (2010), animal ownership ensures varying degrees of sustainable farming and economic stability in Ethiopia.

5.38. Consumption of Beef

All respondents in Habro and Gemechis, while the majority in Chiro and Tullo woreda, respectively consume beef at their home. Whereas, 40 and 8% of the respondents from Chiro and Tullo study area did not consume beef. However, there was no frequent consumption of beef rather, they slaughter and consume once a year after cereal harvest and traditionally they slaughter an ox in a group (*Kircha*) in January (*Tarri*), during religious festivals (*kircha*) mostly by Christian and sometimes buy from butchery houses in nearby town especially during market days. According to most respondents view in the study areas, most Muslims people during their festivals prefer to slaughter sheep and young bulls in the absence of sheep rather than fattened cattle. This somehow agrees with the report of Belay (2013) in East Hararghe, cattle are not the main source of meat for home consumption and are rarely slaughtered for special ceremony of religious festival when a group of farmers jointly purchase an ox or cow for slaughter. However, goats are more commonly slaughtered in different occasions. Many Ethiopians don't consume adequate amount of meat (Malede and Birhan, 2014). The FAO estimates that between 1997-99 and

2030, annual meat consumption in sub-Saharan Africa (excluding South Africa) will increase from 9.4 to 13.4 kg per person. Growth in human population, increasing incomes and changing consumer tastes are among the main drivers for the rise (Ilu and Annatte, 2016).

5.39. Challenges and Opportunities of the Market

During the discussion with focus groups and key informants, the challenges and opportunities concerning cattle fattening and marketing mentioned were summarized as follows:

5.39.1. Challenges

- Lack of support service institution in terms of supplying credit for fattening and up to date livestock market information.
- Inadequate efforts on motivating farmers to form fattening and marketing co-operatives.
- Unethical, unfair and fraudulent behavior of brokers and their involvement to obtain high commission.
- The seasonality of supply of fattened cattle which arises from seasonal feed availability

Many of these challenges were generally mentioned in (ATA, 2016 and Alemayehu, 2006; BCaD, 2015; Hailemariam *et al.*, 2008).

5.39.2. Opportunities

- Presence of abundant livestock, farmers having good and better practices and long-time experiences in fattening.
- Tethering and stall feeding help better management of the fattening cattle to initiate market oriented fattening.

- Availability and utilization of limited crop residues, cereals and some agro-industrial byproducts for fattening in the rural area helped producers to bring fattened cattle to the market continually.
- Availability of premium price paid for fattened cattle and taking fattening as a coping up strategy against the recurrent drought attracted more and more producers.
- Easy access for transportation and participation of traders coming from big towns and cities in the transaction.
- Nation-wide known prominent fattening practice and consumer's preference for Hararghe sanga.
- Increased population and livestock products demand locally and internationally.

5.40. Sensory Evaluation of Urea/EM Treated Stover

Generally in this study, the pH values of all the treated stover were 4.17, 4.30 and 4.27 for T2, T3, and T4, respectively. The pH values in the current study were comparable to the report by Syomiti (2009) which were within the range 3.9-5.4 after evaluating the feed value of maize stover treated by EM which is acceptable for high DM silages. The present pH values represented characteristics of a good silage. Liu Jianxin and Guo Jun (2002) classified silages based on their pH values as excellent, good, average and bad for values below 4, 4.1 and 4.3, 4.4 and 5.0 and above 5, respectively. The current results might be due to the effect of treating the sorghum stover with fermentation enhancer additives such as EM, urea, and EM and urea mix in water solution. In addition the EM solution contains molasses for microbial activation. Otieno *et al.* (1990) obtained a pH of 4.20 and 4.13 with and without molasses, respectively of sorghum silages ensiled for two months. Keskin *et al.* (2005) reported a pH value of 4.23, 5.54 and 4.84 for control, urea and urea plus Molasses treated silages, respectively with different sorghum varieties harvested at the milk stage. However, Keskin *et al.* (2005) reported higher (5.54 and 4.84) pH values than the result obtained in the current study.

The results of the visual appraisal, color and smell in this study were an indication of good quality and obviously show EM as a biological inoculant and urea as a chemical additive could facilitate the fermentation process. These results agree with those of Abera (2015), Yonatan (2010), Hirut *et al.* (2011) and Demeke (1991). In this work, sorghum stover treated with urea (T3) showed dark brown color, having pungent smell, absence of mold and soft texture. Selma (2001) reported similar results after treating sorghum stover with 2 and 4% urea. Otieno *et al.* (1990) reported that silage of sorghum stover with and without molasses showed moderate appearance and smell which is a little bit less than brownish color and typical silage without any foul smell which is a good silage characteristics. Proper chopping, uniform sprinkling of the solution, wetting the stover by the solution and pressing to avoid air space and proper packing of the chopped stover in this study ensured good result of anaerobic fermentation. Therefore, all treated stover was well preserved. Ammonia which was produced during the fermentation process could inhibit mould growth (Pantaleo, 2016). This imply that instead of offering dried sorghum stover, farmers of the study area could use urea treatment of stover by using fertilizer grade urea and packing in plastic bags available in the market to enhance productivity.

5.41. Chemical Composition and *in Vitro* Dry Matter Digestibility of Sorghum Stover

There was no significant variation in the DM of contents of control and treated silages in the current study. Similarly, Keskin *et al.* (2005) reported that there was a non-significant variation in the mean values of the DM of urea (29.46%) and urea plus molasses (32.35%) treated silage over the control (30%) of sorghum harvested at the milk stage. Asma and Mohamed (2008) also reported a non -significant variation in DM content of untreated and with 3 and 5% Rabaa ash alkali treated sorghum stover. Dante *et al.* (2015) observed no difference between treatments for DM, OM and lignin. However, Samsudin *et al.* (2013) reported significant variation in DM cotents between untreated and biologically treated rice stover. Keskin *et al.* (2005) indicated that silage DM content generally increased with the addition of urea plus molasses. But urea did not affect DM content compared to the control. Fiber fractions for the control (T1) in the current study were recorded 77.77, 54.97 and 9.63

for NDF, ADF and ADL, respectively. These values were comparable to the range of values which were 59.9 to 79.3%, 46.4 to 70.0 and 9.2 to 13.5% for NDF, ADF and lignin in four local sorghum varieties in Sudan (Asma *et al.*, 2015).

Sorghum stover inoculated with EM and EM plus urea had resulted in increased level of ash as compared to the control. This might be attributed to the nature of molasses itself that it has naturally high level of minerals. Abdalla (2010) and Assefa *et al.* (2013) reported molasses had 12.4 and 18.4 % ash, respectively. Similarly, Yonatan (2010) reported that the total ash contents increased because of dilution of coffee husk with different levels of chopped grass hay and due to the effect of EM because molasses naturally has high level of minerals. T3 also showed slight increase in the ash content. Getahun (2014) reported that urea treated wheat straw showed a slight increment in Ash (mineral) content over the untreated one. Similarly, Selma (2001) reported that the proximate analysis result of treated and untreated sorghum stover showed that the percent ash content increased from 8.76 to 12.77% as the urea level increased from 2 to 4%. However, different from the current result, Abdalla (2010) reported a decrease in the ash content of sorghum husk (*butab*) when treated with urea. Similarly, Elkholy *et al.* (2009) also reported a decrease in the ash content of urea and yeast with molasses treated corn silage.

In general, the OM content of the sorghum stover has decreased in the order of T2 < T3 and T4 < T1 (untreated) and this might be attributed to the molasses added a starting additive for EM increases the number of microbes and these eventually degrade the OM and ammonia released from urea modifies the lingo-cellulose bonds increasing the nutritional value (Higa and Wididana, 2007; Cañeque *et al.*, 1998).

The NDF and ADF values in T2 were lower than the control. However, there was a significant increase in IVDMD value in T2. Similarly, Abera (2015) reported a decrease in the values of OM, NDF and ADF fractions of treated barely, wheat and oat straw but an increase in the values of percent IVOMD values for the three straws. Samsudin *et al.* (2013) also found lower values of NDF, ADF and ADL in fungal and fungal plus EM-treated rice straw than the untreated one.

The CP value obtained in the current study for untreated sorghum stover was very low and it was comparable with the 3.1% (Seyoum *et al.*, 2007) and similarly, Akinfemi *et al.* (2010) reported that the crude protein content of sorghum stover to be 2.54%. Blümmel and Parthasarathy (2006) reported a range of CP value from 2.88 to 3.88 % for six sorghum types in India. However, Adugna (2007) and Gemiyo (2015) reported a CP value of 5.6 and a range of 7.3-8.3%, respectively. In addition, Heuzè *et al.* (2015) reported that the crude protein content in sorghum areal part fresh ranges from 2.5 to 16.3 %. Varietal difference, agronomic practices, and the time and stage of harvest might attribute to the difference in CP. In general, Owen, (1994) indicated that cereals crop residues are low in nutritive value because of their relatively low digestibility, low crude protein content and low content of available minerals and vitamins.

Generally, a considerable change in the CP values of the treated sorghum stover was observed in this study. The CP content of EM treated sorghum stover increased from 2.93 (untreated) to 5.33% (increased by 81.9%). Comparable to the current values, Batool *et al.* (2013) reported that treatment of *Sorghum halepense* with EM and molasses has increased the value of the CP from 7.62 (control) to 10.37%. Samsudin *et al.* (2013) reported that fungal-treated rice straw was inoculated with EM, there was a significant increment in CP content (5.96 %) of the rice straw compared with control (5%). Akinfemi *et al.* (2010) reported that the crude protein content of fungal treated sorghum stover increased from 2.54 for the control to 4.5% for *Pleurotus ostreatus* and 4.59% for *Pleurotus pulmonarius* treated substrates, respectively. Coffee pulp mixed with different proportion of grass dominated by *Pennisetum clandestinum* ensiled with EM improved the CP content from the range of 10.7-11.5 (control) to 12.8 – 14% (Yonatan, 2010). EM treated dry maize stovers ensiled with spent brewers' grains has shown good silage stability and increased in CP content (Syomiti *et al.*, 2009). EM treated and ensiled rice straw was reported to have CP content 4.98% DM from the untreated 3.46% in the untreated (Lemma and Endale, 2017). The increase in CP content of EM treated sorghum stover might be attributed to the microbial growth and proliferation during the ensiling process. But the difference in CP

value of the different treatments could be due to the type of treatment, the dose of EM and molasses used and the management of silage.

Maqbool *et al.* (1997) reported that by degrading the lingo-cellulosic contents of rice straw, more nutrients are made available for ruminal micro flora, which in turn will sustain the longevity of the microbes. Mahesh and Madhu (2013) indicated biologically treated roughages have higher digestibility for most of the nutrients (both cell walls and cell solubles) with an increase in crude protein content as compared to untreated material, besides ensuring more fermentable substrates in the rumen.

The increase in the CP value of urea treated sorghum stover was comparable to the report of Mehari and Asghedom (2010) who stated urea treatment sorghum stover was effective in upgrading the CP content by 79.7% (from 6.25% to 11.12%). There was 14.2% CP value in urea treated maize stover reported by Bareeba and McClure (1996). Fernandes *et al.* (2009) reported CP values of 7.9, 15.9, 23.8 and 31.8% when urea was applied during sorghum ensilage for urea doses of 0, 2.5, 5.0 and 7.5%, respectively. Ngele *et al.* (2009) reported that urea treatment of rice straw had remarkably enhanced the CP value from 4.44 to 12.35%. Lemma and Endale (2017) similarly reported that rice straw treated with urea increased in CP value from 3.46 to 5.41% DM. Fonseca *et al.* (1998) also reported that urea-treated rye and wheat straw had CP value of 10.4 and 11.5%, respectively. However, Selma (2001) obtained a CP value of 6.06 and 7.35% after treating sorghum stover with 2 and 4% urea, respectively. Similarly, Wambui *et al.* (2006) reported that the urea treatment improved the CP content of maize stover from 5.1 to 8.3%. Batool *et al.* (2013) also reported a range of CP values of 7.61 – 9.24% in urea treated different species of matured grasses which were initially having a range of 5.70 – 8.51% CP. These CP values are lower than the value reported in the current study. The significant increment of CP value for urea treated sorghum stover in the current study shows the effectiveness of urea treatment in low quality roughages such as sorghum stover. Nguyen *et al.* (2001) indicated that ammoniation of low quality feed with urea or ammonia solution increases levels in crude protein content. Chenost (1987) also reported that treatment with urea enriches the nitrogen content of the feed, multiplying it by two or three times its initial value at the average urea dose of 5-6 %

of the DM. In general, the type and quality of crop residue, the temperature, dose of urea applied, duration of treatment, the moisture level of the stover are important factors that contribute to the effective fermentation as indicated by Teshome (2009) and Cañeque *et al.* (1998). Additionally, sorghum variety and stage of maturity are other factors which affect silage quality (Keskin *et al.*, 2005). Similarly effective micro-organism plus urea treated (T₄) sorghum stover in this study had increased the CP value of from 2.93 to 8.73%. Nasia *et al.* (2013) reported that treatment of four different species matured grasses with EM, molasses and urea had increased the CP value from range of initial 5.70 to 8.57 to that of 10.45 to 12.42%.

The EM treated sorghum stover showed lower values for NDF, ADF and ADL than the untreated (control). In consistent with these results, Abera (2015) also obtained lower values for NDF, ADF and ADL in the EM treated barley, wheat and oat straws, respectively than the untreated straw. Similarly, Akinfemi *et al.* (2010) reported lower values of NDF, ADF and ADL in sorghum stover treated with white-rot fungi than the control. The authors further discussed that the decrease in the fiber fractions may be the result of cellulase enzyme secreted by cellulolytic fungi which act on fiber fractions. Samsudin *et al.* (2013) reported among the rice straw groups treated with fungi and fungi and EM (T1 and T2), there was reduction in the mean values of NDF and ADF when compared to the untreated rice straw (T1) and Elkholy *et al.* (2009) reported the same trend of decrease in crude fiber fractions in corn silage. Lemma and Endale (2017) reported that the values of NDF and ADF decreased while the value of ADL increased in EM treated rice straw.

The urea treated sorghum stover showed lower NDF value however, the ADF and ADL values for the same treatment were higher than the untreated stover. This result was in agreement with Mesfin *et al.* (2009) who reported lower NDF value (75.9%) for urea treated than untreated (77.2%) wheat straw but ADF and ADL values were higher (54.6 and 9.9%) for the urea treated wheat straw than the untreated straw value (48.2 and 7.9%), respectively. Lemma and Endale (2017) reported that there was a decrease in the value of NDF but increase in ADF and ADL in urea treated rice straw. Cañeque (1998) indicated the drop in neutral detergent fiber (NDF) of straws treated with urea, in comparison with

the control straws was essentially due to the partial solubilization of the hemicellulose in barely straw. In fact, the degree of solubilization increases with the initial moisture level of the straw. Whereas, Hassoun *et al.* (1990) indicated the acid detergent fiber (ADF) content of the straw generally increases with the urea treatment which is still favored by a high moisture level. The same trend of lower NDF but higher ADF and ADL values were found in urea and EM treated sorghum stover in the present study. However, in contrast to the current study, Keskin *et al.* (2005) reported NDF and ADF values of urea and urea plus molasses treated sorghum stalk were lower than that of the control. Elkholy *et al.* (2009) reported a decrease in the crude fiber content of corn silage treated with urea and yeast with molasses.

In this study, there was also an increase in IVDMD values of all the treated sorghum stovers over the untreated one. There was an increase in IVDMD values of EM, Urea and EM plus Urea treated sorghum stover than the untreated T1 (49.83). The values were 51.07, 54.37, and 51.80 % in T2, T3 and T4, respectively. Regarding the *in vitro* DMD of untreated sorghum stover, Reddy *et al.* (2010) and Adugna (2008) reported an IVDMD values of 50.5 and 59.5%, respectively. However, Madibela *et al.* (2002) reported that *In vitro* dry matter digestibility of twelve local sweet sorghum landraces harvested at dough stage showed an average 78%. The highest IVDMD value was recorded in T3 which could be mainly attributed to the effect of non-protein nitrogen source-urea. Cañeque *et al.* (1998) stated that the ammonia released from urea modifies the ligno-cellulosic bonds, which in turn increases its nutritional value. The value of IVDMD of urea treated sorghum stover in this study was comparable to Elnazeir and Suaad (2013) who reported IVDMD value of 52% after 15 days of fermentation of sorghum straw (94% DM) treated with 5% urea. In agreement with the current result, Smith *et al.* (1989) found that *in vitro* digestibility was unimproved after seven days incubation, but was improved after 21 or 35 days. Mesfin *et al.* (2009) reported there was an increase in IVOMD by 19.6 % (from 45.5 to 54.4%) when wheat straw was treated with urea. Similarly, Aregawi *et al.* (2013) reported that *in vitro* OM digestibility of the sesame straw increased by 33% (from 32.8 to 43.5) in response to treating it with a 4% urea solution.

5.42. In sacco Dry Matter Degradability

The rapidly soluble fraction (a), the insoluble but potentially degradable fraction (b), the potential and effective degradability (PD and ED) values were in the order of T3>T4>T2>T1. The difference in degradability values might be caused by the effect of the different additives used in the study. The degradability fractions a, b and PD values for T1 (untreated sorghum stover) in this study were comparable to the results for degradation characteristics of rice offal reported by Ikhimioya *et al.* (2005). All treated sorghum stover showed higher degradability when compared with the untreated. This result was comparable with the general trend of increment in degradable fraction values of sorghum stover treated with rabaa ash alkali (Asma and Mohamed, 2008). Among the treated groups, the highest increase in DM degradability fractions was observed in T3. This could be due to higher CP and lower NDF (cell wall) content reported in this study. José Luis (2003) stated that degradation of DM has a negative and positive correlation with the contents of fiber and CP, respectively of Lucerne. The current result corresponded to the general trends of the works of Asma and Mohamed (2008) and Niemat (2006). In general, unlike the control, the higher soluble fraction (a) of the three types of treatments might explain how much urea treatment is effective towards the increase in CP and decrease in NDF values. The insoluble but potentially soluble fraction (b) for urea treated stover was higher than the other treatments. In relation to this, Orskov (unpublished data) illustrated that roughages can be upgraded by chemical, biological or physical means or by genetic selection by concentrating on any of the three factors a, b and c. Chemical treatment of roughages in this regard, has the greatest effect on the b value.

The higher potential degradability (PD) values of urea treated (86.04%) followed by urea plus EM treated sorghum stover (81.03%) might explain the higher washing losses and lower NDF values as compared to the control in the present work. The values for PD for the control and the treated sorghum stover in this study were comparable to the results of Tesfayohannes *et al.* (2013) who reported 91.2, 81.2, 79.9 and 73.3% of PD for oat hay, barely straw, maize stover, and wheat straw, respectively after treating with urea. Zhang

and Yan (2002) reported the maximum rate of degradation for ammoniated barley reached 77.1 from 52.1 % in untreated straw.

5.43. Ruminant Degradability of DM

The DM degradation increased with increasing the incubation time and reached maximum at 96 hours in all types of treated sorghum stover in this study. The increased DM degradability with time was a good indication of nutritive value improvement by the biological (EM), chemical (urea) and EM plus Urea treatment on sorghum stover. However, among the three types of treatments, urea treated sorghum stover showed higher values of DM degradability at every hours of rumen incubation starting from six hours. This might be related to the increase in CP and decrease in NDF content in urea treated sorghum stover. A similar general trend of increase in ruminal degradability was reported by Zhang and Yan (2002); Asma and Mohamed (2008) and Syomiti *et al.* (2010). With regard to roughage degradation, Wilson (1994) indicated that the bleaching effect by urea results in the breakage of the ligno-cellulose bonds effecting an unlocking of the once unavailable N to the rumen microbes resulting in their proliferation and increased dry matter digestibility. Smith (2002) also indicated urea breaks down the ligno-cellulose bonds of the residue, increasing rate and extent of rumen microbial digestion and as well, it improves the nitrogen status of the residue. Ørskov *et al.* (1980) stated that poor quality roughages require 48 to 72 hours to reach their potential degradation. However, the highest potential degradation was reached at 96 hrs in this study.

The mean values of ruminal degradability of DM of the T2 and T4 at 72 hours in this study was lower than the value reported by Lawrence (2010) in that the rumen degradability of 8 and 10 day yeast treated maize stover (89.93 ± 4.16 % and 95.61 ± 4.22 %, respectively) were significantly ($p < 0.05$) higher than the control (43.18 ± 4.78 % for maize stover) at 72 hours. The EM used to treat the stover has beneficial micro-organisms which secretes enzymes that can degrade the fiber and at the same time enhance the number of microbes (microbial protein) which can add up to the CP value of the residue. Maqbool *et al.* (1997) indicated that the mico-organisms in the EM are responsible to the DM degradability of

lignocellulosic contents improving the nutritional value of the rice straw and affect the weight gain of animal. Mahesh and Madhu (2013) suggested that biologically treated roughages have higher digestibility for most of the nutrients (both cell walls and cell solubles) with an increase in crude protein content as compared to untreated material, besides ensuring more fermentable substrates in the rumen. Therefore, the results of *in vitro* and *in sacco* experiments showed urea treatment improved digestibility of sorghum stover. So producers in the study would be able to treat sorghum stover with urea, ferment and feed to fattening animals at the recommended level and with the technical support from the development agents and extension experts.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

- The participation of female households in cattle fattening activity was insignificant and this might signify how far most of them were at a distance of access for better financial resources.
- Regarding the educational background of respondents, majority of them were illiterate suggesting that there was lack of initiation to organize and form cooperatives and to adopt new technologies and exposure to fraudulent brokers.
- The young and active age group HHs were the majority to participate in the cattle fattening activity. The work was profitable and capable of attracting this age group.
- Selling was the primary objective of rearing and fattening of cattle in the area so as to get income and fulfill the food the requirement in the household.
- All members in the family of house holds in the study were as more or less were partaking in different activities of cattle fattening. However seasonal labor shortage was the common problem in the study area.
- The existence of long time experience in cattle fattening suggested accumulated indigenous technical knowledge that transits from generation to generation. However, scientific technical back up is needed in the formulation of feeds and some safe use of weeds for fattening animals.
- Young bulls and mature oxen were first priority for fattening by most respondents since there was an easy access for purchase of replacement bulls from the local markets. Whereas, unproductive cows, heifers, old oxen and cows were sequentially third up to last resort to be fattened. Traders bring young bulls from

the lowlands of pastoral areas so producers use bulls for one term plowing and then feed for fattening.

- Producers usually castrate bulls obtained from local cattle either from their own stock or purchased from local markets while bulls coming from lowland pastoral areas were directly fattened without castration.
- There were differences in the mean number of cattle per fattening period, fattening duration (months) and frequency of fattening per year and age (years) of fattening between agro-ecologies and among woredas.
- Tethering and cut and carry system of feeding was the usual way of fattening. Industrial by products mainly wheat bran and oil cakes and locally used concentrates such as maize flour, boiled cereal seeds and crop residues major important feeds in the area. The major crop residues used for feeding were sorghum, maize stover and tef straw in their order of abundance.
- There was less incidence of diseases of fattening cattle in the study areas because of deworming before fattening started by most producers and use of regular vaccination. In addition to this, better body condition of fattened cattle contributed to their ability to withstand diseases. In a few cases they might experience bloating from excess feeding of concentrates. But in general, the major diseases of fattening cattle reported in the study areas were black leg, pastuerellosis, lumpy skin disease (LSD), acidosis and internal and external parasitism.
- Feed shortage, shortage of grazing land, shortage of water and low selling price of fattened cattle were major constraints of cattle fattening practices in the study areas.
- The market participants of the study woredas were dominantly producers, farmer traders, traders, brokers, tax collectors, trekkers and butchers. Producers, farmer traders and traders were higher in number as compared to brokers, broker traders,

tax collectors and trekkers. There was high influence of brokers in the livestock market in West Hararghe zone.

- Information about prevailing price was majorly obtained through a repeated visit of livestock market one to two weeks prior to producer's decision of sell and they prefer to do this more than other ways of getting information.
- Technical assistance or advice regarding the fattening work had not been given for the majority of producers. However, about one third of them got advice from DAs and administration meetings on different aspects of marketing.
- Majority of the producers trekked fattened cattle to the market while a few of them used trucking and both means and in both agro-ecologies there was no problem of access of roads from village to the main road or to the market.
- There was price variation across the different markets based on the number of traders, proximity to the main Addis to Harar/Diredawa asphalt road and accessibility to transportation facility and the degree of influence of brokers.
- Price of fattened cattle was dictated by season of the year which was highly attached with the availability of feeds and festivals. So price of fattened cattle becomes higher during months of May up to October - period of feed shortage and lower between November up to January which was a time of plenty of available crop residues and supply of fattened cattle was higher.
- Health of all the body parts, body conformation, color and age of the animal were major factors determining the price of fattened cattle.
- There was a good perception about the prevailing price among producers in addition, the majority of them indicating the trend of fattened cattle price was increasing from time to time.

- Many factors contributed to the final decision of the end of fattening period; among these were body size change brought about by feeding supplementary feeds, anticipating current and future price, feeding length and the demand of cash for immediate purpose.
- There was high ambition and initiation to expand the fattening work and enhance the number of fattening cattle even without availability of sufficient technical back up, absence of enough feed and lack of credit facilities.
- The pH values obtained in this study represented characteristics of a good silage. The visual appraisal, color and smell observed in this study were an indication of good quality and obviously shows EM as a biological inoculant and urea as a chemical additive could enable facilitate the fermentation process.
- The chemical and biological additives in general used in this study suggested improvement in CP and the level of mineral matter (Ash).
- Treatment of sorghum stover with urea, EM and EM plus urea resulted in a better *in vitro* DM digestibility than the untreated sorghum stover.
- Ensiling sorghum stover with EM, urea and EM plus urea increased the *in sacco* DM degradability and ruminal disappearance rate than the untreated stover.

6.2. Recommendations

- Education has an important role to play in increasing agricultural production in rural Ethiopia. Therefore, there should be an intervention of adult education so that adoption and introduction of a new technology in relation to cattle fattening would easily be feasible.
- Producers should be updated about price information in the central market through collection and dissemination of market information by accessible media broadcasting service. This this is very vital in getting better income from sale of their fattened cattle and avoid cheating by other market agents.
- Estimation of weight from linear body measurements and use of the same for price determination should be initiated in the study areas.
- Legal protection and support to the producers and certified traders should be exercised and implemented accordingly at woreda level.
- Expansion of co-operatives and at the same time mobilizing and organizing producers to participate in it is recommended.
- Investment should be encouraged for feed processing industries and slaughter houses to encourage producers to enter into market oriented cattle fattening practices.
- There should be capacity building trainings for producers, traders and brokers. Organizing brokers and determining the amount of commission to be paid for brokers per fattened cattle could minimize corruption and unnecessary disturbances in the market place.

- The use of ITKs in feeding and other management practices of producers in the study areas was appreciable but requires further thorough scientific investigation that help some correction and technical assistance.
- In the study areas, crop harvesting times aligns with higher supply of fattened cattle to markets. Similarly, in feed scarcity season, the supply decreases. This phenomena urges the need for intervention of better feed conservation systems and improving the nutritive value.
- The use of urea as a chemical and EM as a biological additives should be encouraged in the area through trainings and demonstrations to improve the nutritive value of low quality feeds such as sorghum stover.
- Efforts should be made for the development of formulating standard ration based on the available crop residues, cereal grains, agro-industrial byproducts and other feed sources on the basis of home made ration preparation.

- **Future research areas**
 - Assessment of feed resources and their nutritional value in the West Hararghe Zone.
 - Assessment of crop production, residues utilization, handling, limitations, spatial and temporal variability.
 - Feed intake and body weight gain of Somali cattle breeds feeding urea treated sorghum stover.
 - The role of women in the cattle fattening and marketing activities in West Hararghe Zone.

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8. APPENDICES

Appendix 1: Questionnaire for formal survey on characterization of cattle fattening system.

Part one: Characterization of cattle fattening practices

Name of enumerator _____
 Date of interview _____ Time start _____
 Region----- Zone-----
 Woreda _____ code _____ Kebele name _____ Code _____

Name of house hold head _____ Code _____

1. Sex of house hold head
 1. Male
 2. Female
2. Marital status of the house hold head
 1. Married
 2. Single
 3. Divorced
 4. Other _____
3. Age of house hold head _____ (years)
4. Education level of house hold head
 1. Illiterate
 2. Reading and writing
 3. Elementary school
 4. Junior Secondary school
 5. Secondary school
 6. Above secondary school
 7. Spiritual education
5. How many family members do you have?
 - 1) Male-----
 - 2) Female-----
 - 3) Children (≤ 14 years) -----
 - 4) Adult ($\geq 15-64$ years) -----
 - 5) Dependents (>65 years) -----
6. Educational status of households
 1. Illiterate -----
 2. Read and write only-----
 3. Elementary school-----
 4. Junior Secondary School-----
 5. Secondary School-----
 6. Above Secondary School-----
 7. Spiritual school -----
7. What are the sources of income for living?
 1. Crop production only
 2. Livestock production only
 3. Wage labor/off-farm activity only
 4. Crop and livestock production only
 5. Other _____
8. Responsibility of family members in the routine fattening practices

Activities	Husband(1)	Wife(2)	Children(3)	Partner (4)
Cleaning the barn				
Marketing				
Health care				
Feed and watering				

9. Land holding and land use system

1. Total area of crop land owned by the household _____ha
2. Food crop production _____ha
3. Cash crops _____ha
4. Grazing land _____ha
5. Fallow land _____ha
6. Forage crop production _____ha
7. Forest and woodland _____ha
8. Rented/contracted land _____ha
9. Other (specify) _____

10. Land utilized for major types of food crops

1. Maize _____ha
2. Sorghum _____ha
3. Wheat _____ha.
4. Barley _____ha.
5. Tef _____ha
6. Broad bean _____ha
7. Field Pea _____ha
8. Haricot bean _____ha
9. Chick pea _____ha
10. Oil seed (lean seed rapeseed etc.) _____ha
11. Others (specify) _____ha

11. Major grain yield obtained from major crops

1. Maize _____ Quintal
2. Sorghum _____ Quintal

12. Do you have been involved in cattle production?

1. Yes
- 2.No

13. If yes, when did you start cattle production? ----- (Year/month)

14. Livestock production

Cattle herd structure

Type of animal	Total
Milking cows	
Dry cows	
Oxen	
Calves male	
Calves female	
Heifers	
Bulls	

Sheep and goats

Type of animal	Total
Ewe	
Ram	
Lamb	
Does	
Billy	
Bucks	
Kids	

Equines

Type of animal	Total
Mare	
Stallion	
Mule	
Jennys	
Jack	
Foals	

15. If yes, what is your objective of rearing cattle?

1. Selling Primary_____ Secondary _____ Tertiary_____
2. Draft power Primary_____ Secondary _____ Tertiary_____
3. Food source Primary_____ Secondary _____ Tertiary_____
4. Manure production Primary_____ Secondary _____ Tertiary_____
5. Security (saving) Primary_____ Secondary _____ Tertiary_____
6. Other _____(specify)

16. If for selling, do you practice cattle fattening before selling?

1. Yes
- 2.No

17. When did you start cattle fattening? ----- (Year)

18. Where do you get the animals for fattening?

1. Buy from market
2. Buy from neighbors
3. From own herd
4. From relatives
5. From office of agriculture
6. From other organizations
7. Other _____

19. Who is the owner of cattle in the household?

1. Husband
- 2.Wife
3. Husband and wife
- 4.The family
- 5.Other specify_____

20. Do you fatten male or female animal
 1. Male 2. Female 3. Both
21. Do you recommend castrated or non-castrated animal for fattening?
 Why _____
 1. castrated 2. Non- castrated 3. Both
22. At what average age do you start fattening of male cattle mostly it is born at home?
 _____ Why? _____
23. Which color of cattle do you prefer to start fattening? Why _____
 1. White 2. Red 3. Creamy white (*Dalacha*) 4. Dark 5. Other
24. What is your future opinion about fattening?
 1. I will do fattening 2. I won't do fattening 3. I don't know 4. Other _____
25. If you continue fattening, why?
 1. Means of subsistence 2. Profitable 3. Both 1 and 2 4. Traditional
 5. other _____
26. If you intend to stop fattening, why?
 1. Not profitable 2. Scarcity of feed 3. Lack of money 4. Other _____
27. For how many years do you use young oxen for plowing if it is born in the house?
 1. One 2. Two 3. Three 4. Four 5. More than four
28. How many oxen do you fatten per fattening period?
 1. One 2. Two 3. Three 4. More than Three
29. For how many months do you keep cattle for fattening?
 1. Three 2. Four 3. Five 4. six 5. More than six
30. Frequency of fattening in one year
 1. Once 2. Twice 3. Thrice 4. Other _____
31. How do you select cattle for fattening? (Rank it for multiple answers)
 1. Color _____ 2. Height _____ 3. Horn _____ 4. Conformation _____ 5. Size _____
 6. Price _____ 7. Other specify
32. Have you used the calves resulted from AI service for fattening purpose? Yes / No
 Why? -----
33. What type of cattle do you prefer for fattening purpose? (Rank in the order of preference)
 1. Old oxen _____ 2. Matured oxen _____ 3. Young bull _____
 4. Old cow _____ 5. Unproductive cow _____ 6. Heifer _____
 Why? _____
34. How do you decide the end of fattening period?
 1. By calculating feeding length 2. By considering the body size change
 3. Anticipated Current and future price 4. Others (specify) _____
35. What is your source of technical support about beef cattle production?
 1. Office of Agriculture 2. From fellow farmers 3. Radio 4. Newspapers and television

5. Conferences of the administration 6. Other _____
36. Is the technical support sufficient? 1. Yes 2. No
37. On what issues do you want to get technical support?
 1. Cattle health 2. Cattle feed 3. Cattle product utilization 4. Cattle marketing
 5. Other _____
38. Do you want to expand your beef cattle production or to maintain as it is now?
 1. Reduce 2. Expand 3. Maintain, as it is 4. It depends 5. Other _____
39. What is the opinion of the family on the future number of the beef cattle production?
 1. To expand 2. To reduce 3. To maintain as it is 4. It depends 5. Other _____
40. Is the trend of beef cattle production and productivity increasing or decreasing?
 1. Increasing 2. Decreasing 3. No change 4. Other _____
41. Is the cash income you generate from beef cattle production increasing or decreasing?
 1. Increasing 2. Decreasing 3. It varies 4. I don't know 5. Other _____

Part Two: Survey of feeds, feeding system, watering and housing

42. How grazing lands are owned in your area?
 1. Individually owned 2. Communally owned 3. Both 4. Other _____
43. Do you have sufficient grazing land for your cattle? 1. Yes 2. No
44. If no, how do you overcome the shortage? _____
45. What are the main feed resources for your cattle during feed available seasons?
 1. Thinning 2. Maize stalk 3. Sorghum stalk 4. Grass 5. Weeds
 6. Stubble feeding 7. Other _____ (specify)
46. What are the feed resources for your cattle during dry periods of the year?
 1. *Teff* straw 2. Barely straw 3. Maize stover 4. Sorghum stover
 5. Grass Hay 6. Other _____ (specify)
47. Do you store feed for your animals? 1. Yes 2. No
48. If yes, what type of feed you store?
 1. *Teff* straw 2. Maize stover 3. Sorghum stover 4. Grass hay 5. Other _____ (specify)
49. How do you store crop residues?
 1. Stacked outside 2. Stacked under shed 3. Baled outside
 4. Baled under shed 5. Others (specify) -----
50. What type of feeding system do you follow?
 1. Cut and carry 2. Grazing 3. Semi-grazing 4. Other _____ (Specify)
51. Do you treat crop residues before feeding your fattening cattle? 1. Yes 2. No
52. If yes, what kind of treatment you do before feeding?
 1. Chopping 2. Salting 3. Urea treatment 4. 1 & 2 5. Other specify _____
53. What are the locally made materials like used as feeding and watering?
 1. _____ for feeding and _____ for watering

54. Do you buy cattle feed from the market? 1. Yes 2.No
55. Is there night time feeding? 1. Yes 2. No
56. Is there feed shortage for cattle in general?
1. Yes 2. No 3. It depends on the season
57. When is feed shortage critical? _____ (write months)
58. What do you do to cope up with the feed shortage in this (these) month (s)?
1. Rely on stored feed 2. Rely on farm residues 3. Rely on the natural vegetation
4. Send my animals to other areas 5. Rely on the market purchased feeds 6. Others
59. What are the indigenous technical knowledge of feeding fattening cattle in your area?
60. What are the sources of water for your beef cattle?
1. Spring 2. Rivers 3. Ponds 4. Mechanically assisted water
5. Manually assisted water 6. Other _____ (Specify)
61. Watering frequency
1. Once a day 2. Twice 3. Once every two days 4. Other_____(specify)
62. Do you have any other associated problems regarding water sources? 1. Yes 2.No
63. If yes, what is it? _____ (Mention)
64. What type of housing system do you use?
1. Homestead shades 2. Farmyard shades 3. In living rooms with the family
4. Barn 5. Other _____ (Specify)
65. Do you have sufficient family labor power for cattle production? 1. Yes 2.No
66. In which months do you face labor shortage? (Mention the months)_____
67. Do you have any other consequent beef cattle production problems?
1. Yes 2. No
68. If yes what are the problems? (Mention)

69. If yes, what are the indigenous alleviation strategies?
Mention._____
70. Is there a problem of cattle disease? 1. Yes 2.No 3. It depends on the season
71. Which alternative do you use to assist the health of your cattle?
1. Government 2. Private Veterinarians 3. Traditional medications 4. Other _____
_____(Specify)
72. How much do you pay on average per year for medication of your cattle?

73. How much do you pay on average in a single trip to medicate your cattle?

74. Major constraints of cattle fattening practices in the study areas
1. Shortage of grazing land____ 2. Shortage of water____ 3. Lack of feed____
4. Disease incidence____ 5. Low selling price____ 6. High purchasing price____

Formal survey.

Part Three: Field survey for Beef cattle market assessment

75. Do you get market information before you sell your cattle? 1. Yes 2. No
76. If yes, from where do you get market information?
1. Extension agent 2. Relatives 3. Cooperatives 4. Neighbors 5. Own markets
visit 6. Other (specify) -----
77. Which source of market information do you prefer?
1. Extension agent 2. Relatives 3. Cooperatives 4. Neighbors 5. Own market visit
6. Other (specify) _____
78. What is your reason for selecting the specified source(s) of market information?
1. It is accessible 2. It is reliable 3. Other (specify)
79. To what extent is the market information you get is accurate?
1. Very high 2. High 3. Medium 4. Low
5. Very low 6. Other _____ (specify)
80. How frequent do you get market information?
1. Weekly 2. Fortnightly 3. Sometimes 4. Other _____ (specify)
81. Do you get advice on cattle marketing issues from development/extension agent?
1. Yes 2. No
82. If yes, on what aspect?
1. On quality of cattle to be produced for the market 2. On the time to sale cattle
3. On price of cattle at different markets 4. Other (specify) _____
83. Where do you mostly sell your fattened cattle? Specify-----
84. What is your reason of preference while you decide to sell your fattened cattle at a particular market? 1. Relative advantage of price 2. Proximity of the market 3. Other (specify)
85. How many hours does it take to reach the market that you frequently visit to sell your fattened cattle? 1. nearest market -----hours 2. Farthest market-----hours
86. How do you take your fattened cattle to the market? 1. Trekking 2. Trucking 3. Both
87. Who trek your fattened cattle to the market place?
1. Yourself 2. Relative 3. Hired labor 4. Neighbor 5. Other (specify)
88. If you hire labor, how much do you pay?
1. For nearest market-----birr/head 2. For farthest market-----birr/head
89. To whom do you sell your fattened cattle? 1. Trader 2. Local butcher 3. Abattoir 4. Other (specify) _____
90. Do you think that there is road/ transportation problem to access market in your area?
1. Yes 2. No
91. What is your suggestion to improve physical market access? -----
92. Who determine the price at the market place?
1. Seller 2. Buyer 3. Brokers 4. Negotiation b/n seller and buyer
5. Other (specify) -----
93. Do you think that there is fattened cattle price difference across different markets in your area? 1. Yes 2. No

112. If yes, at what time? 1. During festivals 2. Any time 3. Other
(Specify)
113. How many times? _____ per month.

Time finished _____
Thank you very much for your time!

Appendix 2: Checklist used in the focus group discussions

District_____ Time start_____ Time

finished_____

Peasant Association and Village_____

Date_____

Questions for Discussion

- 1) What cattle breeds are kept in this area?
- 2) Why do farmers castrate local bulls and leave intact the purchased lowland ones?
- 3) What are the historical background of cattle fattening in this area?
- 4) What kind of crops and are grown in this area their local name?
- 5) Do you have a communal grazing area? Feeding of fattening cattle
- 6) What are the major type of feeds in this area? Feeding system, grazing system, seasonality effect on feed availability-in w/c months, feeding calendar and coping mechanism of feed shortage.
- 7) Do you buy and use agro-industrial by products?
- 8) What are the indigenous technical knowledge concerning the management of fattening cattle-the selection, feeding, watering, sanitation, housing, health care etc.?
- 9) What is the participation of women in the activities of beef cattle fattening process?
- 10) What are the challenges of beef cattle fattening practices in your area?.
- 11) What are the opportunities of beef cattle fattening practices in your area?
- 12) What is the marketing situation looks like?
 - Marketing actors and their involvement in the transaction
 - Where do bulls to be fattened come from (source of fattening cattle)
 - Condition of price in different woredas

- Seasonal price variation
- The reason for cattle price variation across months/seasons
- Marketing of beef cattle

13) What is the influence of brokers in the marketing of beef cattle?

14) The supply of animals for fattening, provision of animal health services, feed and provision of credit services.

Appendix 3: Checklist for the development agent/ Woreda and Zone livestock Agency and Trade and Market development office experts

1. How many cattle were fattened last year from the kebele/wereda/zone?
2. How much is the average cattle price in the kebele/woreda market before and after fattening?
3. Condition of marketing sites and routes of purchased fattened cattle in the study woredas
4. The number of fattened cattle delivered to central market
5. How many cattle markets are available in the kebele/woreda/zone level?
6. What are the cattle breeds available in the kebele/woreda/zone?
7. What type of cattle breeds are currently used for fattening purpose in the kebele/woreda?
8. What type of forage development /feed improvement strategies have been practiced in the kebele/woreda?
9. What are the major problems affecting cattle fattening practice in the kebele/woreda/zone?
10. What are the major potentials for improvement of cattle fattening practice in the kebele/woreda/zone?
11. What type of development interventions to be made to enhance the performance of cattle fattening activity in the kebele/woreda/zone?
12. What are the major challenges and opportunities of cattle fattening in in the kebele/woreda/zone?

13. What mitigation strategies are being implemented to decrease the influence of brokers at kebele/woreda/zone level?

Appendix 4: Checklist for traders

1. Market days?
2. What are the facilities and the equipment found in the market place?
3. What type of livestock come to market? Number, sex, age group?
4. From where do these animals come from?
5. Destination of fattened cattle? Fattening cattle transaction routes
6. In which season higher/lower number of fattened cattle come? Why?
7. What type of market participants/actors are found in the market transaction?
8. Why do sellers and buyers prefer this market? What are the opportunities in the market?
9. What are the challenges of fattened animal market?
10. Government Interventions?
11. What is the proposed solution of to this problem?
12. Illegal market routes?

Appendix 5: Checklist for brokers

1. From where do livestock come from, destination?
2. Composition of brokers-(students, jobless, Bankrupted trader, male, female)
3. Their involvement in the market?
4. Range of their work place?
5. Amount of commission they receive from the producer or trader/both?
6. Their disagreement with producers and traders?
7. Are they legally known?
8. Anything they say about traders?
9. Problem they faced
10. Solution they propose.

Appendix 6: Checklist for feed sellers

1. What kinds of feeds do you sell and their current price?
2. Problems associated with the storage, sell and other transaction processes?
3. Who do you buy the feeds frequently (Dairy, every farmer who rear cattle, Cattle fatteners, others)?
4. What are their opportunities/challenges?

Appendix 7: Indigenous technical knowledge of feeds and feeding of the study areas

No.	Locally available feeds	Scientific name	Feeding system	Remark
1	Crop residues			
1.1.	Broad bean and lentil haulms.	<i>Vacia faba</i> and <i>Lens culinaris</i>	Once per day when available	
1.2.	Broad bean and maize haulms	<i>Vacia faba</i> and <i>Zea mays</i>	Once per day when available	
1.3.	Barley straw wetted with salty water.	<i>Hordeum vulgare</i>	Ad-libitum	
1.4.	Sweet potato vine	<i>Ipomoea batatas</i>	Once per day at noon time for wilting	
1.5.	Leaves stripped from maize and sorghum	<i>Zea mays</i> and <i>sorghum biclor</i>	Ad-libitum	
1.6.	Thinning of maize and sorghum crop.	<i>Zea mays</i> and <i>sorghum biclor</i>	Ad-libitum	
1.7.	Feeding of Maize and sorghum stover by wetting the bed area to initiate feeding in the night time	<i>Zea mays</i> and <i>sorghum biclor</i>	Ad-libitum	
1.7.	Feeding boiled sorghum stover stalk left on the field after harvest	<i>Sorghum biclor</i>	Ad-libitum	
2	Concentrates			
2.1.	Fenugreek flour and wheat bran and slightly added water	<i>Trigonella foenum-graecum</i>	Once per day in the morning	2-3 weeks before market to bring oily texture on the skin
2.2.	Fenugreek flour mixed with water and sugar	<i>Trigonella foenum-graecum</i>	Once per day in the morning	2-3 weeks before market to bring oily texture on the skin
2.3.	Yeast mixed with wheat bran and water	<i>Saccharomyces cerevisiae</i>	Once per day late in the morning	Once per day 2-3 kg in the morning.

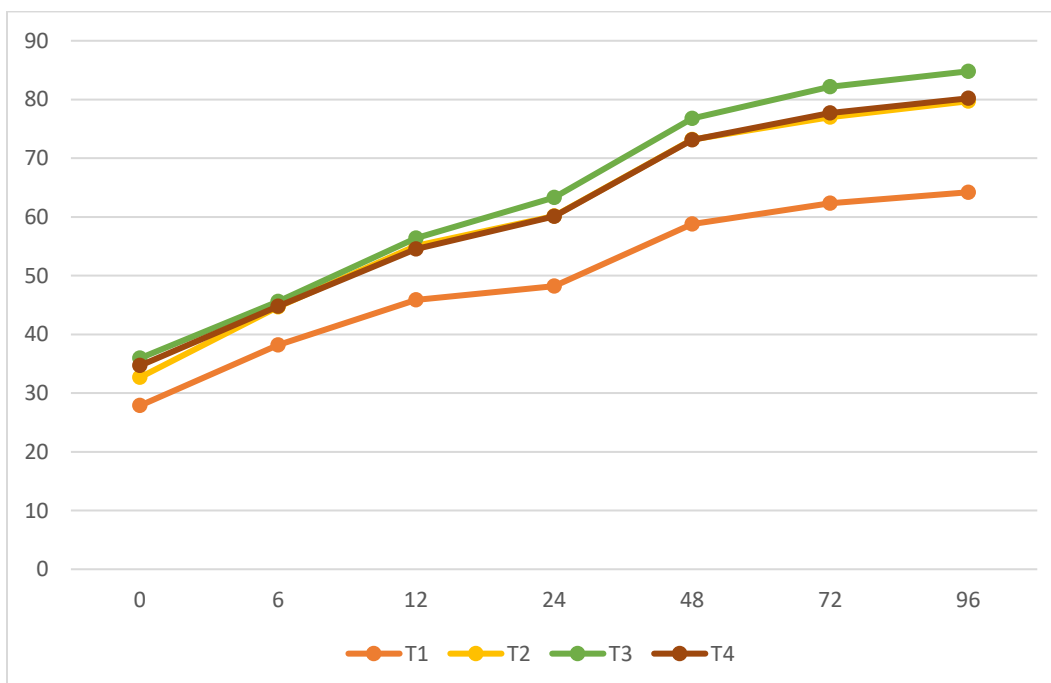
2.4.	Maize flour mixed with wheat bran or sole		Once per day in the morning.	Once in the morning 1:3, maize to wheat ratio.
2.5.	Cooked sorghum seed	<i>sorghum biclor</i>	Once per day in the morning.	
2.6.	Cooked maize seed with salt	<i>Zea mays</i>	Once per day in the morning.	
2.7.	Grinded/ maize seed as it is	<i>Zea mays</i>	Once per day 2 kg in the morning	
2.8.	Cooked cowpea seed with salt	<i>Vigna unguic</i>	Once per day in the morning	
2.9.	Flour left over from mill houses		Once per day in the morning	
2.10.	Cooked haricot bean with salt added/soup	<i>Phaseolus vulgaris</i>	Once per day in the morning	
2.11.	Small amount of urea added on wheat bran and salt		Once per day in the morning	
2.12.	Water soaked fenugreek seed mixed with sugar	<i>Trigonella foenum-graecum</i>	Once per day in the morning 2 weeks before sale to make the cattle shiny skin.	
2.13.	Cooked fenugreek seed with sugar at the end of fattening period	<i>Trigonella foenum-graecum</i>	Once per day in the morning 2 weeks before sale to make the cattle shiny skin	
2.14.	Soaked maize seed with salt and warming it up	<i>Zea mays</i>	Once per day	
2.15.	Soaked linseed with wheat bran	<i>Linum usitatissimum</i>	Once per day	
3.	Crops			

3.1.	Chopped sugar cane tuber	<i>Saccharum officinarum</i>	Once per day	
3.2.	Feeding ear of maize at dough stage	<i>Zea mays</i>	Once per day	
3.3.	Feeding the whole plant of cow pea at seeding filling stage	<i>Vigna unguic</i>	Once per day after wiling	
3.4.	Feeding haricot bean leaves at seed filling stage	<i>Phaseolus vulgaris</i>	Once per day by wilting in the sun to prevent bloating.	
3.5.	Chopped sugar cane planted for cattle or human purpose	<i>Saccharum officinarum</i>	Once per day	
3..6.	Feeding of chick peas crop at full flowering time	<i>Lens culinaris</i>	Once per day when available during October and November	
4.	Root crops			
4.1.	Chopped beet root with salt	<i>Beta vulgaris</i>	Once per day when available available	
4.2..	Chopped sweet potato	<i>Ipomoea batatas</i>	Once per day in less amount during harvest	
4.3.	Chopped local pumpkin with salt	<i>Cucurbita</i>	Once per day during harvest	
4.4.	Chopped <i>Enset</i> root	<i>Ensete ventricosum</i>	Adlibitum	
4.5.	Chopped sweet potato slightly aerated before feeding	<i>Ipomoea batatas</i>	Once per day in small amount.	
5.	Weeds			(Stroud A. and Parker C., 1989).
	Amharic	Oromiffa		
5.1.	Weha akur	Wela gabis	<i>Commelina bengahalensis</i>	

5.2.	Ye harem negus	Balcha	<i>Galinsoga parviflora</i>		
5.3.	Alluma	Orome	<i>Amaranthus hybridus</i>	Should be fed before flowering	Inflicts bloating if fed at large quantity at flowering stage.
5.4.		Amagito	Melitotus indica		Indegenous alfalfa
5.5.	Adey abeba	Key ada	<i>Giziota scabra</i>	Before flowering	
5.6.	Chegogit (Ye setan Merfie)	Tiye	<i>Bidens pilosa</i>		
5.7.	Kuni	kuni	<i>Cyprus rotodus</i>		
6.	Mix of different ingredients				
6.1.	Mixing wheat bran with tef straw, salt and water enhance utilization of tef straw				
6.2.	Sole sugar feeding/licking/in water solution				
6.3.	Common salt mixed with water			At noon time once per day	
6.4.	Licking Amole (local common salt)			Once per two to three days freely	
6.5.	Pounding dry sorghum stover and mixing with wetted wheat bran			Once per day in the morning	
6.6.	Mixing <i>teff</i> straw with wetted wheat bran to initiate feeding more <i>teff</i> straw.				
7.	Browse tree leaves				
7.1.	Wolensu (Gorgo)		<i>Erythrina abyssinica</i>	Feeding leaves once per day in in the morning	During dry season when there is feed shortage
7.2.	Wedessa		<i>Cordia africana</i>	Feeding leaves once per day in in the morning	During dry season when there is feed shortage

7.3.	Gerbi	<i>Acacia albida</i>	Feeding leaves once per day in in the morning	During dry season when there is feed shortage
7.4.	Oda	<i>Ficus basta</i>	Feeding leaves once per day in in the morning	
8.	Local grasses			
8.1.	Serdo	<i>Cynodon nlemfuensis</i>	Cut and carry	Both in wet and dry seasons
8.2.	Burana	<i>Digitaria abyssinica</i>	Dig out roots and feed during dry season	During dry season when there is feed shortage

Appendix 8: Graph showing the ruminal disappearance rate of DM (%) from sorghum stover treated with different additives



*T*₁=Untreated sorghum stover; *T*₂=Effective Micro-organism treated sorghum stover *T*₃= Urea treated sorghum stover; Effective Micro-organism + Urea treated sorghum stover

Appendix 9: Classification of surveyed livestock markets

Market type	Number of livestock	Market day	Livestock types
Primary markets (<500 heads/week)			
Belbelitti		Thursday	Cattle, sheep, goats and donkey
Kuni		Monday	Cattle, sheep, goats and donkey
Debeso		Monday	Cattle, sheep, goats and donkey
Secondary market (500-1000 heads/week)			
Gelemso		Tuesday	Cattle, goats, sheep and donkey
Chiro		Thursday	Cattle, goats, sheep and donkey
Hirna		Saturday	Cattle, goats, sheep and donkey

Appendix 10: Research photos



Fresh (left) and preserved (right) sorghum stover



Sample of fresh harvest of sorghum stover for experment



Turning to uniformly to dry the chopped sorghum stover



Mixing stover with additives for ensiling



Silage making experiment

Appendix 11: Summary table of cattle market participants

No	Market participants	Characteristics
1.	Producer	Farmers found at the grass root level and directly involved in the fattening work.
2.	Farmer trader	Buy fattened cattle from remote areas or competitively buy and sell in the same market. One can find involvement of women.
3.	Traders	Few in number but prominent in the market, had agents and strong ties with brokers.
4.	Brokers	Individuals that involve in the price bargaining process in livestock market.
5.	Broker-traders	Already developed capacity to do broker work and even buy and sell the fattened cattle for traders.
6.	Butchers	Individuals whose trade is cutting up and selling meat in their shop. They buy and slaughter to sell beef in retail trade.
7.	Tax collectors	Staffs from woreda revenue authority office of the respective capital town assigned to collect tax during entrance and exit of livestock.



Loading fattened cattle in Chiro from temporarily built sloppy soil piled area

Appendix 12: List of publications

Daniel Tadesse, Mengistu Urge, Gebeyehu Goshu and Zemelak Goraga (2016). Evaluation of Chemical Composition and *in vitro* dry Matter Digestibility of Sorghum Stover Ensiled with Urea and Effective Microorganisms (EM) in West Hararghe Zone, Eastern Ethiopia. *American –Eurasian Journal of Agriculture and Environmental Science*, 16 (8): 1473-1483.

Daniel Tadesse, Mengistu Urge, Gebeyehu Goshu and Zemelak Goraga (2017). *In Sacco* Dry Matter Degradability of Urea and Effective Microorganism (EM) Treated Sorghum (*Sorghum biclor* L. Moench) Stover. *Advances in Biological Research*, 11 (1): 41-50.

Daniel Tadesse, Mengistu Urge, Gebeyehu Goshu and Zemelak Goraga (2017). The Role of Women in the Traditional Cattle Fattening and Marketing activities in West Hararghe Zone, Oromia, Ethiopia. *Journal of Culture, Society and Development*, 35: 9-15.

Daniel Tadesse, Gebeyehu Goshu, Mengistu Urge and Zemelak Goraga (2017). Indigenous Technical Knowledge of Feeds and Feeding Practices Beef Cattle in Western Hararghe, Ethiopia. *International Journal of Development Research*, 11:17037-17044.

Appendix 13: Ethical clearance certificate for conducting nylon bag test

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ADDIS ABABA UNIVERSITY
College of Veterinary Medicine
and Agriculture
Bishoftu/Debre Zeit

Animal Research Ethical Review Committee

Ethical clearance certificate

Certificate Ref. No: VM/ERC/03/05/10/2018

Name of Applicant: Daniel Tadesse (MSc, PhD fellow)

Address: College of Veterinary Medicine and Agriculture, Addis Ababa University

Title of the project: Characterization of cattle fattening system, marketing assessment and nutritive quality analysis of ensiled Sorghum Stover in West Hararghe, Ethiopia

Date of application: 23/1/2018
Nature of the project: Invasive
Target animal species: cattle
Number of animals involved: 3
Study area: Holeta Agri.Research Center, Ethiopia

Minutes No. and date of review: VM/ERC/05/10/2018, 03/01/2018

The above indicated research project is acceptable from ethical perspective, relevance, originality and technical competence points of view. Hence the project is allowed to be executed provided that:

1. All procedures and conditions stipulated in the proposal are respected and any deviation or changes be reported to the committee
2. The project activities be open for occasional supervision by the committee whenever this is deemed necessary

Dr. Getachew Terefe
Chairman

Signature

Dr. Dinka Ayana
Dean
College of Veterinary Medicine
and Agriculture

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Please quote Our Ref. No. When replying

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Bishoftu/Debre Zeit, Ethiopia