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FEED INVENTORY AND IMPROVEMENT OF LOW-QUALITY FORAGE BY ENSILING WITH WET DISTILLERS GRAIN IN TIYO DISTRICT, ETHIOPIA

BY

KIDIST MERSHA

ADDIS ABABA UNIVERSITY COLLEGE OF VETERINARY MEDICINE AND AGRICULTURE, DEPARTMENT OF ANIMAL PRODUCTION STUDIES

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BISHOFTU, ETHIOPIA

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By

Kidist Mersha

June, 2019

Bishoftu, Ethiopia

Addis Ababa University

College of Veterinary Medicine and Agriculture

Department of Animal Production Studies

As members of the Examining Board of the final MSc open defense, we certify that we have read and evaluated the Thesis prepared by: Kidist Mersha Abebe Entitled: **FEED INVENTORY AND IMPROVEMENT OF LOW QUALITY FORAGE BY ENSILING WITH WET DISTILLERS GRAIN IN TIYO DISTRICT,ETHIOPIA,** And recommend that it be accepted as fulfilling the thesis requirement for the degree of: Masters of Animal production.

Yacob Hailu (Professor) Chairman	______________ Signature	___________ Date
Gebeyehu Goshu (PhD, Assoc.Prof.) Internal Examiner	______________ Signature	___________ Date
Ethalem Tesfaye (PhD, Assoc.Prof.) External Examiner	______________ Signature	___________ Date
1. Ashenafi Mengistu (PhD, Assoc. Prof.) Major Advisor	____________ Signature	_________ Date
2. Belete Shenkute (PhD, Assoc.Prof.) Co-Advisor	____________ Signature	___________ Date
3. Bekele Mechalu (PhD, Assoc.Prof.) Co- Advisor	_____________ Signature	__________ Date
4. Birhan Tamir (Professor) Department chairperson	____________ Signature	____________ Date

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Name: Kidist Mersha

Signature: ___________________

Place: Bishoftu, Addis Ababa University

Date of Submission: ___________________

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LIST OF ACRONYMS AND ABBREVIATIONS

NH3-N	Ammonia Nitrogen Concentration
ADF	Acid Detergent Fiber
CO_2	Carbon dioxide
CP	Crude Protein
DDG	Dry Distiller Grain
DDGS	Dry Distiller Grain With Soluble
DG	Distiller Grain
DMI	Dry Matter Intake
MP	metabolizable protein
NDF	Neutral Detergent Fiber
NFC	Non Fiber Carbohydrate
NPN	Non Protein Nitrogen
TLU	Tropical livestock unit
VFA	Volatile Fatty Acid
OM	organic matter
WDG	Wet Distiller Grain
WDGS	Wet Distiller Grain With Soluble

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDIXES

ABSTRACT

A study was conducted in Tiyo district of the Arsi Zone of Oromia Regional State, with the objectives of identify the sources of feeds, supply, estimate annual feed produced, maintenance requirement, and improvement of low quality forage by ensiling with wet distiler grain. A total of 120 households (HHs) were farming system randomly selected from three Kebeles (40 HHs from each kebeles) and interviewed. Types of available feed resources in the study areas include crop residues, natural pastures, hay, and agro industrial by product. According to the estimation of this study, there was an annual total annual requirement was 1973 ton DM but available feed is 1010.3ton thus, the annual feed supply on year basis is estimate to satisfy 51.1% of the maintenance requirement of livestock in the study area this implies that there is livestock feed deficit or shortage in the study area which suggest that the primary focus needs to be improving the existing feed resources through utilization, applying improvement practices such as treatment of crop residues, by ensiling with wet distiler grain in case of improve its composition and nutritive value. Trials were conducted to evaluate the effects of ensiling wheat straw with WDGS and fababean straw with WDGS and alone on its preservation and nutritive value. In the study, WDGS was blended with fababean straw and wheat straw at 0% (control), 10%, 20%, and 40%, and ensiled for 42 days in bottle silos in a factorial design. Fermentation was monitored by taking samples at day 0, 7, 14, 21 and 42. Results showed the lowest pH value (4.65) was obtained from ensiled solvent extract with 20% WDGS opened on 42nd day. There was an increase in crude protein content of silage ensiled from faba bean straw (11.094 to 25.228) treated with WDGS. From those faba bean straw treated, the lowest ash content (8.13 and 8.356) was recorded with that of WDGS free silage opened on the first and 21st days respectively. The highest organic matter content (91.575%) of the silage prepared from wheat was found with 20% concentration of WDGS ensiled for 21 days. Faba bean silage with 40% of WDGS ensiled for 21days produced the lowest crude fiber (29.53%). There were no significant main effect and interaction effects of different concentration levels of WDGS at different sampling period on dry matter content of the ensiled wheat and faba bean residues.

Key word: *ensiling, wet distiler grain, district, sampling, crop residue*

1. INTRODUCTION

Ethiopia has a large livestock population and diverse agro ecological zones suitable for livestock production and for growing diverse types of food and fodder crops. Livestock feed resources in Ethiopia are natural pasture, crop residue, improved pasture , agro-industrial byproducts, other byproducts like food and vegetable refusal, of which the first two contribute the largest share. (Adunya, 2007). Crop residues, natural pasture, cultivated fodder crops and stubble grazing are the major feed resources in study area. Since the majority of the cultivated land area is allocated to cereal and pulse crops production, the major share of livestock feed is obtained from crop residues which contribute approximately 40% of dry matter (DM) of the total diet .Crop residues are also the major contributor to dietary metabolizable energy (ME) and crude protein (CP), contributing 23% and 24% respectively. Cereal straws such as wheat, barley and maize are the dominant crop residues. Legume residues such as faba bean and field pea are also commonly used as animal feeds. There is wastage of crop residues since all of the residues are not well collected from the threshing ground in this distinct (Solomon, 2004)

There are many alcohol industries established within this decade and many will be expected to be established in future. During alcohol production, distiller grain is the residual end products of alcohol industries. A large volume of this product has been produced in Ethiopian alcohol industries. Unlike Ethiopia many countries efficiently use this product by including in livestock feed and it becomes the fastest growing commodity feed for livestock in many part of the world (Kaiser, 2006).

During alcohol production processes the fermentation of grain will provide ethanol and spent grain, which later on is centrifuged to form distiller grains and thin spillage (Renewable Fuels Association, 2009). This can either be available as a wet distiller's grain with soluble (WDGS) or dry distiller's grain with soluble (DDGS) product. This product is able to lower the feed costs of a farm without compromising performance, thus making it more suitable for use as a protein and energy source in the livestock industry (Dale and Batal, 2005; Huls *et al.*, 2006; Kösper, 2007). The DDGS is a good source of phosphorous as well as protein, it contains three times more phosphorous and protein than amount found in the maize grain.

It also contains excellent source of energy due to its high concentration of degradable neutral detergent fiber (NDF) and fat content (Kaiser, 2006).

Although selling of WDGS reduces the cost associated to drying and allows increasing the production capacity and environmental control requirements, these benefits are offset by the high cost of transportation of water by the track and shorter shelf life of WGDS. Therefore, it is important to, preserve and , WDGS to improve its the shelf life of WDGS for use during periods of feed scarcity by ensiling with feeds that are low in protein and high in their energy content. These preserved silages can be utilized during periods of feed scarcity that can be used as a rescue of livestock in the case of drought occurence that can kill large number of animals especially, in drought prone areas of pastoral and agro pastoral production systems. Maize is generally regarded as an ideal crop for ensiling since it is relatively high in dry matter (DM) content and low in buffering capacity and contains adequate level of water-soluble carbohydrates (WSC) for satisfactory fermentation to lactic acid (McDonald *et al*., 2011).

To obtain improvement in animal production and productivity, an assessment should be done on the types and sources of livestock feed resources, total DM feed production and livestock feed requirement of the area and also the low quality roughages contain low protein concentration and need high consumption. Additionally there is very little information available in the country on ensiling roughages with WDGS in enhancing nutritional quality of low quality forage and in prolonging WDGS shelf life, initiated this study to be conducted to fill these research gaps. Therefore, the objective of the current study was;

- ✓ To estimate the feed dry matter available and animal feed requirement from different feed resources in the study area,
- ✓ To improve the low quality forage by ensiling with wet distillers grain,

2. LITERATURE REVIEW

2.1. Feed Availability and Sources in Ethiopia

Inadequate feed supply, both in terms of quantity and quality, is the major constraint affecting livestock production in Ethiopia. Feed scarcity is indicated as a factor responsible for the lower reproductive and growth performance of animals especially during the dry season (Legesse, 2008). The dry season is characterized by inadequacy of grazing resources as a result of which animals are not able to meet even their maintenance requirements and lose substantial amount of their weight. Animal feeds were classified as natural pasture, crop residue, improved pasture and forage and agro industrial by-products of which the first two contribute the largest share in livestock production (Alemayehu, 2003; Tolera *et al*., 2012). The use of communal grazing lands, private pastures and forest areas as feed resources have declined while the use of crop residues and purchased feed have generally increased (Benin *et al*., 2003).

Though increased utilization of agro-industrial by-products has been reported (Benin *et al*., 2004), they are not available, affordable or feasible for most of the farmers in the highlands of Ethiopia. Under smallholder livestock production system, animals are dependent on a variety of feed resources which vary both in quantity and quality. The fibrous agricultural residues contributes a major parts of livestock feed especially in the populated countries where land is prioritized for crop cultivation**.**

2.1.1. Crop residues

Crop residues are the fibrous by-products which result from the cultivation of cereals, pulses, oil plants, roots and tubers and represent an important feed resource (Yayneshet, 2010).They are important in fulfilling feed gaps during periods of acute shortage of other feed resources. A report by Tolera *et al.* (2012) indicated that crop residues contribute to about 50% of the total feed supplied in Ethiopia. The amount of crop residue produced is closely related to grain production, farming system, the type of crops produced and intensity of cultivation. About 12 million tons of crop residues were produced annually from 6 million hectare of farmland in Ethiopia (Daniel, 1988). A report by CSA (2008) indicted that crop residues production was increased to 31.52 million tones. Zinash and Seyoum (1989) reported that 63, 20, 10, and 7% of cereal straws are used for feed, fuel, construction, and bedding purposes, respectively. Farmers in the Ethiopian highlands have a tradition of conserving crop residues from *teff* (*Eragrostis teff*), barley, wheat and sorghum (Reed and Goe, 1989). straws from *teff*, barley and wheat form the largest component of livestock diet in the mid and highland areas, while maize, sorghum and millet Stover's constitute larger proportion of livestock feed in lower to medium altitudes (Alemayehu, 2001) **.**

Crop residues are fibrous remnants produced after crop harvest or primary processing (Smith, 1993). They constitute important, and often the major feed resource available a utilized by smallholder producers in tropical feeding systems (Smith, 1993; Allen *et al.*, 2011). With an increase in human population, more land is used to crop production and only fragments of marginal lands will be left for feed production in Ethiopia. Consequently, ruminants feed largely on crop residues particularly on cereal straws as their basal diet (Kahsay *et al.,* 2009; Fekede *et al.,* 2011; Dawit *et al*., 2013).

The major crops residues in the high and mid land includes cereals crop residues (*teff*, barley, wheat, maize, sorghum, millet and barley), pulse crop residues (field pea, faba bean, chickpeas, haricot beans, and lentils), oil crop residues and reject vegetables which providing a considerable quantity of dry season feed supply in most farming areas of the country (Fekede *et al.*, 2011). The types of crop residue available in the country vary with agro-ecology or the farming systems prevailing in different areas (Fekede *et al.*, 2011; Mesay *et al*., 2013) and among the altitude (Ahmed *et al*., 2010).

Crop residues are mainly used for livestock feed sources; moreover, they are utilized for different purposes like, for fuel as firewood and constructions for roofing local houses, as binding material for walls of local houses and source of cash income. This type of benefit obtained from crop residues results in sustainable interaction between crop and livestock production systems (Beyene *et al*., 2011). Crop residue as fuel source is one which highly compete daily livestock consumption and an alternative way has to be found to minimize this competition through awareness creation of the farmers should require (Yeshitila, 2007). The major constraints associated with crop residues utilization for livestock feeding in high and mid lands of Ethiopia were collection, transportation, storage and feeding problems (Ahmed *et al*., 2010)

Straws and stovers should be stored with moisture content of less than 10-15% and in well ventilated sheds (Mekonnen and Ali, 2013). Due to shortage of labor for physical treatment, lack of know-how, lack of finance and inaccessibility for chemical treatment are factors to improve the nutritional quality of crop residues in central highlands Ethiopia (Ahmed *et al*., 2010).

2.1.2. Natural pasture

Natural pasture is land devoted to the production of indigenous (grasses, legumes, forbs, shrubs, and tree foliage) forage for harvest by grazing, cutting, or both (Allen *et al.*, 2011). Natural grasslands of the highland areas are rich in legume species, while grasslands of the mid and low land zones have lower proportion of legume; this is due to as altitudes decrease the proportion of legumes decrease due to edaphic differences (Alemayehu, 2006; Mekonnen and Ali, 2013). Moreover, legumes are a narrower range of adaptation to climate change. For example, the majority of tropical and subtropical legumes are more common in 15–18°C. Water stresses also has adverse effects on nodulation and Nitrogen fixation of legumes. Soil deficits are frequently associated with high soil temperatures (Haque, 1984).

In the high and mid land areas, livestock mostly depends on natural pasture and crop residues in wet as well as dry season (Solomon *et al*., 2008). However, both area and productivity of natural grazing lands especially in the mixed farming systems of Ethiopia is low due to factors like expansion of cropping land, expansion of urbanization and poor management systems (overgrazing) leading to land degradation (Fekede *et al*., 2011). Due to poor management, the available grazing lands are grazed and trampled the whole year round without any resting period. The consequences these are reduced yield of plant biomass, depletion of the palatable species and invasion of unpalatable species, increased soil erosion, land degradation and severe feed shortage in the highland crop-livestock mixed farming system (Beyene *et al.*, 2011; Fekede *et al*., 2011).

2.1.3. Agro-industrial by-products

The major feed resources in the country are crop residues and natural pasture, with agro industrial by-products and manufactured feed contributing much less (Berhanu *et al.*, 2009). Agro-industrial by-products have special value in feeding livestock mainly in urban and peri-urban livestock production system, as well as in situations where the productive potential of the animals is relatively high and require high nutrient supply. The major agro-industrial by products commonly used are obtained from flour milling industries (wheat bran, wheat short, wheat middling and rice bran), edible oil extracting plants (noug cake, cottonseed cake, peanut cake, linseed cake, sesame cake, sunflower cake), breweries and sugar factories (Molasses). The current trends of increasing urban population has a significant effect on the establishment of agro-industries due to the corresponding increasing demand for the edible main products (Yayneshet, 2010)

Agro-industrial by-products are important sources of relatively high quality feed and most of them make up part of concentrate rations (Mekonnen and Ali, 2013). Agro-industrial byproducts produced in Ethiopia include: by-products from sugar industry, oil cakes, milling byproducts, slaughter house by-products and brewery by-products (Fekade *et al.*, 2011). They are important sources of feed mostly in urban and peri-urban livestock production or in areas close to the agro-industrial plants due to their sources of relatively high quality feed (Mekonnen and Ali, 2013).

In Ethiopia, the use of agro-industrial by-products as livestock feed resources were not widely used due to high cost and unreliable supply. The high cost of most agro-industrial by-products related with distant from agro-industries most livestock owners are not beneficiaries of these products (Fekade *et al.*, 2011)

Feeding of livestock in different places differs depending on forage availability, climatic variability of a given location or region to mitigate feed shortage problems during worse conditions, season of the year and type of animal the owner prioritize to feed (Beyene *et al.*, 2011).The feeding systems in the country include communal or private natural grazing and browsing, cut and carry feeding, hay and crop residues. At present, in the country stock are fed almost entirely on natural pasture and crop residues. Grazing is on permanent grazing areas, fallow land and cropland after harvest (Tesfaye, 2008).

Adane and Berhan (2005) reported that the herbage yield and nutritional quality of natural pasture is generally low. In certain areas where improved forage crops have been introduced, farmers failed to utilize them at its optimum developmental stages, which would ensure an appropriate balance between quality and quantity to satisfy livestock requirements and support reasonable animal production (Taye, 2004). In the mixed crop-livestock systems of the Ethiopian highlands, the total feed resources available for livestock production come from permanent pastures and transient pastures between cropping cycles, crop residues and crop aftermath grazing

2.1.4. Estimation of Annual Feed Balance

The total annual dry matter (DM) production from available feeds is compared with the total annual DM requirement of the livestock population in order to estimate the discrepancy. For the standard tropical livestock units (TLU) of 250 kg dual-purpose tropical cattle, a DM requirement of 2.5% of body weight is equivalent to 6.25 kg DM per day or 2.28 t DM per year for maintenance (Jahnke, 1982). The numbers of live animals are converted into TLU to calculate the total dry matter feed requirement to understand the feed shortages during crisis periods (FAO, 1987). The conversion factors for cattle, small ruminant, donkey, mule, horse, and poultry equals to 0.7, 0.1, 0.5, 0.7, 0.8, and 0.01 TLUs, respectively (Jahnke, 1982)

2.2. Distiller Grain

Distiller's grains are low in starch, but high in fat, protein, fiber, and phosphorus. Wet and dry distiller's grains have similar chemical composition but vary in dry matter content (wet distiller's, 35-45%; dried distillers, 90-95%, Klopfenstein *et al*., 2007). The process of ethanol production involves the fermentation of maize grain to produce ethanol and stent grain (whole spillage). According to the review by the Renewable Fuels Association (2009), the spent grain is centrifuged to form distiller's grains and thin Spillage, which is the liquid fraction of the spent grain.

Distillers grains can either be available as a wet (WDGS) or dry (DDGS) product. It must be noted that drying cost significantly increase the commodity price for the distillers by-products. However, it does allow for better handling, transportation, and increased shelf life, resulting in a much wider use of the by-product (Kaiser, 2006).The growing supply of distiller's grains with soluble is likely to lower feed costs without comprising performance, making it more favorable for use as a protein and energy source in the livestock industry (Kösper, 2007).

Optimizing the use of distiller's grains is becoming increasingly important as ethanol production increases, with dairy-beef production systems having the potential to use large amounts of DGS (Rinker and Berger, 2003). However, fractionation, changes in enzymes and heat used in the ethanol production process may alter the nutrient composition and digestibility of the ethanol by-products. The challenge for the feed and livestock production industries is to determine the feeding value and the best applications for this growing portfolio of maize DGS. Ensiling of the wet by-product (WDGS) with forage crops will be one possible way of applying the ethanol by-product into diets suitable for ruminants at high inclusion levels (Garcia and Kalscheur, 2004).

It may be cost effective to partially substitute maize with low cost WDGS in livestock feeds. Wet distiller's grains soluble can be incorporated in higher inclusion levels than maize, which is becoming an expensive energy source for livestock producers (Garcia and Kalscheur, 2004). Distiller's grains by-products are generally characterized by higher protein, fat, NDF, ash, and lower starch contents compared with the source (maize) grain (Akayezu *et al*., 1998). Factors influencing the composition of distiller's grains include quality of grain used, amount of solubles added and fractionation of particle size (Akayezu *et al*., 1998).

2.3. Sources of Distiller Grains

Research has also studied DGS from other sources such as barley, rye, sorghum, and triticale (Greter *et al*., 2008; Mustafa *et al*., 2000; Schingoethe, 2006). Corn is the most abundant grain produced about two thirds of the kernel comprised of starch (Klopfenstein *et al*., 2008). During the milling process, the starch component is fermented to produce ethanol. With the starch removed, the remaining nutrients in DGS (protein, fiber, fat, and minerals such as phosphorus and sulphur) are concentrated three fold (Kononoff e*t al*., 2007; Schingoethe, 2006; Spiehs *et al*., 2002).

Depending on the type of DDGS and processing, crude protein (CP) content can range from 28 to 43.6% DM (Boila and Ingalls, 1994; Penner *et al*., 2009; Schingoethe, 2006; Spiehs *et al*., 2002). Corn grain has lower protein content than wheat grain and therefore the resulting DDGS from corn and wheat have different CP content (28 to 32%).Robinson *et al*. (2008) reported that newer processing techniques using Continuous grinding and more efficient fermentation methods can produce corn DDGS with CP content up to 41 %.

2.4. Production of Distiller grain

There are two main distillery processes, dry-milling and wet-milling distillery. The dry-milling process is the main process for producing ethanol (Graybosch and RA Liu RH, 2009).The dry-milling process includes primarily the follow steps: grinding or milling, liquefaction, sacchariication, fermentation and distillation (Heuzé V, Tran G, Sauvant D, Noblet J, Lessire M, , 2015) .The grain is ground to produce bran-free lour, and then mixed with water and enzymes (amylases) to produce a mash (liquefaction). The sacchariication is conducted by adding enzymes to the mash to transform starch into dextrose. After sacchariication, yeast is added to start the fermentation process to produce a beer and Carbon dioxide. The beer is separated through a continuous distillation column to yield alcohol .The remaining material is called whole spillage and consists of all the components of the original grain (except the starch), yeast and added water. The whole spillage is centrifuged to produce wet distiller grain and thin spillage (Heuzé V, *et al* .2015).

2.5. Types of Distiller Grain

Distillers grains can either be available as a wet (WDGS) or dry (DDGS) product. The response to wet or dried DGS is usually considered equal. However, few experiments actually compared wet versus dried DGS; most experiments simply compared DGS to a control diet. When Al-Suwaiegh *et al*. (2002) compared wet versus dried corn or sorghum DGS for lactating cows, they observed similar production for both wet and dried DGS but a tendency for more milk with corn versus sorghum DGS. Anderson *et a*l. (2006) observed greater production when feeding either wet or dried DGS compared with feeding the control (corn-soybean meal) diet.

The main considerations regarding the use of wet versus dried DGS are handling and cost. Dried products can be stored for extended periods, can be shipped greater distances more economically and conveniently than wet DGS, and can be easily blended with other dietary ingredients. Feeding wet DGS avoids the cost of drying the product. However, wet DGS will not remain fresh and palatable for extended periods; 5 to 7 day is the norm, possibly less in hot weather and a little longer in cooler weather. Claims are made for some silage additives to extend the storage time of wet DGS (Stangler *et al.,* 2005). Researchers at South Dakota state University and elsewhere have successfully stored wet DGS for more than 6 month in silo bags when the wet DGS was stored alone or blended with soy hulls (Anderson *et al*.,2009), corn silage (Kalscheur *et al*., 2003), or beet pulp (Kalscheur *et al*., 2004).

2.6. Chemical Composition of Distillers Grain

Garcia and Kalscheur (2004), suggested that WDGS supplied approximately 10 percent more energy than maize grain and approximately 30 percent protein, 10 percent fat and 1 percent phosphorus, which are highly priced nutrients and thus desirable in a feed. No significant amount of starch or soluble solids are present in WDGS but the hemicellulose, cellulose and insoluble proteins remain after fermentation of the maize grain (White and Johnson, 2003). Composition of fat essentially remains equivalent to that of maize because maize oil is not recovered during ethanol production. The high fat concentration in WDGS contributes to the energy value of feed and helps negate the energy dilution effects of the high fiber content in DGS (Spiehs *et al*., 2002).

The nutrient content of the soil can affect the concentration of some nutrients in maize and ultimately distillers grains (DG) (Spiehs *et al.*, 2002). However, measuring soil fertility and its correlation with maize nutrient levels is beyond the scope of this study. The ratio of grains and solubles used to manufacture DGS will have more influence on the final nutrient concentration of DGS than soil fertility differences. Most of the variation in the nutrient content of DGS is likely a result of the maize crop used, percentage of solubles added to the distillers grains, and completeness or duration of the fermentation process, which affects the degree of starch removal (Spiehs *et al*., 2002).

Availability of distiller's grains as a feed for ruminants has increased as the ethanol industry expands due to higher demand for greener fuels. Distiller's grains contain high concentrations of protein, fiber and fat as a result of starch fermentation during ethanol production. Distiller's grains can be fed to animals as a protein source when fed at less than 15% DM or as an energy source when included at levels greater than 15% DM in finishing diets.

2.7. Dietary Component of Distiller Grain

2.7.1. Distillers grains as an energy source

With the high cost of corn, there has been a shift to consider WDGS as more than a protein source, but as energy source as well (Klopfenstein *et al*., 2008). In the past, whether WDGS was used as energy or a protein source seemed to depend on the producer (Hersom, 2006). Currently, overwhelming evidence suggests that the energy value for WDGS is between 10 and 40% higher than corn, depending on the inclusion rate as a percentage of DM intakes (Ham *et al*., 1994; Buckner *et al*., 2008; Loy *et al*., 2008). Although WDG have higher energy values than DDGS in beef finishing diets (Al-Suwaiegh *et al*., 2002). One of the theories for the increased energy value of DDGS when compared to corn may be the difference of the fermentable and digestible substrates in each (Klopfenstein *et al*., 2008).

The energy content in DDGS comes from digestible fiber and fat instead of starch as it does in corn (Schingoethe, 2004). Because of this substrate shift, increasing dietary inclusions of DDGS is believed to increase the ruminal pH linearly. In fact, one study in which steers were fed diets containing 30% grass hay found pH did increase linearly when dietary DDGS inclusion increased from 0 to 60% (Leupp *et al.*, 2009). Replacing corn with DDGS reduces dietary starch intake and is believed to increase feed efficiency by reducing ruminal acidosis (Ham *et al*, 1994).

The fat percentage in DDGS is approximately three times that of corn which also contributes to its high energy value. Because fatty acids are not fermented in the rumen and are absorbed post-ruminally, they do not contribute to the fermentation acid load in the rumen. There are many factors that may attribute to the higher energy value of DDGS when it is compared to corn. The high level of fat in DDGS is likely the primary factor that increases its energy value. The decreased risk of acidosis, due to increased rumen pH on DDGS diets, may be another factor; however, this effect has been not been scientifically documented. Although, the energy value of DDGS cannot be linked to any one component, the increased energy values can improve performance (Ham *et al.*, 1994; Buckner *et al*., 2008; Depenbusch *et al*., 2009)

2.7.2. Distillers grains as an protein source

Distillers grains (DG) have been used as a protein supplement for cattle and have higher comparative protein values than soybean meal when used in combination with urea (Waller, 1980). Both wet and dry forms of DG have been used as cattle feeds. Wet DG (WDG) was used extensively in dairy and feedlot diets as a protein supplement (Schingoethe, 2004). The WDG average 30% DM and can be difficult and expensive to ship and store because of the high water content; therefore, using wet DG typically depends on a producer‘s proximity to an ethanol plant (Jones *et al*., 2007).

Dried DG with solubles (DDGS), at 85 to 90% DM is readily available in the feed industry, and they are much more easily shipped and stored. There are numerous reports comparing and contrasting the benefits of WDG and DDGS that are beyond the scope of this review, and the interested reader is directed to these review articles for further information (Firkins *et al*., 1985; Ham *et al*., 1994; Tjardes and Wright, 2002; Schingoethe, 2004; Klopfenstein *et al*., 2008).
However, the bypass protein in DDGS makes it an attractive supplement for cattle. Bypass protein characteristics allow DDGS to provide a valuable source of protein to the small intestine of the animal, which is often expensive to meet (Firkins *et al*, 1984; Hersom, 2006). For this reason, DDGS has typically been included in cattle finishing diets at 15 to 25% of dry matter intake (DMI) as a protein supplement (Erickson and Klopfenstein, 2002)

2.8. Importance of Distiller Grain

2.8.1. Feeding value in beef cattle

Extensive research gave some insight into when and where distillers' grains may fit in for feeding beef cows (Köster, 2007). These situations include feeding as a protein source, particularly for low quality forages (replace soybean meal), as a low starch-high fiber energy source (replace soy hulls), and as a source of supplemental fat (soybean replacement). Beef cows need less supplemental protein than dairy cows, but in many production systems they are fed poor-quality, low-protein forages (McCully. 2006).

In these situations distillers grains fit well as a supplemental protein source. Depending on the animal production goal, DGS can often serve as the sole supplemental source for cattle (Köster, 2007). This could be practiced in lower quality pastures as it is a medium protein feed of which the protein content is approximately 50 percent degradable intake protein and also contains other commonly limiting minerals such as phosphorus in relatively high quantities (Huls *et al.*, 2006). Therefore, DGS can be fed successfully as a replacement for other protein sources (such as sunflower oilcake, cotton seed oilcake, urea, etc) in beef cattle supplements on pasture (Köster, 2007).

However, it must be emphasized, when feeding DDGS as a sole protein source on low quality pastures, it is important to remember that sufficient quantities must be fed to specifically meet the degradable protein requirements. In such a case, distillers by products may combine well in a blend with non-protein nitrogen (NPN) source when degradable proteins are the major nutrient of concern (Luebb.2005).

2.8.2. Feeding Value in Dairy Cattle

Distillers by-products provide a unique feed ingredient for the high producing dairy cow as it is an excellent source of NDF and non fiber carbohydrates (NFC) when compared to maize and soybean oilcake blend (Kösper, 2007). The unique properties of distillers grains further include high fat concentration of 8 to 12 percent (Kaiser, 2006), which provides a good source of non-carbohydrate energy to compliment that of high starch ingredients. The fat concentration of distiller's grains is also high in long-chain unsaturated fatty acids, which may increase processing, healthfulness and marketability of dairy products. Replacing some of the starch with DGS stabilizes rumen pH, which improves rumen health and cow productivity, particularly in the early lactating-higher producing cow (Kösper, 2007).

Feeding info News Services (2007) mentioned that distillers' grains had been proposed to be beneficial for treating animals with acidosis or other liver ailments due to its low starch concentration. It is however not previously proposed that distillers' grains can promote cardiac development, thereby treating or ameliorating or preventing arrhythmia (Feed info News Services, 2007). It is noted that many cardiovascular pathologies such as arrhythmia are caused by oxidants or by increased calcium influx into the heart (Feed info News Services, 2007). As such, wet and/or dry distillers grains may act as an anti-oxidant or may act as a calcium channel antagonist, thereby relieving stress on the cardiovascular system of the animal .Rations involving maize DGS are low in lysine, while the importance of lysine and methionine to enhance milk production and composition is well documented. Distiller's grains with soluble are palatable when fed to dairy cows (KöSper, 2007).

According to an overview by (Leupp, J.2009), DGS combined with the more unpalatable blood meal, improved the overall palatability of the total ration and the high lysine levels in the blood meal complimented the higher methionine levels in maize DGS. This combination is an excellent rumen protected amino acid blend for higher producing dairy cows (Kösper, 2007).studies with dairy cows showed that dry matter intake was as high as or higher than the intake of control diets (alfalfa hay and maize meal), even with more than 20% DGS in the die (Hippen *et al.*, 2004; Kalscheur, 2005).

2.8.3. Feeding Distiller Grain for Small Ruminants

Abundant distiller grain from ethanol production can be used as alternatives to feed grains and other premium ingredients in sheep feeding to reduce feeding costs for sheep farmers. However, most of the studies with feeding wheat distiller grain are with cattle or pigs. With our best knowledge, only one study was conducted using growing lambs fed diets containing wheat distiller grain (O' Hara *et al*. 2011). Replacing part of barley grain with 20% of wheat distiller grain in finishing lambs also maintained a healthy rumen function, growth performance and carcass characteristics (O' Hara *et al*. 2011). Distiller grain could replace up to 60% barley grain without adversely affecting on growth performance or carcass traits of lambs. Inclusion of wheat distiller grain in growing or finishing lamb diets is likely a viable feeding management since wheat distiller grain can entirely replace protein supplement to meet protein requirement of growing lambs, and simultaneously used as energy and fiber source because of its high contents of protein, energy and fiber (McKeown *et al*. ,2010).

2.9. Ensiling Wet Distillers Grains with Forage

Dried distiller's grains, with or without soluble are more convenient to store than the wet distillers grains, since it only contains 10-13% moisture (Ganesan *et al*., 2005). Wet distiller's grains (moisture content of 40-70%) will mold and go out of condition in as few as four days, although typically, WDGS have about seven days of shelf life before going out of condition (Loy, 2006). Organic acid may extend shelf life, but the additional cost needs to be considered. Wet distiller's grains have been successfully stored for more than six months in silage bags, either bagged alone or in combination with other feeds (Tjardes and Wright, 2002).

The conditions required are similar to those needed for any ensiled crop air exclusion, adequate compaction and low pH. Ensiling in silo bags is probably the method of choice as air exclusion is high, resulting in low spoilage and dry matter losses. Ensiling distiller's by-products with plant forages may provide the solution to the problem of nutrient variability and storage (spoilage) of the ethanol by-product. Wet distiller's grains have been successfully preserved alone or in combination with soy hulls, beet pulp or maize silage. One advantage of WDGS is that it sticks well to dry particles of other feeds, increasing the palatability and homogeneity of the diet (Garcia and Kalscheur, 2004).

Garcia and Kalscheur (2004) suggested blending distillers' grains with forages that had a complementary nutrient profile such as maize plants. Maize plants have low protein, energy, fat and phosphorus concentrations. Combination of such blends will create a dilution effect, making the blend more appropriate to be fed to ruminants both from a health and environmental protective (Garcia and Kalscheur, 2004).

However, when distillers' grains are blended with other feeds that also supply these nutrients (protein, fat and phosphorus), dietary excesses of nitrogen and phosphorus may result in increased nutrient excretion and thus environmental concerns. The fermentation is not a classic ensiling process because wet distillers' grain has a very low initial pH (less than 4). However, this acid level, provided by the addition of sulphuric acid to stop the fermentation process during ethanol production (Garcia and Kalscheur, 2006), does aid in preservation.

McCullough *et al*. (1963) ensiled WDGS with forage plants and reported an increase in protein, but with a less fiber concentration. Feeding WDGS silage to Guernsey cows produced the most consistent influence on milk production. This influence resulted in an increase in milk production. Aines *et al*. (1997) evaluated the ensiling of fescue grass with whole Spillage at 0, 15, 30 or 60 percent of the total DM. The fescue-spillage mixture was ensiled for 20 days in small laboratory silos. Lactic acid increased with increasing spillage level. The silages were finally evaluated in a digestibility trial, where digestibility increased linearly with an increasing level of spillage in the silage. Muntifering *et al*. (1983) concluded that ensiling offered a means of storing WDG, thus saving drying costs. However, these authors concluded that ensiling reduced the protein-bypass value of WDGS.

Garcia and Kalscheur (2004) reported that blending WDGS with other feeds resulted in a fermentation pattern that shifted from the traditional lactic acid fermentation towards a more acetic acid fermentation. The other feeds that are good alternatives for blends with WDGS include soy hulls and beet pulp (Garcia and Kalscheur, 2004). Both are low in protein, fat and phosphorus, although they provide fermentable energy due to the presence of highly digestible carbohydrates. Soy hulls and beet pulp when blended with WDGS offer the additional advantage of increasing acetate production in the rumen, thus reducing the risk of acidosis (Garcia and Kalscheur, 2006).It is recommended that feed intakes be restricted to avoid excessive weight gains because of the high energy content and palatability, combined with increased intake potential for rations involving DDGS (Garcia and Kalscheur, 20

3. MATERIALS AND METHOD

3.1. Survey

3.1.1. Study area description

Survey was conducted in three Kebeles namely Dosha, Gorasilingo and Dhenkaka of Tiyo district of Arsi zone, Oromia Regional state. Tiyo district is located in Arsi Zone, Oromia state at a distance of 175 km from Addis Ababa to the south west of the country. Tiyo district has a latitude and longitude of 7°57′N 39°7′E, respectively and an elevation of 2,430 meters. The study area also receives an annual rainfall of around 1100 mm. It consists of 73 rural and 2 urban Kebeles. The total land area is 108449ha out of which 60.7% was grazing land, 3.7% forest, 20% potentially cultivable (CSA, 2010; Tiyo District Agricultural office)

3.1.2. Sampling Technique and sample size determination

Three Kebeles were purposively selected from Tiyo district based on their livestock production potential, type of crop residue they used and representative of mixed crop-livestock. A total of 120 households (HHs) were farming system randomly selected from three Kebeles (40 HHs from each kebeles) and interviewed independently. A pre-tested questionnaire was used to collect socioeconomic information from individual farmers through individual interview at their farm gates. Moreover, focus group discussion was made to generate pertinent information. The sample size was determined by using mathematical model of (Arshame, 2007). The sample size, N, can then be expressed as largest integer less than or equal to 0.25/SE2.

$$N=0.25/SE^2$$

SE is standard error (considering SE of 0.0456 with 95 % coefficient interval as follows, N= 0.25/0.04562 = 120. Accordingly, one hundred twenty (120) households were randomly selected in study areas

3.1.3. Methods of data collection and statistical data analysis

Both primary and secondary data was used for this study. Survey questionnaire was prepared and the primary data were collected by through interview with structured questioner. The secondary data were collected from Tiyo District Agricultural Office. Preliminary surveys were conducted to gather information about the availability of the different feed resources in each three kebeles. Before actual data collection, information was gathered in single visit interviews using semi-structured questionnaires. Data collected using questionnaires strengthened by information obtained from key-informants through cross-questioning, making field visit and checking at the time of survey.

Primary data from surveyed households was organized and analyzed using Statistical Package for Social Science (SPSS version 20). Mean and percentage values of various parameters were compared between the three study locations

3.1.4. Quantification of Dry Matter from Different Feed Resources

Dry matter (DM) yield of different feed resources were used to calculate the balance between annual feed availability (supply) and requirements (demand) for livestock in the study area. The quantity of DM yield from different land use systems such as natural pasture land, aftermaths, bush and shrub land, fallow land, forest lands were estimated by multiplying each land use system by conversion factors of 2, 0.5, 1.2, 0.7 and 1.8 tones ha^{-1}, respectively. The quantity of DM from crop residues was estimated from crop grain yields using the conversion factors as follows: 1.5 for teff, wheat, barley and oat, 1.2 for chickpeas, horse bean and oil seeds (FAO, 1987).

3.1.5. Estimation of livestock population and their dry matter requirement

The total livestock population of the district was converted to tropical livestock unit (TLU) as recommended by Jahnke (1982) for local animals. Therefore, the conversion factors for local oxen and bulls, cows, heifers and calves were 1, 0.7, 0.5 and 0.2, respectively. For sheep and goats conversion factors of 0.1, horses 0.8, donkeys 0.5, and mules 0.7 were used. DM requirement of an animal was calculated based on the daily DM requirement of 250 kg dual purpose tropical cattle (an equivalent of one TLU) for maintenance requirement that needs 6.25kg/day/animal or 2281 kg/year/animal (Jahnke,1982)

3.1.6 Farming Systems and Land use Types of Tiyo District

There are two farming systems in Tiyo district that are classified based on the crop commodities they produce and species of livestock they rear. Accordingly an area where crop commodities of wheat, barley and fababean are abundantly produced and where cattle is the predominant species from livestock is called (Table 2) The total land area is 108449ha; out of these 60.7% grazing land, 3.7% forest, 20% potentially cultivable (CSA, 2010) (Table1)Shortage of feeds is one of the limiting factors in livestock production aggravated by both shortage of grazing land and shortage of rainfall, which denied the growth of sufficient feed resources IPMS (2005).

Table 1.Land use type of Tiyo district of Arsi zone

Land use	Area coverage/ha
forest	4019
Bush land	6985
Shrub land	2940
Grazing land	65835
Cultivated land	21773
irrigation	4347
mountain	2550

Source: Tiyo District Agricultural office (2009/2010 E.C)

Regarding livestock population of the Tiyo district, farmers in Tiyo have an estimated total 107608 heards of cattle, 9894 sheep, 16117 goats, 11058 horses, 687 mules and 72698 poultry.

Table 2. Livestock population of the Tiyo district of Arsi zone.

Livestock species	population	TLU
cattle	107608	75325.6
Goat	16117	1611.7
sheep	9894	989.4
donkey	39290	19645
horse	11058	8846.4
Mule	687	480.9

Source: (CSA, 2009/2010)

1.1. Laboratory experiment

1.1.1. Study area

Laboratory activity was conducted at three places namely Arsi University, Animal Science Laboratory and National Veterinary Institute & Debrezeit Agricultural Research Center, Soil and Plant Nutrition Analysis, Bishoftu town. The Mini Silo preparation (ensiling) and incubation were done at Animal Science laboratory. Arsi University is located 175km from Addis Ababa and at elevation of 2430masl average monthly rainfall of 85 mm and an annual mean rainfall is 1,020 mm. Debrezeit Agricultural Research Center which is located 47km from Addis Ababa at 08044' N latitude and 380, 38'E longitudes and at elevation of 1900masl in Bishoftu town. It has tepid to cool sub moist agro-ecology and receives an annual average rainfall of 1100mm. The maximum and minimum annual mean temperature is 28.3 ^{0}C and 8.9^{0}C respectively.

1.1.2. Experimental material/sample collection

The straw of wheat and fababean representing the three surveyed kebeles were collected while wet distillers' grains with soluble (WDGS) was brought from Addis Ababa National Alcohol and Liquor factor. Plastic bottles of 3 liter size, hand glove, mouth cover, plastic eye glass and wooden compressor, sensitive balance, beaker, kaki Posta, shaker, thermometer, pH meter and Oven dry were used for this activity. Buffer and distilled water for calibration of pH meter and washing purpose during ensiling period. WDGS consignment was immediately placed in cold storage (5-7°C) until time of ensiling. Their representative samples will be taken at the point of packaging into plastic bags for chemical analysis.

1.1.3. Ensiling procedures and experimental treatments

Based on the proposed design, samples were taken from two bottles representing each treatment for further examinations on 0day, 7^{th} day, 14th day, 21st day and 42^{nd} day ensiled sampling period respectively. Temperature of the min silo was recorded every two days using thermometer to see the development of microorganisms which the indicators of emerging of silage spoilage. Ensiled sample weight of 20gm added with 100ml of distilled water were transferred to a beaker (500ml size) and shacked for 6hrs on shaker adjusted to 180 revolution power per minute. Then the ensiled solvent was sieved from the treated straw part using a piece of cotton cloth. Before measuring the pH value, the pH meter was calibrated with buffer solution at 4 and 7 pH values. The pH of the ensiled solvent was measured by inserting the sensitive part into a beaker with solvent and value was recorded from its reading tip.

Ensiled sample weight of 80gm from two containers of each treatment up on sampling time were taken, oven dried in oven dry machine for 3days on a temperature of 65^{0}C.And silage quality assessment by aroma was taken during opening time. Then the samples were sent to Soil and Plant Analysis Laboratory, DZARC and National veterinary Institute (NVI), Bishoftu for chemical constituent analysis (Crude protein, Organic matter, Fiber content and dry matter) analysis.

1.1.4. Sampling procedure and sampling times

The different treatments were ensiled up to a period of 42days. For each of the experimental treatment, two bottles were opened at day 0,7,14, 21 and 42 post ensiling. During the time of analysis, two sub-samples of each treatment at a time will be thawed overnight and one fraction (80g) of the sample will be used for obtaining a silage extract (liquid supernatant). The silage extract (supernatant) from each sample was obtained for the determination of fermentation characteristics.

The bottles were sealed and shaken for 6 hours at 180 rpm using a horizontal shaker (Bechaz, 2000). The extracted silage was then filtered through four layers of cheese cloth to remove the plant material. This extract was used for the determination of pH value. The second fraction of each of the two samples will be oven-dried at 55°C for 48 hours and analyzed for nitrogen (N) concentration.

1.1.5. Analysis of chemical composition and fermentation characteristics

The samples which were oven-dried at 55°C were used to determine N concentration. The dry matter and nitrogen concentration (Kjedahl method) of silage samples were determined according to the procedures of AOAC (2000). Ash content was determined by combustion at 550°C for 2 hrs (Engels and Van der Merwe, 1967).

Silage fermentation characteristics like pH value and temperature were also measured. The pH was measured by means of an electrode pH meter (Mettler Toledo) after it had been calibrated by means of pH 4 and pH 7 buffer solutions. Buffering capacity was expressed as described by Playne and McDonald, (1966).

1.1.6. Data collected

Chemical composition like Dry Matter (DM), Crude protein (CP), Ash, Organic matter (OM), Crude Fiber (CF) and pH value of silage extract was calculated.

1.1.7. Experimental design and data analysis

The experimental treatments included the ensiling of feeds (95% DM) blended with 0, 10, 20 and 40% of WDGS (40% DM) as a component of straw-WDGS silage. These four treatments involved mixing WDGS and feeds on weight ratio. There were 16 bottles ensiled per treatment (80 bottles in total). The treatments were laid out in factorial arrangement for laboratory studies. Data was analyzed using SAS software version 9.0 for repeated measure analysis to test statistical differences between experimental treatments (0, 10, 20 and 40% WDGS) and between sampling periods (day 0, 7, 14, 21 and 42). All recorded data were subjected to analysis of variance procedures and treatment means were evaluated using the least significant difference (LS.D) at 95% of confidence interval ($P<0.05$ level of significance). The two bottles per sampling period per treatment will be used as replicates.

4. RESULT

4.1. Survey part

4.1.1. Land holding and land use pattern of the households

The total land holding of the respondents was the lowest in Dhenkaka (1.8 ha/hh) compared to Gorasilingo (2.08ha/hh) and Dosha (1.9ha/hh) (Table 1). This was mostly due to small amount of total land and large human population in this Kebele's. In the study district, the average total land owned by the households was 1.9hectares ranging from 0.26 to 8 hectare (Table 1).

Table 3. Land use or land holding of the study area. (Mean±SE in ha)

Land use type	Names of Kebele's			
	Gorasilingo (N=40)	Dhenkaka (N=40)	Dosha (N=40)	Over all Mean
Grazing and Browsing land	0.34±.067	0.475±0.084	0.522±0.11	0.454±0.054
Fallow land	0.450±0.14	0.383±0.051	0.445±0.05	0.4162±0.036
Forest land	0.250±.048	0.236±0.043	0.334±.048	0.281±0.028
Total land	2.091±.243	1.893±.188	1.912±.248	1.96±0.131

4.1.2. Livestock Holding in the Study Area

The total populations of livestock in the district were estimated to be 106899TLU. As shown in table 2, cattle comprised 70% of the total TLU of the livestock population in the district.).

In Gorasilingo Kebele's cattle and goat had a relatively greater mean population than Dhenkaka and Dosha, which may be due to the favorable, agro-ecological for goats and the livestock keeper. The total TLU value of the study area based on the surveyed data were found to be 732.7.

Table 4. Livestock population in study area (TLU) (Mean±SE)

Classes of livestock	Names of Kebele's			
	Gorasilingo (N=40)	Dhenkaka(N=40)	Dosha(N=40)	Average(TLU)
Cattle	5.078±0.689	4.533±0.522	1.688±0.402	4.760±0.3193
Sheep	.4263±0.051	0.720±0.077	0.673±0.093	0.629±0.048
Goat	0.570±0.095	0.480±0.020	0.350±0.050	0.537±0.071
Horse	1.100±0.146	1.363±0.159	1.219±0.119	1.271±0.091
Donkey	1.118±0.118	0.625±0.037	0.732±0.060	0.827±0.051

4.1.3. Land used for crop production in study area.

Land allocated for barley was higher (P< 0.05) in Dosha Kebele's, but that allocated for field pea is lower in Dhenkaka Kebele's. However, there is no difference in land allocation for the remaining crops between the three Kebele's (Table 3).

Table 5. Land allocation for crop production (Mean±SE)

	Type of crop	Names of Kebele's			
		Gorasilingo (N=40)	Dhenkaka (N=40)	Dosha (N=40)	Average(TLU
1	Wheat	0.948±0.132	0.565±0.093	1.001±0.343	0.848±0.12
2	Barley	0.301±0.045	0.827±0.110	1.045±0.128	0.818±0.074
3	Teff	0.335±0.041	0.500±0.000	0.350±0.061	0.347±0.034
4	Fababean	0.302±0.034	0.276±0.035	0.312±0.027	0.295±0.019
5	Maize	0.211±0.040	0.250±0.068	0.194±0.040	0.211±0.028
6	Field pea	0.153±0.028	0.279±0.037	0.405±0.037	0.308±0.025

N=Number of respondents, SE=standard Error, ns=Non significant,*=significant at (p<0.05),

4.1.4. Grain yield of Tiyo district (Mean±SE)

The results of the present study shown that the dominant crops in the area were wheat, barley, faba bean and teff. The mean yield of teff and field pea varied highly significantly (P<0.01) among three Kebele's of study areas due to the lower land size. The average yield of barley in Gorasilingo was highly significantly lower (P<0.05) than in Dhenkaka and dosha Kebele's The variations of yields observed among the study Kebele's were due to the result of variation of size of cropping land and altitude (Table 5)

Table 6. Grain yield in (t ha-1) for common field crops grown in study District (Mean±SE)

SN.	Crop types	Names of Kebele's			
		Gorasilingo N=40	Dhenkaka N=40a	Dosha N=40	Mean
1	Wheat	2.3675±.48139	1.4650±.25117	1.5244±.25915	1.7878±.20319
2	Teff	0.3825±.08142	0.0500±.03772	0.0962±.04018	0.1868±.03804
3	Barley	0.2553±.10545	2.7850±.35896	3.3600±.47047	2.1653±.23663
4	Faba bean	0.3163±.04663	0.5550±.09008	0.4949±.07113	0.4550±.04201
5	Maize	0.4513±.20807	.0725±.02931	0.1179±.03954	0.2127±.07180
6	Field pea	0.0800±.02682	0.2713±.05975	0.4368±.07834	0.2677±.03705
	Total	3.85±0.948	5.19±0.81	6.032±0.74	5.02±0.83

4.1.5. Annual feed dry matter of different crop residues and land use type

The major crop residues available for livestock feeding in the area were wheat, barley, teff, faba bean and maize. The annual total dry matter (DM) feed produced from crop-residues in the study area was 7.43 ton (t) per household. The overall average yield of crop residues varies among the study area. The overall average Yield of crop residues owned per house holding Gorasilingo Kebele's was highly significantly lower (P<0.01) than the overall average yield of crop residues owned in Dhenkaka and Dosha Kebele's The reason of lower yield of crop residues in Gorasilingo was due to lower crop land size than in Dhenkaka and Dosha Kebele's (table 3). The average dry matter yield of barley straws of Gorasilingo was significant lower than (P<0.05) than dry matter yield of barley straws of Dosha and Dhenkaka Kebele's (Table 5). Barley and wheat straws contributed the largest DM related to other crop residues in the study area.

Table 7. Estimated annual feed dry matter obtained per household farm from different crop residue (Mean±SE)

		Names of Kebele's			
SN.	Crop residue	Gorasilingo (N=40)	Dhenkaka (N=40)	Dosha (N=40)	Mean
1	Wheat	3.5513±.72208	2.1975±.37675	2.2872±.38869	2.6819±.30478
2	Teff	0.7991±.19528	0	0	0.7991± .19528
3	Barley	0.3829±.15817	4.1775±.53844	5.0405±.70575	3.2481±.35496
4	Faba bean	0.3835±.05628	0.7240±.11571	0.5938±.08536	0.5669±.05269
5	Maize	0.9026±.41615	0.1450±.05861	0.2359±.07909	0.4254±.14360
6	Field pea	0.0960±.03218	0.3255±.07170	0.5242±.09401	0.3212±.04446
	Total DM	6.11±0.046	7.56±0.057	8.69±0.09	7.43±0.34

4.1.6. Feed resource of Tiyo district

Stubble grazing (94.4%) and Natural pasture (81.5%) were major feed resource in wet season (Table 6). Agro industrial by product (74.2%), Hay (72.3%) crop residue (71.8) were reported to be the major feed resources during the dry season (Table 6). The feed resources used as the least alternative during wet season and dry season were agro industrial by products (25.8%) and stubble grazing (4.6%) respectively. According to the responses of respondents, in the study area, the availability of feed resources varied in seasons with respect to quantity. The principal dry season feed resources available to livestock in all Kebele's include crop-residue, natural pasture, stubble grazing, and hay in their order of magnitude. Whereas, during the wet season, the principal feed resources in all Kebele's include natural pasture, stubble grazing, and agro industrial by product (Table 6).

Table 8 Major types of feed resources available in Tiyo district

SN.	Major feed type	Percent of feed available in area (%)	
		WET	dry
1	Crop residue	28.2	71.8
2	Natural pasture	81.5	18.5
3	Brows species	61.7	38.3
4	Stubble grazing	94.4	4.6
5	Agro industrial	25.8	74.2
6	Hay	27.7	72.3

4.1.7. Ways of feeding and storage systems of crop residues

The respondents feed crop residues to their animals in different ways (Table 7) in which, 51% of the respondent practiced whole feeding, 0.8% chopped,20.8% treated the feed and 27.5% of the respondents mix crop residues with other feeds.. Generally, in the study district, most of the farmers fed crop residues as whole feeding and this increase wastage of the feed and reduce efficient utilization of the available feeds.

In the study area 65% of the respondents store feed outside in open air whereas 36.7% store under shed (Table 6). Although, baling the hay is important for efficient utilization of feeds, all the respondents in the study district did not bale the hay and crop residues due to lack of facilities.

Table 9 Ways of feeding and storage systems of crop residues in frequency (Freq.) and Percentage (%)

	Name Kebele's				
	Gorasilingo (N=40)	Dhenkaka (N=40)	Dosha (N=40)	Over all	x^2
Forms of feeding	Freg. (%)	Freg. (%)	Freg. (%)	Mean	(p Value)
Whole	23(57.5%)	21(52.5%)	17(42.5%)	51%	
Chopped	1(2.5%)	0(0%)	0(0%)	0.80%	11.22
Treated	8(20%)	4(10%)	13(32.5%)	20.80%	(0.08)
Mixed with other feed	8(20%)	15(37.5%)	10(25%)	27.50%	
Form of storage					
Stacked outside	26(65.0%)	29(72.5%)	20(50.0%)	62.50%	7.570
Stacked under shade	14(35%)	11(27.5%)	19(47.5%)	36.70%	(0.023)

N=Number of respondents, Freg= Frequency, x^2=Chi square

4.1.8. Major Livestock production constraints

Forty percent (40%) of the respondents revealed that feed shortage as the major constraint for livestock production. Disease problem (37.50%) and water scarcity (30%) were the second and third problems. The result also indicated that the prevalence of disease in the area was common.

Table 10.Major Livestock production constraints

SN.	Major constraint	Total number of respondents of three Kebele's (120) 1	2	3	4	Rank
1	Shortage of feed	40%	48.30%	10.00%	1.70%	1
2	Disease problem	37.50%	47.50%	12.50%	2.50%	2
3	Water scarcity	30.00%	35.80%	16.70%	17.50%	3
4	Marketing problem	6.70%	51.70%	29.20%	12.50%	4

4.1.9. The annual feed balance in study district

Feed resources used in the study areas were crop residues, natural pasture, forests and fallow land. From these feed resources a total of 1010.03 tons of dry matter (DM) were produced from three Kebele's. Crop residue was the major contribution for feed supply in study area (Table 9). The total dry matter yield of the three kebeles was1010.3ton (Table 9.)

Table 11. Total dry matter production (ton) of the three Kebele's.

		Names of Kebele's			
SN.	Feed sources	Gorasilingo (N=40)	Dhenkaka (N=40)	Dosha (N=40)	total
1	Grazing land	13.5	31.3	27	71.8
2	Fallow land	3.34	17.5	17.45	38.29
3	Forest land	3.36	3.86	7.63	14.85
4	Crop residue	231.82	313.25	341.05	886.12
	Total annual Dm (ton)	252.02	365.91	393.13	1010.03

DM requirement for maintenance of one TLU is 6.25 kg/day (2.28 ton/year/TLU); total annual requirement was 1973 ton DM. The three kebeles had 865 TLU (652.3 livestock, 47.5 sheep, 14.5 goat, and 152 equines) (Table 10). Actually total annual feed requirement was 1973 tone DM per year but the available feed is 1010.3t/Dm thus, the annual feed supply on year basis is estimate to satisfy 51.1% of the maintenance requirement of livestock in the study area this implies that there is livestock feed deficit or shortage in the study area.

Table 12 Annual DM requirement (ton) of livestock species in the study area-

SN.	Livestock species	TLU	DM requirement head/ Yea	Total DM
1	Cattle	651.7	2.28	1485.9
2	Sheep	47.2	2.28	107.61
3	Goat	14.5	2.28	33.06
4	Donkey	71.2	2.28	162.23
5	horse	81	2.28	186.68
	Total	865.8	-	1973.48

4.2. Laboratory results

Recording out puts of the laboratory experiments were started from the day of ensilation (0day) by measuring temperature of ensiled mini silo (17^0C) of all treatments and pH of solvent extract of each four treatments of wheat and faba bean straw separately. Periodically based on the proposed sampling time, an aerobically ensiled treatment with the plastic bottles was opened, pH was recorded, samples were oven dried and made ready to be sent for chemical analysis (Appendix Figure 1).

Statically, there was highly significant ($p \leq 0.01$) and a highly ($p \leq 0.001$) interaction effects between types of crop residues, concentration levels of WDGS and sampling period on organic matter ,ash content and crude fiber contents of the silage respectively (Table 4,Table 5, Table 6 and Appendix Table 1). There was a highly ($p \leq 0.001$) interaction effects between WDGS concentration level and sampling period for ash, organic matter and crude fiber contents except for crude protein and dry matter contents . For pH of ensiled solvent extract, there was highly ($p \leq 0.01$) interaction effect between WDGS concentration level and sampling period (Table 2, Table 4, Table 5, Table 6 and Appendix Table 1).

A highly ($p \leq 0.001$) interaction effects between types of crop residues and WDGS concentration levels was recorded only for crude protein and fiber contents (Table 3, Table 6 and Appendix Table 1).No significant difference was observed between types of crop residues and WDGS concentration levels for ash, organic matter content and pH of ensiled solvent extract (Table 2, Table 4, Table 5 and Appendix Table 1). For Crude protein content, dry matter and pH of ensiled solvent extract, there was no significant interaction between types of crop residues, concentration levels of WDGS and sampling period (Table 1, Table 3, Table 5, Table 6 and Appendix Table 1). There were no significant main effect and interaction effects of different concentration levels of WDGS at different sampling period on dry matter content of the ensiled wheat and faba bean residues (Table 1 and Appendix Table 1).

4.2.1. pH of silage solvent extract

There was significant ($p \leq 0.05$) difference between wheat straw (5.798) and faba bean straw (5.633) for pH of silage solvent extract (Table 13, Appendix Table 1). There was a highly significant ($p \leq 0.001$) difference on crude protein, ash, organic matter and crude fiber contents but no significant different for dry matter (Table 13 and Appendix Table 1).

Table 13 Effects of different types of crop residues (wheat straw and faba bean straw) on pH of ensiled solvent extract, crude protein, ash, organic matter, dry matter and crude fiber.

Types of crop residues	Means of parameters					
	Mean CP	Mean Ash	Mean OM	Mean DM	Mean CF	Mean pH
Wheat	12.669^{b}	15.473^{a}	84.528^{b}	94.071^{a}	33.496^{b}	5.798^{a}
Faba bean	20.384^{a}	11.098^{b}	88.902^{a}	95.489^{a}	36.699^{a}	5.633^{b}
CV	11.42	2.53	3.6	6.99	12.49	11.42
Std. Error	0.5342	0.4123	0.4123	1.4577	0.4880	0.0725
LSD	1.079	0.834	0.834	2.945	0.988	0.017

Means followed by the same letter in the same are not significantly different at 5% significance level

The interaction effect of sampling periods and WDGS concentration levels was highly significant ($p \leq 0.01$) for pH silage solvent extract (Table 14 and Appendix Table 1). The highest pH value (6.61) was recorded by the solvent extract from WDGS free (0%) min silo opened on the first day.

The lowest pH value (4.65) was obtained from ensiled solvent extract with 20% WDGS concentration level opened on 42nd day (Table 15).

Table 14. Interaction effects of sampling period (days) and concentration levels of WDGS (%) on pH of ensiled solvent extract of wheat straw and faba bean straw lonely.

Sampling Period (days)	Concentration level of WDGS (%)			
	0	10	20	40
0	6.61[a]	6.1475[abc]	5.7125[abcd]	5.3925[cde]
7	6.0725[abc]	6.165[abc]	5.645[bcd]	5.4875[bcde]
14	6.5825[a]	6.1575[abc]	6.21[abc]	5.525[bcde]
21	5.8825[abcd]	5.3725[cdef]	5.415[cde]	5.355[cdef]
42	6.35[ab]	5.1[def]	4.65[f]	4.75[ef]
SEM	±0.1422	±0.2296	±0.2546	±0.1414
CV	6.12			
LSD	0.917			

Means followed by the same letter are not significantly different at 5% significance level

4.2.2. Crude Protein content

There was a highly significant (P ≤0.001) interaction between Wheat straw (12.669) and Faba bean straw (20.384) for crude protein content of the silage (Table 13, Appendix Table 1). A highly significant (p≤0.001) difference between types of crop residues (wheat straw and faba bean straw alone) and concentration levels of WDGS was recorded for crude protein contents of the silage (Table 15 and Appendix Table 1).

The silage made from faba bean straw treated with 20% of WDGS contained the optimum crude protein (25.228). The lowest crude protein (6.789 and 11.094) were recorded in both silage prepared from wheat and faba bean straw free of WDGS. Statistically, there was an increase in crude protein content of silage ensiled from wheat straw (6.789 to 14.518) treated with WDGS of 0-10%. There was an increase in crude protein content of silage ensiled from faba bean straw

(11.094 to 25.228) treated with WDGS from 0-20% and decreases (25.228 to 22.66) when treated with WDGS of (10-20%) (Table 15).

Table 15 Effects of different concentration levels of WDGs on crude protein contents of wheat and Faba bean residues.

Concentration. Levels of WDGS (%)	Types of Crop Residues	
	Wheat	Faba bean
0	6.789[e]	11.094[d]
10	14.518[c]	22.556[b]
20	13.865[c]	25.228[a]
40	15.503[c]	22.66[b]
SEM	±1.9886	±3.1579
CV	15.05	
LSD	2.2146	

Means followed by the same letter are not significantly different at 5% significance level

4.2.3. Ash Content

There was a highly significant ($p \leq 0.001$) difference between wheat straw (15.473) and faba bean straw (11.098) for pH of silage solvent extract (Table 13, Appendix Table 1). No significant interaction effects were observed between the types of crop residues and concentration levels of WDGS for ash content of the silage (Appendix Table 1). Highly significant ($p \leq 0.01$) interaction effects were recorded between types of crop residues, sampling periods and concentration levels of WDGS for ash content (Table 16 and Appendix Table 1).

The optimum ash (23.71 and 22.91) containing silage were ensiled from wheat straw treated with 40% of WDGS incubated for 14 days and 10% of WDGS ensiled for 7 days respectively. The lowest ash content (8.425) of wheat straw silage was recorded with 20% WDGS ensiled for 21 days. The silage prepared from faba bean straw treated with 10% WDGS for 21 days contained the highest (15.79) ash. From those faba bean straw treated, the lowest ash content (8.13 and 8.356) was recorded with that of WDGS free silage opened on the first and 21st days respectively (Table 16). The mean organic matter content of the silage prepared from wheat straw ensiled for 14 days were significantly increasing (14.585,16.27,17.17 1nd 23.71) with the increase concentration of WDGS(0,10,20 and 40%) respectively (Table 16).

4.2.4. Organic Matter Content

Statistically, there was a highly significant ($p \leq 0.001$) difference between wheat straw (84.528) and faba bean straw (88.902) for pH value (Table 13, Appendix Table 1). There was no significant difference between types of crop residues and concentration levels of WDGS used to make silage for organic matter (Appendix Table 1). There was highly ($p \leq 0.01$) significant interaction effects between types of crop residues, concentration levels of WDGS and sampling period for organic matter content of the silage (Table 5 and Appendix Table 1). The highest organic matter content (95.575%) of the silage prepared from wheat was found with 20% concentration of WDGS ensiled for 21 days. The least organic matter content (76.29%) of silage of wheat was recorded with 40% concentration of WDGS for 14 days.

The highest organic matter of faba bean straw silage (91.87% ,91.65% , 90.79% and 90.63%) were recorded with WDGS free opened on first day, WDGS free ensiled for 21 days , 20% of WDGS ensiled for 42 days and 10% of WDGS opened on first day respectively. Silage prepared from faba bean straw treated with 10% WDGS ensiled for 21 days contained the lowest organic matter (84.21). The highest organic matter content was found in silage ensiled from faba bean straw as compared to silage ensiled from wheat straw. Unlikely, low organic matter content was found in silage prepared from wheat as compared to silage ensiled from faba bean straw (Table 17).

4.2.5. Crude Fiber content

Statistically, there was a highly significant ($p \leq 0.001$) interaction between wheat straw (33.496) and faba bean straw (36.699) for crude fiber content of the silage (Table 13, Appendix Table 1). Sampling period had no significant difference on crude fiber content of the silage. The interaction effect of types of crop residues, concentration levels of WDGS and sampling period was a highly significant ($p \leq 0.001$) for crude fiber contents of the silage (Appendix Table 1).

Silage made from wheat straw treated with 20% concentration of WDGS opened on the first day contained the highest (42.485%) crude fiber. The lowest crude fiber of wheat straw silage (28.595 and 27.23) was found with 10% WDGS treated and opened on first day and treated with 40% of WDGS for 21 days respectively. The highest crude fiber (45.76% and 44.905%) faba bean silage were recorded with 10% WDGS and WDGS free ensiled for 14 days and 7days respectively. Faba bean silage with 40% of WDGS ensiled for 21days produced the lowest crude fiber (29.53%). Crude fiber content of faba bean silage opened on 7^{th} day and 42^{nd} day were decreasing as concentrations of WDGS were increasing (Table 17).

Table 16.Interaction effects of types of crop residues, sampling period and concentration levels of WDGS (%) on Ash contents of silage from wheat straw and faba bean straw lonely.

Sampling Period (Days)	Types of Crop residues (Wheat and Faba bean) and Concentration level of WDGS (%)							
	Wheat Residue				Faba bean Residue			
	0%	10%	20%	40%	0%	10%	20%	40%
0	13.045^{c}	12.87^{c}	16.785^{abc}	15.36^{b}	8.13^{f}	9.37^{ef}	10.745^{c}	11.495^{c}
7	11.385^{c}	22.91^{ab}	15.855^{b}	17.345 ^{abcd}	10.16^{de}	12.53^{c}	10.03^{de}	11.46^{c}
14	14.585^{c}	16.27 ^{abc}	17.17^{abcd}	23.71^{a}	10.54^{de}	10.24^{de}	12.43^{c}	12.63^{c}
21	11.975^{c}	12.985^{c}	8.425^{f}	18.29^{abc}	8.355^{f}	15.79^{bcd}	10.3^{de}	11.62^{c}
42	13.015^{c}	15.25 ^{b}	16.825^{abc}	15.395^{b}	11.345^{c}	11.7^{c}	9.215^{ef}	13.88^{c}
SEM	±0.5466	±1.8338	±1.6611	±1.5309	±0.6284	±1.1118	±0.5333	±0.4683
CV	13.88							
LSD	7.7351							

Means followed by the same letter are not significantly different at 5% significance level

Table 17. Interaction effects of types of crop residues, sampling time and concentration levels of WDGS (%) on Organic matter contents of wheat straw and faba bean straw.

Sampling Period (Day)	Types of crop residues (Wheat and Faba bean) and concentration level of WDGs (%)							
	Wheat				faba bean			
	0%	10%	20%	40%	0%	10%	20%	40%
0	86.955[b]	87.13[b]	83.215[bc]	84.64[bc]	91.87[a]	90.63[ab]	89.255[b]	88.505[b]
7	88.615[b]	77.09[ef]	84.145[bc]	82.655[cd]	89.84[abc]	87.47[b]	89.97[abc]	88.54[b]
14	85.414[b]	83.73[bc]	82.83[cd]	76.29[f]	89.46[abc]	89.76[abc]	87.57[b]	87.37[b]
21	88.025[b]	87.017[b]	91.575[a]	81.71d[def]	91.645[a]	84.21[bc]	89.7[abc]	88.38[b]
42	86.985[b]	84.75[bc]	83.175[bc]	84.605[bc]	88.655[b]	88.3[b]	90.785[ab]	86.12[b]
SEM	±0.5468	±1.8339	±1.6611	±1.5309	±0.6284	±1.1118	±0.5333	±0.4683
CV	2.13							
LSD	7.735							

Means followed by the same letter are not significantly different at 5% significance level

Table 18 Interaction effects of types of crop residues, sampling time and concentration levels of WDGS (%) on Crude fiber contents of wheat straw and faba bean straw.

Sampling Period (Days)	Types of crop residues (Wheat and Faba bean) and Concentration level of WDGS (%)							
	Wheat				Faba bean			
	0%	10%	20%	40%	0%	10%	20%	40%
0	32.555^{d}	28.595^{ij}	42.485^{abc}	33.745^{cd}	39.39^{abc}	36.21^{bc}	30.945^{ef}	34.685^{cd}
7	33.305^{d}	33.97^{cd}	31.825^{d}	31.39^{efj}	44.905^{ab}	40.67^{abc}	38.54^{abcd}	31.295^{ef}
14	36.915^{b}	30.03^{ghij}	32.075^{d}	32.625^{d}	37.77^{abcde}	45.76^{a}	32.98^{d}	30.325^{fg}
21	36.575^{abcdef}	32.84^{d}	38.05^{abcde}	27.23^{j}	38.83^{abcd}	36.4^{b}	40.09 ^{abc}	29.53^{hij}
42	35.985^{bc}	31.240^{ef}	35.29^{cd}	33.195^{d}	42.51^{ab}	36.4^{b}	34.29^{cd}	32.445^{d}
SEM	±0.8929	±0.9599	±1.9948	±1.169	±1.3182	±1.8675	±1.7144	±0.9005
CV	6.22							
LSD	9.156							

Means followed by the same letter are not significantly different at 5% significance level

4.2.6. Physical characteristic of silage

At first days of ensilage, the mini silo were opened and examined for physical characteristics the physical characteristic (Table 19) showed that the aroma of all treatment was sweet and vinegar taste which was a good characteristic of silage . At 21 day of sampling the quality of silage is high which is very pleasant from other .For 42^{th} day of opining all treatment of the silage was less pleasant from other in all treatment of silage.

Table 19 Aroma of silage (wheat and fababean with WDGS)

Sampling Time(Day)	**Concentration level of WDGs (%)**			
	0	10	20	40
0	sweet	sweet	sweet	Sweet
7	very sweet	very sweet	very sweet	very sweet
14	pleasant	pleasant	pleasant	Pleasant
21	very pleasant	very pleasant	very pleasant	very pleasant
42	less pleasant	less pleasant	less pleasant	less pleasant

4.2.7. Temperature of silage

Temperature is constant from day 0 to 21 for all treatment except 40% fababean straw with WDGS which record (20.1°C) which is above ambient temperature A sustained rise in temperature of the silage was observed at day 42 for 20% wheat with WDGS which record (21.7°C),40% (22.4°)C which is above ambient temperature. In 42 day of opening for faba bean straw with WDGS similar measurement was recorded .this implies small microorganism start to develop or it is sign of spoilage (Table 20).

Table 20 Temperature measuring in (^{0}C) during opining time

Temperature measuring time (day)	Types of crop residues and concentration level of WDGs (%)								
	wheat straw with WDGS				Faba bean straw with WDGS(%)				
	0	10	20	40	0	10	20	40	ambient
0	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
7	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6
14	19.5	19.5	19.5	19.5	19.5	19.5	19.5	20.1	19.5
21	20.1	20.2	20.31	20.4	20.1	20.4	20.7	20.9	20.1
42	21.2	21.2	21.7	22.0	21.2	21.2	21.6	22.4	21.2

5. DISCUSION

5.1. Survey part

In the study district, the average total land owned by the households was 1.9hectares ranging from 0.26 to 8 hectare**.** It was higher than the average national landholding size (0.96 ha/hh) and Oromia region (1.15 ha/hh) (CSA, 2011). The overall land holding per household in the current study was higher than the 0.93 value reported by Belete (2009) for Goma district In agreement to the current study, in highland production system of the country, cattle comprised 92% of total TLU (Funte et al., 2010) . The overall average TLU of livestock per household in the study district is 4.7, 0.6, 0.5, 1.2 and 0.8 for cattle, sheep, goat, horse and donkey. Comparable to the current study, the average TLU of cattle (5.35), sheep (0.49), goats (0.03), and donkeys (0.22) in Jeldu district were reported (Bedasa, 2012.)

Land allocations for maize, teff and fababean were comparable with the report of Netsanet (2006) in both Sodo Zuria and Bedegacho district. This output was lower than 8.74 t DM at Adami Tulu Jiddo Kombolcha District which was reported by Dawit *et al*. (2013). The main feed resources to livestock in study area were natural pasture.

The respondents feed crop residues to their animals in different waysin which, 51% of the respondent practiced whole feeding, 0.8% chopped,20.8% treated the feed and 27.5% of the respondents mix crop residues with other feeds. Similar to the current finding, Zewdie (2010) reported that feeding crop residues in whole (55%) and treated straw (10%) was practiced around central Rift valley crop residues and hay which agreed with earlier reports Yeshambel *et al.* (2001) and Mergia *et al*. (2014).

In the study area 65% of the respondents store feed outside in open air whereas 36.7% store under shed. Although, baling the hay is important for efficient utilization of feeds, all the respondents in the study district did not bale the hay and crop residues due to lack of facilities.

In other study, the majority (57.8%) of the responding households indicated to store hay under open air, 29.3% under shelter shade, and 12.9% reported to use some plastic covering on the hay stored outside (Fekede et al., 2013). Almost similar results was obtained by Fekede *et al*. (2013) as hay was stored in loose form by the majority (77.5%) of the respondents in central highlands of Ethiopia.

The most livestock production constraints as reported in the current study was in consistence with the observations of Desta *et al.* (2000) who indicated that the inadequate feed and nutrition, poor health, low productivity of local breeding stock are the main livestock production constraints in Ethiopia

5.2. Laboratory Part

pH of the silage is reduced from 0 day to 42 as inclusion of WDGS increase **.**Garcia and Kalscheur (2006) recorded pH levels below 4 at day 3 when ensiling a blend of chopped maize and wet distillers grains (WDG).The reduced rate of a pH decline in silage blended with WDGS at day 21, as compared to the control, as well as an increased moisture concentration which reduced the activity of lactic acid bacteria (Kung and Stokes, 2005). The pH values for all treatments blended with WDGS continued to decrease until day 42, contrary to the study of Garcia and Kalscheur (2006) who reported no further pH decline after day 3. The low pH for 40% WDGS could have been partly as a result of a high concentration of sulphuric acid present in WDGS (Garcia and Kalscheur, 2006 At 40% WDGS level of inclusion, the final pH values was below the pH range of 3.7 to 4.2 as suggested by Kung and Shaver (2001). Contrary to other reports (Zimmerman, 2002), pH was not affected by high moisture concentration. During preservation, the pH of each treatment decreased from weeks 0 to 4. These results coincide with the study of Jintawanit *et al*. (2006),

WDGS with fababean straw is significantly high crude protein than WDGS with wheat straw because. Wheat straw is generally low in CP, phosphorous, limited in calcium, and high in fiber and lignin (Anderson, 1978).These values were comparable with the findings of Sahin *et al*. (2013), who reported the chemical composition of DDGS (DM basis) and complete ration replacing soya bean meal with DDGS in concentrate. Abdelrahim *et al*. (2014) reported similar results of chemical composition of DDGS average CP (26.5%) of and DDGS replacing corn and soya bean meal in complete rations. Yossifov *et al*. (2012) also had similar results of chemical composition of DDGS and using DDGS average CP of (23.6%) in total rations replacing sunflower meal.

Crude protein content of cereal grain residues is generally low and varies greatly due to cereal grain variety, weather conditions during growth of the plant, as well as harvest time in relation to the plant stage maturity Horton and Steacy (1979) reported CP of untreated wheat straw with means of 6.9%CP for straws. ZorrillaRios *et al*. (1991) reported similar measures for untreated wheat straw of 5.6%Saenger *et al*. (1983).

The present findings were in agreement with speihs *et al.* (2002) who reported the crude protein content was 30.20% in corn DDGS. Whereas, Batal and Dale (2006) reported that crude protein content in distillers by products ranged from 23-30%. Present findings were similar to findings of Chhorn and Mediha (2008), Xue *et al*. (2012), Lodge *et al*. (1997) and Cherenkov et al. (2010).Lulseged and Jamal (1989), 10-13.6% CP for five varieties of untreated faba bean straws reported by Yetimwork (2005), 7.7% CP for faba bean haulm reported by Ermias (2008).

The level of CP contents for control crop residue in this study was below the CP content of 6-11% required to satisfy ruminal microbial demands for nitrogen that would provide sufficient CP for the maintenance requirement of the animal (Van Soest, 1994). The values were contrary with 5.8% CP for faba bean haulms reported by Seyoum *et al*. (2007) but comparable with previously reported by others such as 7.2% CP content of faba bean haulms reported by Lulseged and Jamal (2009),

Changes in ash content may be indicative of two things: first, a loss in ash content can be caused by a loss of minerals in effluent, and second, an increase in ash content can occur if there are OM losses from fermentation and oxidation (McDonald et al., 1991).). Because the ash content increased only slightly over time, there was an indication of active fermentation and limited effluent loss, but these changes were numerically small .Ash content increased with days of ensiling. Kalscheur (2004.).
The ash content of faba bean straw in the current study was higher than the reported value of 7.60% for faba bean straw (Abreu and Bruno-Soares, 1998), faba bean and field pea straws (Wondatir et

al., 2011), field pea straws (Solomon *et al*., 2008a).However, the ash value in the current study was lower than the value of faba bean straw reported by (Solomon *et al*., 2008; Asar *et al*., 2010) and oats varieties (Fekede, 2004.The present findings were higher than Belyea *et al*. (2004) who reported 4.6% total ash content in Corn DDGS. Whereas, Batal and Dale (2006) reported that ash in distillers grains ranged from 3.9-5%.

Organic Matter content of rice straw were 82.1(S.Ahmed, M. J. Khan, M. Shahjalal and K. M. S. Islam,2002) Through prolonged storage periods, the contents of DM and OM in the mixture declined in contrast with the increase in CP content, which agreed with the findings of Adeyemi *et al*. (2007). The decline of OM may have been due to the generation of moisture and loss of fermentation substrates, such as NFC.

The chemical composition results of cereal and legume straw obtained in this study are in agreement with those presented in Sultan *et al* (2011) and Lopez et al (2005) whose studies found higher levels of CP and OM in legumes than in cereal crop residues. The results for the OM obtained in this study match those reported in Sultan et al (2011) and Lopez *et al* (2005) studies The crop residue OM value presented in Savadogo et al (2000) is higher than that obtained in the current study Generally, chemical composition values reported for cereal and legume crop residues (Theander *et al*., 1984; Sultan *et al*., 2011) are consistent and within the ranges of those obtained in this study

Crude fiber components of cereal grain residue fiber composition and percentage varies greatly dependent upon the cereal grain variety, residue type, and stage of plant growth. As cereal grains mature to seed-setting, the bulk of the plant's nutrients shift from roots, stem, and leaves to the grain (Anderson, 1978). As such, at the time of harvest of cereal grains the stem of the plant that is to be utilized as roughage in livestock diets has low CP, high fiber, and poor DM digestibility. Plant cell wall is composed primarily of cellulose, hemicellulose, and lignin with proportion of lignin increasing as the plant matures (Van Soest, 1991).

Crude fiber content of urea treated straw (A was 33.78 %;(S. Ahmed, M. J. Khan, M. Shahjalal and K. M. S. Islam, 2002) the increase in DDGS levels they were comparable with control. Pande *et al*. (1999) observed no significant difference in CF content in bullocks on feeding complete rations with 40, 50 and 60% level of wheat straw.

The present findings were contrary with Speihs et al. (2002) who reported crude fiber content was 18.8% in corn DDGS. Whereas, Chhorn and Mediha (2008) reported that crude fiber content was 9% in corn DDGS and 17.9% in wheat DDGS. Results of present investigation were similar to the findings of Cozannet et al. (2010), Xue *et al*. (2012) and Senne *et al*. (1996(TOT7) Crude fiber value (19.64%) is lower than 22.38% and 22.07% reported by Olorunnisomo *et al*. (2006) and Ezieshi et al. (2011) respectively.

The result obtained in this study lower than the values (38.49%, 17.84%, 47.31 and 55.37%) reported by Sani (2014). However the values of CF from this study are higher than the values (14.75-38.02%), reported by Lamidi (200)

6. CONCLUSION AND RECOMMENDATION

A study was conducted in Xiyo district the main objectives of the study were to characterize the livestock production system, to assess the feed resource base and their management practices and to quantify the major livestock feed resources in the study area. The annual feed supply on year basis is estimate to satisfy 51.1% of the maintenance requirement of livestock in the study area.. Trials were conducted to evaluate the effects of ensiling wheat straw with WDGS and fababean straw with WDGS and alone on its preservation and nutritive value. In the study, WDGS was blended with fababean straw and wheat straw at 0% (control), 10%, 20%, and 40%, and ensiled for 42 days in bottle silos in a factorial design.. The silage made from faba bean straw treated with 20% of WDGS contained the optimum crude protein (25.2) this result is highest crude protein record in silage. Generally as WDGS level increase the crude protein and organic matter record is increase. As the day of ensiling increase the pH value reduce, the low silage pH of WDGS blended silage suggested that preservation could be enhanced by combining WDGS and straw.

Based on the above conclusions the following recommendations are forwarded

- Development of strategies in improving the quality and quantity of livestock feed should be done to enhance feed supply in the study areas..
- Since the production, productivity, storage and utilization efficiency of the available feed was low, further research and development works should be designed utilization efficiency of feeds.
- In order to increase nutritional quality of low quality feed ensiling with other type of agro industrial by product is recommended increasing the productivity of animal
- It had better to conduct further experiment with varied .type of crop reside with different inclusion level to obtain optimum value of protein, crude fiber, organic matter and pH value.

7. REFERENCE

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8. APPENDIX

Appendix Table 1. Computed mean squares of parameters (chemical analysis)

		Mean Squares					
Sources	**D.F.**	**CP**	**Ash**	**OM**	**DM**	**CF**	**pH**
TCR	1	1190.66***	382.681***	382.681***	40.271ns	205.088***	0.543*
CL	3	514.82***	54.966***	54.966***	44.579ns	132.940***	4.011***
ST	4	9.27ns	18.853**	18.853**	39.285ns	2.379ns	2.448***
TCRxCL	3	42.25***	6.243ns	6.243ns	40.941ns	84.901***	0.157ns
TCRxST	4	3.44ns	16.018**	16.018**	32.211ns	15.496*	0.182ns
STxCL	12	8.84ns	12.816***	12.816***	54.430ns	23.021***	0.357**
TCRxSTxCL	12	4.87ns	11.891**	11.891**	44.224ns	24.480***	0.115ns
Error	39	5.710	3.399	3.399	42.498	4.763	0.105
CV %		**14.460**	**13.880**	**2.130**	**6.880**	**6.220**	**5.670**

TCR: Types of Crop Residue CL: Concentration Level ST: Sampling Time CP: Crude Protein

OM: Organic matter DM: Dry Matter CF: Crude Fiber pH: power of Hydrogen

Means followed by the same letter are not significantly different at 5% significance level

(*=p≤0.05,=p≤0.01,***=p≤0.001).**

Appendix Table 2. Questioner for the survey part

1. General information

1.1. Date: ----------------------

1.2. Region: -------------------

1.3. Zone and District: ----------------------------------

1.4. Kebele's name--------------------------------

1.5. House holders' name-------------------------------

1.6. Sex -----------------

1.7 What is your main farming activity presently? Circle one of it.

(A) Livestock production (B) Crop production (C) both (D) Others specify---------------------------
----

1.8. Land use system or land holding in the household

Land use	Area(ha/ximad)
Grazing and browsing	
Fallow land	
Forest and wood land	
Bush and shrubs	
Aftermath grazing	
Other specify	

1.9. Land utilized for food crops of household

Types of food crops	Area(ha/ximad)
Wheat	
Teff	
Barley	
Faba bean	
Field pea	
Maize	
other specify	

1.9. Grain yield from major crops in the household

Types of crops	Quintal
Barley	
Wheat	
Teff	
Maize	
Other crops	

2.0. Livestock population in household

Name of livestock	Number of livestock
Cattle	
Sheep	
Goat	
Mules	
Horse	
Donkey	
Chicken	

2.1. Factor limiting livestock production in the house hold ranking

(1=highest,2=Medium,3=low,4=very low)

No	Factors	Rank
1	Shortage of feed	
2	Water scarcity	
3	Drought	
4	Marketing problem	
5	Lack of credit	
6	Disease problem	
7	Other(specify)	

2.2. Feed resources and feeding system of household

Types of feed resources	Wet period	Dry period
Natural pasture		
Crop residue		
Browse species		
Hay		
Agro industrial by Products		
Stubble grazing		
others		

2.3. Are agro industrial by products available in the area? 1.Yes--------- 2.no-----------

2.4. If yes list agro industrial by product in the area?

2.5 Why is this animal given priority?

2.6. Do farmer cultivated forage crops in the area? Yes--------------- no----------

2.6. Do farmer use communal grazing in the area? Yes------- no------------------------

2.7. Do farmer practice grazing after harvesting of crops? On which crop they practice?

2.8. What are major crop residues in the household? Rank according to feeding preference.

1-----very important 2----------important 3-----------less important 4----------not important

Maize Stover	Wheat straw	Barley straw	Teff straw	Sorghum Stover

2.9. How do you store crop residues?

1 stacked outside 2.Stacked under shade 3.Baled outside 4.Others (specify)

3.0. Which animal groups are given priority of feeding crop residue?

A) Cattle B) Sheep C) Goat D) equine

3.1. Is there supplemental feeds in the area? When do you start feeding crop residues for your animals? (A) Soon after collection (B) One month after (C) Two months later (D) Over two months (E) Other (specify) ------------------------------

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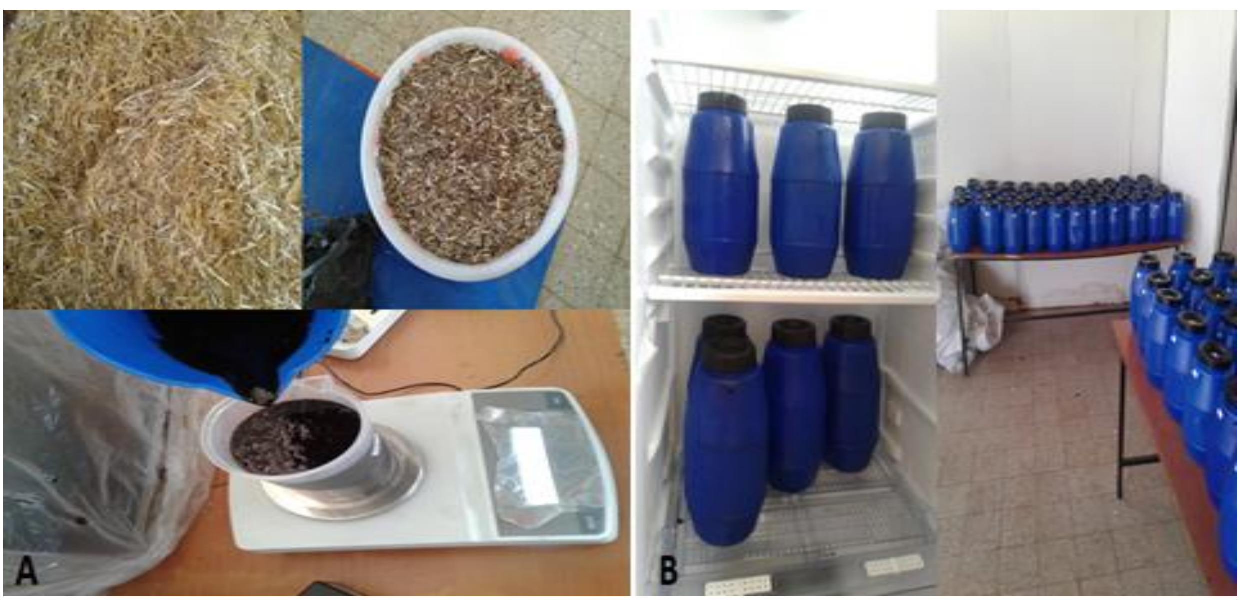
Appendix Figures

Appendix Figure 1. Interview made with different house holders of the three kebeles of Tiyo district



Appendix Figure 2. Materials for Min silo preparation and Procedures during Mini silo preparation incubation time. A) Wheat and Faba bean straw (10mm-20mm size) (Top) and Wet Distiller Grain /WDGS (Bottom) B) WDGS in Plastic bottles Preserved in Refrigerator(left) and Laid out bottled min silo at different sampling incubation periods(Right)

Appendix Figure 3. Mixing and Packing of the silage. A) Mixing of the crop residue with WDGS (Left) B) Packing of the well mixed silage in to the plastic bottle tightly

Appendix Figure 4. Some of the materials and steps during chemical analysis at National Veterinary Institute (NVI) Laboratory A) Oven dry machine (Left), Grinder machine(Middle) and grinded sample for analysis(Right) B) Grinded sampling weighing on sensitive balance for further chemical analysis(Left).