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Review Article

Review on Forage Soybean Utilization and Status in Ethiopia

Hilena Yifred*

Animal Production, Ethiopia Institute of Agricultural Research, Jimma Agricultural Research Center, Jimma, Ethiopia

Abstract

Soybean is a vital crop that is known to support the livelihoods of millions of people in West and Central Africa. Soybean is one of the forage legumes it can be planted for high-protein feed, such as grazing, haying, or ensiling. It grazed or harvested from the flowering stage to near maturity for use as high-quality hay. Soybean has great future potential as a high protein and nutritious forage. This review is focusing on the forage production and adoption in Ethiopia. This work includes a critical review of several published journals, publications, and studies related to animal feeding. The development of Ethiopia's livestock sub-sector is hampered by several restrictions, one of which being a lack of feed and poor feeding practices. In Ethiopia, feed scarcity, particularly during the dry season, is the most significant barrier to optimal output. The introduction of legume forages in farming systems could be one solution to tackle these constraints. Soybean is a forage legume and a candidate fodder that can aid in nutrient reduction in agricultural leftovers and natural pastures. A soybean plant has a nutritional value comparable to early-bloom alfalfa, which is high in protein and easily digestible by lactating dairy cows. Animal evaluation feed trial should be implemented to know the effect of the feeding value of forage soybean [*Glycine max* (L) *Merrill*].

Keywords

Animal Feed, Forage, Soybean

1. Introduction

Livestock in Ethiopia accounts for 15 to 17 percent of the national GDP, 34 to 47.7 percent of agricultural GDP, and 37 to 87 percent of household income [16]. It also accounts for 15% of export revenues and 30% of agricultural employment [26]. On the other hand, the development of Ethiopia's livestock sub-sector is hampered by several restrictions, one of which being a lack of feed and poor feeding practices [19, 17]. Green fodders from natural pasture (grazing) and crop residues with low nutritional value are the main ruminant animal feed resources in Ethiopia [6]. The main drawback of grazing as a feed source for ruminant cattle is its poor dry matter output. In Ethiopia, feed shortage especially during the dry season is the most important constraint to optimal productivity [8, 9, 14].

There are factors contributing to the DM supply imbalance including the rapid deterioration of natural grazing land associated with increased agricultural cultivation. Those are overgrazing, recurring droughts, seasonal variations in rainfall, inadequate grazing land management, soil nutrients, conversion of grazing grounds to croplands, and lack of for-

*Corresponding author: hilenayifred@gmail.com (Hilena Yifred)

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age species diversity [1, 7, 21]. Leading to low dry matter yield, crude protein (< 5%), and metabolizable energy which results in a critical shortage of animal feed, below the maintenance requirement of livestock [32]. During the dry season, natural pastures typically dry out and are overgrazed, resulting in poor protein and calorie content in the fodder. As a result, huge flocks of productive livestock cannot be maintained on such poor- quality feeds to meet the animals' basic maintenance needs [32].

Developing feeding packages to support current traditional production as well as new private producers and exporters is a timely intervention to boost production and productivity to fulfill the market demand for meat and live animal exports. The improvement of forage quantity and quality through forage legume inclusion is crucial for improved animal performance [29], and a very small amount of improved feed (0.32%) was used as animal feed in Ethiopia [21].

The introduction of legume forages in farming systems could be one solution to tackle these constraints. Legumes are non-animal good source of valuable proteins, micronutrients, and vitamins in human and animal nutrition for many years. Nutrient, nitrogen, and biological nitrogen fixation are very crucial for legumes' growth. Besides, sulphur deficiency is very sensitive to nodulation and nitrogen fixation [10]. Because of their good influence on enhancing metabolizable energy intake, N intake, and feed efficiency, legume forage crops have been examined as prospective supplements for ruminants [33].

Soybean is one of the forage legumes as well as one of the candidate forages that can aid in nutrient reduction in agricultural leftovers and natural pastures. Soybean is a vital crop that is known to support the livelihoods of millions of people in West and Central Africa. Rural families benefit from its production in the form of food, animal feed, and cash income. Soybeans have been used as healthy hay and silage crop. Before World War II, the principal use of soybeans was as forage [34]. Moreover, soybean has great future potential as a high protein and nutritious forage in the form of pasture, hay or silage that can be used alternatively with alfalfa, possessing equivalent forage quality [34].

It can be planted for high-protein feed, such as grazing, haying, and ensiling. Adapted forage soybean varieties should provide high- quality pasture similar to Alfalfa [31]. Soybean plants grazed or harvested from the flowering stage to near maturity for use as high-quality hay. Given the current relative pricing, using soybeans for forage, rather than grain, is also economically feasible given the current relative values [34]. However, soybean forage is not highly adopted by farmers. Generally, comprehensive review presented aiming on forage soybean to improve animal feeds and can help readers to increase their knowledge regarding soybean as feed.

2. Methodology

This document was created after completing a critical review of various published journals, books, conferences, and reports. The researcher conducted a rigorous review, concentrating on the use of soybeans in animal feed. Both qualitative and empirical findings were thoroughly analyzed to improve the information on the nutritional characteristics of soybean for livestock feed. Various literatures were reviewed and useful information was recorded accordingly until the work was done.

3. Literature Review

3.1. Origins and Domestication of Soybean

After being cultivated in China in 2500 BC, soybean (*Glycine max* (L) *Merrill)* expanded throughout Southeast Asia and was brought to the United States in 1765, where it was mostly produced as a fodder crop until the 1920s and 1930s. The use of soybean for feed in the northern United States was defended in the early 1900s due to forage shortages of other crops and a reduced grain production due to frost damage [27]. In sub-Saharan Africa, soybean [*Glycine max* (L) *Merrill*] is a non-native and non-staple crop that has the potential to be commercialized due to its several uses as a human food source, an animal feed source, and an industrial raw material. Chinese traders initially brought soybean to sub-Saharan Africa in the 19th century, and it was grown there as a commercial commodity as early as 1903 [20].

Soy production in Africa only began in the second half of the 20th century. Similarly, Ethiopia is thought to have received soy in the 1950s [15]. About twenty soybean genotypes were published as a direct introduction to the farming system based on the research activities. ''According to the study by [2], the Pawe Agricultural Research Center in particular, Jimma, and other collaborative centers were conducting research on soybeans across all disciplines, including variety development research (breeding and genetics research), agronomy research, crop protection research (pest and disease control), soil fertility regulation research, food, and nutritional quality laboratory research, and socioeconomic research''. A significant part of the development of soybean technology is played by soybean varietal development through traditional breeding techniques, which include the introduction of new germplasm, selection, crossing, and hybridization, followed by advancing generation. In order to promote genetic diversity in line with acceptable, stable, and innovative varietal development, crossing and hybridization of soybeans were started in Ethiopia in 2011–12, mainly at Jimma and Pawe [12].

Since the introduction of soybean breeding in Ethiopia in the 1950s, there has been notable progress made in raising yields and creating varieties that are compatible with the vast agroecology of the nation. In order to create superior soy-

bean varieties and increase the genetic diversity of the crop in the nation, the Jimma Agricultural Research Center's soybean-breeding program is currently engaged in a joint research and genetic resource exchange project [2].

3.2. Soybean Growth and Development

Soybeans can either have a determinate or an indeterminate growth habit. Indeterminate soybean varieties continue to produce nodes on the main stem until the beginning of seed fill (growth stage R5), which occurs when at least one 1/8-inch long seed is present in a pod at one of the four uppermost nodes, while determinate soybean varieties stop vegetative growth and produce nodes on the main stem shortly after flowering begins. The plant's vegetative parts provide about half of the nutrients needed for seed filling, and the roots' nutrient intake and N fixation processes provide about the other half. Peak nitrogen fixation at this point, stress can lower the number of pods, the number of seeds per pod, the size of the seeds, and the potential yield. At this point, plants have reached their maximum height, node count, and leaf area [25].

But until the start of seed fill, determined types will continue to produce nodes on branches. Although the nodes on the main stem of determinate types only flower for around three weeks, the overall flowering duration when branches are included is comparable to that of indeterminate variety at the same maturity [25]. Depending on the maturity and planting date, the overall flowering period could last anywhere between 3 and 6 weeks. Temperature and day length affect soybean development, as do soil moisture levels, plant nutrition, and other factors. The maturity group (MG) and variety selected will have a significant impact on how many days there are between growth phases. Therefore, according on the variety, climate, and planting dates, soybean development stages will vary [24].

According to [2], soybean (Glycine max L. Merr), a crop that was only introduced to Ethiopia in about 1953, has a great potential for productivity and nutritional value there. In 2001/2002, research was done to assess the effects of various planting dates on the growth, dry biomass, and grain yields of several soybean cultivars [28]. Beginning in the 1950s, the crop underwent plant introduction as part of breeding work. The introductions were assessed in order to choose appropriate varieties that might adapt to Ethiopia's various environmental circumstances and, concurrently, to identify possible regions for soybean production in the nation [18].

3.3. Soybean Compared with Other Forages

As a fodder crop, soybeans will perform better than other broadleaf forage legumes like field pea or vetch [13]. In addition, soybeans may have a similar feeding value to ensiled alfalfa, which presents producers with a significant opportunity. According to studies and the work of [13, 4], soybeans grown for pasture will yield the most at a rate of roughly 900,000 seeds per hectare, but with a more restricted spacing of 20 cm or less. To produce high-quality hay, soybean plants can be grazed or harvested from the blossoming stage to just before maturity. In terms of protein and fiber composition, soybean forage gathered when the leaves start to turn yellow but before they start to fall is equivalent to alfalfa hay harvested during the early bloom stage. A useful legume fodder is soybean. Fodder soybean is best suited for summer cropping since it tolerates drought and grows well when other fodder legumes like alfalfa are scarce. According to [23], forage soybean can be sown either by itself or in conjunction with other forage crops like sorghum.

As with other forage legumes, soybean forage has a variety of advantageous qualities for use as fodder. To make hay, soybean leaves and stems can be grazed, ensiled, and dried. In addition to having a high nutritional content and good digestion, the leaves are particularly tasty to cattle [10]. Till 1934, soybean was produced in the USA for use as animal feed. However, following this time, it was cultivated more for the development of oilseed and protein crops than pasture crops. But anytime the financial benefits of soybean grain decline, such as after a drought or frost [27, 30], interest in soybean fodder increases. Forage-grade soybeans can be used to make excellent feed. According to [11], the nutritional value of a soybean plant can be compared to early-bloom alfalfa, which is high in protein and easily digested by lactating dairy cows.

3.4. Yield and Nutritional Quality of Forage Soybean

When nutrients are applied in higher amounts than necessary for optimal yield response, the nutrients are typically consumed in excess. For instance, adding more nitrogen, phosphorous, and sulfur to the soil may result in a higher concentration of nutrients in the plants. Heavy applications of nitrogen and phosphorus did not typically have an impact on legume forages [20]. According to [5] changes in forage genotype, maturity, season, management, and anti-quality components were to blame for the variable in forage quality.

Animal nutritionists employ the relative values of CP, CF, NDF, ADF, RFV, and TDN to identify high-quality feed. The quality and amount of soybean fodder were influenced by row spacing, sowing rate, and harvest timing. Row spacing and planting rate had no significant impact on soybean pasture's crude protein, degradable protein, or invitro dry matter digestibility. However, as maturity increased, they drastically diminished [3].

Table 1. Nutritional content of different soybean genotypes.

Traits	Mean of 9 soybean genotypes
DM	90.4
Ash	10.3
CP	15.7
NDF	45.4
Lignin	7.8
Invitro	71.7

Source: [31]

4. Conclusions

Feed with good nutrient composition is the major component in livestock production. Soybean meal is the best source of animal protein and contains amino acid compositions in the needs of animal diets. Soybean seeds and its by-products are the best and preferred ingredient in the feed processing industries due to its high-quality protein and good nutrient composition in the requirements of animal diets. Forage soybean [*Glycine max* (L) *Merrill*] is a non-native and non-staple crop that has the potential to be commercialized due to its several uses as a human food source, an animal feed source, and an industrial raw material. Fodder soybean is best suited for summer cropping since it tolerates drought and grows well when other fodder legumes like alfalfa are scarce. As with other forage legumes, soybean forage has a variety of advantageous qualities for use as fodder. To make hay, soybean leaves and stems can be grazed, ensiled, and dried. In addition to having a high nutritional content and good digestion, the leaves are particularly tasty to cattle. Animal evaluation feed trial should be implemented to know the effect of the feeding value of forage soybean *[Glycine max (L) Merrill]*.

Abbreviations

USA	United States of America
DM	Dry Matter
NDF	Neutral Detergent Fever
CP	Crude Protein
TDN	Total Digestible Nutrient
ADF	Acid Detergent Fever
CF	Crude Fever
RFV	Relative Feed Value
MG	Maturity Group

Author Contributions

Hilena Yifred is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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