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Estimation of Feeds and Fodders for Livestock Population of Ethiopia and Mitigation of Feed Shortage

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Abstract
The aim of this paper was to review estimation of feeds and fodders for livestock population of Ethiopia and mitigation of feed shortage. Shortage of feed is one of the major constraints that limit cattle production in Ethiopia. Major feed resources for cattle in the country are natural pasture, crop residue, and crop aftermath and non-conventional feed resources. This available animal feed satisfies only 63% of demand at a national level. Strategies like a use of fodder tree, integration of forage production into crop farming system, sustainable conservation of hay and crop residues during a surplus season, proper storage, processing and proper utilization of available feed resources are an option to mitigate feed shortage.
Keywords: feed resource, feed estimation, mitigation strategies

INTRODUCTION

Livestock are key assets in rural Ethiopia providing multiple economic, social, and risk management functions. Currently, livestock production accounts for about 12-16% of the GDP and about 16% of foreign earnings of Ethiopia (Bewket *et al*., 2015). Livestock is the primary source of livelihood to pastoralists living in the vast dry sub-humid, semi-arid and arid areas of the country (Bewket *et al*., 2015). In Ethiopia, livestock production is an important source of income and means of livelihood for farmers (Dereje *et al.*, 2014) and generates >85% of the farm cash income (Yeshitila *et al.,* 2008). Livestock are kept for production of replacement stock, source of food, draught power, transport, income generation, soil compaction for planting small cereal crops and manure production for soil fertility management (Dereje *et al.,* 2014). Nevertheless, poor nutrition is the major limiting factor (Yeshitila *et al.,* 2008) with the consequences of weight loss, lower milk yield, mortality and absence of heat (Zewdie, 2010).

Feed is the most important input in livestock production and its adequate supply throughout the year is an essential prerequisite for any substantial and sustained expansion in livestock production (Samuel *et al*., 2008). Livestock feed resources in Ethiopia are classified as natural pasture, crop residue, improved pasture and forage, agro-industrial by products, other by-products like food and vegetable refusal, of which the first two contribute the largest feed type (Alemayehu, 2003). Feeds are either unavailable in sufficient quantities due to fluctuating weather conditions or are available but of such poor quality that they do not provide adequate nutrition (Gebremedhin, 2003).

The availability of feed resources and the nutritional quality of the available feeds are the most important factors that determine the productivity of livestock. One of the major problems to low production in the country is associated with shortage of livestock feeds both in quantity and quality, especially during the dry season (Zewdie, 2010). The role of natural pasture is diminishing from time to time due to shrinking grazing land size and the use of native hay is limited in coverage (Yayneshet, 2010). Even during years of good rainy season, forage is not sufficient to feed livestock in the highlands for reasons associated with restricted grazing land and poor management (Melese *et al.,* 2014).

Assessment of the quantity and quality of available feed resources in relation to livestock requirement has not been yet well addressed in most livestock production areas of the country (Zewdie, 2010). In highlands of Ethiopia, the annual DM production could satisfy only two-third of the total DM requirements of the livestock (Funte *et al.*, 2010), due to this at dry season animals lose their weight which is an indicator of feed shortage. Most of the research in different parts of the country only indicated the shortage of feeds without quantifying the amount of dry matter obtained in each feed type and whether this is adequate to the total number of livestock available to that particular area (Yeshitila, 2008). Thus, to obtain improvement in animal production and productivity, an assessment should be done on the types and sources of livestock feed resources, total DM production of the area and livestock feed requirement (Endale, 2015). Therefore, the objectives of this paper was to review the estimate of existing animal feed resources and to set livestock feed resources shortage mitigation strategies in the country.

Feed Resource and Availability

Sufficient and quality feed resources availability are some of the major determinants of livestock productivity (Eba *et al.,* 2013). Seasonality in feed availability and lack of knowledge on feed conservation has created feed shortage both in the highland and lowland ecologies of Ethiopia (Tesfaye *et al.*, 2010**).** Furthermore, the population pressure and expansion of crop land calls for alternative ways of feed production, conservation and

utilization. However, the seasonally surplus total dry matter biomass could be effectively utilized to support market-oriented ruminant production (Tesfaye *et al.*, 2010). Feed supply was erratic and seasonal. There was severe shortage during the dry season from January to the beginning of the small rain (ESAP, 2009).

Natural grazing and browsing on plots of permanent grazing land and stubble following crop harvest make the main sources of animal feed in Ethiopia. Conserved natural hay and different crop residues such as *teff*, barley and wheat straws, too, are important feeding strategies and feed components of ruminants in the highland areas. The use of cultivated improved fodder crops for animal feed is not widely practiced because of an ever-expanding demand for farming land, even at the expense of permanent pasture land (AACCSA, 2006).

Feed resources availability depends on the intensity of crop production and amount and distribution of the rain fall (Mohammed and Abate, 1995). As data gathered by the CSA (2012) on animal feed practices used by small holders in the rural sedentary areas of the country indicates, green fodder (grazing) is the major type of feed (about 57.5 percent), followed by crops residue (29.6 percent). Hay and by-products were also used as animal feed, comprising about 7.1 and 0.9 percent of total feed, respectively. A very small amount of improved (0.22 percent) and other types of feed (4.7 percent) were used. Farming systems and altitude are important variables affecting vegetation distribution (Ayana, 1999; Amsalu, 2000). Botanical composition of plant species and productivity of the pasture land are highly influenced by animal species, intensity of grazing and edaphic factors. Biomass production over time varies and therefore, causes seasonal variation in forage availability (Holechek *et al*., 1998).

Natural pasture

Natural pasture comprises the largest feed resource and estimates of its contribution to overall feed resource vary greatly. In the highlands and semi-highlands, natural pastures account for 80% of animal feed. This is because the availability and quality of native pastures for livestock use vary with altitude, rainfall, soil type, and cropping intensity. Seasonal fluctuations of feed resources in the tropics also follow the pattern of vegetation growth which is modified by availability of rainfall (Tesfaye *et al.*, 2010). Pasture growth is a reflection of the annual rainfall distribution pattern (Seyoum *et al.*, 2001). The total area of grazing and browsing is 67.7 million hectares, of which about 19% is found in the highlands, and the remaining around the pastoral areas (AACCSA, 2006). However, quality and productivity of natural pastures is very poor to meet the nutrient requirement of animals (Malede and Takele, 2014) particularly in the dry season, due to poor management and their inherent low productivity and poor quality.

Natural grazing is the major source of livestock feed and in the lowlands livestock production is almost totally dependent on it. In the highlands with the rapid increase of human population and high demand for food, pastures are steadily being converted to farmlands (Malede and Takele, 2014). According to Dereje *et al.* (2014), grazing of natural pasture constitutes the main source of animal feed throughout the year with maximum availability during crop growing season (June to December).

Crop residue

Crop residue is one of main feed in animal production in Ethiopia, especially those area which practice livestock and crop production. Apart from being a source of animal feed, residues are also used as fuel, sold as an income source and are also used for house construction, particularly for plastering of walls and thatching of roofs. Some farmers also use crop residues for mulching purposes to enhance fertility of the soil (Dereje *et al.,* 2014). In the mixed cereal livestock farming systems of the Ethiopian highlands, crop residues (wheat, teff, millet, maize and sorghum) provide on average about 50% of the total feed source for ruminant livestock. The contributions of crop residues reach up to 80% during the dry seasons of the year (Adugna, 2007). Yeshitila (2008) confirmed that more than 65% of the feed resources are obtained from crop residues. Cereal crop residues are fed to livestock during the dry season when the quantity and quality of available fodder from natural pasture declines drastically (Getachew, 2002). Crop residues are abundantly available at the beginning of the dry season following the harvest and threshing of cereal and pulse crops. The low protein-content (3.1-6.7%) and poor digestibility (40.7-54.1%) of these stuffs make them feeds of low nutritional value (Malede and Takele, 2014; AACCSA, 2006).

Crop residues which constitute another major feed resource are produced in large amounts on farm, but only a small fraction of the amount available is used strategically. A large quantity of cereal straws is left on the field for in situ grazing, instead of being harvested, treated and stored for long term feeding. When left on the field, the residues rapidly deteriorate, and a large amount is usually trampled upon and wasted. In addition, the nutrient imbalance which characterizes these fibrous residues is not corrected by appropriate supplementation (Olanrewaju, 1993).

Agro-industrial by-products

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 (Andualem, 2016**)**. Agro-industrial by-products cover flourmill by-products such as wheat bran and middling, oilseed cakes (Niger seed cake, linseeds, sesame seeds and rapeseeds), brewers' grain and sugarcane byproducts like molasses and bagasse. However, the contribution of these by-products is proportionally low, due to their escalating prices (AACCSA, 2006) and low accessibility (Felekech *et al.,* 2013). Thus, the use of agro-industrial by-product is restricted to the emerging private dairy and fattening farms (Yayneshet, 2010). Even though, there are limited accessibility of agro-industrial by-products farmers supply agro-industrial by-products to their animals during the dry season to mitigate feed shortage (Beyene *et al.*, 2011).

Non-conventional feed

Non-conventional feed resources generally refer to all those feeds that have not been traditionally used for feeding livestock and are not commercially used in the production of livestock feeds (Amata, 2014). Non-conventional feeds such as vegetable refusals, sugar cane leaves, Enset leaves and fish offal used as animal feed (Endale, 2015). As reported by Beyene *et al.* (2011), non-conventional feeds like left over of Enjera and Porridge were supplemented to livestock in Benishangul-Gumuz region. On other area non-conventional feeds type like kitchen waste and coffee residues used as animal feed in Jimma Zone, South-Western Ethiopia (Zemene *et al.*, 2016). However, the categories of non-conventional feed vary according to the feeding habit of the community (Endale, 2015). House wastes and local alcohol by-products known as '*areke*', '*tela*' and '*atela*' were commonly used in central rift valley of Ethiopia (Felekech *et al.,* 2013). Likewise, Endale (2015) was reported that farmers were utilizing non-conventional feeds such as vegetable refusals and local alcohol waste for their animal. Non-conventional feeds like abish (Trigonela foenum gracium), tobacco, and mineral soils were used for feeding animals in south west Shewa zone (ESAP, 2009). However, non-conventional feeds are not available at large and their contribution to livestock feed as a cooping strategy was small (Zewdie, 2010).

Status of Grazing Land

Grazing lands that have been serving as a source of natural pasture for livestock in the highlands of Ethiopia are continuously shrinking due to high population pressure, land degradation and conversion of grazing lands into arable lands (Shimelis and Temesgen, 2016). With the rapid increase of human and livestock populations coupled with an increasing demand for food; grazing lands are steadily shrinking. This is particularly evident in the mixed farming highlands and mid-altitudes. The evidence shows that pasture lands in the country are diminishing by about one percent a year (AACCSA, 2006). This is due to grazing lands are converted into croplands and expensive market price of concentrate feeds (Zewdie, 2010).

Grazing feed sources are mostly communal with strong seasonality in supply due to rainfall patterns and overgrazing. This type of feed exceeds 80 percent of total feed supply in the pastoral regions (i.e. Afar, Somali, Benishangul Gumuz and Gambella), where gazing lands are predominantly owned by the community. In recent years, grazing as a source of livestock feed has declined in these areas as a result of increasing commercial cultivation and changing patterns of land use (i.e. lack of land fallow for regeneration) (FAO, 2015).

The conditions and trends of grazing lands are becoming key challenges in feeding the increased numbers of livestock population. The highlands face slow plant growth due to low temperatures. The high stocking density and intensity of cultivation is out of proportion to the carrying capacity. In the lowlands, the short growing season suits only fast maturing plants. Limited rainfall and recurrent drought, shrub invasion and overgrazing are major issues within the lowland grasslands. Overgrazing and seasonal feed shortages are recurring problems within the country (FAO, 2015). Likewise, Kassahun *et al.* (2015) reported that the quality of grazing land is deteriorating due to disappearance of better quality and palatable species of grasses, expansion of invasive plants such as *Raphanus raphanistrum* and *Partinium hysterophorus,* and overgrazing and depletion of soil.

Seasonality of Feed Availability

Under nutrition of tropical ruminants is a major area of study (Yeshitila, 2008). The study indicated that the livestock feed availability, access, quality and quantity different in different seasons of the year. In some seasons of the year, there were excess feed availability and there were also some seasons in which livestock face dearth feed shortage (Jimma *et al*., 2016). Animals are undernourished because of fluctuating supply of nutrients, insufficient intake of available feeds or from inherent deficiencies in the available feeds (Yeshitila, 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 which is an indicator of feed shortage (Endale, 2015; Funte *et al*., 2010)

The amount of forage was reported to fluctuate seasonally and mainly dictated by rainfall patterns. According to Yeshitila (2008) availability of feeds depends on the season of the year when lands are covered with either *Meher* or *Belg* season crops. The duration extending from planting of major *Belg* and *Meher* crops

until their harvest makes major challenge to the availability of livestock feeds. Belay *et al.* (2012) confirmed that feed shortage occurs in wet season due to water logging of the grazing pasture lands and intensive cropping.

The quantity of feed is inadequate in the dry season for the existing livestock, while there is surplus in the wet season (Getachew, 2002). Natural pastures support animal productivity in the rainy season, while in the dry season these pastures can hardly maintain the animals as most of the feed resources are less available and of poor nutritional quality. This could be due to the poor practices of feed conservation and flash burning of the feed resources during the dry season (Tesfaye *et al.*, 2010). In the wet season natural pasture is the sole sources of livestock feed, while in the dry season, natural pasture, crop residues, stubble grazing and grass hay are the major feed resources. Next to natural pastures, crop residues are other main sources of livestock feed during the dry season (Tesfaye *et al.*, 2010). According to Dereje *et al.* (2014), there is plenty of natural pasture during the wet season, while farmers do not have a tradition of conserving and keeping the excess forage for the dry season, when there is a relative shortage of feed. Crop residues are abundantly available at the beginning of the dry season following the harvest and threshing of cereal and pulse crops in.

Estimation of Annual Feed Availability

The major reason for low levels of animal production in numerous African countries is the inadequate supply and low level of feeding due to serious shortage of feedstuffs (Amata, 2014).

The national annual feed demand for all livestock species is estimated at 95.8 million ton DM, whereas the available amount from various feed sources amounts only to 65.6 million ton DM, leaving a demand gap of about 32% (AACCSA, 2006). The sub-sector is not only constrained by a supply problem but is also affected by the poor quality of the available animal feed. For instance, natural pasture has less than 6% protein and about 10 MJ/kg DM, with a digestibility of around 61.5%, furnishing only 75% of the nutrient requirement for maintenance and production of animals (MoARD, 2006). According to the MOARD (2008), an estimated 64 million tons of annual animal feed, including forage and dry matter, are required annually to sustain the livestock population in Ethiopia. However, the same source estimates that only about 37 million tones are currently available, meaning that the system satisfies 58% of the requirement. This gap signifies the extent of the feed challenge for the sector, which may result in even higher feed prices (FAO, 2015).

Mergia *et al.* (2014) reported that the total feed DM was 326.6 tons per year while the total dry matter requirement of livestock was 467.2 tons which cover only about 69.9% of the total dry matter requirement of animals. Likewise, Zemene *et al.* (2016) reported that estimated available feed resource was 12.82 ton DM whereas the livestock maintenance requirement was 15.39 ton DM resulting in a negative balance. This feed resources were able to support about 83.3% of the livestock requirement. This feed deficit is exacerbated by the fact that estimated yields include a very high percentage of poor quality feed in terms of digestible nutrients (ESAP, 2009).

Endale (2015) was also reported a total of 180,778.04 tons of crop residues from different crop types. Tadesse and Solomon (2014) were found 100,706.17 tons of DM per year from natural pasture and 579068.54 and 172925.59 tons of DM from crop residues and aftermath, respectively. The available feed/forage source addresses only 72% of the annual DM requirement. Therefore, report from different parts of the country indicates that there is feed shortage which is more pronounced at dry parts of the season. Nutrient supply from forages and crop residues, the main feed resources usually therefore fall below requirements of livestock for acceptable performance. The consequence is a negative feed balance sheet both of the farm and country level, even when all feed resources are taken into account (Olanrewaju, 1993).

Productivity of Native Pasture

In the lowland areas, native pasture yields one ton of dry matter per ha or less. And, in intermediate and high altitude areas, the yields of freely drained soil are 3 tons of dry matter per ha, and in seasonally waterlogged fertile areas, 4-6 tons of dry matter per ha (Alemayehu, 1987).

Pasture productivity in the high and mid-altitude areas ranges between 1.5 and 2 ton/ha a year, whereas the corresponding figure for the rangelands is less than a ton. Similarly, ESAP (2009) reported that annual average primary production of 2t DM/ha for the whole grazing areas containing poorly managed and overgrazed unimproved pastures from Adaa Liben district. In the Ethiopian highlands, natural pasture can produce 6 tons DM/ha but when continuously grazed it yields only 2.5 tons DM/ha (Jutzi *et al*., 1987). As frequent grass out take leads to a reduction in DM yield up to 50 percent, yield from heavily grazed pasture may not exceed 1.5 tons DM/ha (Jutzi *et al*., 1987).

Mitigation of Feed Shortage

The major reason for low levels of animal production in numerous African countries is the inadequate supply and low level of feeding due to serious shortage of feedstuffs (Amata, 2014). Integration of forage production into crop farming system, sustainable conservation, proper storage, processing and proper utilization of available

feed resources is option for mitigating feed shortage in Ethiopia (Kassahun *et al.,* 2015; Mulugeta *et al.* 2015; Endale, 2015; Belay *et al.,* 2012). In addition to these, curbing the free and uncontrolled grazing system, and cut and carry systems could contribute to the alleviation of the feed shortage problem, especially in the highlands of the country (Berhanu *et al.,* 2009). Therefore, gearing research efforts toward the development and promotion of forage species suitable for under-sowing, inter-cropping and relay-cropping will help address the land shortage for feed production (AACCSA, 2006).

Forage production is often in excess of immediate requirements of livestock during the rains. This excess forage should be harvested and preserved to expand the feed base, and ensure a year round supply of good quality fodder (Olanrewaju, 1993). With the exception of haymaking, feed conservation is not widely practiced in Ethiopia. If and when properly preserved, surplus feed during the rainy season, in the case of a pastureland, and following crop harvest, in crop residues, could make for the shortfalls during lean periods (AACCSA, 2006).

Fodder trees and shrubs are important animal feeds in Ethiopia especially in arid, semi-arid, and mountain zones, where large number of the country's livestock is found (Alemayehu, 2004). Most browse species have the advantage of maintaining their greenness and nutritive value throughout the dry season when grasses dry up and deteriorate in quality and quantity (Andualem, 2016). Multipurpose legume trees can provide high-quality feed and improve soil fertility (Lenné and Thomas, 2006). Fodder tree/shrub legumes have the potential for alleviating some of the feed shortages and nutritional deficiencies experienced in the dry season on smallholder farms (Olanrewaju, 1993).

CONCLUSION

Livestock production is highly integrated with the life of farmers in Ethiopia. However, feed shortage gets the main place to boost productivity of livestock in Ethiopia. Animal feeds include natural pasture, fodder crops, fodder trees, crop residues and non-conventional feeds are used as animal feed in different parts of the country. Animal feed is surplus at wet season and scarce at dry season results in wastage of animals due to unsustainable production throughout the year. Natural pasture is main animal feed at wet season while crop residue is at dry season of the year. Feed resource extinction was critical in dry seasons (January-May) in most areas when all grazing and crop residues were completely finished. At this time grazing lands are decreasing in size because of expansion of crop production due to increased human population. Productivity of these grazing land is also reduced due to overgrazing and deterioration. As obtained from different sources, the available animal feed satisfy only 63% of demand at national level. Data from different parts of the country also indicates that available feed satisfy about 78.2% of demand. This indicates that there is great deficit of animal feed supply and demand which need attention to develop possible solution. However, there is options to fill the gap between availability and demand. Strategies like use of fodder tree, integration of forage production into crop farming system, sustainable conservation of hay and crop residues during surplus season, proper storage, processing and proper utilization of available feed resources are option to mitigate feed shortage which is mostly pronounced at dry season.

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