

## Review Article

# Effect of Seed Rate on Forage Yield, and Nutritional Value of Sudan Grass and Vetch Mixtures in Ethiopia: A Review

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## Abstract

The livestock feed resources in Ethiopia are classified as natural pasture, crop residues, improved pasture and forage, agro-industrial by-products, and also hay production of which the first two feed resources are the major feed contributors for the livestock production in Ethiopia but they are lacking in protein and minerals. Natural pastures contribute about 80-85 of animal feed in Ethiopia, including naturally occurring grasses, legumes, shrubs, herbs, and tree foliages. Crop residue is one of the feed resources used for animal production in Ethiopia and is available in those areas in which livestock and crop production are practiced. Around 30 million tonnes of DM of agricultural crop residues are produced annually on the national scale, of which 70% are used as animal feed. The major agro-industrial by products commonly used in Ethiopia are obtained from different agro-industries. The nutritional values of agro-industrial by products are excellent but their productivity is small, limited, and limited to few farms in urban and peri-urban areas and they contribute much less to livestock feed. Furthermore, traditional livestock feed supply mainly depends upon natural pasture and crop residues, which have low crude protein and other chemical composition. However, there is tremendous potential to alleviate feed shortages using improved forage production. To fulfill this gap, producing a stable improved forage in the livestock sector is mandatory. For that reason, the legume and grass intercropping system are important to increase biomass production and forage yield. Hence, Sudan grass (*Aden gode*) known with its plant height than other cultivars and vetch (*Vicia dasycarpa*) have greater plant height and creeping growth habit that enable compatible to larger grass species and they are selectable forages to enhance the forage yield and quality under similar times.

## Keywords

Grass-Vetch, Mixture, Forage Yield and Quality

## 1. Introduction

Ethiopia has the largest livestock population in Africa with an estimation of 70 million cattle, 42.9 million sheep, 52.5 million goats, 13.33 million equines, 8.1 million camels, and 57 million poultries [8]. Livestock production has been con-

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tributing a substantial portion to the economy of the country [8]. In addition to this, the livestock sector has been contributing a significant role to the Ethiopian economy by providing food, cash income, promoting saving, social functions, and employment. Therefore, livestock sectors contribute about 16.5% of the national GDP and 47% of the agricultural GDP [13]. Animal production is the main component of agriculture that can support the livelihoods and security of large numbers of people in a developing country [23].

Among potential forage grasses that required knowledge is Sudan grass. Sudan grass has been gaining increasing importance in animal feed, due to its ease of cultivation, rapid establishment, and growth [12] and also stated that Sudan grass could be used for grazing, and silage due to its high production (5.56-9.1t/ha DM) potential especially in drought. Trials at numerous places have demonstrated that Sudan grass promises high value for hay with a 12.98% CP [15]. Similarly, stated that Sudan grass had the highest crude protein content sown with Cow pea (11.73%) compared to its sole (8.16%) [3].

Among the annual forage legumes, vetches are well adapted and more promising as short-term fodder crops in Ethiopia [9]. Forage legumes including vetches are a rich source of nitrogen for livestock with cheaper prices compared to concentrates, especially in developing countries [18]. Knowing information on plant height, days to maturity, growth habit, and other growth characteristics of the forage legumes are important to integrate with other forages [11]. Therefore, *Vicia dasycarpa*, and *Vicia atropurpurea* have creeping growth habits, tall plant height, and intermediate to late maturity. Despite the large livestock number and the importance of animal production in our country, their productivity is low due to various problems such as poor management practices, inappropriate infrastructure, feed shortages both in quality and quantity, and health constraints [2]. Among these problems, the shortage of feed was identified as one of the primary constraints for livestock production.

## 2. Major Feed Resources in Ethiopia

Feed resources in Ethiopia are classified in to free grazing pasture, crop residues, improved feed, hay, industrial by-product, and other feed resources [8]. Similarly [16] and Sefa [22] reported the most endowed feed resources used for animal production in our country Ethiopia are free grazing pasture, preserved hay, produced forage, crop residue, Agro-industrial by-products, aftermath feed, and weeds from cultivated land. From these feed resources, communal grazing pasture land is a large amount of feed resource in Ethiopia [16]. According to CSA [8] report 54.59, 31.06, 6.81, 1.53, and 5.11% of natural pasture, crop residue products, hay, agro-industrial by-products, forage productions, and other feed resources account for the nation's overall of livestock feed supply respectively.

### 2.1. Improved Forage Production

Improved forage crop production has diversified advantages. Forages can be divided into three categories: legumes, grasses, and multipurpose browses (fodder trees). Improved forages, especially legumes, are required to increase the nutritional content of crop residues even in the presence of abundant crop residues, which are frequently fed to ruminants. The main aim of improved forage production in Ethiopia is to increase feed availability and enhance the intake and digestibility of the low nutritional value hay and the crop residues through fresh green forage supplementation [10].

### 2.2. Improved Forage Production in Ethiopia and Its Challenges and Opportunities

Despite the introduction of new forages, Ethiopia has poor management and utilization of forage resources [24]. Hence, the contribution of improved forage to the total feed resource is still low (0.32%) because of factors such as type of livestock production system, lack and un adoptable forage technologies, poor extension services, and others [7]. To enhance or improve forage production, these criteria such as selection of forage species, forage development strategies, preparation and servicing of extension practice, and formulation of forage seed production system are the main consideration [10].

### 2.3. Advantage of Supplementation of Fresh Forage to the Livestock

Green forages have a cooling effect on the Animals, are also more palatable, and have easily digestive nutrients. According to [14] description, green forage tends to contain more minerals than matured or dry forage. The leaves contain 20–30 times as much vitamin E as the stems for the maintenance of cellular membranes, immunity, and reproductive function.

Green herbage is also an exceptionally rich source of  $\beta$ -carotene, a precursor of vitamin “A” and used for vision, normal growth and development, spermatogenesis, and maintenance of skeletal tissue and epithelial tissue. Green feeds also provide vitamin K to animals for the synthesis of proteins. Green feed is also used to reduce methane emissions to the environment [20]. The enteric methane emission was reduced by 5-12% by feeding green fodder-based rations to river buffaloes [14].

## 3. Over View of Intercropping Forage Production System

Intercropping is the way of producing or cultivating two or more forages together on a specific piece of land during the same cultivation period [12]. Production of two or more forages together has the effect to increase forage biomass production.

One of the most affordable and efficient agronomic techniques to increase forage biomass output, nutritional quality, and financial returns is grass-legumes intercropping [17]. In highland, moderate altitude, and lowland areas, intercropping of annual leguminous species with grass provides the predominant quantity and quality of forage yield strategies [3].

### 3.1. Advantages of Grasses and Legumes Mixture System

Forages of legume and grass intercropping are climate-smart options that has potential for enhancing herbage production simultaneously. Previous studies have reported that legume intercropping can enhance biomass and yield over corresponding monoculture [25]. According to the author [21] the way to overcome the feed shortage problems sustainably is through establishment of grass-legume intercropping. Grass-legume intercropping also has the advantage to improved forage yield, reduced weed invasion, and improved forage nutritive value and animal production. The improvement in nutritive value is due to a slower decline in digestibility with advancing maturity and higher levels of protein in legumes [24]. When compared to grass monocultures legumes can improve palatability, digestibility, nutritional value, and often herbage yield by increasing the nutritive content of the low-quality grass cultivated inside them [25].

### 3.2. Land Equivalent Ratio

The land equivalent ratio measures the proportion of a single forage relative area needed to produce the yield obtained through intercropping [22]. Land equivalent ratio is also the relative area of land under monocrop which is needed to obtain the yield produced in intercropping [6]. Grass and legume intercropping has been acknowledged as a productive method that maximizes fodder production per unit area and unit time while also using better resources [12]. Grass and legume intercropping was the obvious intercropping method

and the most productive, stable, and advantageous in respect to the land equivalent ratio under irrigated conditions.

### 3.3. Effects of Seed Rate Intercropping on Growth Development of Sudan Grass

Plant height is affected by the seed rate [19]. The plant height of Sudan grass (*Sorghum sudanense*) is higher in intercropping than its sole cropping due to the seed rate probably create suitable growth condition in the intercropping. In addition, the seed rate proportion of sown forages has its effects on plant height [19]. It is possibly due to light competition between forages grown together or component crops in the intercropping [4]. Hence, the differences in plant height are due to intercropping seed rate of both grass and legume components, Sudan grass planted combined with legumes gave the tallest plants.

Leaf number is one of the advantageous morphological parameters of Sudan grass that contribute to the total dry matter yield. It is known that fresh matter and then dry matter yields are formed by photosynthesis in leaves, so it is important to determine the effect of technological measures such as seed rate on leaf development and leaf surface formation in the plant. In the experiment, Sudan grass seed rate affected the leaf developments [16]. Therefore, values recorded for the number of leaves per plant for forage *sorghum-sudanense* are generally between 14 and 17 [19].

The number of shoots per plant is an important yield contributing character that may affect the forage yield of Sudan grass (*Sorghum sudanense*). The intercropped Sudan grasses (*Sorghum sudanense*) gave better tillers number per plant [20]. Hence, the seed rate increased the number of tillers per plant decreased. Higher seed rate had a negative relationship with the tiller number per plant and hence, the tiller's number per plant increased with low rates of seeds [19]. Although, with seed rate intercropping of Sudan grass and legumes affected tiller number. Significant differences had observed between solid crops and their intercropped [20].

### 3.4. Effects of Seed Rate in Intercropping on Nutritional Value and Yield of Sudan Grass Forages

**Table 1.** Nutritive value of Sudan grass hybrids in alone and mixture forages.

	DM%	CP%	NDF%	ADF%	Source
Sudan grass (Jumbo) alone	-	10.0	64.9	42.6	[17]
Sudan grass alone	-	8.8	65	40	[10]
Sorghum hybride intercrop		8.40	-	-	[4]
Sudan grass alone	-	9.03	66.04	48.32	[14]
Sudan grass alone	-	15-18	57.2	33.9	[12]
Sorghum hybrid alone	26.83	8.64	55.18	36.52	[20]
Sorghum hybride intercrop		9.21	-6.37	-	[22]

	DM%	CP%	NDF%	ADF%	Source
Sudan grass alone	-	14.66	38.63	33.12	[21]
Sudan grass intercrop	-	15.47	38.94	33.25	[14]
Sudan grass alone	23.9	12.6	72.4	43.4	[25]
Sudan grass alone	-	12.42	59.24	33.18	[24]

DM% = Dry matter percent, CP% = Crude protein percent, NDF% = Neutral detergent fiber percent, ADF% = Acid detergent fiber percent

## 4. Over View of Vetch Species Adaptation and Used for Forage Production

Vetch species are predominately found in Ethiopia's central highlands and midland areas [9]. Predominantly vetch species are known by their adaptability, versatility (either in green manure or as a pasture), they are used for ruminant feed [15]. Vetches (*Vicia spp.*) are the most common annual leguminous forage used for animal feed [20]. More research has classified vetch species based on growth behaviors, growth variations, climatic adaption, and other factors.

### Adaptability Measurements of Vetch Species

Forage legumes must be integrated with grass in mixed stands or in intercropping, so information on plant height and other growth traits of the forage legumes is crucial things. Plant height and growth habits should be taken into account during integration because they affect compatibility in intercropping. *Vicia dasycarpa* has greatest plant height than other *Vicia* species followed by *Vicia villosa*, and *Vicia atropurpurea* in Holetta [11]. [1] reported that plant height adaptability of vetch species at harvesting stage, *Vicia villosa* (144cm) has highest plant height and *Vicia dasycarpa* (125cm), *Vicia atropurpurea* (132cm), and *Vicia benghalensis* (114cm) are different from *Vicia sativa* (65.3cm) in North Gondar. Number of branching/tillering performance of vetch species is an important agronomic trait for selection of crops to better forage yield. Environmental, genetic variability and managemental practices have a significant impact on the branching performance of vetch species [5]. As reported by [11] vetch species DM yields were ranged from 1.39 to 5.84 and 1.99 to 7.62 t/ha at Holetta and Ginchi respectively and *Vicia villosa* gave relatively higher total DM yield followed by *Vicia dasycarpa* in Holetta. Whereas, [1] reported that highest herbage yield was obtained from *Vicia villosa* (32.0t/ha) while the lowest herbage yields from *Vicia sativa* (9.6t/ha).

## 5. Conclusion

Improved forage development practices in our country were more related to the objective to increase improved for-

age production. As pointed out by different mechanisms of forage development strategies like backyard forage development, under sowing of cereal crops with forage legumes, forage development on stock exclusion area, forage development on conservation structures, and over sowing on existing grazing/pasture land are practicing in Ethiopia even though, their production potential is very low. Therefore, intercropping is used to boost forage production potentials for livestock production. Intercropping is the production of two or more companion forages in the same field concurrently, and as a result increases the productivity of forage biomass per unit area through efficient use of soil nutrients and water resources. Intercropping has its advantages in the productivity of forage, solving the land shortage, yield stability, pest control, and nutrient use efficiency. However, grass forage is relatively low nutritive value as compared to legume forages. Legumes are intercropped with grass due to a good source of protein improvement purpose.

## Abbreviations

%	Percent
ADF	Acid Detergent Fiber
CP	Crude Protein
CSA	Central Statistical Agency
DM	Dry Matter
GDP	Gross Domestic Product
NDF	Neutral Detergent Fiber

## Author Contributions

**Habtie Ambaw:** Conceptualization, Data curation, Formal Analysis, Methodology, Supervision, Writing – original draft work, Visualization & Editing

**Mequant Tadlo:** Conceptualization, Methodology, Supervision, Writing – review & editing

**Berie Kumie:** Conceptualization, Data curation, Formal Analysis, Methodology, Supervision

## Conflicts of Interest

The authors declare no conflicts of interest.



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