CHARACTERIZATION OF LIVESTOCK PRODUCTION SYSTEMS IN THREE SELECTED DISTRICTS OF JIMMA ZONE, SOUTHWEST ETHIOPIA

M.Sc. Thesis

Mohammed Hussen Ali

February, 2015

Jimma University

CHARACTERIZATION OF LIVESTOCK PRODUCTION SYSTEMS IN THREE SELECTED DISTRICTS OF JIMMA ZONE, SOUTHWEST ETHIOPIA

M.Sc. Thesis

Submitted to the Department of Animal Sciences, School of Graduate Studies,

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In Partial Fulfillment of the Requirements for the Degree of Master of Science in Agriculture (Animal Production)

By

Mohammed Hussen Ali

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Thesis Submission Request Form (F-05)

Name of student: Mohammed Hussen Ali   ID No. 00528/04

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I have completed my thesis research work as per the approved proposal and it has been evaluated and accepted by my advisers. Hence, I hereby kindly request the Department to allow me to present the findings of my thesis work and submit the thesis.

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We the thesis advisers have evaluated the contents of this thesis and found to be satisfactory, executed according to approved proposal, written according to the standards and format of the university and is ready to be submitted. Hence, we recommend the thesis to be submitted.

Major Advisor: Yisehak Kechero (PhD) Signature____________ Date___________

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DEDICATION

I dedicate this manuscript to my family for their day to day assistance and encouragement while I was conducting this research work.

STATEMENT OF THE AUTHOR

I declare that the thesis hereby submitted for the M.Sc. degree to Jimma University, College of Agriculture and Veterinary Medicine is my own work and has not been previously submitted by me or others to any University or institution for any degree. I concede copyright of the thesis in favor of the Jimma University, Collage of Agriculture and Veterinary Medicine.

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Date of Submission: February, 2015

BIOGRAPHICAL SKETCH

The author, Mohammed Hussen Ali, was born in Gimbi town of West Wollega Zone, Oromia National Region, Ethiopia, in 1982 G.C. He completed his elementary school at Gimbi Kidus Quran Primary School in 1996 and his junior secondary education at Gimbi Dagimawi Adwa Dill and senior secondary school at Gimbi Comprehensive High School in 1998 and 2002, respectively.

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LIST OF ABBREVIATIONS

AFC	Age at First Calving
AFF	Age at First Foaling
AFK	Age at First Kidding
AFL	Age at First Lambing
AI	Artificial Insemination
ANOVA	Analysis of Variance
BoARD	Bureau of Agriculture and Rural Development
CGL	Communal Grazing Land
CI	Calving Interval
CP	Crude Protein
CR	Crop Residue
CSA	Central Statistical Agency
DM	Dry Matter
EARO	Ethiopian Agricultural Research Organization
EIAR	Ethiopian Institute of Agricultural Research
FA	Farmers Association
FAO	Food and Agriculture Organization of the United Nations
FI	Foaling Interval

List of Abbreviations (*continued…..*)

FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GLM	General Linear Model
GOR	Government of Oromia Region
ha	Hectare
HAR	High Altitude Region
HH	House Hold
IAR	Institute of Agricultural Research
IBC	Institute of Biodiversity Conservation
IFAD	International Fund for Agricultural Development
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
IPS	International Project Service
IVDMD	In vitro Dry matter digestibility
KI	Kidding Interval
LAR	Low Altitude Region
LI	Lambing Interval
m.a.s.l	Meter Above Sea Level
MAR	Medium Altitude Region

List of Abbreviations (*continued…..*)

MoA	Ministry of Agriculture
NABC	Netherlands-African Business Council
NEPAD-CAADP	New Partnership for Africa's Development- Comprehensive Africa Agriculture Development Program
PA	Peasant Association
SEM	Standard Error of Means
SG	Stubble Grazing
t	Tons
TLU	Tropical Livestock Unit
UCR	Utilizable Crop Residues
USD	United States Dollar
VLIR-UOs	Vlaamse Interuniversitaire Raad (Flemish Interuniversity Council) – University Cooperation for Development
WBISPP	Woody Biomass Inventory and Strategic Planning Project
WISP	World Institute for Sustainable Pastoralist

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ABSTRACT

The cross-sectional field survey was conducted in three selected districts of Jimma zone, Southwest Ethiopia with the aim of characterizing the prevailing livestock production systems as well as to identify the major constraints and opportunities in relation to livestock production. The study districts were selected based on their livestock production potential and accessibility. Accordingly 122, 188 and 104 households (HHs) from Kersa, Omo Nada and Tero Afeta districts, respectively were participated in the study. The respondents were purposively selected depending on their livestock keeping experience. This study revealed that livestock production systems in the study districts were mixed crop-livestock production system where livestock production is totally based on the indigenous livestock breeds with no improved input and low output. The average number of livestock in terms of tropical livestock units (TLU) was 5.10±0.32/HH, which varied significantly (P<0.01) between the study districts. Overall, the herd structure comprised of cattle (4.74±0.24 TLU/HH) (P<0.05), sheep (0.10±0.01 TLU/HH), goats (0.06±0.01 HH), donkey (0.07±0.02 TLU/HH) (P<0.05), horses (0.05±0.02 TLU/HH) and mule (0.06±0.03 TLU/HH). Natural mating was the only means of breeding system (P>0.05). The study on productive and reproductive performance of livestock revealed that average age at first calving (AFC) of cows was 4.50±0.08 years, calving interval (CI) of 25.56±0.43 months, lactation milk yield (LMY) of 203.29±4.75 litters, lactation length (LL) of 7.84±0.30 months and 4.56±0.10, 5.61±0.14 years for draught age and life span of oxen, respectively. Average age at first kidding and kidding interval of goats were 2.05±0.04 years and 15.45±0.30 months, respectively (P<0.05). The average age at first foaling (AFF), foaling interval (FI, P<0.05) and age at first work (AFW) of horses were 4.95±0.14 years, 35.57±1.76 months and 6.28±0.30 years, respectively. The average AFW for mules was 6.60±0.14 years (P<0.05). The average AFF, FI (P<0.05) and AFW (P<0.05) of donkeys were 6.22±0.32, 2.56±0.17 and 6.38±0.37 years, respectively. The study on livestock feed resource revealed that crop residue, stubble grazing and natural pasture in a decreasing order were the main feed resources; however, they varied with seasons (P<0.05). Asteraceae, Fabaceae and Poaceae were the major fodder plant families. The main crop residues were teff straw, maize and sorghum stovers. The Mean annual total utilizable feed supply per HH was 4.53 tDM of which, 4.01 tDM (about 88.5%) was derived from cropping system which comprised of 3.04 tDM utilizable crop-residues and 0.97 tDM stubble grazing. Total utilizable DM production from cropping system per household significantly varied (P<0.05) between the study districts. The annual maintenance DM requirement per HH for TLU was estimated to be 11.44 tDM. Hence, the existing feed supply can satisfy only 39.59% of the annual maintenance DM requirement of livestock units per HH (P<0.05), pointing to the need to discern adaptation of livestock to feed insufficiency athwart the year. The feed supply can no longer support the existing livestock in the study districts unless possible interventions is made by decision making bodies and channeled to the farming community through extension workers.

The main constraints of livestock production were feed shortage, animal diseases and low productivity of the indigenous livestock breeds. Good climatic condition of the study area for livestock production and high demand for livestock products due to geometrically increasing human population are the opportunities for livestock production in the study area.

Keywords*: DM requirement; Feed resources; Mixed crop-livestock production; Natural mating; Productive and reproductive performance*

1. INTRODUCTION

Livestock contributes 15 to17 percent of GDP and 35 to 49 percent of agricultural GDP, and 37 to 87 percent of the farming households income in Ethiopia (Sintayehu *et al*., 2010). They provide inputs (draught power, manure) to the other segment of the farming system such as crop production, and generate consumables or saleable outputs (milk, manure, meat, hides and skin, wool, hair and eggs) (FAO, 2004).

There are about five livestock production systems in Ethiopia, which are based on integration of livestock with crop production, level of input and intensity of production, agro-ecology and market orientation. The following livestock productions systems are exist in Ethiopia: pastoral, agro-pastoral, mixed crop-livestock farming, urban and per-urban farming and specialized intensive farming systems (Yoseph, 1999; Mohammed *et al*., 2004; Yitay, 2007). However, the level of contribution from the livestock sub-sector in Ethiopia is generally low compared to other African countries due to production constraints grouped under technical, organizational, institutional, infrastructural, and environmental and policy aspects (NABC, 2010). According to Desta *et al*. (2000), Alemayehu (2006), Melkamu and Gebreyohannes (2014), inadequate feed, widespread diseases, poor breeding stock, and inadequate livestock policies with respect to credit, extension, marketing and infrastructure are the major constraints affecting livestock performance in Ethiopia.

In mixed-crop livestock farming livestock provides inputs (draught power, transport, manure) and in turn, crops provide livestock with feed in the form of crop residues and by-products from crop production, which are converted into valuable consumable or saleable products like milk, meat, hides and skins, wool, hair and eggs) (ILCA, 1992; BoARD, 2003; Alemayehu, 2004).

Livestock feed resources in Ethiopia are classified as natural pasture, crop residue, crop aftermath, road sides, improved pasture and forage, crop thinning, agro-industrial by-products, other by-products like food and vegetable refusal, of which the first two contribute the largest feed type (Alemayehu, 2006; Tolera *et al*., 2012). In the highlands, crop residues and agro-industrial by-products augment natural pasture and in the pastoral system, livestock production is almost totally dependent on pastures and woody plants (Daniel and Tesfaye, 1996; Zinash *et al*., 1998). According to Yisehak *et al.* (2013), the major feed resource bases of three districts in Jimma zone of Southwest Ethiopia are natural pasture (mainly communal), crop after math grazing, crop residues, green fodder and non-conventional feeds like *attela* (local alcohol leftover), households food leftover, grain mill byproducts, *Khat* (*Catha edulis*) leftover, coffee pulp and husk. According to the same authors continuous grazing on natural pasture, stubble grazing and road sides grazing are the prevailing livestock feeding system practiced in the study area. However, the natural grazing lands in the mixed crop livestock systems of the highlands of Ethiopia are seriously overloaded with stocks generally beyond their optimum carrying capacity causing overgrazing, erosion and overall land degradation (Zinash *et al*., 1996; Yisehak *et al*., 2009).

Livestock husbandry in South western Ethiopia is mainly practiced for food (milk, milk products and meat), fiber (hides and skin), draught power (traction, pack transport, sport/riding, cart pulling) and cash income (Yisehak *et al*., 2013). According to the same authors livestock keeping, however, is primarily a subsistence activity to meet household food needs and supplement farm income.

For optimum livestock productivity, the available feed resource should match with the production systems practiced and the number of animals in a given area. On the other hand the availability and relative importance of different feed resources varies from place to place and from time to time depending upon agro-ecology, livestock production systems and seasons of the year. Therefore, characterization of the prevailing livestock production systems, the available feed resources in relation to season and the constraints and opportunities of livestock production in a given area is important to diagnose the problems and suggest intervention measures to be taken by farmers and policy makers. There are scanty of information regarding the characterization of livestock production systems in three districts around Gilgel Gibe dam catchments in Southwest Ethiopia. Therefore, this study was initiated to characterize the livestock production systems in order to identify the constraints and opportunities of livestock production in three districts of Gilgel Gibe Dam Catchments of Southwest Ethiopia with the following specific objectives:

1. To characterize the livestock production systems under prevailing management conditions
2. To Identify constraints and opportunities for livestock production in the study areas

2. LETIRATURE REVIEW

2.1 Livestock Production Systems in Ethiopia

Livestock production systems in Ethiopia can be described based on integration of livestock with crop production, level of input and intensity of production, agro-ecology and market orientation. Accordingly there are five identified production systems: pastoral, agro-pastoral, mixed crop-livestock farming, urban and peri-urban farming and specialized intensive farming systems (Yoseph, 1999; Mohammed *et al*., 2004; Yitay, 2007).

2.1.1 Pastoral and agro-pastoral livestock production system

The lowlands in Ethiopia cover about 60% of the country's land area and are situated below 1500 m.a.s.l. The lowlands are situated in the eastern, southern, and western part of the central highlands (Afar, Somali, Borena, South Omo, some part of Gambela and Beneshangul) (NEPAD-CAADP, 2005). According to the same source the sector is characterized as pastoral and agro–pastoral production systems, where by about 20% of cattle, 25% of sheep and 75% of goats of the total national livestock population are found. According to EARO (2002), 20% of equines and 100% of the country camels population are found in low land. According to the same report this area contributes about 50% to the national agricultural Gross Domestic Product (GDP) and 90% of the annual hard currency earnings from live animal.

The pastoral production system is characterized by sparsely populated pastoral rangelands, where subsistence of the pastoralists is mainly based on livestock and livestock products. The livestock husbandry in this system is dominated by goats, cattle, sheep and camels. Since the main source of food is milk, pastoralists tend to keep large herds to ensure mainly sufficient milk supply and generate income (IBC, 2004).

In this system, livestock do not provide inputs for crop production but they are backbone of life for their owners, providing all of the consumable and saleable outputs by sales of animals and animal products and hiring out of drought animals to the highlanders, in addition, representing a living bank account and form of insurance against adversity (Coppock, 1994; Beruk and Taffese, 2001). The pastoral areas have been the traditional source of export animals. Some scholars also indicated that, to a certain extent, Middle East importing countries have preference to the local breeds/types/strains of livestock raised in these areas (Mohammed *et al*., 2007).

According to Gemedo-Dalle (2006), despite the large population of livestock in pastoral area, their economic contribution to the regional and national level is not significant due to human and natural resources limitations. Environmental and rangeland degradation from human side and increasing aridity and the occurrence of recurrent droughts at shorter intervals of every third year from the nature side are causing feed and water shortages. This results in high livestock mortalities in most pastoral areas (Amaha, 2003). Recently in the Borena pastoral system cattle holdings per household are declining and herd dynamics is following a "boom" and "bust" pattern. Drought in the 1980's and 1990's has resulted in the death of 37% to 42% of the cattle population, respectively. Aggregating and analyzing the information on mortality of cattle over 17 years, the Borena losses were valued at about 300 million USD (Solomon and Coppock, 2000).

Agro-pastoralists are segments of the pastoral society who promote opportunistic crop farming to improve food security. Traditionally its one way of maintaining ownership rights over the use of land. It enables the production of crops to be used by both humans and livestock (Beruk and Tafesse, 2001). This system dominates in mid agro-ecological zones where a tendency for crop production has shown besides livestock production and farmers in this system are sedentary. Livestock are used for draught, savings and milk production. The production system is subsistence type of milk and or meat production (Zinash *et al*., 2001; Alemayehu, 2004).

A shift to agro-pastoralism could allow some Boran to procure more food energy and still restrict sales of animals for grain purchases so that herd capital can be retained for other ` purposes (Coppock, 1993).

2.1.2 Mixed crop- livestock production system

The high crop-related livestock production system in Ethiopia is found between 1,500 and 3,000 m.a.s.l especially in the highlands of Tigray, Wollo, Gondar, Gojjam, Bale, Arsi, Sidama, Shewa and parts of Wellega (Alemayehu, 2003). This production system encompasses 40% of the country land area, about 80% of cattle, 75% of sheep and 25% of goats (NEPAD-CAADP, 2005) 80% of equines (Alemayehu, 2004) from the total national livestock holdings and 95% of the national cropped area (Alemayehu, 2003).

The principal objective of farmers engaged in mixed farming is to gain complementary benefit from an optimum mixture of crop and livestock farming and spreading income and risks over both crop and livestock production (Agajie *et al*., 2002; Lemma and Smit, 2004; Solomon, 2004). Livestock provide inputs (draught power, transport, manure) and in turn, crops provide livestock with feed in the form of crop residues and by-products from crop production, which are converted into valuable consumable or saleable products like (milk, manure, meat, hides and skins, wool, hair and eggs) (ILCA, 1992; BoARD, 2003; Alemayehu, 2004). According to McDowell and Hildebrand (1980), livestock convert crop residues and other plant biomass to utilizable products by human beings, and either mediate or accelerate nutrient transfer and turnover to the soil. In this respect, mixed farming is at least partially, a closed system so that the waste products of one enterprise are used by the other enterprise (Amir and Knipscheer, 1989). Hence, the productivity of mixed farming system can be increased via considerable attention of the interaction between crops and livestock (IFAD, 2005).

In the mixed crop-livestock system of Ethiopian highlands, farm size is most critical constraint for efficiency of production as well as improving the living condition of the rural family. Currently, with increasing human population and demand for crop production, grazing lands are shrinking and livestock are kept in low potential lands that are not suitable for crop production and other purposes which in turn affect livestock productivity (Alemayehu, 2002; Alemayehu, 2005). Accordingly poor soil fertility and unreliable and seasonal rainfall limit the amount of feed obtained from these areas (EARO, 2001b).

Livestock are an integral part of the agricultural activity in Jimma zone since it's in the mixed crop-livestock system of Ethiopian highlands. According to Yisehak *et al*.(2013), livestock husbandry is practiced for food (milk, milk products and meat), fiber (hides and skin), draught power (traction, pack transport, sport/riding, cart pulling) and cash. Livestock, mainly oxen complement crop production by supplying draught power in all the districts. Livestock keeping, however, is primarily a subsistence activity to meet household food needs and supplement farm income. According to the same report Food security through livestock keeping, however, in Jimma zone, would be influenced in three ways: 1) Direct use of products like, meat, milk and milk products, 2) Using the income from milk, manure or animal sale to buy food and 3) Using manure as fertilizer to improve household food production like vegetable and other food crop production.

2.1.3 Urban and peri-urban ruminant animal production systems

Urban and peri-urban ruminant animal production system is an important component of livestock production system in Ethiopia (Yoseph *et al*., 2003). These production systems are developed in areas where the population density is high and agricultural land is shrinking due to urbanization, around big cities like Addis Ababa and other regional towns. In this system crossbred dairy animals (ranging from F1 to a higher blood level of exotic breeds mainly Holstein Friesian) are kept in small to medium-sized farms. These production systems include commercial to smallholder dairy farms and owns most of the country's improved dairy stock (Tsehay, 2002; Mohamed *et al*., 2003; Sintayehu *et al*., 2008). The main sources of feed are both own farm produced and purchased hay and agro-industrial by products (Oil Seed Cakes, Bran, etc) and the primary objective is to get additional cash income from milk sale (Ketema and Thehay, 2004; Yitay, 2008). According to Zegeye (2003), 100% zero grazing or cut and carry feeding system is practiced in this production systems. Tsehay (2002), described that urban milk production system inside and around Addis Ababa consists of 5167 small, medium and large dairy farms producing about 35 million liters of milk annually. Out of the total volume of milk produced in and around Addis Ababa, 73%, 10%, 9.4%, 7.6% were marketed, left for HH consumption, fed to calves and processed in to butter and *ayib* (Ethiopian cottage cheese), respectively (Azage and Alemu, 1998). Contribution of per-urban production system to the total domestic milk supply for Addis Ababa remained at only 14% (Belachew *et al*., 1994).

According to the survey conducted by Ulfina *et al*. (2013), in western Oromia the highest number of crossbred animals (13 animals per household) was reported from Jimma than the other towns. The number of lactating cows from Jimma (4.3 cows/ household) was also high as compared to those in the other towns that were more or less similar. The average milk produced per cow per day was 2.1±0.6 litters with lactation length of 9.5±1.2 months and 9.3±0.9 litters with lactation length of 10.2±1.0 months for local and crossbreed dairy cow, respectively. Among the surveyed western Oromia towns natural pasture has little importance in Jimma town since the system is almost zero grazing. Forage conservation in the form of hay is mostly practiced in Jimma by 46% households as opposed to the rest of per-urban dairy system. According to the same report 82% of respondents from Jimma, practice supplementation of lactating cows.

Small scale fattening of ruminant animals is a common practice for highland farmers of Hararghe and Wolayta, where 1-2 head of cattle are tethered and hand fed. In addition several households in Nazareth, Mojo and Debrezeit towns are also engaged in small-scale fattening activities, consisting of 1-3 head of cattle (Arend Jan Nell, 2006).

According to the same report the developments of private feedlots and cattle fattening have been seen around Nazareth, Mojo and Debrezeit towns in close proximity to the terminal markets in Addis. The feedlots buy cattle from primary and secondary markets and feed them on concentrates such as wheat bran, oil seed cake and molasses for 3-4 months. Finished animals are sold direct to butchers and traders. While the small-scale fattening activities are still going on in these areas, the initial success of commercial feedlots has been severely affected by increasing cost, shortage of concentrate feeds and the import bans on live animals in the Middle-east. In addition the butcheries offer low prices for the fattened animal on the grounds of lower shelf life of the meat, relatively lower dressing weight and consumers' preferences for pasture-fed cattle. As a result many of commercial feedlots that were set to dominate the terminal markets at one time have been closed. Recently some of the feedlots have been revived, e.g. the feedlot of ELFORA in Wonji, where 3 – 5 year old Boran bulls are fattened for life export to Egypt (Arend Jan Nell, 2006).

2.1.4. Intensive dairy farming

This is a more specialized dairy farming practiced by state sector and very few individuals on commercial basis. These are concentrated in and around Addis Ababa and are basically based on exotic purebred stock (Ketema and Thehay, 2004). Producers use all or part of their land for fodder production and purchased concentrates are also another sources of feed (Yoseph, 1999). The urban, peri-urban and intensive dairy farmers are produce 2% of the total milk production of the country (Ketema and Thehay, 2004).

2.2. Livestock Feed Resources in Ethiopia

Livestock production throughout the world is dependent on a variety of feed resources. Worldwide, there are more than 560 different types of feeds derived from herbaceous forages, trees and shrubs, food crop residues, food crop green feeds, food crop roots and tubers, concentrates and agro-industrial by-products, mineral supplements, and others (ILRI, 2005).

Major livestock feed resources in Ethiopia are natural pasture and browse, crop residues, improved pasture and forage, agro-industrial by-products, conserved forages and other by-products like food and vegetable refusal, pods and leaves of trees of which the first two contribute the largest feed type (Alemayehu, 2003; Alemayehu, 2004; Tolera *et al*., 2012). Yoseph (1999), has also reported that feed resources of dairy cows in urban and per-urban dairy production systems of Addis Ababa milk shed, were categorized in to five classes: pasture roadside grazing, hay, crop residues, concentrates and non-conventional feeds. According to same report there were insignificant production of improved pastures and forages around dairy and fattening areas. According to Yisehak *et al.* (2013), the major feed resource bases of three districts in Jimma zone of southwest Ethiopia are natural pasture (mainly communal), after math grazing, crop residues, green fodder and non-conventional feeds like *attela* (local alcohols leftover), households food leftover, grain mill byproducts, *chat* (*Catha edulis*) left over, coffee pulp and husk. Same authors justified that livestock are reared on natural pasture under continuous grazing systems. In the highland crop livestock production system, livestock get their feed mainly from natural pasture and crop residues (Zinash and Seyoum, 1991; Gashaw, 1992; Getnet, 1999; Tolera *et al*, 2012). The contribution of agro-industrial by-products is also minimal and restricted to some urban and per-urban farms (Alemayehu, 2004).

2.2.1 Natural pasture

Natural pastures refer to naturally occurring grasses, legumes, herbs, shrubs and tree foliages that are used as animal feed. They are used either by direct in situ grazing or browsing by livestock or can be harvested and conserved as hay for using period of lean feed availability (Tolera *et al*., 2012). The grassland region of Ethiopia accounts for some 30.5% of the area of the country and is most extensive in the western, southern and southwestern semi arid lowlands. Even though, it is changing due to increasing population and cropping, the total grazing and browsing land in the country is estimated to be 61-65 million hectares (Alemayehu, 1998). The land covered by native pasture in the highlands is estimated to be about 7.3 million hectares (Lulseged, 1987). In more humid areas, open grasslands (90% of which covered by grass) with some trees are common. In the drier patches, bushes are common and the proportion of grasses is reduced to about 70% (Alemayehu, 2004). In the highlands, natural grassland are confined to degraded shallow upland soils, fallowed cropland and to soils which cannot be successfully cropped because of physical constraints such as flooding and water logging (Getnet, 1999) therefore livestock grazing in this area is limited to road side and marginal areas that are not suitable for crop production(Tolera *et al*., 2012). Estimates of productivity of natural pasture vary probably due to variations in ecology, rainfall, soil type, season of the year, stage of growth and cropping intensity. Accordingly the quantity and quality of feed obtained from natural pasture particularly decline during the dry season. The protein content and digestibility of most grass species decline rapidly with advancing physiological maturity. According to same report due to the occurrence of recurrent drought at frequent intervals and the pastoralists' loss of key dry season and drought reserve grazing areas due to increasing population pressure, expansion of cultivation and other development intervention the contribution of natural pasture to the dietary need of animals is substantially decreasing from time to time. The previous estimates of natural pasture yield for highlands and mid altitude on freely drained soil was 3 tons of DM per hectare and on seasonally water logged fertile areas about 4-6 tons of DM per hectare (Alemayehu, 1998). The botanical composition of natural grasslands varies depending on topography, climate and soil type. In the highland areas, grasses constitute the main part of natural pastures and the composition of legume species increases with increasing altitude. In areas, which have 2,200 meters of altitude, there is a wide range of annual and perennial trifolium species and annual medicago species (Alemayehu, 1985).

According to Zinash and Seyoum (1991), the yield and quality of natural pasture in the Ethiopian highlands may be decreasing through years due to overgrazing, drought and lack of proper utilization.

2.2.3 Crop after math

Crop stubble is one of the important feed sources since livestock are allowed to graze stubble of different crops after harvesting the crops. According to Beyene *et a*l. (2011), livestock are allowed to graze stubbles of maize, sorghum, *teff*, and pulses between October and December in Benishangul Gumuz region, western Ethiopia in which the stubbles are accessible to all animals in the community. However, Sisay (2006), reported that stubbles are accessible only to livestock owned by individual farmers in central highlands of Ethiopia.

2.2.5 Crop residues

Crop residues includes cereal straws and Stover, grain legume haulms and other by-products such as sweet potato vines, cassava tops, sugarcane tops and enset by-products (Tolera *et al.*, 2012). The principal crop residues used for animal feeding are the straws of cereals and pulses. Based on crop production data of Central Statistical Agency (CSA) the annual production of cereal and pulses crop residues in 2010/11 was estimated to be around 35.7 million tons. The use of crop residues is increasing due to the current rapidly increase of human population, expansion of arable land which results in steady decrease in grazing land (MoA, 1998; Alemayehu, 1998; Alemu *et al*.1989; Getnet, 1999). Accordingly, Tolera *et al.* (2012), reported that crop residues contribute to about 50% of the total feed supply in Ethiopia. The contributions of crop residues reach up to 80% during the dry seasons of the year (Tolera *et al*., 2007). However the actual quantities of crop residues available for livestock feeding is reduced by the costs of collection, transport, storage and processing, seasonal availability, other alternative use and wastage.

The availability of crop residues is closely related to the farming system, the type of crops produced and intensity of cultivation (Alemayehu, 2004). In the highlands and midlands, various food crop residues including cereals crop residues (*teff*, barely, wheat, maize, sorghum and millet); pulse crop residues (faba beans, chicken peas, haricot beans, field peas and lentils), oil crop residues and rejected vegetables are providing a considerable quantity of dry season feed supply in many farming systems of the country. *Teff* and wheat straws are important sources of livestock feed in the highland vertisol area, while barley and oats straws are also important in areas where they are produced (Getachew *et al*, 1993).

The nutritive value of crop residue is variable depending on the species and variety of the crop, time of harvest, handling and storage and other factors (Tolera *et al*., 2012). Cereal straw and Stover are generally characterized by relatively low nutrient content, high fiber content, low digestibility, and low voluntary intake by animals. Most cereal straws and stover have low nutritive value than the haulms from grain legumes and /vine from root crop such as sweet potato. The haulms of pulse crops represent medium quality roughage with a crude protein content of 5-12% (Tolera, 2007).

2.2.6 Fodder trees and shrubs

Fodder trees and shrubs are important animal feeds in Ethiopia especially in arid, semi arid and mountain zones, where large number of the country's livestock is found (Alemayehu, 2004). Most browse species have the advantage of maintaining their greenness and nutritive value throughout the dry season when grasses dry up and deteriorate in quality and quantity (Rangnekar, 1992). Foliage, pods and fruits of different trees like *Acacia species, Balanities aegyptiaca* and *Prosopis* can be used as a substitute of concentrate supplement in which the supplements are expected to play a catalytic role in feed utilization so that it's needed in small quantities relative to the basal roughages (Tolera *et al*., 2012).

The leaves and pods from fodder trees and shrubs are rich in CP, vitamins and mineral elements and lower in fiber content than dry grasses forage and crop residues (Devendra, 1990; Tolera *et al*., 2012). However, their utilization is reduced by the presence of tannins and other phenolic compounds in their leaves (Devendra, 1990). Compared to grasses, fodder trees and shrubs have relatively high concentrations of crude protein and minerals. These nutrients are subject to less variation than in grasses and this particularly enhances their value as dry season feeds for livestock (Ibrahim, 1981; Moog, 1989). However, nutritive value of fodder trees decreases with aging, since they become woody as they mature. But such situation can easily be overcome by regular lopping of the plants.

2.2.7 Improved pasture and forage crops

Improved pasture and forages have, been grown and used in government ranches, state farms, farmers' demonstration plots and dairy and fattening areas (Mengistu, 1997; Alemayehu, 2004; Mengistu, 2006). Forage crops and grasses grown to feed dairy cattle include oats, vetch, fodder beet, elephant grass, siratro, desmodium, rhodes, phalaris, sesbania, leucaenia and tree lucerne. Yield of improved pasture and forage ranges from 6 to 8 tons and 3 to 5 tons of DM per hectare/year, respectively, while that of tree legumes ranges from 10 to 12 tons of DM per hectare/year. In suitable areas, yield of oat-vetch mixtures are commonly 8 to 12 tons of DM per hectare/year.

Despite the advantages of improved pasture and forage crops, due to unprecedented population increase, land scarcity and crop dominated farming, there has been limited introduction of improved pasture and forages to smallholder farming communities and the adoption of this technology by smallholder mixed farmers has been generally slow (Alemayehu, 2002; Mekoya et al., 2008).

In Ethiopia, most improved tropical species can be grown in the lowlands (1,500-2000 meters) except temperate species, which can grow in areas between 2,100 to 3,000 meters above sea level (Alemayehu, 2002). Pasture establishment is relatively difficult in the highlands compared to the humid, warmer and lower areas because of the types of soil and climate. In the wet season water logging, relatively low soil temperatures and reduced long and short radiation limits the establishment and subsequent growth of the pasture in the highlands (IAR, 1983). According to IAR, heavy emphasis is put in Ethiopia on the use of forage legumes in cropping system, through under-sowing, improvement of fallows, and establishment of tree legumes as hedges to partly address the major problems of long-term sustainability of crop production (Alemayehu, 2002).

2.2.8 Agro-industrial by-products

Agro-industrial by products produced in Ethiopia includes by-products from flour milling, oil seed cakes, sugar factory (molasses), abattoir and breweries. These feed ingredients are the main constituents of concentrate feeds. These by-products are mainly used for dairy, fattening and commercial poultry production and the scope for their wider use by smallholder producers is low due to availability and price (Alemayehu, 1998; Tolera *et al*., 2012).

The use of agro-industrial by-products for supplementary livestock feeding is justified when the forage supply is inadequate for the animals' needs, in terms of either quantity or quality or when the cost of the supplementation is less than the value of increased animal production achieved. Supplementary feeding is also justified in times of drought or other feed shortages when the importance of providing the animal's immediate nutrient requirements to keep them alive sometimes outweighs other considerations, including the cost of the feed (ILCA, 1979).

In general they are rich in energy or protein or both and have low fiber content and high digestibility compared with the other classes of feeds (Seyoum and Zinash, 1989). They also have more than 35% CP and 50-70% in-vitro dry matter digestibility (IVDMD) for oil seed cakes and 18-20% CP and more than 80 % IVDMD for milling by-products. Supplementing ruminants reared on low quality feeds with agro-industrial by-products enables them perform well due to its high nutrient density to correct the nutrient deficiencies set by the basal diet.

2.2.9. Other feed resources

Livestock feed resources are classified as conventional and non-conventional (Alemayehu, 2003), where the non-conventional ones vary according to feed habit of the community and others, e.g. vegetable refusals are non conventional. Thinning of extra seedling, leaf stripping or removing of the bottom leaves from the plant of maize and sorghum and topping (harvesting of maize plant tops at silking stage) can generate animal feed throughout the cropping cycle in addition to their dry Stover after grain harvest (Tolera *et al*., 2012). Sweet potato vine and tuber can also use as animal feed. It contains low carbohydrate, but higher protein and fiber content than the tuber. The DM content of the vine can be as high as 6 tons/ha with a crude protein content of over 20% and digestibility of 70%. Sweet potato vine have good palatability. In densely populated and land scarce areas, sweet potato has a promising potential for use as food-feed crop because of its relatively short vegetative cycle (4-5 months) high yield potential with minimal horticultural practice. The leaves, pseudo-stems and peelings of banana can be used as animal feeds. Banana leaves have moderately high CP content 15% and its pseudo-stem is rich in fermentable energy (Tolera *et al*., 2012). Banana leaves and pseudo-stems have relatively high digestibility of 65% and 75% respectively, and can be used as supplementary feeds to pasture and crop residue based diets.
Like banana all parts of enset plant can be fed to livestock but due to the use of pseudo-stem, corm and the stalk of inflorescence parts for human food leaf pruning and thinned enset plant

can be fed to animals. The CP content of the leaf about 17% is comparable to many browse species and makes it a favorable feed resource in ruminant feeding (Tolera *et al*., 2012). However, the CP content of the pseudo-stem and corm is usually very low (less than 7%). Additionally *chat* (*Catha edulis*) left over, coffee pulp and husk and *attela* are also other non conventional feed resources used in livestock feeds in Jimma zones of southwest Ethiopia (Yisehak *et al*., 2013).

2.3 Livestock Feeding System in Ethiopia

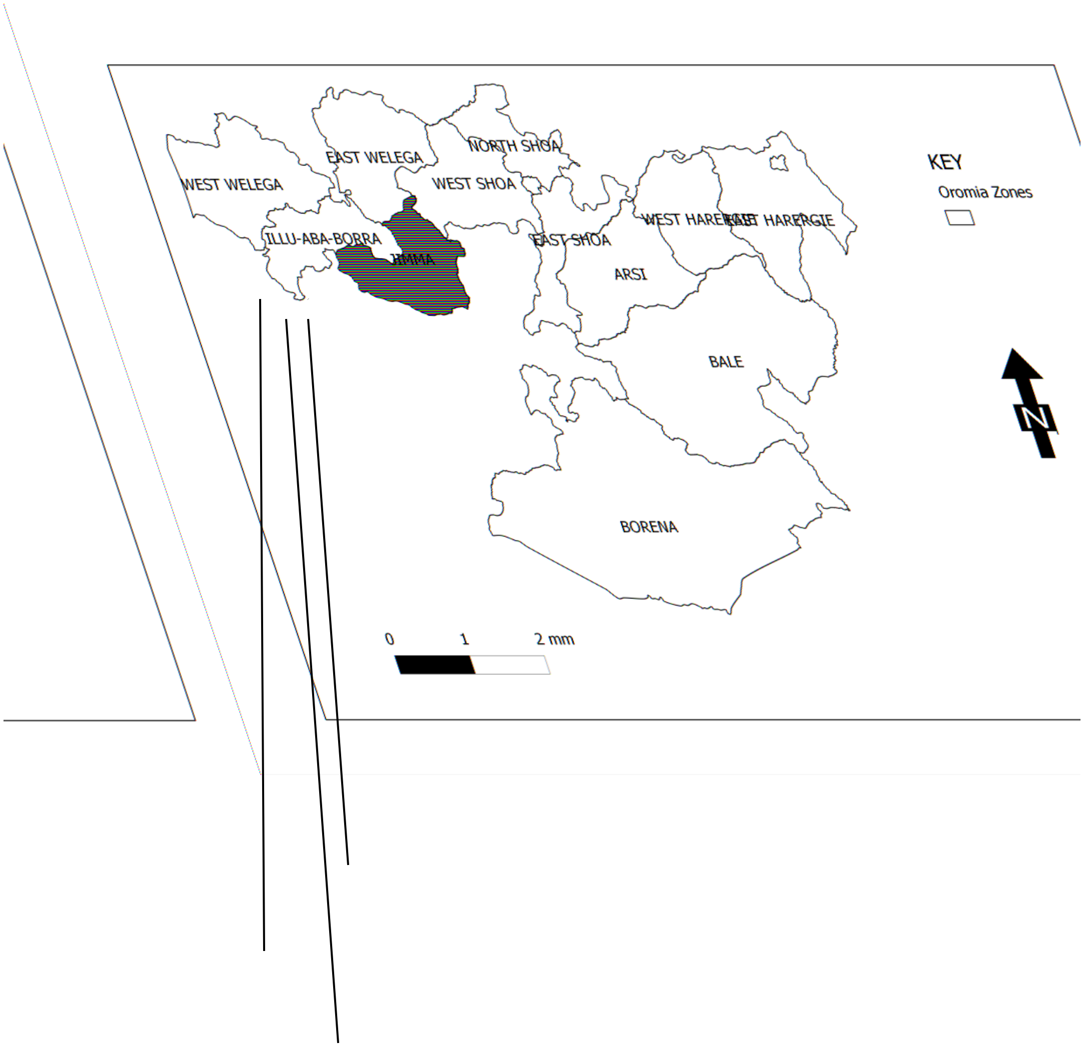
The livestock feeding systems in Ethiopia include grazing and browsing; cut and carry and stall feeding based on hay, crop residues and concentrates to some extent. At present, livestock in many places are fed almost entirely on natural pastures and crop residues. Grazing is done mainly on permanent grazing areas, fallow lands and crop aftermath. Mohamed and Abate (1995), indicated three feeding periods in the central highlands of Ethiopia: the main rainy season (June-September), when green feed is available; the dry season (October-February), when straw and other crop residues become gradually available and the short rainy season, when feed supplies decline, although new re-growth may occur depending on the time-lines and amount of the short rains.

The amount and type of feeds allocated to different classes and species of animals is mainly based on seasonal availability than level of livestock productivity. For instance according to a study conducted by Samuel (2005), in Ada-Liben Wereda more farmers give priority for oxen, cows and calves in decreasing orders in their feeding of available feed resources. Some crop residues were stored to supply for working oxen when cultivation is practiced mainly from February to March and June to August. Yitaye *et al*. (2000), on the other hand have reported that cows receive a relatively more amount of maize and *noug* cake supplementation followed by work oxen and calves. According to the assessment made by Gashaw (1992), in Selale Dairy Development Project about 35% of the total on farm DM was consumed by cross bred dairy cows although they accounted only 17% from the total tropical livestock unit (TLU) in the farms.

3. MATERIALS AND METHODS

3.1 Description of the Study Area

The cross-sectional field survey was conducted in three districts of Jimma zone (Kersa, Omo Nada and Tero Afeta), Southwest Ethiopia. These districts are located in the Gilgel Gibe catchments of southwest Ethiopia (Figure 1). The climate of the Gilgel Gibe catchment is characterized as hot humid tropical with bimodal heavy rainfall which is uniform in amount and distribution, ranging from 1200 to 2800 mm per year, with short and main seasons occurring from mid February to May and June to September, respectively (http://en.wikipedia.org/wiki/Jimma_Zone). In normal years, the rainy season extends from mid February to early October. The mean annual temperature of the area is 19.5°C (http://www.weatherzone.com.au/world/africa/ethiopia/jimma). The study districts are further described in Table 1.



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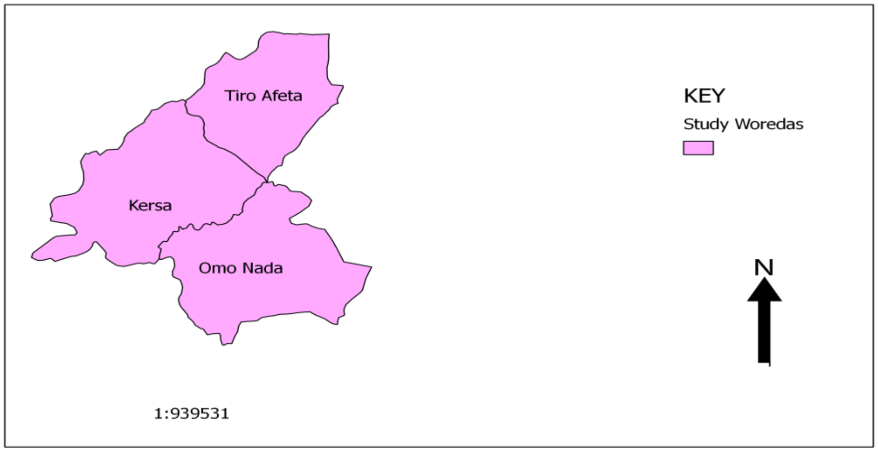


Figure 1. Map of the study districts in Jimma zone Oromia region, Ethiopia

Table 1. Description of the study areas

Variables	Study Districts		
	Kersa	**Omo Nada**	**Tero Afeta**
Area (km^2)	975	1589.4	1001.9
Topography	platues, hills plains,	dissected plateaus,	dissected platues, mountains,

	mountains, valley	mountains, plains valleys	valleys
Altitude	1740 to 2660 m.a.s.l	1000 to 3340 m.a.s.l	1640 to 2800 m.a.s.l
Climate	33% Dega, 67% Woinadega	40% Dega, 45% W/Dega and 15% Kolla	85% Woinadega, 15% Dega
Soil type	Orthic Acrisols and Pellic Vertislos	Pellic Vertisols and Orthic Acrisols	Chromic and Pellic vertisol, Orthic acrisol
Vegetation	high forests, hoodlands, reverie and manmade forests	high forest, woodland, riverine, shrub and manmade forests	high forest, woodland, reverine, bush and shrub and manmade forests
No. pop.	131,150	194,978	100,700
Land use	58.6% arable, 17.3% grazing land, 6.3% forest	56.8% arable,25.2% grazing land, 14% forest	26% arable, 8.3% grazing, 14% forest
Livestock population	184,551 cattle, 12,364 sheep, 7,032 goats, 5690 Equines	1,207,732 cattle 22,336 sheep, 12,924 goats, 15,334 equines	42,563 cattle, 4,377 sheep, 4,120 goats, 2157 Equines
Widely cultivated crops	*teff*, maize, sorghum, wheat barley, horse bean, field pea and haricot bean	maize, *teff*, sorghum, wheat, barley, horse bean, lentils and filed pea	*teff*, maize, sorghum, barley, horse bean, field pea, wheat, *neug* and haricot bean

Source: GOR, 2011

3.2 Sampling Technique

The three districts (Kersa , Omo Nada and Tero Afeta), in Gilgel Gibe catchments of Jimma Zone, Southwest Ethiopia were purposively selected for this particular study. These districts are selected based on their livestock potential, accessibility and availability of research fund obtained through Institutional university cooperation (VLIR-UOS/ IUC-JU) project during planning stage. VLIR-UOS/ IUC-JU program have a multidisciplinary project in the Gilgel

Gibe catchments with the aim of investigating the impact of the Gilgel Gibe Dam. For representation of each agro-ecology, three farmers associations (FAs) from each districts representing three topographic locations (HAR: high altitude region, 2001-2800 m.a.s.l); MAR: medium altitude region, 1751-2000 m.a.s.l) and LAR: low altitude region, 1200-1750 m.a.s.l) were selected using stratified random sampling technique. Households (HHs) who have a minimum of 10 years experience in livestock production and have at least two species of livestock were included in the study. So from HHs met the above criteria 10% of them from each districts were selected by systematic random sampling. Accordingly, 122, 188 and 104 HHs from Kersa, Omo Nada and Tero Afeta districts, respectively and a total of 414 HHs from the three districts participated in the study. The selected farmers were interviewed using a structured questionnaire which was pre-tested with 18 farmers in each district.

The total sample size for household interview was determined using probability proportional sample size-sampling technique Cochran's (1977).

$$no = \frac{Z^2 * (P)(q)}{d^2} \rightarrow n_1 = \frac{no}{(1 + no / N)}$$

Where;

n_o = desired sample size according to Cochran's (1977) when population greater than 10,000

n_1 = finite population correction factors (Cochran's formula, 1977) population less than10,000

Z = standard normal deviation (1.96 for 95% confidence level)

P = 0.1 (proportion of population to be included in sample i.e. 10%)

q =is 1-P i.e. (0.9)

N = is total number of population

d =is degree of accuracy desired (0.05)

Discussion with 10 key informants organized from different groups was held in each study FAs for triangulation purposes and to gain an in-depth insight about the topics covered in the structured questioner for interview and to check whether patterns found in the HHs were valid by focus groups. In general, focus group discussions using checklists that contained livestock production systems, opportunities and constraints for livestock production coupled with pretested questionnaire helped the researcher to design structured questionnaire. Finally, systematic random sampling technique was followed to select the respondent HHs.

3.3 Data Collection

Pre-tested structured questionnaire format was used for the interview of sampled HHs to collect socio-economic and farming system characteristics, livestock husbandry and management practice and livestock feed resources and utilization were collected using questioner which is attached in the appendix part.

3.3.1 Socio-economic data

Socio-economic data like: age, sex, marital status, educational level and family size of the respondent household, land holding and usage, sources of income, objective of livestock keeping were collected.

3.3.2 Livestock production data

Livestock production data like livestock herd size and composition, reproductive performances like age at first calving/foaling and calving/foaling interval, lifespan calving, age at first kidding and kidding interval; age at first lambing and lambing interval, and production performances like lactation length and milk yield per-lactation, draught age of oxen, draught lifespan of oxen, draught age of equines, livestock management (housing, watering, health), livestock feed resources and utilization systems, constraints and opportunities of livestock production in the study areas were collected.

3.4. Feed Resource Assessment and Quantification Data

Data on types of available livestock feed resources, conservation and utilization practices and livestock feeding systems in the study districts were collected.

3.4.1. Dry matter yield of natural pasture

The total amount of DM available in natural pastures in the study area was determined by multiplying the average value of private grazing land holding with the per hectare DM output of the natural pastures 2 tDM/ha/year (FAO, 1987) (Appendix Table 7). Amount of DM obtained from communal grazing land (1.5 tDM/ha/year) was factored in to the total communal grazing areas available for each total households TLU eligible to graze on this land unit.

3.4.2. Dry matter yield of available crop residues and after math grazing

The quantity of available crop residues (DM basis) was estimated from the total crop yields of the households, which was obtained from questionnaire survey, according to FAO (1987), conversion factor for the Ethiopian condition (Appendix Table 8). Conversion factors are 1.5 for barley, wheat, *teff*, oats; 2 for maize, 1.2 for pulse and oil crop straws and 2.5 for sorghum. The quantity of crop residue on the basis of DM available and those actually available for livestock consumption was estimated by deducting 10% as wastage (Tolera and Said, 1994). And quantities of available DM's in aftermath grazing was determined by multiplying the cultivated crop land by the conversion factor of (0.5) FAO (1987), (Appendix Table 7).

3.4.3. Estimation of the balance between DM supply and requirement for livestock

Total available DM from natural pasture, crop residues and crop aftermath were compared to the annual DM requirements of the livestock population in the sampled households. Data of livestock population in the sample households was obtained from the interview of HH heads during the survey. To compare the DM requirement with the DM production, the number of livestock population was converted into tropical livestock units (TLU) using the conversion factors of (Gryseels, 1988; ILCA, 1990; FAO, 2002) (Appendix Table 6). The DM requirements of the livestock population were calculated according to the daily DM requirements for maintenance of 1 TLU or a 250 kg animal which is 2.5% its body weight (6.25 kg DM/day) (Kearl, 1982).

In this study neither poultry feed availability assessment nor poultry feed requirement were included due to shortage of time and required budget for the data enumerators and the researcher, as well as lack of TLU conversion factors.

3.5. Statistical Analysis

Data (both qualitative and quantitative) was cleaned and entered into Microsoft office Excel 2007 sheet every day after administering questionnaire to prevent loss of data. All the surveyed data were analyzed using Minitab Statistical Software (2013), version 16.1. Statistical variations for qualitative variables (frequencies and percentages) were tested by means of cross tabs, with significant differences at $P \leq 0.05$. Mean comparisons were carried out using Chi-square test for the qualitative variables. The descriptive statistics for the quantitative variables were subjected to one way analysis of variance (one-way ANOVA) using the general linear model procedure of Minitab. Mean comparisons were carried out using Tukey test for the quantitative variables. Levels of significance also considered at $P \leq 0.05$. Analyzed data were presented using tables, figures, percentages, means, and standard errors. The appropriate statistical model used for characterization of the production systems:

$$Y_{ij} = \mu + l_i + \varepsilon_{ij}$$

Where, y_{ij} = the response of the j^{th} HH in the i^{th} location

μ = overall mean

l_i = effect of i^{th} location (i= 3)

ε_{ij} = random error

4. RESULTS AND DISCUSSIONS

4.1 Socio-economic Characteristics of the Respondents

4.1.1 Households characteristics

Sex of HH heads, age, educational status and family size are presented in Table 2. Out of the overall responded household heads, 94.04% of them were males. Teshager *et al*. (2013), reported male dominated HH heads (95.6%) in Ilu Aba Bora zone, Southwest, Ethiopia. According to Workneh and Rowland (2004), about 96% of households in Oromia region are male headed.

The overall mean age of respondents in the study districts was 45.32±0.88 years (P <0.05). The highest mean age was found in Omo Nada (47.34±0.95 years) followed by Tero Afeta (45.77±0.84 years) and the lowest mean age was found in Kersa (42.86±0.85 years) districts, respectively. The current study is in agreement with the report of Adebabay (2009), who reported 45.08 years in Bure district of northern Ethiopia. The current finding is higher than the report of Tesfaye (2007), who has reported overall average age of 41.2 years in Metema district, Northern Ethiopia. However its lower than Zewdie (2010), who reported mean age of 47±1.7 years in Highlands and Central Rift Valley of Ethiopia

There were a significant difference (P<0.05) in the educational status of the studied HHs and the overall educational status of the respondent depicts (avg., 80%) illiteracy. Accordingly, the highest level of illiteracy was recorded in Kersa (82.22%) followed by Tero Afeta (80%) and the lowest level of illiteracy were observed in Omo Nada (71.11%). Similar finding was reported by Yisehak *et al*. (2013), in three districts of Jimma zone, Southwest Ethiopia. The current finding is higher than the finding of Yeshitila (2008), who has reported 58.5% illiterates HHs in Alaba district. Teshager *et al*. (2013), reported 11.7% illiterate HHs in Ilu Aba Bora zone of Southwest Ethiopia. Since education is an important tool to bring fast and sustainable development and had roles in affecting household income, adopting technologies, health and the whole socio-economic status of the family this low educational level might had a negative impact to adopt technologies in the study areas. The low level of education in the studied households has an influence on the transfer of agricultural technologies and their participation in development (Mulugeta, 2005).

Family size of the household was not significantly different (*P*>0.05). The overall mean family size in the studied HHs was 8.34±0.41. The result of the current study is in agreement with the finding of Yeshitila (2008), who reported 8.52±0.41 in Alaba district of Southern, Ethiopia. However, the current finding is higher than the average family size reported by (CSA, 2008), Kedija (2007), and Teshager *et al*. (2013), who reported mean family size of 5.0, 6.62±0.22 and 7.09±0.15 in Oromia region, Mieso district and Ilu Aba Bora zone of Oromia national region, respectively. The main source of labor in the sampled HHs is their family.

In the current study 9.63% and 3.70% of male headed HHs have had two and three wives, respectively. This might be due to their objective to have many childrens so that they would helped the during the time of their retirement.

Table 2. Household characteristics of the respondents in the study areas

Characteristic		Districts, (Mean ±SEM) Kersa	Omo Nada	Tero Afeta	Overall	P
Age of respondents		42.86 ±0.85[b]	47.34 ±0.95[a]	45.78±0.84[a]	45.32±0.88	*
Family size		8.48±0.41	7.92±0.32	8.6±0.5	8.34±0.41	ns
		District, % respondents				
Sex of the HH heads	Male	91.11	94.44	96.67	94.07	ns
	Female	8.89	5.56	3.33	5.93	ns
Number of wives of Male HH	1	87.78	90.00	82.22	86.67	ns
	2	10.00	5.56	13.33	9.63	ns
	3	2.22	4.44	4.44	3.70	ns
Educational status of the HH head						
	Literate	17.78[b]	28.89[a]	20.00[ab]	20.00	*
	Illiterate	82.22[a]	71.11[b]	80.00[ab]	80.00	*

*Means in the same row for each parameter with different superscripts are significantly different (P <0.05); *P<0.05; ns: non-significant difference (p>0.05); SEM: standard error of means.*

4.1.2 Land holding and its allocation

Land holding and utilization of the study areas are presented in Table 3. There was no significant difference ($P>0.05$) in total land holding in the study districts. The overall average land holdings per household in the study districts was 2.14±0.06 ha. The total land holding in the current study is in agreement with the finding of Yisehak et al. (2013), in Jimma zone of Southwest Ethiopia. The total land holdings in the current study areas were greater than the finding of Shitahun (2009), and Belete (2009), whose have reported 1.55 ha and 1.93 ha in Bure district of Amhara National Region and Goma district of Jimma zone, Oromia National region, respectively. Also, it's greater than the national average land holding of 1.2 ha (CSA, 2008). In all the study districts discussion with key informants revealed that land holding per HHs where decreasing in the last three decades. This is because land holding is fixed whereas successive new families to be formed due to population growth share only what was previously owned by their families. This small area of land holding together with large family size and low productivity of this land implies food insecurity of these households.

Farmers in the studied districts allocate larger proportion of their land for crop production than grazing land which agrees with the finding of Teshager *et al*. (2013), in Ilu Aba Bora zone of Southwest Ethiopia. In the current study out of the total land only 0.19±0.34 ha (8.92%) was allocated for grazing in all the study districts. This finding is higher than the finding of Shitahun (2009), who reported 0.04±0.01 ha (3.14%) grazing land per household in Bure districts of Amhara region.

Table 3. Mean ± SEM landholding (ha) per HH and land use in the study areas

	Districts, (Mean ± SEM)				
Land holding	Kersa	Omo Nada	Tero Afeta	Overall	P
Grazing (pastureland)	0.23±0.04	0.15±0.03	0.20±0.04	0.19±0.34	ns
Crop land (arable)	1.96±0.11	1.96±1.10	1.91±0.10	1.94±0.01	ns
Total land	2.19±0.12	2.11±0.12	2.11±0.11	2.13±0.06	ns

SEM: standard error of means

4.1.3 Sources of income in the study households

In the current study both crop and livestock productions were the major sources of HHs income (Figure 2). From all the surveyed HHs, 84.07% of them revealed that their major sources of income were both crop and livestock sale followed by only crop sale (7.78%) and only livestock and livestock products sale accounts (6.67%) and the rest was from non-agricultural activities. The current finding is in agreement with Teshager *et al*. (2013), who reported (72.8%) HHs income from both crop and livestock in Ilu Aba Bora zone of Southwest Ethiopia and Yisehak *et al*. (2013), in Jimma zone of Southwest Ethiopia. According to the results of the study, livestock production has multiple contributions for a source of income and survival of the studied households. Poorer households supplement their annual cash income through local agricultural labor employment (weeding and harvesting) on the fields of middle and better-off households and also participate in sale of charcoal and firewood.

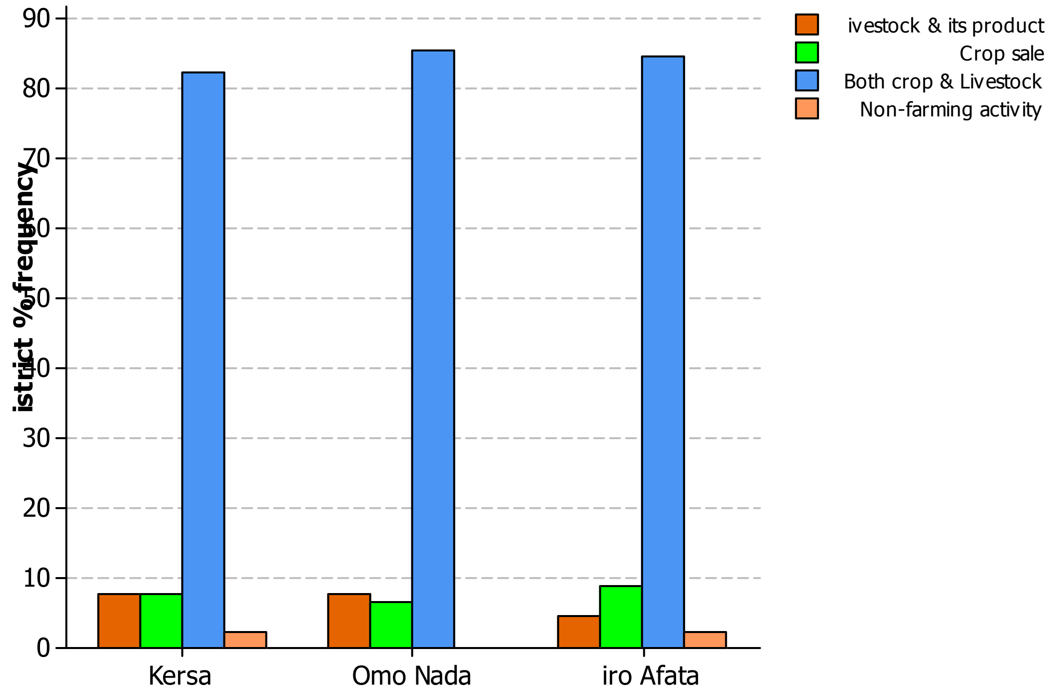


Figure 2. The main sources of income of the surveyed households in the study areas

4.1.4 Livestock holding and their role

The overall average holding of total livestock in TLU per HH was 5.10±0.32 TLU (P<0.001). The highest number of livestock in TLU was observed in Tero Afata 5.99±0.30 followed by Omo Nada 4.79±0.34 TLU and Kersa district which was 4.52±0.32 TLU. In the current study all farmers keep only local breeds of livestock in all the study areas.

The combination of livestock owned in this study was similar to other findings conducted in other rural areas of Ethiopia (IPS, 2000; Workneh and Rowland, 2004). Out of the total livestock cattle accounted for 4.74±0.24 TLU (92.94%), which could imply that, the importance of cattle in the farming system.

The result of the current finding is lower than the finding of Yeshitila (2008), who reported 9.87 TLU of livestock and 7.38 TLU of cattle in Alaba district of Southern Ethiopia. However, contrary to the present study, there were more number of goats (44%), than cattle (42%) and camels (14%) in Mieso district of Hararghe zone (Kedija, 2007). The higher proportion of cattle in the study areas was probably due to the existing farming system of mixed crop livestock production. According to the respondents in the study areas they used cattle (oxen) primarily for traction purpose in addition to their use as sources of beef and milk for rapidly growing human population.

There was a significant difference (P<0.05) in total cattle composition between Tero Afeta and the rest two districts. Accordingly, the highest number of cattle in TLU observed in Tero Afeta district 5.54±0.23 TLU was higher than 4.47±0.25 TLU in Omo Nada and 4.22±0.24 TLU in Kersa district. Generally, in all the study districts the herd structure was female dominated (P>0.05) compared to males. This shows that cow is the most important animals because it is a source of milk and milk products, replacement stock (calves) and cash. Besides, female animals are highly valued and counted as live resources than male animals. Having a large number of cows are considered by the communities as a prestige and used as markers of wealth status in the studied districts. This finding is in agreement with Teshager *et al.* (2013), in Ilu Aba Bora zone of Southwest Ethiopia in which the proportion of cow is higher from all cattle herd structures.

There was a significant difference in male cattle holding (P<0.001) and oxen (P<0.05) between Tero Afeta and the rest two districts. The number of male cattle and oxen in Tero Afeta district was (1.20±0.10 TLU) and (0.42±0.05 TLU), respectively were higher than the two study districts.

Sheep was the second populous livestock next to cattle in all the studied districts ($P>0.05$). However, there were a comparable number of sheep and donkey (0.13±0.01) and (0.13±0.03), respectively in TLU in Tero Afeta district which may indicate the importance of donkey.

According to the discussion with key informants across the study districts, the primary purpose of keeping sheep was for cash income and as a source of meat. In times of insufficient crop harvest, sheep are the first animals to be sold to purchase food grain and other family needs and the skin of sheep is also an important source of income in all the studied districts.
Like sheep, goats are mainly kept for meat and cash income. During periods of low crop harvest, goats, like sheep, are sold in order to purchase food and serve as one of the means to minimize food insecurity.

Equines were the most valuable pack animals for transportation of peoples and other goods in many parts of the study areas especially where other means of transportation are not available. Among the equines, donkeys 0.07±0.02 TLU were more abundant followed by horses 0.05±0.02 TLU and Mules 0.06±0.03 TLU and this indicates the importance of donkeys in the farming system. However, there was a significant difference ($P<0.05$) between Tero Afeta and the two study districts in composition of donkey. Accordingly, the number of donkey (0.13±0.03 TLU) was observed in Tero Afeta district and this may be due to the poor infrastructure (poor road) and raged topography of Tero Afeta for modern transportations so that donkeys are more important to transport agricultural inputs (fertilizer, pesticides, herbicides etc) and harvested grains to the farmland/homesteads and to market places, respectively. In general, as most of the farmlands are far from residence, donkeys are used to transport inputs, farm equipment, and harvested grains or crop residues from the farm land and to homesteads or market places in all the study districts. In mixed production systems where animals are used for draught and transport, the proportion of mature oxen or donkeys in herds tends to be relatively high (ILCA, 1990). Horses are used mainly for transporting people and rarely for packing, while donkeys are used solely for packing. In addition to transportation, equines are used for threshing and transporting agricultural products to and from the homestead, drinking water for animals and human beings, wood, crop residues and charcoal to market places. The finding in the current study is in agreement with Lemma (2002) and Ahmed *et al. (* 2010). According to the discussion with key informants, mules are preferred for transporting people in mountainous rugged and undulating places due to their strength and physical fitness.

Table 4. Mean ±SEM livestock holding in TLU and herd composition per/HH across the study districts

	Districts, (Mean ± SEM)				
Livestock in TLU	Kersa	Omo Nada	Tero Afeta	Overall	P
Total Livestock	4.52±0.32[b]	4.79±0.34[b]	5.99±0.30[a]	5.10±0.32	**
Cattle	4.22±0.24[b]	4.47±0.25[b]	5.54±0.23[a]	4.74±0.24	*
Oxen	0.28±0.04[b]	0.20±0.03[b]	0.42±0.05[a]	0.3±0.04	*
Male Cattle	0.59±0.08[b]	0.82±0.10[b]	1.20±0.10[a]	0.87±0.09	**
Female Cattle	3.35±0.20	3.45±0.18	3.92±0.18	3.57±0.19	ns
Sheep	0.08±0.01	0.10±0.01	0.13±0.01	0.10±0.01	ns
Goats	0.09±0.02	0.05±0.01	0.06±0.01	0.06±0.01	ns
Donkey	0.04±0.02[b]	0.04±0.02[b]	0.13±0.03[a]	0.07±0.02	*
Horse	0.05±0.20	0.04±0.02	0.07±0.03	0.05±0.02	ns
Mule	0.04±0.02	0.09±0.03	0.06±0.03	0.06±0.03	ns

*SEM, standard error of means; means with different superscripts in a row indicate statistically significant difference between the districts (P<0.05); *P<0.05; **P<0.001; ns, non-significant difference (P>0.05)*

4.1.5 Purpose of livestock keeping

Livestock keeping has multiple advantage in sustaining food security in the current study. Accordingly the main objectives of livestock keeping were to produce food (milk, milk products and meat), for draught power (traction, pack transport, threshing) and to increase cash income from sale of live animals and animal products (Figure 3). Livestock keeping, however, is primarily a subsistence activity to meet household food needs and supplement farm income. Accordingly, the overall survey result of (88.8%) and (11.2%) depicted that livestock are source of food from direct use/sale of milk, milk products and meat to buy food , and indirect use of livestock for draught power (traction, threshing) and their manure as fertilizer. The current finding is in agreement with the report of Teshager *et al*. (2013) and Yisehak *et al*. (2013) in Ilu Aba Bora and Jimma zones of Southwest Ethiopia, respectively.

Livestock, mainly oxen complement crop production by supplying draught power in all the study districts. According to the discussion with key informants' farmers in the study areas sell livestock mainly small ruminants to mitigate household problems like medication, school fees, payment for fertilizer purchases and others. Livestock also plays an important role in maintaining the livelihoods of the farmers by providing social and cultural identity, medium of exchange and means of savings and investments.

In the high and mid-altitude areas where mixed farming system is practiced, livestock remains an important safety resource, a living bank and a buffer during periods of crop failure, and represent more than half the average wealth of rural households (WISP, 2008; NABC, 2010).

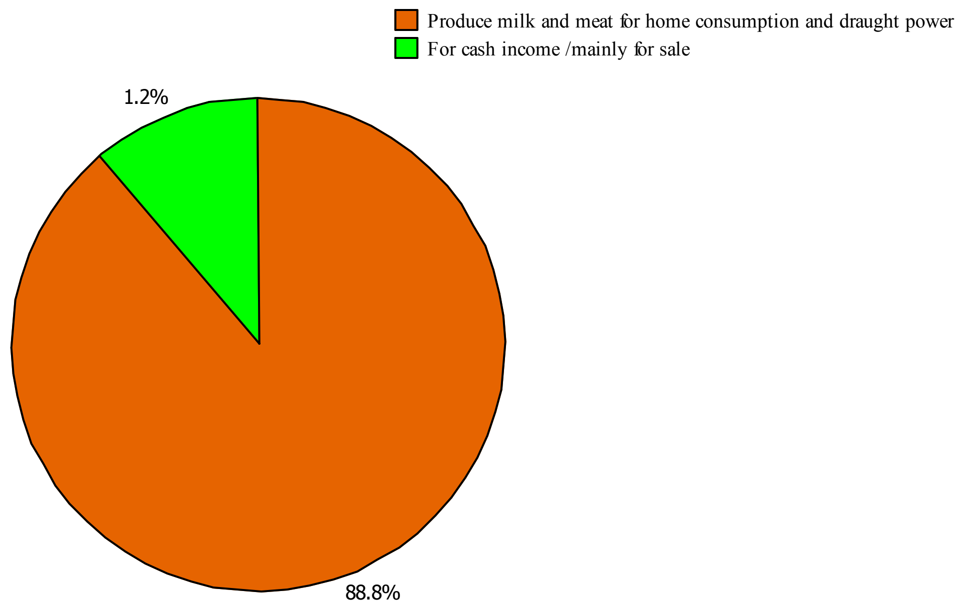


Figure 3. Purpose of livestock keeping in the study areas

4.1.6 Trends in livestock population and species composition

According to (60%) of the respondents in the current study there was an increasing trend in the number of livestock per HH in the last three decades Table 5. According to the respondents, there were different reasons for an increment in livestock holding per household. Among the reasons, to satisfy an increasing demand for meat and milk (27.41%) for the rapidly increasing human population and to increase cash from sale of live animals and animal products (23.70%) were the major reasons. On the other hand (40%) of the respondents across the districts disclosed a decreasing trend in the number of livestock per HH in the last three decades. There was a significant difference (P<0.05) in reasoning for declining trend in livestock holding per HHs for a decade. Among the reasons, feed shortage was the major prominent in Omo Nada (55.56%) followed by Tero Afeta (43.33%) and Kersa (32.22%) but disease occurrence was the most prominent in Kersa (25.56%) followed by Omo Nada (15.56%) and the least in Tero Afeta (14.44%). The current finding is against the report of Yisehak *et al.* (2013), who has reported a decreasing trend in livestock holding per household in Jimma zone of Southwest Ethiopia.

According to 68.89% of respondents in the current study there was a change in livestock species composition in the last three decades (Table 5). According to 78.15% of the respondents cattle were the first changing livestock species in the study areas. Discussion with key informants revealed that, decreasing in grazing land due to expansion of crop land is enforcing them to reduce large ruminants and shift to small ruminants.

Table 5. Trends in livestock population and species composition for the last three decades and reason for change across the study districts

	Districts, % of respondents				
Parameters	Kersa	Omo Nada	Tero Afeta	Overall	P

Increasing	54.44	64.44	61.11	60.00	ns
Decreasing	45.56	35.56	38.89	40.00	ns
Reason for increasing					
To satisfy increasing demand of milk and meat	32.22	22.22	27.78	27.41	ns
To increase cash income	14.44	28.89	27.78	23.70	ns
Decreasing	53.33	48.89	44.44	48.89	ns
Reasons for decreasing					
Feed/land shortage	32.22[c]	55.56[a]	43.33[b]	43.70	*
Disease occurrence	25.56[a]	15.56[b]	14.44[b]	18.52	*
Change in species composition					
Exist	65.56[b]	58.89[c]	82.22[a]	68.89	*
Don't exist	34.44[b]	41.11[a]	17.78[c]	31.11	*
Change observed in					
Cattle	77.78[b]	87.78[a]	68.89[c]	78.15	*
Shoats	11.11[a]	4.44[b]	11.11[a]	8.89	*
Equine	4.44[b]	0.00	8.89[a]	4.44	*
No Change	6.67[b]	7.78[b]	11.11[a]	8.52	*

*Different superscripts in a row indicate statistically significant difference between the districts (P<0.05); *P<0.05; ns, non–significant difference*

4.2 Livestock Management

4.2.1 Animal housing

Most of the respondents (86.67%) in all the study districts provided nighttime shelter to their lactating and pregnant cows in human living rooms (P>0.05) while the rest 13.33% of respondents house in open yard and separate houses (Table 6). About 89.63% and 10.37% of HHs, respectively had housed their calves and small ruminants in the human living rooms. The current study is in agreement with Yisehak *et al*. (2013), who reported 88.33% of calves and small ruminants were housed in human living room in Jimma zone of Southwest Ethiopia. However, its higher than the finding of Teshager *et al*. (2013), who reported 34.4% in Ilu Aba Bora zone of Southwest Ethiopia share human living room with their livestock. Discussion with key informants revealed other species of animals as well as young bulls and heifers are housed in keral.

Table 6. Livestock housing systems across the study areas

		Districts, % of respondents				
Types of animal		Kersa	Omo Nada	Tero Afeta	Overall	P
Pregnant/lactating cow	1	85.56	88.89	85.59	86.67	ns
	2	14.44	11.11	14.44	13.33	ns
Caves/small ruminants	1	93.33	87.78	87.78	89.63	ns
	2	6.67	12.22	12.22	10.37	ns

1=housed in human living rooms; 2= housed in separate place; ns, non-significant difference

4.2.2 Sources of water and frequency of animal watering in the study areas

The main sources of water in the study areas are presented in Table 7. Accordingly, the main sources of water for livestock were river water (95.7%) and shallow-well pond (4.3%). According to Teshager *et al*. (2013), the main sources of water for cattle in Ilu Aba Bora zone were river (97.8%), pond (1.7%) and tap water (0.6%). Farmers in the current study areas water their animals *Adlibitum* (92.06%), twice a day (5.67%) and once a day (2.27%) both in dry and rainy seasons. The current finding is in agreement with the finding of Yisehak *et al*. (2013), in Jimma zones of Southwest Ethiopia.

Table 7. Sources of water and frequency of animal watering across the study areas

	Districts, % of respondents				
Sources of water	Kersa	Omo Nada	Tero Afeta	Overall	P
River	92.4	96.3	98.5	95.7	ns
Pond	7.6	3.7	1.5	4.3	ns
Watering frequency					
Adlibitum	90.3	92.2	93.7	92.06	ns
Once a day	2	3.8	1	2.27	ns
Twice a day	7.7	4	5.3	5.67	ns

ns: non-significant

4.2.3 Animal breeding

Farmers in the studied areas reported that breeding system was entirely natural using local type bulls available in their area (Table 8). Accordingly AI service was not yet started in the study districts and these areas were totally lacking technological intervention to introduce foreign (improved) breed.

According to 94.07% and 90.37% of respondents in the current study their sources of heifer/replacement stock and breeding bull, respectively were raised at home and only (5.93%) and (9.63%) of respondents purchase replacement heifer and breeding bull respectively (Table 8). The result of the current study is in agreement with the finding of Yisehak *et al*. (2013), who reported (92.78%) of the animals in Jimma zone were obtained from home breeding whereas higher than the finding of Belay *et al*. (2012), who has reported about 25% of the oxen and 72.2% of the cows owned by the households in Dandi district of Oromia region were reared on farm.

Bulls commonly run with cows year round and breeding is thus uncontrolled. As cattle herders do not use controlled breeding and the reproduction of their cattle is primarily regulated by seasonal feed availability (Kedija, 2007).

Table 8. Sources of heifer and breeding bull across the study districts

	Districts, % of respondents				
Sources	Kersa	Omo Nada	Tero Afeta	Overall	P
Heifer					
Raised at home	93.33	96.67	92.22	94.07	ns
Purchased	6.67	3.33	7.78	5.93	ns
Breeding Bull					
Raised at home	93.33	88.89	88.89	90.37	ns
Purchased	6.67	11.11	11.11	9.63	ns

ns: non-significant

4.2.4 Health management

In the current study discussion with key informants and survey result revealed that farmers in the study areas uses different treatment methods described on Table 9. Accordingly 78.89% of the respondents get veterinary assistance and purchase drug from any shops and nearby clinics. From all the surveyed households in all the study districts only 3.3% use veterinary assistance as the primary alternative to treat their sick animals. On the other hand 12.22% of the respondents in the study areas uses traditional medicine to treat their sick animals.

According to the discussion with key informants and surveyed households the reason why they used drug purchase and traditional medicines to treat their sick animals were due to lack of adequate veterinary services and long distance to clinics.

Table 9. Methods of sick animal treatment in the study areas

	Districts, % of respondents				
Treatment methods	Kersa	Omo Nada	Tero Afeta	Overall	P
1	6.67[a]	2.22[b]	1.11[b]	3.33	*
2	3.33[b]	10.00[a]	3.33[b]	5.56	*
3	78.89	77.78	80.00	78.89	ns
4	11.11[b]	10.00[b]	15.56[a]	12.22	*

*Different superscripts in a row indicate statistically significant difference between the districts (P<0.05); *P<0.05;ns non significant: 1= only veterinary assistance; 2=only drug purchasing; 3=both 1&2; 4=only traditional medicine*

4.3 Productive and Reproductive Performance of livestock

4.3.1 Age at first calving (AFC) and calving interval (CI) of cattle

In the current study, the overall mean AFC and CI in the study districts were 4.50±0.08 years and 25.56±0.43 months, respectively (Table 10). The average CI obtained in the current study falls within the range of calving interval for Ethiopian zebu cattle of 12.2 to 26.6 months reported by Mukassa-Mugrewa (1989). However, the overall mean AFC obtained in this study was above the range reported by Mukasa-Mugerwa and Azage (1991) of 35-53 months. The average AFC and CI in the current study agrees with the finding of Yisehak *et al*. (2013), in Jimma zone of Southwest Ethiopia. Similarly, Tesfaye (2007), has also reported longer age at first calving of 4.54±0.05 years in Metema district of Amhara region. The mean AFC and CI reported in the current study are higher than the finding of Belay *et al*. (2012), who has reported the mean age at first calving of 50.59±6.94 months and calving interval of 22.19±7.73 months, in Dandi district of Oromia region. Also the current result is higher than the finding of Kedija (2007), who has reported an average AFC of 52.49±0.91 months and average CI of 16.01±0.49 in Mieso district, Oromia region. In contrary to the present study, the longer mean AFC of 60 months (5 years) for Horro cattle on farm level was reported by Gizaw *et al.* (1998). The long calving interval in the current study might be an indication of the poor nutritional and management status of cattle under smallholder farmers. This fact is in line with the report of Mukasa- Mugerwa (1989), who indicated that heritability of age at first calving is generally low, indicating that this trait is highly influenced by environmental factors, feed and health.

4.3.2 Lactation milk yield and lactation length

In this study, the average milk yield per cow per lactation and lactation length were 203.29±4.75 liters and 7.84±0.30 months respectively (Table 10). The mean lactation length in this study is in agreement with Teklay (2008), who reported lactation lengths of 7.49 months for indigenous cows. The finding of this study is lower in average milk yield per cow per lactation and higher in mean lactation length reported by Kedija (2007), in Mieso district of Oromia region which was 271.4 liters per cow per lactation and 7.29±0.17 months respectively. Similarly Yisehak *et al*. (2013), has also reported higher average milk yield per cow per lactation and lower lactation length in Jimma zone of Southwest Ethiopia. The mean lactation length in this study is lower than that of Belay *et al*. (2012) and Ulfina *et al.*(2013), which were 8.96±4.63 and 9.3±0.9 months in Dandi district and Jimma town, respectively. In the current study the average milk yield per cow per day is around 0.86 litters when adjusted to lactation length of 235 days and this is below the national average value of 1.09 liter/cow/day (Dagena and Adugna, 1999). The low lactation milk yield in the current study may be attributed to shortage of livestock feeds both in quantity and quality, especially during dry season which is in agreement with the finding of Ahmed *et al.* (2010), in the central high lands of Ethiopia.

4.3.3 Productive and reproductive lifespan of cattle

The overall mean reproductive lifespan of cows in the current study depicts 8.21±0.02 years (Table 10). The reproductive life span of cow in this study is shorter than Horro cattle (10.1±0.01 years) which was reported by Gebreyohannes *et al.* (2006). According to Yisehak *et al.* (2013), the reproductive life span of indigenous cows in Jimma zone was 7.69±0.14 years.

In the current study the overall mean draught age of male cattle and draught lifespan of oxen were 4.56±0.10 and 5.61±0.14 years, respectively. The current finding is in agreement with Yisehak *et al.*(2013), who has reported age at first ploughing of 4.47±0.07 and draught lifespan of 5.07±0.08 years for indigenous male cattle in Jimma zone.

4.3.4 Reproductive performances of sheep and goat

The mean age at first lambing (AFL) and lambing interval (LI) of sheep were 2.46±0.24 years and 15.91±0.38 months, respectively (Table 10). The mean LI in this study agrees with the finding of Yisehak *et al*. (2013), who has reported average lambing interval of 15.80±0.23 months in Jimma zone. The current finding is higher than the finding of Belay *et al*. (2012), who has reported 12.64±5.29 and 7.37±0.77 months of AFL and LI in Dandi district of Oromia region.

The mean age at first kidding (AFK) and kidding interval (KI) of goat were significantly different ($p<0.05$) between the study areas. The overall mean age at first kidding and kidding interval were 2.05±0.04 years and 15.45±0.30 months respectively. The longest mean AFK was observed in Omo Nada 2.12±0.04 years followed by Kersa 2.06±0.04 years and the shortest AFK was observed in Tero Afeta district 1.97±0.05 years. The mean KI in the current study is in agreement with the finding of Yisehak *et al.* (2013), who has reported average KI of 15.48±0.2 months in Jimma zone. However the mean AFK and KI in the current study are higher than the finding of Belay *et al*. (2012), who has reported mean AFK and KI of 10.90±3.14 and 6.56±1.42 months, respectively in Dandi district of Oromia region.

4.3.5 Productive and reproductive age of equine

Productive and reproductive age of equine animals in the study areas were depicted on Table 10. The overall ages at first foaling (AFF) and foaling interval (FI) of horses were 4.95±0.14 years and 35.57±1.76 months respectively. However there was a significant difference in foaling interval of horses in the study areas ($P<0.05$). Accordingly the longest FI of 39.65±2.2 months was found in Tero Afeta district followed by Omo Nada districts 37.48±1.95 months and the shortest FI of 29.59±1.13 months was observed in Keras district. The mean AFF and FI of horses reported in the current study are lower than the finding of Belay *et al.* (2012), who has reported average AFF and FI of 35.25±18.30 and 18±6 months respectively in Dandi district of Oromia region. The overall mean age at first work (transport) of horses in the study areas was 6.28±0.30 years.

There was a significant difference in age at first work (transport/draught) of mule ($p<0.05$). Accordingly the longest age at first work of 6.75±0.12 years was observed in Omo Nada district followed by 6.72±0.09 years in Tero Afeta district and the shortest age at first work of 6.32±0.20 years was observed in Kersa district. The overall mean age at first work for mule in the study areas was 6.60±0.14 years.

The overall age at first foaling for Jennies was 6.22±0.32 years in all the studied districts. The overall mean FI of Jennies in the current finding is 2.56±0.17 years ($p<0.05$). The longest foaling interval of 2.88±0.19 years was observed in Kersa districts followed by 2.48±0.17 years in Omo Nada district and the shortest FI of 2.33±0.16 years was observed in Tero Afeta district. The mean AFF and FI of Jennies found in the current study are higher than the finding of Belay *et al*. (2012) who has reported average AFF and FI of 45.33±13.52 and 19.86±6.47 months, respectively in Dandi district of Oromia region.

The overall mean age at first work in the current study is 6.38±0.37 years ($P<0.05$). Accordingly the longest age at first work of 6.95±0.84 years was observed in Kersa district followed by 6.20±0.10 years in Omo Nada district and the shortest age at first work of 5.98±0.18 years was observed in Tero Afeta district. The difference in age at first work of donkey in this study may contribute to the difference in management system between the study districts.

Table 10. Production and reproductive performances of livestock's across the study areas

Species	Variable	Kersa	Omo Nada	Tero Afeta	Overall	P
		Districts, (Means ± SEM)				
Cattle						
	Age at first calving (*years*)	4.59±0.08	4.48±0.08	4.42±0.09	4.50±0.08	ns
	Calving interval (*months*)	25.31±0.43	25.92±0.40	25.45±0.46	25.56±0.43	ns
	Lactation length (*months*)	7.75±0.31	7.76±0.30	8.02±0.30	7.84±0.30	ns
	Lactation milk yield (*liters*)	208.24±5.12	201.13±5.04	200.48±4.93	203.29±4.75	ns
	Reproductive lifespan of cows (*years*)	8.30±0.20	8.35±0.20	7.97±0.21	8.21±0.02	ns
	Draught age of male cattle (*years*)	4.75±0.11	4.43±0.10	4.41±0.10	4.56±0.10	ns
	Draught life span of oxen (years)	5.48±0.14	5.65±0.14	5.70±0.15	5.61±0.14	ns
Sheep						
	Age at first lambing (*years*)	2.44±0.25	2.53±0.25	2.39±0.21	2.46±0.24	ns
	Lambing interval (*months*)	16.01±0.34	15.99±0.44	15.74±0.35	15.91±0.38	ns
Goats						
	Age at first kidding (*years*)	2.06 ± 0.04^{ab}	2.12 ± 0.04^{a}	1.97 ± 0.05^{b}	2.05±0.04	*
	Kidding interval (m*onths*)	15.89 ± 0.29^{a}	15.63 ± 0.33^{ab}	14.83 ± 0.27^{b}	15.45±0.30	*
Horse						
	Age at first foaling (*years*)	5.01±0.11	4.86±0.17	4.98±0.15	4.95±0.14	ns
	Foaling interval (*months*)	29.59 ± 1.13^{b}	37.48 ± 1.95^{a}	39.65 ± 2.2^{a}	35.57± 1.76	*
	Age for work (transport) (*years*)	5.93±0.22	6.33±0.32	6.59±0.35	6.28±0.30	ns
Mule						
	Age for work (transport) (*years*)	6.32 ± 0.20^{b}	6.75 ± 0.12^{a}	6.72 ± 0.09^{ab}	6.60±0.14	*
Donkey						
	Age at first foaling (*years*)	6.57±0.26	5.69±0.37	6.39±0.32	6.22±0.32	ns
	Foaling interval (*years*)	2.88 ± 0.19^{a}	2.48 ± 0.17^{ab}	2.33 ± 0.16^{b}	2.56±0.17	*
	Age for work (transport) (*years*)	6.95 ± 0.84^{a}	6.20 ± 0.10^{ab}	5.98 ± 0.18^{b}	6.38±0.37	*

*Different superscripts in a row indicate statistically significant difference between the districts (P<0.05); ns, non-significant difference (P>0.05); *P<0.05*

4.4 Assessments of Feed Resources and Feed Utilization

The sources of feed for livestock in the study areas were natural pasture and roadside grazing, stubble grazing/crop aftermath, crop residue, wild browse/fodder trees and shrubs, crop thinning and non conventional feeds like *chat* (*catha edulis*) leftover and household leftover according to respondents perception (Figure 4). Accordingly natural pasture and crop residues were the major feed resources for livestock feeding in the study areas which agree with the reports of (Tolera *et al*., 2012; Dawit *et al.,* 2013; Yisehak *et al*., 2013), whose have reported natural pasture and crop residue to be the major feed resources for highlands of Ethiopia.

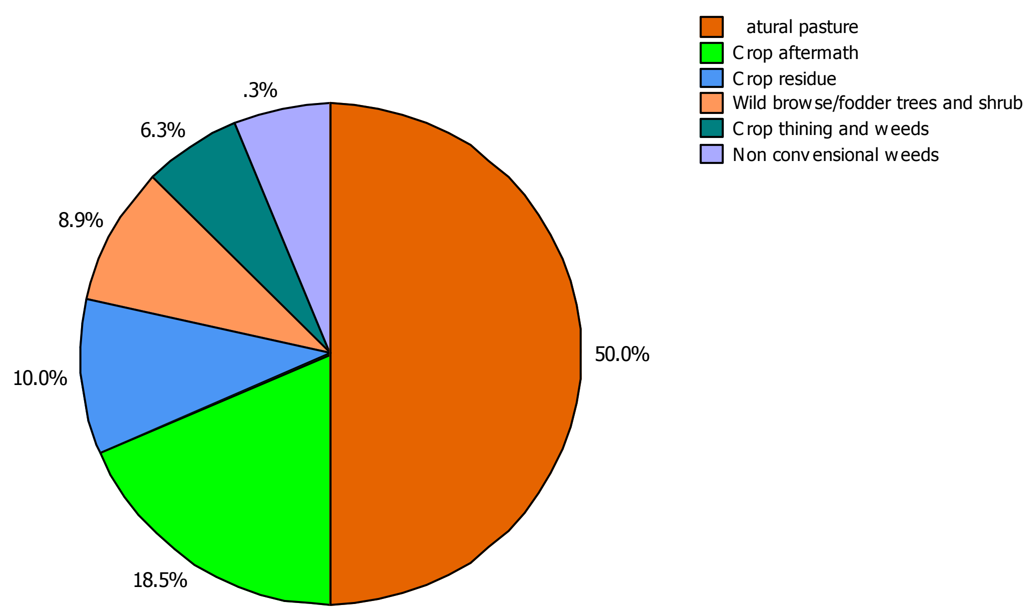


Figure 4. Livestock feed resources according to respondents perception in the study areas

4.4.1 Natural pasture

There were private and communal grazing lands in all the studied districts. According to 50% of the respondents across the study districts, the primary feed to animals came from natural pasture which conforms to the general indication that natural pasture is one of the major sources of animal feed (Belay *et al*., 2012; Teshager *et al*., 2013; Yisehak *et al*., 2013). Of the sampled households, 45.56%, 53.33%, and 51.11% in kersa, Omo Nada and Tero Afeta districts respectively have ranked natural pasture as the primary source of feed (Figure 4).

Browse species are commonly used in the diets of ruminants (Yisehak *et al.,* 2010). According to the same authors *Pennesetum clandestinum, Cynodon dactylon, Digiteria spp, Eragrostis spp, Sporobolus spp, Brachiaria spp, Phalaris spp, Hyparrhenia spp, Eleusine spp* and *Andropogon spp* are the most common grass species of the study area.

4.4.2 Dry matter production from private grazing land

There were no significant difference in private grazing land holding and DM produced from private grazing land in the study districts. The overall mean DM produced from private grazing land was 0.38±0.18 tons/year from an average private grazing land holdings of 0.19±0.34 hectares according to yield estimate of FAO (1987), (Table 11). This finding is lower than the finding of Yeshitila (2008), who has reported average DM production of 1.22±0.09 tons from an average grazing land holding of 0.44± 0.04 ha in Alaba district. The average livestock holding per HH in the study districts was 5.10±0.32 TLU so the annual DM requirement per HH for maintenance is 11.63±0.73 tons according to the daily DM requirements for maintenance of 1 TLU (Kearl, 1982). Hence the value of DM obtained from private grazing land in this study implies private grazing land is not the only sources of feed for the livestock. Additionally out of all the surveyed HHs only 47.7% have had private grazing land and the rest 53.3% relies on communal grazing land and other feed sources (Figure 5). This finding is in agreement with Shitahun (2009), who reported annual DM production of 0.12 tons per HH in which only 55.56% of the respondents do not have private grazing land.

Private grazing land holding in the current study ranges from 0 to 3 ha in which majority of the HHs leave only small piece of land for the average livestock holding discussed earlier. The fact that the households have few land allocated for grazing and less tradition of providing supplementation for their animals resulted in very low productivity of livestock. Moreover discussion with key informants revealed that DM production from this private grazing land is successively decreasing from time to time due to lack of management.

Table 11. Means ± SEM tons of DM production from PGL and CGL per HH across the study districts

	Districts, (Mean ± SEM)				
Description	Kersa	Omo Nada	Tero Afeta	Overall	P
PGL holding	0.23±0.04	0.15±0.03	0.20±0.04	0.19±0.04	ns
DM production PGL	0.46±0.08	0.30±0.06	0.40±0.08	0.38±0.08	ns
CGL	0.1±0.03	0.2±0.02	0.1±0.04	0.13±0.03	ns
Total	0.56±0.11	0.50±0.08	0.50±0.12	0.51±0.11	ns

SEM: standard error of means; DM: dry matter; PGL: private grazing land; CGL: communal grazing land; ns, non-significant difference

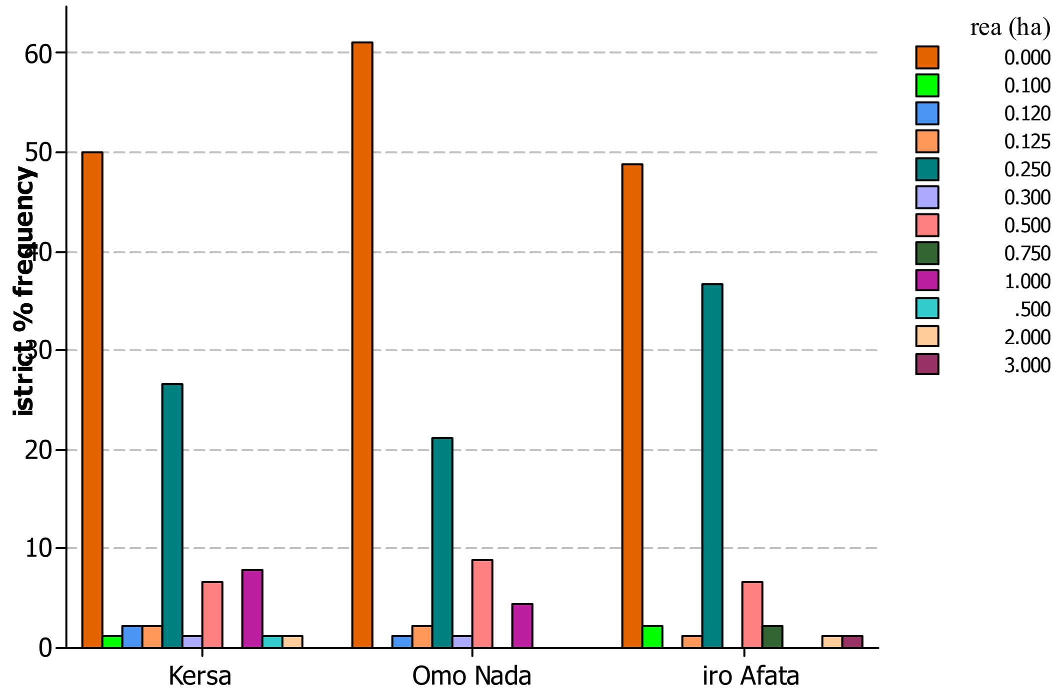


Figure 5. Percent of respondents having private grazing land in the study areas

4.4.3 Dry matter production from communal grazing land

There was no significant difference in the amount of DM produced from communal grazing lands in all the study districts (Table 11).

Accordingly amount of DM obtained from communal grazing land and factored for each total households associate TLU eligible to graze on this land were 0.1±0.03, 0.2±0.02 and 0.1±0.04 tons/year in Kersa, Omo Nada and Tero Afeta districts, respectively. The overall mean DM produced from communal grazing land in the study areas was 0.13±0.03 tons/year. The current finding is higher than Yeshitila (2008), who has reported 0.06±0.18 tons of DM from communal grazing land in Alaba district of Southern Ethiopia. Moreover discussion with key informants revealed that communal grazing land is successively decreasing due to increasing human population and allocation of the available land for the newly formed house hold families by local leaders. Also DM production from the available communal grazing land is very low due to overgrazing of the limited land by large livestock population which results in land degradation and soil erosion.

4.4.4 Conservation and utilization of natural pasture

In the current study, only 31.85% of the respondents conserved natural pasture and the rest of the respondents do not practiced pasture conservation at all (Table 12). Out of those who practiced conservation only 6.77% practiced hay making. There was no silage making in all the studied districts which may be due to lack of awareness mainly linked with inadequate extension services. Majority of the respondents (96.30%) utilize conserved pasture in dry season. Types of animals get accesses to conserved pasture were lactating and fattening (84.44%), draft animals (11.48%) and all kinds of animals (4.07%). According to (94.07%) of the responded HHs free/continuous grazing was the common natural pasture feeding system practiced in the study areas.

Table 12. Practice of pasture conservation and utilization in the study areas

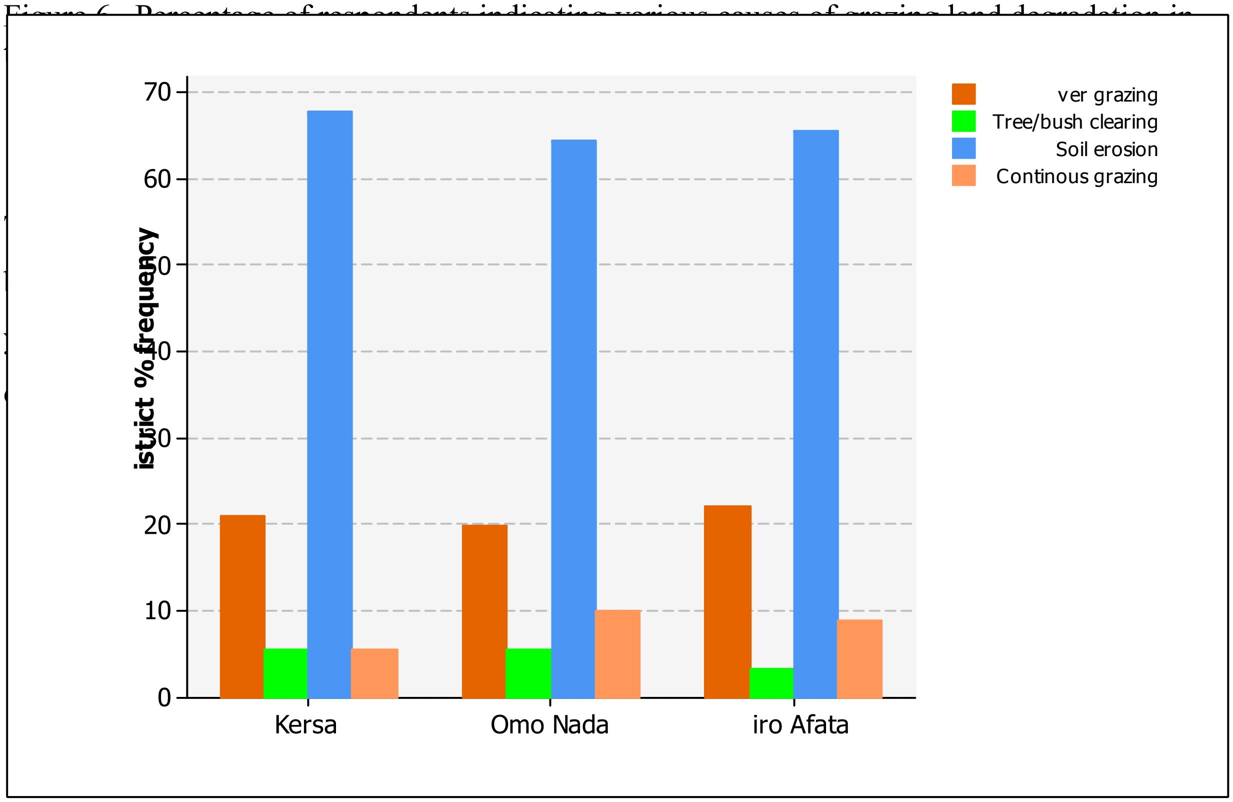
Conservation and utilization methods		Districts, % of respondents Kersa	Omo Nada	Tero Afeta	Overall	P
Practice of pasture conservation						
	Exists	25.56[b]	33.33[a]	36.67[a]	31.85	*
	Not exists	74.44[a]	66.67[b]	63.33[b]	68.15	*
Form of pasture conservation						
	Hay making	7.78	6.67	5.56	6.67	ns
	Standing hay	92.22	93.33	94.44	93.33	ns
	Silage	0.00	0.00	0.00	0.00	ns
Season of conserved pasture utilization						
	Dry season	96.67	97.78	94.44	96.30	ns
	Wet season	3.33	2.22	5.56	3.70	ns
Types of animals get accesses to conserved pasture						
	Lactating and fattening	87.78	84.44	81.11	84.44	ns
	Draft	7.78[c]	11.11[b]	15.56[a]	11.48	*
	All kind of animals	4.44	4.44	3.33	4.07	ns
Common grazing practice	Free/continuous grazing	93.33	95.56	93.33	94.07	ns
	Controlled grazing/tethering	6.67	4.44	6.67	5.93	ns

*Different superscripts in a row indicate statistically significant difference between the districts (P<0.05); ns, non-significant difference (P>0.05); *P<0.05*

4.4.5 Causes of grazing land deterioration and its impact on livestock

The respondents described different opinion for the cause of reduced grazing land productivity. Soil erosion (65.93%) and overgrazing (21.11%) were the most common causes of grazing land deteriorates throughout the districts (Figure 6). According to the discussion with key informants livestock and human population pressure contributed to the current degradation of the grazing land in the studied districts. Accordingly overstocking of livestock on a limited communal grazing land and trees/bush clearing for construction and fuel were major causes. Poor knowledge of the farmers on improved management of the grazing land was also another factor according to the discussion with the key informant from all districts.

Figure 6. Percentage of respondents indicating various causes of grazing land degradation in



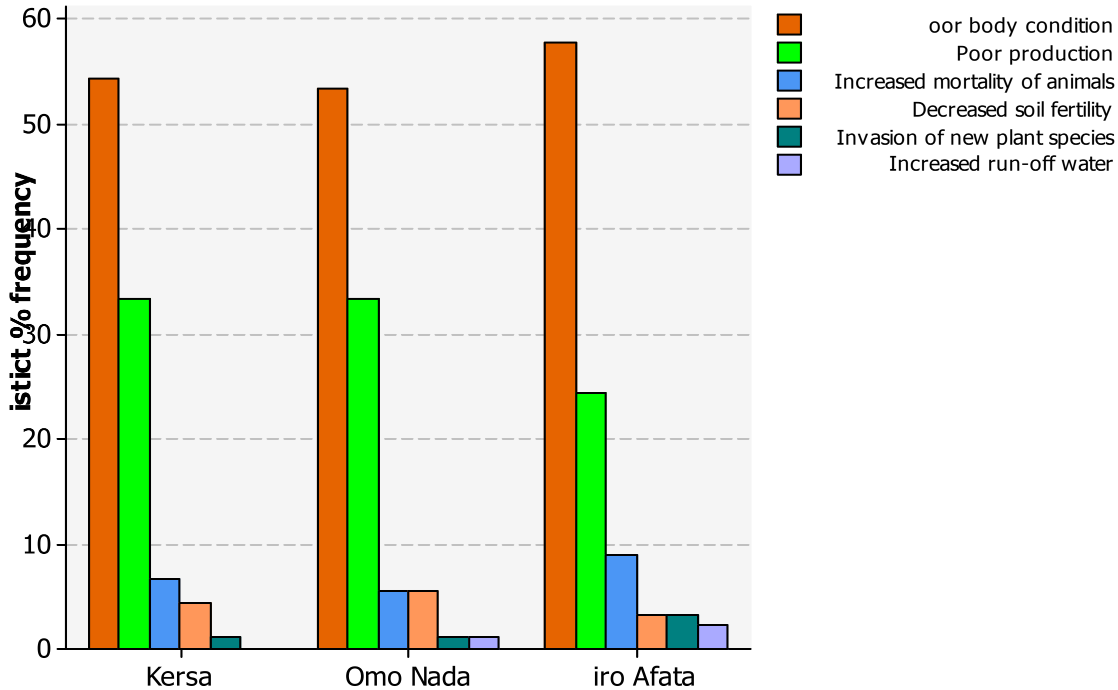


Figure 7. Impact of grazing land degradation on livestock output across the study area

4.4.7 Crop residue

4.4.8 Crop residue production

Crop residues were the second feed resources for livestock followed by wild browse/fodder trees and shrubs, crop thinning and weeds and non conventional feeds according to the perception of the respondents in all the study districts. However, the total amount as well as the type of crop residue varied among the districts. Accordingly the major annual crops grown by farmers in the studied districts were: maize, sorghum, *teff* in all the studied districts and Taro (*Godere*) in Kersa district (Table 13). Other crops like barely, wheat, millet, pea, Faba bean, and *noug* were also produced in all the studied districts. However, due to their minimum DM production these crops are not listed on the table but the annual DM obtained is added to the total DM production of each district. From all types of crop residues maize and sorghum residues were the main crop residues produced in all the studied districts. This finding is in agreement with Teshager *et al*. (2013), who reported maize and sorghum residues are the main crop residues produced in Ilu Abba Bora zone of Southwest Ethiopia. Similarly Kurtu (2000), has also indicated that sorghum and maize are the major crops, providing staple food to people and various forms of feed and by products to livestock in Harari region. There was a significant difference in the total amount of residues produced in the studied districts ($p<0.05$). Accordingly, more of the crop residue or 4.76±0.76 tons was produced in Tero Afeta district followed by 2.69±0.60 tons in Kersa district and the least 2.63±0.35 tons of crop residues was produced in Omo Nada district. Generally the overall mean crop residues produced in the study areas was 3.35±0.59 tons of DM/year and this finding is lower than Dawit *et al.* (2013), who has reported 9.7±0.6 tons of crop residues in Adami Tulu Jiddo Kombolcha district of Oromia region. This differences may be attributed to the area of crop land, soil fertility, types of crop grown and crop management.

Table 13. Mean DM produced from Crop-residues and stubble grazing per HH across the study areas

	Districts, (Means ± SEM)				
Types of crop	Kersa	Omo Nada	Tero Afeta	Overall	P
Maize	$1.56{\pm}0.24^{b}$	$1.61{\pm}0.17^{b}$	$3.06{\pm}0.46^{a}$	2.08±0.29	**
Teff	$0.32{\pm}0.05^{b}$	$0.32{\pm}0.03^{b}$	$0.69{\pm}0.12^{a}$	0.44±0.07	**
Sorghum	$0.36{\pm}0.11^{b}$	$0.70{\pm}0.15^{ab}$	$0.89{\pm}0.11^{a}$	0.65±0.12	*
Godare (Taro)	$0.41{\pm}0.18^{a}$	-	-	0.14±0.06	*
Total CR	$2.69{\pm}0.60^{b}$	$2.63{\pm}0.35^{b}$	$4.76{\pm}0.76^{a}$	3.35±0.59	*
Utilizable CR	$2.42{\pm}0.5^{b}$	$2.37{\pm}0.32^{b}$	$4.28{\pm}0.68^{a}$	3.02±0.53	*
Aftermath	0.98±0.06	0.98±0.05	0.96±0.05	0.97±0.06	ns

*Different superscripts in a row indicate statistically significant difference between the districts (p<0.05); ns, non-significant difference (P>0.05); *P<0.05; CR: crope residue; Utilizable CR= 90% of total CR; SEM: standard error of mean*

4.4.9 Alternative uses, conservation and utilization of crop residues

Farmers in the current study areas uses crop residues as bedding material in livestock barns, as mulching/organic fertilizer by leaving on the field and as source of fuel (Table 14). From all the surveyed households (80.37%) of the respondents leave crop residues on the field as organic fertilizer for the next crop calendar. The rest of the respondents (12.59%) and (7.04%) uses crop residues as source of fuel and as bedding material in livestock barns, respectively. On the other hands discussion with key informants and surveyed households revealed that farmers in the study areas can also use *teff* straw as a construction material for plastering walls of living home. According to Yeshitila (2008), crop residues are alternatively used for fuel by 71% of the households, as roof shatter by 9.5%, as fences by 8.5% and a combination of all the three by 10% of the surveyed households in Alaba district of Southern Ethiopia. Similarly, according to Tolera and Said (1994), 10% of crop residues produced in the highlands of Ethiopia are considered as wastage or use for other purposes like for construction or as fuel.

According to (92.96%) of the surveyed HHs in all the study districts balling under shade was the main crop residue conservation method for dry period use (Table 15). According to the respondents after harvesting of the grains residues of maize, sorghum and *teff* were collected and stored under temporary shades constructed for this purpose. The rest (7.04%) of the respondents stack/bale outside mainly on the field or around homestead without any shading.

From all crop residues produced in the current study districts 2.42±0.5, 2.37±0.32 and 4.28±0.68 tons of DM/HH/annum were utilized as livestock feeds in Kersa, Omo Nada and Tero Afeta districts, respectively. The overall mean DM of crop residue annually utilized per HH in the study areas was 3.02±0.53 tons.

Lactating animals (85.56%), draft animals (8.15%) and fattening animals and all kinds of animals (2.59%) were the prioritized animals in gating access to the conserved crop residues.

Feeding of crop residues as it is under shade or on the field without any physical or chemical treatments were commonly practiced in all the study districts. Accordingly (95.56%) of the respondents fed as it is under shade or on the field which implies no quality improvement and treatment of this poor quality crop residue for better animal performance. The rest (4.44%) of the respondents chopped to decrease the size and increase palatability.

Practices of supplementing animals offered crop residues in the current study areas revealed that (84.44%) of the respondents supplement their animals by household leftover followed green forage and grain mill shorts by (6.3%) of the respondents and the rest (2.29%) of the respondents supplement by cereal grains.

The organic matter digestibility of crop-residues ranges from 40-50% (Mukassa, 1981). Because roughages have low digestibility and low protein content during most of the year, (without feed supplement and/or proper treatment method) the roughage feed supplies can at most meet maintenance requirement resulting in slow growth, poor fertility and high calf mortality. Crop residues are very important feed resources in smallholder systems, but they are generally inadequate feed materials, thus their use with proper treatment methods and with supplements needs consideration (Van Soest, 1988). In general in the study areas, feed supplement and straw treatment were not yet well practiced. As a result, even if huge amount of crop-residue was produced, especially during the dry season animals may not get the required nutrient to the level they could produce as per their genetic potential.

Table 14. Alternative uses of crop residues across the study areas

	Districts, % of respondents				
Alternative uses	Kersa	Omo Nada	Tero Afata	Overall	P
1	6.67	6.67	7.78	7.04	ns
2	86.67[a]	85.56[a]	68.89[b]	80.37	*
3	6.67[b]	7.78[b]	23.33[a]	12.59	*

*Different superscripts in a row indicate statistically significant difference between the districts (p<0.05); *P<0.05;ns non significant: 1= use as bedding material in livestock barns; 2=mulching/organic fertilizer;3=source of fuel*

Table 15. Conservation and utilization methods of crop residue in the study districts

	Districts, % of respondents				
Parameters	Kersa	Omo Nada	Tero Afeta	Overall	P
Method of storing crop residues					
Beling under shade	91.11	93.33	94.44	92.96	ns
Stacked/baled outside	8.89	6.67	5.56	7.04	ns
Form of crop residue to be fed					
Fed as it is	93.33	95.56	97.78	95.56 `	ns
Chopped	6.67	4.44	2.22	4.44	ns
Animals fed crop residue (ranking order)					
Lactating animals	88.89^{a}	88.89^{a}	78.89^{b}	85.56	*
Draft animals	4.44^{b}	7.78^{b}	12.22^{a}	8.15	*
Fattening animals	2.22	1.11	4.44	2.59	ns
Dry animals	2.22	0.00	1.11	1.11	ns
All kind	2.22	2.22	3.33	2.59	ns
Practices of supplementing animals offered crop residues					
Household leftover	90.00^{a}	85.56^{ab}	77.78^{b}	84.44	*
Green forage	4.44^{b}	3.33^{b}	11.11^{a}	6.30	*
Grain mill shorts	4.44	5.56	8.8	6.30	ns
Cereal grains	1.11	5.56	2.22	2.29	ns

*Different superscripts in a row indicate statistically significant difference between the districts ($p<0.05$); *$P<0.05$;ns non significant*

4.4.10 Stubble grazing/crop aftermath

Crop stubble is one of the important feed sources in the studied districts. According to 18.5% respondents aftermath grazing is perceived as the livestock feed source in all the study areas (Figure 4). After harvesting the crops, livestock are allowed to graze stubble of different crops (maize, *teff*, sorghum, etc) mainly from October to January depending on the type of crop and time of harvest. There was no significant difference in the amount of stubble grazing in the studied districts and the overall mean stubble grazing produced per HH was 0.97±0.06 tons of dry matter/year. The current result is lower than the finding of Shitahun (2009), who has reported 1.14 ±0.05 tons of stubble grazing per household in Bure district of Amhara region. Yeshitila (2008), also reported 1.34±0.71 tons of stubble grazing per household in Alaba district of Southern Ethiopia. This difference may be attributed to the area of cultivated land since dry matter yield from aftermath is mainly dependent on area of crop land.

According to the discussion with key informants farmers in the studied districts use aftermath grazing as one means to sustain their livestock for duration of about 3 - 4 months starting from October until January. Therefore, stubble grazing is one of the ways by which livestock keepers in the studied districts greatly depend on.

4.4.11 Wild browse/fodder trees and shrubs

According to (8.89%) of the respondents perception wild browse/fodder trees and shrubs were the main sources of livestock feeds mainly during the dry season (Figure 4).

It was observed that majority of the households (64.07%) did not have practice of integrating fodder trees and shrubs in to their farming system and the rest (35.93%) have had very low practice of integration (Table 16). However due to heavy crop cultivation, population pressure, over grazing and erosion hazard, have been thoroughly noticed in the studied districts which needs shift in farming system which towards expansion of dual purpose trees and shrubs.

Syzygium guineense, Draceana studeri, Ficus ovata, Ficus vasta, Ficus sycomorus, Ficus capensis, Ficus thonningii, Salix purpurea, Arundinaria alpine, Syzygium guineense, Milletia *ferruginea, Sapium ellipiticum,*and *Vernonia amygdalinaspecies* are some of the trees and shrubs well known by farmers and highly utilized in livestock feeding (Yisehak *et al*., 2010).

However, very few farmers climb up forage trees to lop down and give it to their livestock during critical feed problems. Due to this quantification of DM yield from these fodder trees and shrub was not possible. Fodder trees and herbaceous legumes offer an opportunity for use as potential feed supplements by smallholder farmers in the tropics due to their high CP content and degradability (Melaku *et al*., 2003) as well as for the possibility of incorporating them in the general farming activity.

Table 16. Practice of integrating fodder tree/shrubs in to farming system and reason for not using agro-industrial by-products in the studied HH

	Districts, % of respondents				
Available Practice	Kersa	Omo Nada	Tero Afeta	Overall	P
Present but very low	34.44	30.00	43.33a	35.93	ns
Absent	65.56	70.00	56.67	64.07	ns
Reason for not using agro-industrial by products as livestock feed					
High cost	87.78	91.11	85.56	88.15	ns
Produce in very far area	7.78	3.33	6.67	5.93	ns
Lack of awareness	4.44	5.56	7.78	5.93	ns

ns: non-significant

4.4.12 Non Conventional Feed resources

According to 6.3% of respondents in all the studied districts non conventional feed resources including households leftover were also the main livestock feeds. Accordingly residues of local drinks like coffee, *areke*, *tela* and leftover of *Chat* (*catht edulus*), fruits and vegetable refusals and households food leftovers were mainly used as livestock feeds. However it was not possible to get a clear data of these non conventional feed resources utilization, but one can assume this will increase the total dry matter of feed used in the studied households.

4.4.13 Agro-industrial by-products

In the current study none of the household use agro-industrial by products as a potential concentrates for livestock feeds (Table 16). According to 88.15% of the respondent households, high cost for agro-industrial by-products was one of the main limiting factors not to use as livestock feeds. On the other hand lack of awareness on use of agro-industrial by products as livestock feed was also mentioned by 5.93% of the surveyed households. The rest 5.93% of the households described all agro-industrial by-products are produce in very far area.

4.5 Annual Utilizable DM Supply from Different Feed Source in the Studied HHs

The total annual DM production and contribution of available feed resources in the studied households were shown in Table 17.

In terms of annual DM production per household, the available feed resources could be arranged as crop-residue, stubble grazing, private grazing land and communal grazing land in a decreasing order.

Proportions and shares of the feed resources in the studied districts showed that, from total utilizable DM production the contribution of cropping system was 88.5% per household which comprised of 67.1% crop-residues and 21.4% stubble grazing. This finding is in agreement with Shitahun (2009), who has reported 84.81% of feed from cropping system in Bure district of Amhara region, but it’s higher than the finding of Solomon (2004), who has reported 74.5% in Sinana sub-district of Bale highland. This may be due to a shift in land use from grazing land to crop production to satisfy the increasing food demand as a result of increasing population pressure. However, DM production from crop residue varies among the studied districts (*P*<0.05). Accordingly the highest DM produced from crop residue was observed in Tero Afeta (4.28 tons) followed by Kersa (2.46 tons) and Omo Nada (2.37 tons) per year.

The contribution of natural pasture as feed source only accounted for about 11.5% in which private grazing land accounted 8.6% and communal grazing land accounted 2.9%. This finding is in agreement with Shitahun (2009), who has reported the contribution of natural pasture 13% but lower than Solomon (2004), who has reported 25.85% in Bure district of Amhara region and Sinana sub-district of Bale highland, respectively.

Table 17. Amount and percent contribution of different feed sources to the total DM supply per HH

	Study Districts								
	Kersa		Omo Nada		Tero Afeta		Overall		
Feed sources	tDM	%	tDM	%	tDM	%	tDM	%	p
PGL	0.46	11.5	0.3	7.8	0.4	6.9	0.39	8.6	ns
CGL	0.1	2.5	0.2	5.1	0.1	1.7	0.13	2.9	ns
UCR	2.46^{b}	61.5	2.37^{b}	61.6	4.28^{a}	74.6	3.04	67.1	*
SG	0.98	24.5	0.98	25.5	0.96	16.8	0.97	21.4	ns
Total supply	4^{b}	100	3.85^{b}	100	5.74^{a}	100	4.53	100	*

*Different superscripts in a row indicate statistically significant difference (P<0.05); ns, non-significant difference (P>0.05); *P<0.05; PGL: Private Grazing Land; CGL: Communal Grazing Land; UCR: Utilizable Crop Residue= crop residue (90%); SG: Stubble Grazing; TDM: Tons Dry Matter*

4.6 Estimation of Annual Feed Balance

The overall mean annual utilizable feed production per households was 4.53 tDM and the overall mean annual maintenance DM requirement according to Kearl (1982), was 11.44 tDM (Table 18).

Hence the annual utilizable feed dry matter satisfied only 39.59% of the livestock maintenance requirement of the studied HH which is quite far below the requirements. This is quite low and clearly shows the gap that exists between feed balance and livestock number at any rate and it is incomparable with many of other results. For instance Wondatir (2010) and Dawit *et al*. (2013), reported 83% and 86% maintenance DM requirement coverage per farm per year in central Rift Valley and Adami Tullu district, respectively.

However in the current study not all livestock feed resources used in the studied districts were quantified, for instance non conventional feeds like households food leftovers, residues from different local drinks, *chat* leftover which was usual used by households every day, vegetables and fruits refusals and fodder trees and shrubs.

Table 18. Annual maintenance requirement vs annual utilizable DM supply in the study areas

	Study Districts				
Variables	Kersa	Omo Nada	Tero Afeta	Overall	P
Annual utilizable feed supply (tDM)	4^{b}	3.85^{b}	5.74^{a}	4.53	*
Annual Maintenance Requirement (tDM)	10.31b	10.93^{b}	13.09^{a}	11.44	*
Balance (supply - requirement) (tDM)	-6.31	-7.08	-7.35	-6.91	ns
Supply from the requirement (%)	38.79^{b}	35.22^{c}	43.85^{a}	39.59	*

Different superscripts in a row indicate statistically significant difference between the districts ($p<0.05$); *$P<0.05$; ns non significant: tDM: tons Dry Matter

4.7 Available Feed Resources and their Distribution Over Seasons

In all the studied districts, the availability of feed resources varied in seasons with respect to quality, quantity and type of feed. According to (93.33%) of the respondents in all the studied districts natural pasture is available year long but it's not adequate. However there was a significant difference ($P<0.05$) in the availability of hay but not crop residue by season (Table 19). In general the principal dry season feed resources available to livestock in the study areas include crop-residue, hay, and natural pasture in their descending order. Whereas, natural pasture, crop-residue and stubble grazing are wet season livestock feeds in their descending order of importance. There was no concentrate feed availability as livestock feed in all the studied districts except household leftover. According to the discussion with key informants feed scarcity is more sever in the dry season mainly from April to June until new grass grow in the long rainy season.

Different feed scarcity coping mechanism was also described by farmers and key informants (Figure 8).

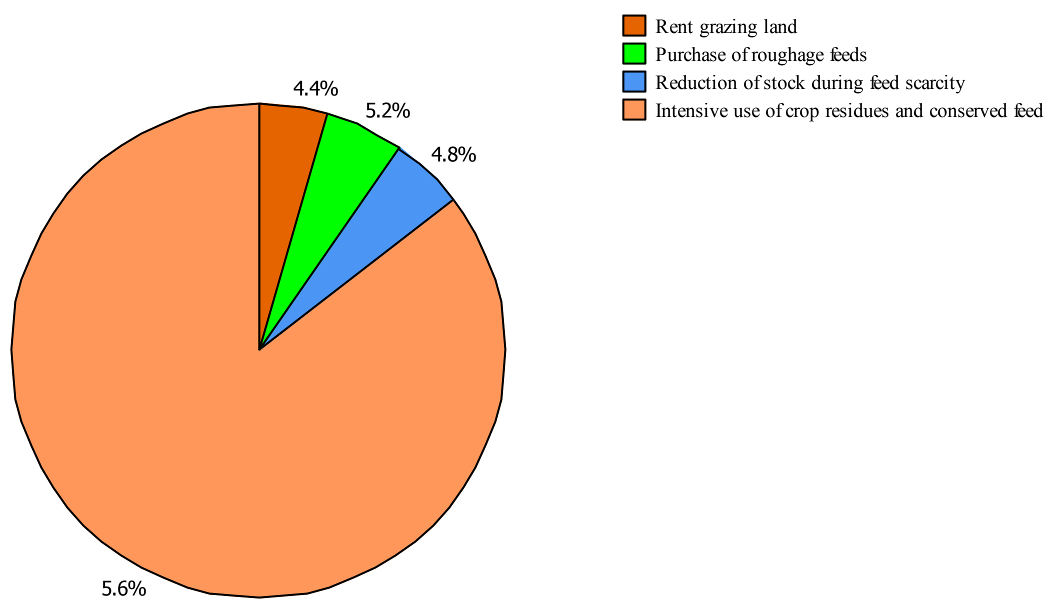


Figure 8. Traditional feed scarcity coping mechanisms in the study areas

Table 19. Types of feed resources and their availability by season in the study areas

Variables		Kersa	Omo Nada	Tero Afeta	Overall	P
		Districts, % of respondents				
Availability of roughage feed in dry season						
	Adequate	7.78	8.89	10.00	8.89	ns
	Not adequate	92.22	91.11	90.00	91.11	ns
Roughage feed resources in wet season						
	Not adequate	100.00	100.00	100.00	100.00	ns
Month's Natural pasture available						
	Mainly on rainy season	5.56	5.56	8.89	6.67	ns
	Year long	94.44	94.44	91.11	93.33	ns
Months Hay available	January to May	1.11[b]	2.22[b]	7.78[a]	3.70	*
	February to May	43.33[b]	65.56[a]	65.55[a]	58.15	*
	Not practiced	55.56[a]	32.22[b]	26.67[b]	38.15	*
Months crop residues (stover & straw) available						
	December to May	90.00	93.33	84.44	89.26	ns
	Don't exist	3.33	3.34	5.56	4.07	ns
	December to March	6.67	3.33	10.00	6.67	ns
Months crop aftermath available						
	September to January	34.3	40	43.2	39.17	ns
	October to January	65.7	60	56.8	60.83	ns
Months concentrate available to livestock						
	Nil	100.00	100.00	100.00	100.00	ns

*Different superscripts in a row indicate statistically significant difference between the districts (P<0.05); *P<0.05;ns non significant*

Table 20. Feed categories year round ranked by respondents across the study areas

	Districts,% of respondents					
	Feed categories year round ranked in order of importance					
Districts	1st	2nd	3rd	4th	5th	6th
Kersa	45.56	16.67	14.44	11.11	6.67	5.56
Omo Nada	53.33	16.67	8.89	8.89	7.78	4.44
Tiro Afata	51.11	22.22	6.67	6.67	4.44	8.89
All	50.00	18.52	10.00	8.89	6.30	6.30

1=grazing natural pasture and road sides; 2= crop residues;3= stubble grazing/crop aftermath;4=wild browse/Fodder trees and shrubs;5=crop thinning and weeds;6= household leftover

In all the studied districts grazing natural pasture and road side, crop residues, stubble grazing, wild browse (fodder trees and shrubs), crop thinning and weeds and household leftovers were the main livestock feed resources year round in a decreasing order of importance.

4.8 Utilization of Feed Resources

It has been proved that the overall livestock feed produced from different sources in the current study was 4.53 tons of DM per year for a livestock unit of 5.10 TLU which shows dry matter to livestock unit ratio of 0.89 which is quite low and clearly shows the gap that exist. Moreover in addition to feed scarcity poor utilization efficiency of the available feeds in the study area was also observed. For example lack of grazing land management mainly private grazing land like, use of continuous grazing system and lack of cut and carry system was resulting in selection of more palatable species and trampling over the less palatable species.

From total DM produced in the study area 67.1% comes from utilizable crop residues. However there was utilization problem due to less attention given to storage and crop residues were excessively dumped during harvest period in addition to alternative uses of this residues. Feeding of *teff* straw at the threshing area was also observed which results in trampling, defecating and urinating.

According to the discussion with key informants *adlib* feeding of maize and sorghum Stover in the storage place was common in the study area. This feeding system may not be efficient as the Stover was trampled and refused by the cattle while they compete to get easily palatable and leafy part of the Stover when the animals are allowed to feed with free access. But it is possible to increase utilization efficiency of the Stover by offering bit by bit when the cattle utilized efficiently without trampling, urinating and defecating on the Stover in such storage condition. Additionally lack of chemical or physical treatment except chopping and soaking which is practiced by a few farmers to improve this poor quality feed source was also the main utilization problem observed in the study area.

4.9 Constraints of Livestock Production in the Study Areas

The main livestock production constraints in the current study areas are depicted on Table 21. According to 71.48% of the respondents in the, feed shortage is the number one constraint followed by diseases and low productivity of the indigenous livestock breeds. On the other hand, 28.52% of the respondents said diseases followed by feed and low productivity of the indigenous livestock breeds as the major challenges of livestock production and productivity. There was a significant difference between the studied districts ($P<0.05$). Accordingly, 77.78% of the respondents in Omo Nada district 75.56% of the respondents in Tiro Afeta district and 61.11% of the respondents in Kersa district prioritized feed followed by diseases and low productivity of the indigenous livestock breed as the main livestock production constraint. Based on the survey result and discussion with key informants feed shortage was ranked 1st followed by animal diseases (2nd) and low productivity of the indigenous livestock breed (3rd) as the main livestock production constraints in all the study areas. The current finding is in agreement with Yisehak *et al.* (2013) who reported feed as (1st) and disease as (2nd) animal production constraints in Jimma zone of Southwest Ethiopia. On the other hand, Teshager *et al*. (2013) has reported cattle disease, shortage of grazing land, water shortage, and inadequate animal health services in descending order as cattle production constraints in Ilu Aba Bora zone of Southwest Ethiopia.

According to discussion with key informants feed constraint was mainly related to shortage of grazing land due to increased population and competition of the available land for crop production. Successive decrease in grass composition and increase in unpalatable plant (bushes/trees) for a decade of the available range lands mainly on communal grazing lands were the main range land related problems. Moreover grazing land degradation due to soil erosion, overgrazing and tree/bush clearing was also the main cause of feed scarcity.

Table 21. Livestock production constraints and major livestock diseases in the study areas

	Districts % of respondents				
Constraints	Kersa	Omo Nada	Tiro Afeta	Overall	P
Feed-disease-low productivity	61.11[b]	77.78[a]	75.56[a]	71.48	*
Disease-feed-low productivity	38.89[a]	22.22[b]	24.44[b]	28.52	*
Major diseases					
Selected Infectious diseases	76.67[b]	83.33[a]	78.89[b]	79.63	*
Respiratory diseases	12.22[a]	8.89[b]	12.22[a]	11.11	*
Gastro-intestinal disorders	11.11	7.78	8.89	9.26	ns

*Different superscripts in a row indicate statistically significant difference between the districts ($p<0.05$); *$P<0.05$*

Livestock disease described by the respondent households and key informants constraining livestock production in the study areas were grouped under: selected infectious diseases, respiratory diseases and gastro-intestinal disorders (Table 21). According to 79.63% of the respondents in the study areas selected infectious diseases were the primary livestock diseases constraining livestock production and productivity in the study areas. Respiratory disease like CBPP and CCPP were also described as 2nd livestock diseases constraining livestock production and productivity in the study areas. Types of diseases described by respondents in the current study is in agreement with the findings of Workneh and Rowland (2004), in Oromia region indicated that the major cattle diseases were Blackleg, Trypanosomosis, Pasteurollosis, Anthrax, Foot-and-mouth disease (FMD), gastrointestinal disorders and respiratory diseases.

The other important constraints of livestock production described by key informants in the study areas were lack of credit service, poor livestock extension service and inadequate animal health services. Accordingly, lack of credit services for livestock producer was one of the limiting factors constraining livestock production. Discussion with key informants revealed that lack of own capital which was more aggravated by absence of any governmental or nongovernmental organizations which can provide loan/credit service for small scale livestock producers were the other limiting factors of livestock production in the study areas.

On the other hand lack of training on livestock husbandry and feed was also described as the main problem related to poor livestock extension service constraining livestock production.

Inadequate animal health services mainly related to shortage of veterinarians, lack of nearby animal health clinics and cost of medications were the most constraints related to a animal health service in the study areas.

4.10. Opportunities of Livestock Production in the Study Area

In the current study area there are multiple opportunities for intensification of livestock production. This is because the area is highly endowed with natural forests and various annual and perennial plants that can be potential feed sources for livestock.

The area has fertile soil and also receives enough amount of rainfall that can be used to develop various types of grasses, legumes and browses species used as livestock feeds.

The area is also known for coffee production. However, the productivity and the price of coffee have been highly variable. So farmers face income shortage during times of coffee failure. The integration of livestock production is important as they can be intermediate cash sources during coffee failure time.

High demand of livestock and livestock products in the local market as a result of geometrically increasing trend in population, urbanization, and increase in income can be considered as an opportunity for the livestock producers.

Nowadays new big abattoir is constructed in Jimma city which is nearest to the current study area so that agents and assemblers purchase live animals even at farm gate from producers to slaughter and process in this abattoir for export.

Moreover, Jimma airport is starting international flight soon, which could be another opportunity for export of live animals to different countries. So that a high demand for livestock specially live animals' mainly small ruminants and fattened cattle.

5. SUMMARY AND CONCLUSION

A cross-sectional survey was undertaken in three districts of Jimma zone, around Gilgel Gibe dam catchment in order to assess the livestock production systems and livestock feed resources utilization as well as to identify the constraints and opportunities for livestock production in the study districts.

Accordingly, the livestock production system practiced in the study districts was traditional mixed crop livestock production system.

The average livestock holding per HH was 5.10±0.32 TLU. Out of the total livestock cattle accounts 4.74±0.24 TLU (92.94%) which implies the importance of cattle in the farming system.

The main objectives of livestock keeping were to produce food (milk, milk products and meat), for draught power (traction, pack transport, threshing) and to increase cash income from sale of live animals and animal products

The main sources of water for livestock were river and farmers in the study areas water their animals *Adlibitum*.

Livestock breeding is entirely natural mating by local bulls and AI or use of exotic breed bull were not yet started until the last day of this survey in all the study districts.

The mean AFC and CI of cattle were 4.50±0.08 years and 25.56±0.43 months, respectively. The average milk yield per cow per lactation and lactation length were 203.29±4.75 liters and 7.84±0.30 months, respectively.

Natural pasture and roadside grazing, stubble grazing/crop aftermath, crop residue, wild browse/fodder trees and shrubs, crop thinning and non conventional feeds like *chat* (*catht edulus*) leftover and household food leftover were the livestock feed resources according to the perception of the respondents. However, crop residues, crop aftermath and natural pasture were the major livestock feed sources in terms of DM production/year.

The mean annual DM produced was 4.52 t/HH/year and the mean annual maintenance DM requirement was 11.44 t/HH/year. Hence, the annual utilizable feed dry matter satisfied only 39.5% of the livestock maintenance requirement which is quite far below the requirements.

In all the study districts only 31.85% of the respondent HHs practiced pasture conservation. Out of those practiced 93.33% of them conserved in the form of standing hay which might result in losses of required nutrients for the animal.

However in the current study not all livestock feed resources used in the studied districts were quantified, for instance non conventional feeds like households food leftovers, residues from different local drinks, *chat* leftover which was usual used by households every day, vegetables and fruits refusals and fodder trees and shrubs.

Based on the output of focused group discussion, feed shortage, diseases, low productivity, lack of training on livestock production, lack of credit service for livestock production were the major challenges of livestock production in the study areas.

So, from the current study it is possible to conclude the livestock production system of the study area as traditional mixed crop livestock production system with no improved input and low output.

The existing livestock feeds can no longer support the existing livestock in the study areas unless possible interventions is made by decision making bodies and channeled to the farming community through extension workers.

The feed deficit observed in the study districts could be one of the contributing factors for low productive and reproductive performance of livestock.

6. RECOMMENDATIONS

As obtained in the current study 53.3% of the respondent HHs do not have private grazing lands or they did not allocate land for their livestock, therefore,:- encouraging and advising livestock keepers to allocate grazing land from their total land holding is very crucial since communal grazing land is not further available due to population growth and expansion of crop farming.

There should be land use policy regulation in the area which can secure area for livestock feed production to increase the contribution of livestock sector for eradication of poverty and sustaining food security in the smallholder livestock producers as well as in the country.

To efficiently utilize the crop residues which accounted 67% of the total supply different quality improvement methods should have to be encouraged and advised to the farmers by any development organizations involving in livestock development sector in the study area.

It was noted that farmers lack awareness on the use of improved forages and hence consolidated extension service and training as well as facilitation of accessibility of improved forage with low cost is required for the farmers by agricultural development professionals.

On the other hand in order to make livestock provide better value to their owner, much more needs to be done with respect to balancing the nutrient supply with the nutrient need of the livestock population in a particular area. This may be done by limiting the household herd size preferably replacing the less productive animals with fewer more productive animals especially in areas like the current study where livestock are stocked beyond the carrying capacity.

The current study only focused on the major available feed resources in terms of type and quantity based on established conversion factor made so far by different scholars. Hence, detail study on DM production of all types of feeds used by livestock keepers as well as the chemical composition and digestibility of each feed are further required to plan sustainable livestock development strategy in the study area.

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8. APPENDICES

Appendix 1

Questionnaires for the survey

Household Questionnaire to Study Characterization of Livestock feed Resources and Feeding Systems in Gilgel Gibe Dam Catchments of Jimma Zone Southwest Ethiopia.

PART I

Section one: General information

1. Date of the interview---------------------2012
2. Region: Oromia Zone: Jimma *Woreda*_______________
4. Landscape position according to the farmer (Upper/Medium/Low)_______________________
5. PA's name____
6. House holder's name ___Sex M____F____ Age _______years
7. Literacy status 1, literate (read and write) 2 Illiterate

Section two: Household characteristics

1. Family size (including the head of the household) under different age category:

Age category	≤5 years	5<x<15 years	15 ≤x ≤64 years	> 64 years	Total

Male					
Female					
Total					

1.2 What is your main farming activity presently? Tick one: Livestock production________ Crop production______ (√)

What is your farming activity before five years? Livestock production________ Crop production______

Section three: Livestock production

Annex-1, livestock holding by type, sex and age structure of the HH.

Type of animal	No at present		No died last year		No given as gift	
	Male	Female	Male	Female	Male	Female
Cattle						
Calf						
Young						
-Mature						
-Oxen						
-Milking cow						
Sheep						
Lamb						
Young						
Mature						

Goats						
Kids						
Young						
Mature						
Horses						
Young horse						
Calf						
Mature						
Donkey						
Young donkey						
Calf						
Mature						
Mule						
Young horse						
Calf						
Mature						
Poultry						
Total						

Calf<1 yr.
Kids or lamb<6 months Young cattle-3 yrs. Old
Young sheep and goat =6 months-1yr.
Mature cattle> 3 yrs. Mature sheep and goat >1yr.
Equines follow the cattle age structure

2. Land holding and farm characteristics of the family (ha)
2.1 Average land holding under different land use

No	Type of land use	Hectares
1	Homestead /backyard	
2	Cultivated land including fallow	
3	Private grazing land	
4	Area under forage cultivation	
5	Closed plantation land	
	Total	

2.2 Types of crop produced by the family/year

No	Crops	Rain fed		Irrigation		Mark "X "For double cropping
		Area ha	Average yield in qt.	Area ha	Average yield in qt.	

4. Feeds and feeding

What is the livestock feed resource for your HH farming system? (√) Tick each.

A. Grazing land---------------------------------

B. Crop residues--------------------------------

C. Improved forage and pasture---------------

D. Household left over, if so tell the type of the left over and name it-----

E. Tree legumes grown as hedge or any---

F. Stubble grazing

2. What are the major feed resources in the area?

(Rank 1-6 in the order of importance).

Feed source	Natural pasture	Crop residue	Hay	Fodder tree	Stubble grazing	Concentrate	Other
Dry							
Wet							

4.1 Grazing land

A. Is there communal grazing land in your area? A. Yes B. No
B. If yes, what is the status? A. Decreasing B. Increasing C. No change or others specify.
C. What is the type of communal grazing land in the area? A. Open grassland
B. Tree covered grass land C. Bush land grass land D. Swampy or any other specify.
D. Do you have private grazing land? 1. Yes 2. No If yes, what type?
A. Open grassland
B. Tree covered grassland
C. Bush land grassland
D. Swampy or any other specify.
E. Grazing pasture and fodder trees/shrubs
F. Is the grazing resource adequate to your animals? (1) Yes (2) No if so
What measures do you take to alleviate this problem?
(1) Purchase concentrates
(2) Purchase forage (rent grazing land)
(3) Use crop residues
(4) Preserve any feed during high abundance
(5) Exclude areas from stock
(6) Undergo destocking programme
(7) Others (specify

4.2 Improved forage and pasture crops
A. Do you plant improved forage pastures, legumes or trees? (1) Yes (2) NO
If yes, which one do you most prefer?
(1) Over sowing of natural pasture of private and communal.
(2) Under sowing legumes under your monocot crop.
(3) Planting tree legumes as hedge and live fence.
(4) Planting in pure stand.
B. Did you saw any forage crop last year or this year if so which way of the above did you use? --------------------------.
If you have sawn the forage, name the forage and in how many plots of ha?
-----------------------Forage in --------ha
-----------------------Forage in --------ha
-----------------------Forage in --------ha
C. Do you graze animals your improved pasture or feed by cut and carry?
1. Grazing-----------------, or
2. Cut and carry system---------------------, tick one of the two.
D. If you do not plant improved pasture, what is it for?
(1) Shortage of land
(2) Shortage of forage seed
(3) Unevenness of rainfall

(4) I'm not aware about it
5. No effort to introduce by any other org., if it were would you accept the introduction?
(5) Not interested in it
(6) Other (specify)------------
D. Would you consider beneficial introduction or sowing much of your farm by improved pasture? (1) Yes (2) No, if so why?
1. Expecting high forage yield and quality for your animals.
2. To control soil run off.
3. To fertilize the soil.
If not, why not?
1. Because doesn't establish
2. Requires much care
3. Do not tolerate grazing
4. Invades cropland
5. Others, tick one of it
5.1. When do you start feeding crop residues?
(1) Soon after collection
(2) One month after
(3) Two months later
(4) Over two months
5.2 How long does it last keeping on feeding of crop residues by your livestock? in months----------------.
5.3 Do you use any other crop as animal feed during feed short time? (1) Yes
(2) No

4.3 Crop aftermath
4.3.1 Do you graze your field after harvesting crops? (1) Yes (2) No
4.3.2 How much of the total do you leave on the ground for aftermath? --------
4.3.3 How many days do your animals graze on the aftermath? -------Months.
4.3.4 How many months in the year you get abundant feed for your livestock? -------------------Months.
4.3.5 Do you give any other feeds to your animals while grazing on the aftermath?
(1) Yes (2) No, if yes tell type of animal and feed given.
Type of, animal. ------------------ Type of, feed.-------------------
-------------------- -------------------
-------------------- -------------------
4.1. Non conventional feed resources given to livestock in the area.
4.1.1 Do you use any non-conventional feed resources? (1) Yes (2) No
If yes what is the name and amount given? Name--and amount in kg--------per animal.

4.1.2 What is the amount of non-conventional feed resource produced? ------kg

4.4 Feed preservation and storage

4.4.1 Do you use the feed resource on the pasture? (1) Grazing (2) Cut and carry

4.4.2 If cut and carry, do you feed fresh or conserve as hay (1) Yes, fresh (2) No We conserve,

4.4.3 If you conserve when do you use it, (1) during dry season (2) any time.

4.4.4 How long will the preserved feed be enough to your livestock--------months?

4.4.5 How do you decide the appropriate time for cutting to make hay?

Suggest your own experience. --------------.

4.4.6 Do you conserve crop residues as hay? (1) Yes (2) No

4.4.7 If you are not producing hay either from pasture or crop residues, what are the Reasons?

(1) Inadequacy

(2) Labor shortage If other, specify

4.4.8 What considerations do you make in selecting the crops you grow in relation to animal feeds?

(1) Select crop varities that yield higher residues in both quality and quantity

(1) Yes (2) No,

If yes which crop residue is most preferred by your livestock? Rank them

---------------- --------------------- ------------------------

(2) Do you change crop combinations so as to produce residues favored by your livestock?

(1) Yes (2) No, if so which combinations do you?

(3) Other considerations (specify)-----------------

3.4.9 At which season do you face feeds shortage?

(1) Short rainy season

(2) Long rainy season

3.4.10 what are the consequences of the feed shortage?

(1) Weight loss

(2) Milk yield reduction

(3) Increased mortality of young stocks and adult animals

(4) Abortion frequency

(5) Weakness

(6) Anoestrus

Others, specify-----------------

4.4.11 Measures taken to alleviate this problem

(1) Feed preservation as hay.

(2) Use of improved forage production.

(3) Fodder bank.

(4) Forage purchase.

(5) Destocking.
(6) None
(7) If others, specify---------------------------

4.4.12 Have you ever tried to balance the livestock with total feed produced in your household? (1) Yes (2) No, if yes how?

(1) Destocking
(2) Restocking
(3) Seeding improved forage & planting productive forages.
(4) Conserving as hay grasses and straws
(5) Purchase of forage
(6) Transferring stocks to relatives
(7) Any other, specify.

Section four: Seasonality of feed availability, Indicate year round fodder.

Type of feed	J	F	M	A	M	J	J	A	S	O	N	D
Natural pasture												
Sawn pasture												
Hay												
Crop residue												
• Cereal												
• Pulses												
• Maize												
•												

Aftermath												
Commercial												
Tree legumes												
Others												

Section five: Nutritive quality improvement

5.1 Do you use any feed quality improvement techniques in your household? Like for instance soaking with water, alkali etc.

5.2 Is there any technique of improving nutritive value of your livestock feeds?

If so what type?

A. Grinding

B. Water soaking

C. Crushing

D. Peleting

E. Any other, specify

Section six: Feeding calendar

6.1 Do you use proper feeding calendar for your animals? AYes B.No

That is do you graze at night or early in the morning.

A.Yes B. No and it should be different from oxen.

Section seven: Sources of water for your livestock

1. River
2. Pond
3. Pipe line

Section eight: Problems of livestock production

1. Feed shortage
2. Diseases
3. Water shortage
4. Low productivity of the indigenous breed

Section 9 Check Lists presented for Focus Group discussion

Part I Production aspect

1. Major farming activities of the area

2. Major livestock production system existed in the area

3. Major livestock production constraints and mechanisms to alleviate the problems

4. Available livestock feed resources and main source of water

5. Trend of grazing land and problems related with scarcity of land and its consequences on livestock

6. Training and Extension services on livestock production

Part II Health aspect

1. Major animal disease affecting cattle production and productivity of the area?

2. Known disease outbreaks emerging frequently? Losses due to the out breaks

3. Indigenous knowledge in coping different diseases

4. Problems related with health input and service provision

Part III Credit service

1. Is credit available, adequate and timeliness?

2. Problems associated with credit?

Appendix 2: Analysis of variance (ANOVA) tables

Appendix Table 1: Sex and educational status of the interviewed HH heads in the study areas

	Districts % frequency (N= 90 for each district)				
Parameters	Kersa	Omo Nada	Tiro Afeta	Overall	p
Sex of the HH					0.285
Male	91.11	94.44	96.67	94.07	
Female	8.89	5.56	3.33	5.93	
Educational status of the HH head					0.027
literate	17.78	28.89	20.00	20.00	
Illiterate	82.22	71.11	80.00	80.00	

Appendix Table 2: ANOVA test on Age and family size of respondent versus study districts

Parameters	Source of variation	Sum of Squares	df	Mean Square	F	Sig.
Age	District	933.4	2	466.7	6.72	0.001
	Errors	18553.5	267	69.5		
	Total	19487.0	269			
Family size	District	23.8	2	11.9	1.03	0.359
	Errors	3086.5	267	11.6		
	Total	3110.3	269			

Appendix Table 3: ANOVA test on livestock holding per/HH in the study areas

Parameters	Source of variation	Sum of Squares	df	Mean Square	F	Sig.
TLH	District	184.62	2	92.31	10.04	0.000
	Errors	2454.02	267	9.19		
	Total	2638.64	269			
Cattle holding	District	71.66	2	35.83	7.25	0.001
	Errors	1319.96	267	4.49		
	Total	1391.63	269			
Oxen holding	District	2.192	2	1.096	7.89	0.000
	Errors	37.088	267	0.139		
Total		39.280	269			
Sheep holding	District	0.0802	2	0.0401	2.56	0.079
	Errors	4.1784	267	0.0156		
	Total	4.2587	269			

Goat holding	District	0.0616	2	0.0308	1.97	0.141
	Errors	4.1741	267	0.0156		
	Total	4.2357	269			
Horse Holding	District	0.0569	2	0.0284	0.52	0.594
	Errors	14.5351	267	0.0544		
	Total	14.5920	269			
Donkey Holding	District	0.4741	2	0.2370	4.08	0.018
	Errors	15.5083	267	0.0581		
	Total	15.9824	269			

TLH: Total livestock holding

Appendix Table 4: ANOVA test on reproductive performances of cows in the study districts

Parameters	Source of variation	Sum of Squares	df	Mean Square	F	Sig.
AFC	District	1.206	2	0.603	0.90	0.407
	Errors	178.544	267	0.669		
	Total	179.750	269			
CI	District	18.5	2	9.2	0.56	0.571
	Errors	4393.8	267	16.5		
	Total	4412.2	269			
LL	District	4.36	2	2.18	0.26	0.768
	Errors	2197.20	267	8.23		
	Total	2201.56	269			

LMY	District	3340	2	1670	0.73	0.481
	Errors	608155	267	2278		
	Total	611495	269			

LL = lactation length, AFC = age at first calving, CI = calving interval, LMY lactation milk yield

Appendix Table 5: ANOVA test on amount crop residues produced in the study districts

Types of crop residue	Source of variation	Sum of Squares	df	Mean Square	F	Sig.
Teff	District	121.54	2	60.77	8.33	0.00
	Errors	634.65	87	7.29		
	Total	756.19	89			
Maize	District	1086.4	2	543.2	7.26	0.001
	Errors	6512.5	87	74.9		
	Total	7598.9	89			
Sorghum	District	64.41	2	34.21	5.00	0.009
	Errors	595.54	87	6.85		
	Total	663.95	89			

Taro	District	177.0	2	88.5	3.74	0.028
	Errors	2058.2	87	23.7		
	Total	2235.2	89			

Tables of different conversion equivalents used in the study

Conversion equivalents of sub-Saharan Africa livestock into TLU (Gryseels; 1988; ILCA, 1990; FAO, 2002) and Land use dry matter (FAO, 1987).

Appendix table 6. Conversion of Livestock to Tropical Livestock Unit (TLU)

Species	TLU
Oxen/bull	1.1
Local cow	0.8
Heifers	0.5
Immature males	0.6
Calves	0.2
Horses/mules	0.8
Sheep/goats	0.1

Donkeys	0.5

Appendix table 7. Conversion equivalent of different land use to dry matter yield

Land use	Tone DM(yield/ha/year)
Natural Pasture	2.0
Aftermath	0.5
Fallow land	1.8
Forest	0.7
Wood, bush land and shrub	1.2

Appendix table 8. Conversion equivalent of grain yield to residues

Sources of crop type	Conversion factor
Barely straw	1.5
Wheat straw	1.5
Finger millet straw	1.5
Maize stover	2
Sorghum stover	2.5
Rice straw	1.4
Oat straw	1.5
Teff straw	1.5
Faba bean straw	1.2

Chick pea straw	1.2
Field pea straw	1.2

(FAO, 1987) and (Teshome, 2009)