Brachiaria hybrid cv Mulato II and Greenleaf desmodium (*Desmodium intortum*) production and utilization practices by livestock farmers in Ethiopia

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Abstract

The study was conducted to assess Brachiaria hybrid cv Mulato II and *Desmodium intortum* production and utilization practices in selected areas of Eastern Amhara Regional State, Ethiopia. The survey was conducted in 2022-2023. For this study, two districts namely, Kalu and Dawa Chefa with a total of 180 respondents, 90 respondents from each district, were purposively selected. Data collected through questionnaire were described by descriptive statistics using SPSS version 26. The average land holding per household was 1.5±0.59 ha. Feed shortage was ranked first in both study areas. To alleviate the feed shortage, cultivation of improved forage is crucial. Brachiaria hybrid cv Mulato II and *Desmodium intortum* were produced mainly in association with PPT (91.1 and 85.6%) during main rainy season (100% and 98.9%) in Kalu and Dawa Chefa districts, respectively. The result revealed that the majority of respondents (58.9% and 74.4%) were experienced in the production of Brachiaria and *Desmodium intortum* in Kalu and Dawa Chefa districts, respectively. Most of the farmers (63.3 and 74.4%) used cut and carry system to feed their livestock in Kalu and Dawa Chefa districts, respectively. The major purposes of Brachiaria hybrid cv Mulato II and *Desmodium intortum* were crop pest control and livestock feed in both study areas. But, land scarcity and shortage of planting materials were the major impediments. Lack of awareness was the other reported constraint by the majority of respondents (91.1 and 94.4%) in Kalu and Dawa Chefa districts, respectively. Thus, farmers could be supported through training, workshops and providing planting materials. Further research should be conducted to assess those forage species in a larger scope with respect to their sole production and utilization practices.

Key words: Brachiaria, *Desmodium intortum*, Forage, Push-pull technology, Cut and carry

Introduction

Ethiopia has the largest livestock population in Africa, comprising 70 million cattle, 42.9 million sheep, 52.5 million goats, 10.8 million donkeys, and 8.1 million camels (CSA, 2020). Livestock play a vital role in the people's livelihoods by providing draft power, income, employment, food, and insurance (FAO, 2018). Despite the huge livestock numbers, manifold roles and favorable environmental conditions of the country, their productivity is far below its potential and unable to meet the demands of the rapidly growing human population in the foreseeable future (Shapiro et al., 2015). Amongst other factors, feed shortage both in quality and quantity is the major hindering factor for productivity (Dawit et al., 2013).

Feed intake is an important index of the well-being and performances of animals (Bhat et al 2022). The common livestock feed resources in Ethiopia are natural pasture, crop residues, improved feed, hay, and agro-industrial byproducts (CSA, 2020). Though natural pasture and crop residues are the major feed resources in the country, they are poor in nutritive value and could not support beyond the maintenance requirements of the animals (Shapiro et al., 2017). Moreover, the changes in seasonal patterns of feed resources availability could pose additional challenge for grazing animals (Montcho et al 2024). Animals would fail to prove their full genetic potential of higher production when fed at low level (Patel et al 2016). For animals to perform to their full potential, they require supplemental feeds to meet their nutritional requirements, increase feed intake and provide animals with additional nutrients. In spite of more than five decades of forage research and development efforts carried out in the country, the contribution of improved forages as livestock feed is insignificant (CSA, 2020) and reluctant to change farmers' production and know-how, lack of planting materials and lack of land for fodder cultivation were often cited as the main reasons for such a problem (Workye et al., 2018; Fantahun et al., 2020). Nowadays, both the availability and price of concentrate feed are also becoming more challenging for the majority of the smallholder livestock producers in the country. The ingredient for concentrate feed is a cereal grain; which is a major staple food for the alarmingly increasing human population. This could create high competition and thus, result in higher prices now and in the years to come. The production of cereals (maize and sorghum) in Ethiopia has been also constrained with pests such as striga and stemborers (Murage et al., 2015; Tesfaye et al., 2016). As the solution, Brachiaria grass and desmodium have been used in push pull technology; could be considered as an integrated pest management of cereal production (Tesfaye et al., 2016). This integrated pest management technique using Brachiaria hybrid grasses particularly cv Mulato II and *D. intortum* could be called push-pull technology (PPT). In this PPT, *D. intortum* is a repellent intercrop while Brachiaria hybrid cultivar is an attractive trap plant. As an additional advantage of the PPT, improved forages, both grass and legumes together which represent energy and protein nutrient, respectively could be obtained and considered as a promising approach in getting quality and quantity of forage in the production system (Khan et al., 2011). The PPT could also support the integration of crop -livestock production system to be productive, resilient and sustainable, since the majority of farmers adopt it (Seid et al., 2019).

Most of the PPT studies documented the roles of Brachiaria hybrid grass and *Desmodium intortum* from pests' management point of view for maize and sorghum cereal production (Tesfaye et al., 2016; Seid et al., 2019) with limited information about Brachiaria grass as livestock feed (Wubetie et al., 2018) and *D.intortum*. Hence, there is limited information about how those forages are produced and utilized by farmers in the production system. Supporting farmers through the identification and promotion of forage species enriched with manifold merits such as high nutritive value, wide adaptability to drought and low soil fertility is crucial to tackle feed shortage (Mundia, 2021). Brachiaria hybrid grass and *Desmodium intortum* are among the potential forages that could help to improve livestock productivity. Exploitation of PPT through the improved forages (Brachiaria grass and desmodium) could contribute in reducing the current Ethiopia's livestock feed gap both in dry matter and critical nutrients such as protein and energy (FAO, 2018). The PPT could also benefit the improved forage production in the country which otherwise be limited for sole forage cultivation because of land shortage.

Looking for such information on Brachiaria hybrid cv Mulato II and *D. intortum* is of paramount importance in setting future development strategies, research plans and any intervention options for sustainable livestock production while maintaining the natural environment. Thus, this study was conducted to assess the production and utilization practices of Brachiaria hybrid cv Mulato II and *D. intortum* PPT as livestock feed in selected areas of Eastern Amhara Regional State, Ethiopia.

Materials and Methods

Description of study areas

The survey work on Brachiaria hybrid cv Mulato II and *D. intortum* production and utilization practices were conducted in selected districts of Eastern Amhara Regional State, Ethiopia.

Kalu

Kalu district is located in South Wollo administrative zone, Amhara Regional State, Northeast of Addis Ababa, Ethiopia. Geographically, it is situated at $11^0$31'05''North latitude and $39^0$36'34'' East longitude. Kombolcha, the capital of the district, is located at 380 km from Addis Ababa. The altitude of the district ranges from 1400 to 1850 m.a.s.l. The mean annual minimum and maximum temperatures are 12.5 and 22.5 °C, respectively. It receives a mean annual rainfall of 700–900 mm in a bimodal pattern. The long rainy season (*Kirmet*) occurs from June to August, while the short rainy season (*Belg*) lasts from January to March.

Dawa chefa

Dawa Chefa district is located in the Oromia administrative zone of Amhara Regional State. It is situated at 10° 43' N latitude and 39° 52' E longitude. The altitude of the area ranges from 1500 to 2300 m a.s.l. The district falls within the dry Kolla agroclimatic zone. The rainfall distribution of the area is highly seasonal and has temporal variations. The annual rainfall of the district ranges from 660mm- 1100mm. The mean annual temperature ranges from 19.7 ^{0}C to 24.1 ^{0}C.

Sample size and sampling technique

Each district was purposively selected for the study based on the practice of push-pull technology, animal production potential and accessibility. Three rural kebeles (smallest administrative unit) from each district and 30 farmers from each kebele were purposively selected depending on push pull technology practice (Fig. 2); since Brachiaria and D. intortum production involved in the system. A total of 180 respondents, 30 from each kebele were purposively selected in both study areas.

Data collection techniques

A semi-structured questionnaire (combination of open-ended and close-ended questions) was developed and administered by experienced and trained enumerators. Open-ended questions were allowed respondents to express their thoughts and opinions without restrictions, while close-ended questions present choices from which respondents can select their answers. For focus group discussion, elderly people and kebele leaders were recruited, whereas animal science experts and the head of the district livestock resource promotion agency were selected as key informant interview. In addition, secondary data was obtained from agricultural and rural development offices, published articles, books, and websites. The data collected were socio-economic characteristics, Brachiaria hybrid cv Mulato II and D. intortum production, utilization and management practices, the push-pull technology as improved forage source, and associated challenges. The dependent variables tested were the production and extent of use of Brachiaria and *D. intortum* as livestock feed and the constraints associated with them. The actual household survey was conducted during 2022-2023.

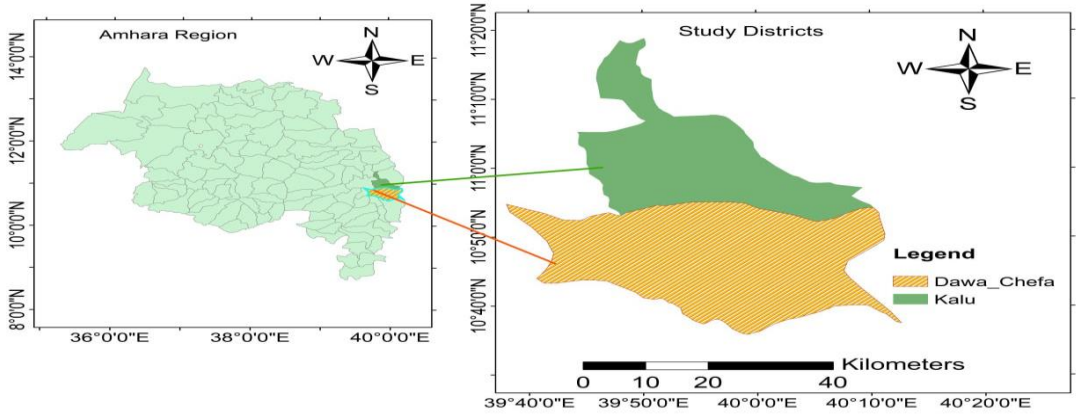

Figure 1. Map of the study areas

Figure 2. Brachiaria and Desmodium forages grown around the border of Maize crop. Source: Pushpull Team at Wollo University

Statistical analysis

Prior to conducting the data analysis, the household questionnaires were organized, sorted, and coded in MS excel sheet. Following coding, the collected data on survey study was analyzed to interpret the result accurately. Descriptive statistics, mean comparisons, and percentage values and tabular presentations were used to analyze survey data employing SPSS v.16 computer software. For the two means comparison, T test was used. However, Welch's test was employed to analyze the quantitative variables which violated the homogeneity test. In addition, index values were used to rank some of the variables under study. Index values were calculated by employing the following formula: Index= sum of ($N*1^{st}$ order+ $(N-1)*2^{nd}$ order+ $(N-2)*3^{rd}$ order+ $(N-n)*n^{th}$ order for individual variables divided by the sum of ($N*1^{st}$ order+ $(N-1)*2^{nd}$ order+ $(N-2)*3^{rd}$ order+ $(N-n)*n^{th}$) for all variables. Where N= number of variables considered for ranking; and n= order. Furthermore, OriginPro computer software was used to plot the graphs for this study.

Results

Socioeconomic characteristics of respondents

Table 1 shows the socioeconomic characteristics of respondents. In both districts, the majority of the respondents were male headed households. Half (50%) of the interviewed farmers in Kalu and 42.2% in Dawa Chefa districts were in the productive age category (41-50). The majority of the household heads, 72.2% in Kalu and 53.3% in Dawa Chefa were illiterate. Only 2.2% and 5.6% of the respondents have completed secondary education in Kalu and Dawa Chefa districts, respectively. Family size varied significantly ($p<0.05$) between the study districts. On average, the family size of households in Kalu and Dawa Chefa districts were 5.93 and 6.49, respectively. Furthermore, mixed farming (92.2% and 97.8%) was predominantly practiced by interviewed farmers in Kalu and Dawa Chefa districts, respectively. The total average land holding per household varied significantly ($p<0.05$) between the two study areas. On average, the land holdings of a household in Kalu and Dawa Chefa districts were 1.3 and 1.7 ha, respectively.

Feed shortage and mitigation strategies of respondents

Feed shortage mitigation strategies of the respondents in study districts are shown in Table 2. In this study, all of the interviewed farmers mentioned that they experienced feed shortage for their livestock in both study areas. The majority of the respondents (78.9% and 94.4%) reported that they faced seasonal feed shortage particularly during the dry season in Kalu and Dawa Chefa districts, respectively.

Purchasing crop residues (47.8% and 63.3%) was the main feed shortage coping mechanism in Kalu and Dawa Chefa districts, respectively. Furthermore, all of the interviewed farmers reported that moving animals somewhere was not practiced in both study areas since they practice mixed farming.

Available improved forages and their utilization practices

The available improved forage types in both study areas are shown in Figure 3. The result showed that all of the respondents owned Brachiaria and D. intortum since they were engaged in PPT and purposively selected. On top of this, other types of improved forages were cultivated in both districts. In decreasing order of their availability, Sesbania (Sesbania sesban), Elephant grass (Pennisetum purpureum), Oat (Avena sativa), Vetch (Vicia dasycarpa),

Tree lucerne (Chamaecytisus palmensis), Lablab (Lablab purpureus), Alfalfa (Medicago sativa), and Cowpea (Vigna unguiculata) were the major improved forages types in Kalu district. On the other hand, Sesbania (Sesbania sesban), Elephant grass (Pennisetum purpureum), Vetch (Vicia dasycarpa), Oat (Avena sativa), Lablab (Lablab purpureus), Cowpea (Vigna unguiculata), Tree Lucerne (Chamaecytisus palmensis), and Alfalfa (Medicago sativa) were the available improved forage types in Dawa Chefa district. This study revealed that Sesbania sesban (84.4 and 75.3%)

Table 1. Socioeconomic characteristics of the respondents

Description	**Kalu**	**Dawa Chefa**	***P* value**
	N (%)	N (%)	
Sex			
Male	82 (91.1)	79 (87.8)	
Female	8 (8.9)	11 (12.2)	
Age			
18-30	7 (7.8)	9 (10.0)	
31-40	16 (17.8)	26 (28.9)	
41-50	45 (50)	38 (42.2)	
51-60	13 (14.4)	10 (11.1)	
60+	9 (10)	7 (7.8)	
Educational level			
Illiterate	65 (72.2)	48 (53.3)	
Grade 1-4	18 (20)	24 (26.7)	
Grade 5-8	5 (5.6)	13 (14.4)	
Grade 9-12	2 (2.2)	5 (5.6)	
Certificate and above	-	-	
Major occupation			
Crop farming only	-	-	
Livestock farming only	4 (4.4)	2 (2.2)	
Mixed farming	83 (92.2)	88 (97.8)	
Mixed farming and trading	3 (3.3)	-	
	Mean±SE	Mean±SE	
Family size			
Total family size	5.93±0.16	6.49±0.14	0.011
Land holding (ha)			
Cultivated land	1.04±0.04	1.4±0.04	0.000
Grazing land	0.11±0.02	0.15±0.02	0.174
Fallow land	0.04±0.01	0.06±0.01	0.150
Cultivated fodder land	0.07±0.01	0.1±0.01	0.179
Total land holding	1.3±0.06	1.7±0.06	0.000

N=number of respondents; SE= standard error

Table 2. Feed shortage and coping mechanism of respondents

Description	**Kalu N (%)**	**Dawa Chefa N(%)**	**Overall N (%)**
Feed shortage			
Yes	90 (100%)	90 (100)	180 (100)
Seasonality of feed shortage			
Dry season (mid November- May)	71 (78.9)	85 (94.4)	156 (86.7)
Wet season (June-October)	3 (3.3)	1 (1.1)	4 (2.2)
Both seasons	16 (17.8)	4 (4.4)	20 (11.1)
Mitigating strategies			
Purchase concentrate feed	3 (3.3)	6 (6.7)	9 (5)
Rent grazing land	6 (6.7)	8 (8.9)	14 (7.8)
Purchase crop residues	43 (47.8)	57 (63.3)	100 (55.6)
Stock reduction	25 (27.8)	14 (15.6)	39 (21.7)
Minimize the amount of daily feed supply	13 (14.4)	5 (5.6)	18 (10)
Moving animals to somewhere	-	-	-

N= number of respondents

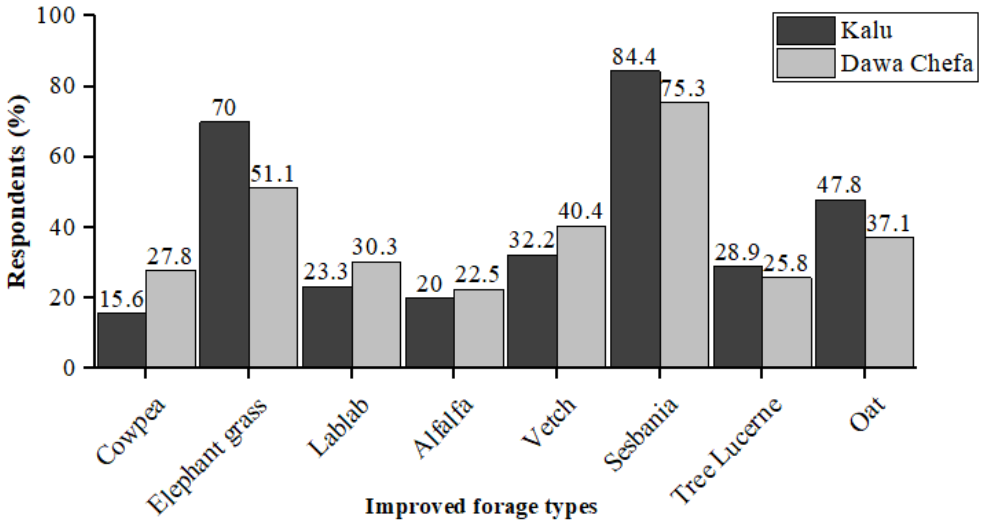

Figure 3. Available improved forage types in the study districts

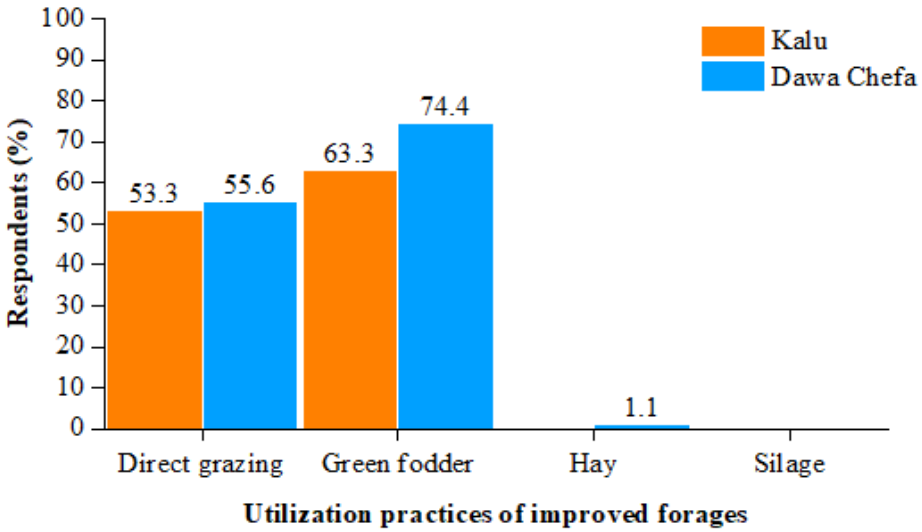

Figure 4. Utilization of improved forages in the study areas

And *Pennisetum purpureum* (70 and 51.1%) forages were cultivated by the majority of respondents in Kalu and Dawa Chefa districts, respectively. Improved forage utilization practices are presented as shown in Figure 4. The majority of respondents (63.3 and 74.4%) used green fodder/cut and carry system to feed their livestock in Kalu and Dawa Chefa districts, respectively.

Challenges of improved forages production

The major constraints that impede improved forages production in the study areas were identified (Table 3). Respondents ranked land shortage (index=0.28), planting material scarcity (index=0.24) and financial problem (index= 0.16) as the 1st, 2nd and 3rd major constraints for improved forage production in both study areas. In addition, poor extension service was another challenge that was ranked (5th) in both study areas.

Brachairia and D. intortum production in the study areas

Production strategies of Brachiaria and *D. intortum* by the respondents are shown in Figure 5. Accordingly, respondents indicated that Brachiaria and *D. intortum* were cultivated in the border of push-pull technology only (PPT) (91.1 and 85.6%), backyard and PPT (7.8 and 11.1%), and soil bunds, roadside and stock exclusion areas and PPT (5.6 and 8.9%) in Kalu and Dawa Chefa districts, respectively.

Table 3. Major challenges of improved forage production

Constraints	Kalu		Dawa Chefa	
	Index	Rank	Index	Rank
Land scarcity	0.28	1	0.28	1
Shortage of planting material	0.24	2	0.24	2
Financial problem	0.16	3	0.16	3
Drought	0.075	6	0.14	4
Free grazing	0.14	4	0.08	6
Poor extension service	0.102	5	0.10	5

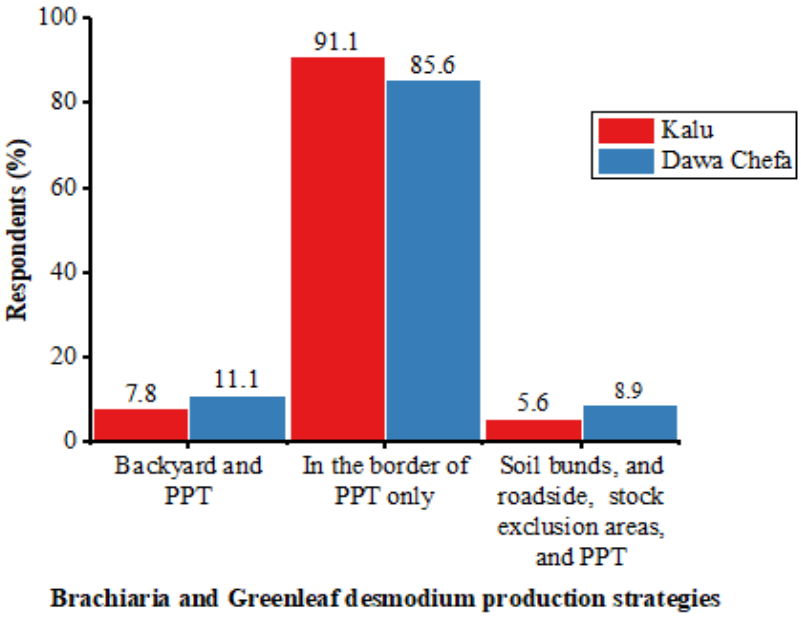

Figure 5. Brachiaria and *D. intortum* production strategies

Experience in Brachiaria and *D. intortum* production, planting materials, sources of planting materials, planting and harvesting seasons are shown in Table 4. The majority of respondents (58.9% and 74.4%) were experienced in the production of Brachiaria and *D. intortum* in Kalu and Dawa Chefa districts, respectively. The percentage of experienced respondents in Kalu (58.9%) was lower than that of Dawa Chefa (74.4%).

The planting materials used for Brachiaria and *D. intortum* were seed (82.2% and 52.2%) followed by both seed and seedlings or tillers (17.8% and 47.8%) in Kalu and Dawa Chefa districts, respectively. The use of seed alone as planting material was higher (82.2% and 52.2%) than both seed and seedlings (17.8% and 47.8%) in Kalu and Dawa Chefa districts, respectively. The use of seedlings (tillers) alone as planting material was not practiced in both study areas. Those planting materials were mainly obtained from government institutions (67.8 and 74.4%) and other NGOs (38.9 and 45.6%) in Kalu and Dawa Chefa districts, respectively. However, the contribution of farmers to farmers as a source of planting material was very minimal (2.2 and 5.6%) in Kalu and Dawa Chefa districts, respectively. In both study areas, the major crops planted along with Brachiaria and *D. intortum* were sorghum and maize. On the other hand, only 4.4 and 9% of respondents participated in the cultivation of Brachiaria and D. intortum in addition to in associations with PPT in Kalu and Dawa Chefa districts, respectively. Moreover, the production of Brachiaria and D. intortum in the study areas was mainly dependent upon rain fall. As a result, all respondents in Kalu district and the majority of the respondents (98.9%) in Dawa Chefa district largely rely on water availability during the main rainy season (June-mid September). Besides, the majority of respondents (95.6% and 91.1%) used to harvest Brachiaria and *D. intortum* during dry season (October- January) in Kalu and Dawa Chefa districts, respectively; but, the practice of harvesting those forages in the short rainy season (February-May) was almost negligible in both study areas.

Table 4. Brachairia and *D. intortum* production

Description	Kalu N (%)	Dawa Chefa (N%)
Farmers experience		
Yes	53 (58.9)	67 (74.4)
No	37 (41.1)	23 (25.6)
Planting materials		
Seed ONLY	74 (82.2)	47 (52.2)
Tiller (seedling) ONLY		-
Seed and seedling	16 (17.8)	43 (47.8)
Sources of planting materials		
Government institutions	61 (67.8)	67 (74.4)
NGOs	35 (38.9)	41 (45.6)
Farmers to farmers	2 (2.2)	5 (5.6)
Crops planted with Brachiaria and *D. intortum*		
Sorghum	65 (72.2)	60 (66.7)
Maize	44 (48.9)	64 (71.9)
Alone	4 (4.4)	8 (9)
Planting season		
Short rainy season (February- May)	-	-
Main rainy season (June-mid September)	90 (100)	89 (98.9)
Dry season (October-January)	-	2 (2.2)
Harvesting season		
Short rainy season (February- May)	-	1 (1.1)
Main rainy season (June-mid September)	4 (4.4)	7 (7.8)
Dry season (October-January)	86 (95.6)	82 (91.1)

Table 5. Farmers' management practices of Brachiaria and D. intortum production

Descriptions	Kalu	Dawa chefa	Overall
	N (%)	N (%)	
Fertilizer application			
Yes	26 (28.9)	39 (43.3)	65 (36.1)
No	64 (71.1)	51 (56.7)	115 (63.9)
Fertilizer applied			
Organic	26 (28.9)	39 (43.3)	65 (36.1)
Inorganic --	-	-	-
Both type	-	-	-
Practice weeding			
Yes	27 (30)	35 (38.9)	62 (34.4)
No	63 (70)	55 (61.1)	118 (65.6)
N= number of respondents			

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Table 6. Purposes and challenges of Brachiaria and *D. intortum* production

Descriptions	Kalu	Dawa Chefa	Overall
	N (%)	N (%)	
Purpose of B. hybrid cv Mulato II and *D. intortum*			
Livestock feed	90 (100)	90 (100)	180 (100)
Pest management	90 (100)	90 (100)	180 (100)
Soil conservation	53 (58.9)	78 (86.7)	131 (72.8)
Cash source	7 (7.8)	13 (14.4)	20 (11.1)
Challenges associated with Brachiaria and *D.intortum*			
Land scarcity	90 (100)	90 (100)	180 (100)
Shortage of seed/planting material	90 (100)	90 (100)	180 (100)
Pricks and stick with cloths	90 (100)	90 (100)	180 (100)
Leaf shuttering problem (*D.intortum*)	88 (97.8)	86 (95.6)	174 (96.7)
Lack of awareness	82 (91.1)	85 (94.4)	167 (92.8)
Difficulty to clear land while needed	87 (96.7)	90 (100)	177 (98.3)

N= number of respondents

Purposes and challenges of Brachiaria and *D. intortum* production

The purposes and challenges of Brachiaria and *D. intortum* production are presented in Table 6. All respondents used Brachiaria and *D. intortum* forages as animal feed and pest management in both study areas. Very few respondents (7.8% and 14.4%) reported that they were used those forages as cash source in Kalu and Dawa Chefa districts, respectively. Despite the contribution of Brachairia and *D. intortum* to the farming system, the production is yet influenced by several factors. As perceived by the respondents, the major challenges were land scarcity, shortage of seed/planting materials, prick and stick with cloths, leaf shuttering, difficulty to clear land while needed and lack of awareness in both study areas

Discussion

The study assessed the overall production and utilization practices of Brachairia and *D. intortum* by smallholder farmers. Obviously, education tends to raise household income through technological advances. The majority of interviewed farmers are illiterate (Kalu: 72.2%; Dawachefa: 53.3%) which could hinder adoption of various agricultural technologies, thus limiting the production of those forages (Table 1).

On top of this, the proportion of land allocated for grazing land, fallow land, and cultivated fodder land was very small (Kalu: 0.04-0.11 ha; Dawachefa: 0.06-0.15 ha) due to land scarcity (Table 1). Less land allocation for forage production could result in the shortage of livestock feed.

Consequently, understanding feed shortage mitigation strategies is compulsory to identify various intervention options. Purchasing roughage (Overall: 55.6%) was one of the options identified as a major feed shortage coping mechanism. But, the use of concentrate as a feed shortage mitigation strategy was the least preferred option (Overall: 5%) (Table 2). They believed that those feed resources were not accessible to many farmers. Besides, none of the interviewed farmers practiced moving their animals from place to place in search of feed and water since they practice mixed farming as their major occupation.

Moreover, the production and contribution of improved forage crops as a feed shortage mitigation strategy in the farming system are very limited elsewhere in the region (Workye et al., 2018; Alemu, 2022). Kefialew et al. (2016) noted improved forage cultivation was not common in Dawa Chefa district. The author contended that limited extension work, lack of information and absence of improved forage seeds in the district were the most important factors. The fact that *Sesbania Sesban* and *Pennisetum Purpureum* cultivated by the majority of the respondents in this finding could be attributed to the suitability of the forages as a fence and backyard forage development strategy (Figure 1). Identifying the utilization practices of improved forages is as crucial as their availability. Cut and carry feeding system was practiced when the feed resources are available in protected (enclosure) areas, soil conservation structures and crop lands (Adisu et al., 2016); Solomon et al., 2019). The practice of conserving feeds as hay and silage was negligible in the two study areas as a result of the lower quantity of forages produced in their farming system. This in turn, could be due to the very small land allocated for forage cultivation.

Among improved forages, Brachairia and *D. intortum* play a significant role in livestock feeding beyond their primary function in crop pest management. As mentioned by the farmers, the main production strategies of Brachiaria and *D. intortum* were predominantly in the border of push pull technology (PPT) (Kalu: 91.1 and Dwachefa: 85.6%) (Fig 5). In both study areas, only fewer farmers (Kalu: 5.6% and Dawa Chefa: 8.9%) have cultivated Brachairia and *D. intortum* in backyard and soil bunds, roadside and stock exclusion areas in addition to PPT due to the unavailability of adequate land.

The planting materials used for Brachiaria and *D. intortum* in both study areas were seed (overall 52.2%) followed by both seed and seedlings or tillers (overall 47.8%) (Table 4). The interviewed farmers perceived that using seedlings or tillers as a planting material was tedious and laborious work and more costly compared to seed as a planting material. Consequently, the use of seedlings (tillers) alone as planting material was not practiced in both study areas.

The production of Brachiaria and *D. intortum* in both study areas was mainly dependent upon rainfall. This might be due to the lack of irrigation practices for the cultivation of crops such as maize and sorghum during the dry season. Beyond this, the majority of farmers harvest Brachairia and *D. intortum* forages during the dry season (October- January) due to the association of those forages with cultivated crops.

The success of Brachiaria grass and *D. intortum* production is dependent on farmers' management activities. As indicated by the majority of farmers (overall 63.9%), the application of fertilizer on Brachairia grass and *D. intortum* was not adequate in both study areas. Only 36.1% (overall) the farmers used to apply organic fertilizer (manure) since the cost of inorganic fertilizer is skyrocketed (Table 5). Moreover, the poor participation of

farmers (overall 34.3%) in weeding of Brachairia and *D. intortum* could be due to the family members spending much of their time on the management of food crops. Farmers also argued that lack of awareness was another hindering factor for management of Brachiaria and *D. intortum* in both study areas. Farmers used Brachairia and *D. intortum* as animal feed besides their prominent use in PPT to manage crop pests. They also used those forage species for soil conservation in both study areas and it was higher in Dawa Chefa (86.7%) compared to Kalu district (58.9%) due to the relatively good experience in the production of forages and the good acceptance of the limited extension services. Further, the very low utilization of Brachiaria grass and *D. intortum* as a cash source by interviewed farmers in the current study could be due to the lower amount of forage produced on their farmlands (Table 6). Though Brachairia grass and *D. intortum* provide farmers with a multitude of advantages, the production of these forages in both study areas has been challenged by several factors. All respondents perceived that lack of land and scarcity of seed/ planting material were the major challenges (Table 6). The lack of seed/ planting material in both study areas is probably due to its high cost which was not easily afforded by the resource-constrained farmers.

Conclusion and Recommendation

This study revealed that cultivation of improved forages in the farming systems is one way out of the present feed shortage crisis. Use of multipurpose improved forages such as Brachiaria and *D. intortum* could be a prominent solution having a win-win advantage. Those forage species used in push-pull technology in one hand to increase crop yield and in another hand to produce livestock feed. In both study areas, farmers were mainly dependent on main rainy season to produce Brachiaria and *D.intortum* and application of fertilizer and weeding were very limited. Cut and carry system was the common utilization practice by farmers to feed Brachiaria and *D. intortum* to their livestock in both study areas. Farmers utilize Brachiaria and *D. intortum* as livestock feed, pest management, and soil conservation. In both study areas, land scarcity and shortage of seed/planting material were the major hindering factors for the production of Brachiaria and *D. intortum.*

This study provides a key lesson to various stakeholders such as governmental institutions and NGOs to undertake strong extension services and provision of planting materials. In general, measures such as technical, institutional and technological interventions are suggested to help farmers increase their knowledge and perceptions about the production and utilization of Brachairia hybrid cv Mulato II and *Desmodium intortum.* Farmers could be assisted through training, workshops, and providing planting materials to avert the existing feed shortage. This survey work on the assessment of Brachiaria hybrid cv Mulato II and *Desmodium intortum* production and utilization was specifically conducted in association with push-pull technology practices. Thus, further research should be conducted to assess those forage species in a larger scope with respect to their sole production and utilization practices in the farming system.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

Declaration of interest None.

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