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Assessments of farmers′ perception and utilization status of *Brachiaria* grass in selected areas of Ethiopia

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Abstract. *Adnew W, Tsegay BA, Tassew A, Asmare B. 2018. Assessments of farmers' perception and utilization status of* Brachiaria *grass in selected areas of Ethiopia. Biodiversitas 19: 955-966.* The study was conducted to evaluate farmers′ perception and utilization status of *Brachiaria* grass in selected areas of Ethiopia. It was done between April and June 2017. The study employed a multistage sampling method based on the level of distribution of *Brachiaria* grass as push-pull technology and animal feeds. Respondent farmers were selected purposely based on their practice of *Brachiaria* grass production and use. A total of 280 household heads, 160 from Oromiya and 120 from Amhara regions, proportionally selected were interviewed. The average land holding per household was 1.79±1.73 hectares and average household size was 6.60±1.99 persons. Identified constraints of forage production were ranked as land shortage (1st), free grazing (2nd), lack and high cost of planting materials (3rd), poor extension service (4th), drought (5th), and lack of awareness (6th). Of the problems, the finding indicated that feed shortage during long dry season (77.0%) is a critical problem. From total respondents, 96.1% faced feed shortage for their livestock at least once a year. Major constraints to improve forage production were ranked as land shortage, unmanaged grazing, lack of grass planting materials, poor extension service and drought, orderly. All respondents (100%) from Oromiya and 52.1% of respondents from Amhara have got training about use of *Brachiaria* grass. Majority of the respondents (97.3%) believed that *Brachiaria* grass is much productive compared to other grasses. Overall, the study showed that training to farmers and adequate provision of extension services on the use of *Brachiaria* grass are necessary to exploit the potential of the grass in the study districts as well as the country at large.

Keywords: *Brachiaria* grass, extension service, smallholder farmers, push-pull, perception

INTRODUCTION

The livestock sector has considerable economic and social importance at household and national levels in Ethiopia (Gelayenew et al. 2016). However, productivity of livestock is low due to inadequate supply of feed and poor feeding practice (Gelayenew et al. 2016). The main feed resources for livestock in Ethiopia are natural pastures, crop residues and aftermath grazing (Getnet 2012; CSA 2016). These types of feed resources cannot support the expected animal productivity due to their nutritional limitations. Use of improved and climate-smart forage species is receiving considerable recognition as an option to overcome this problem. According to Getnet (2012), the integration of improved forage crops in agricultural systems has many advantages including soil conservation; reduced weeds, pests, and diseases, in addition to their primary use as high-quality animal feeds. *Brachiaria* grass is one of the different candidate forages that have multidimensional function in the farming systems of the tropics, including Ethiopia.

Species of *Brachiaria,* which are native to eastern Africa, are extensively grown as livestock forage in South America and East Asia, and are believed to occupy over 99 million hectares in Brazil alone (Jank et al. 2014). These grasses have a very crucial role in supporting a highly vibrant beef industry. Adaptation to low fertility and acidic soils; tolerance to drought, shade, and flooding; high biomass production potential; ability to accumulate carbon into soils and efficiently use nitrogen are among the important qualities of these grasses. They also can minimize emission of greenhouse gasses and groundwater pollution (Arango et al. 2014; Rao 2014; Ghimire et al. 2015). Recently, *Brachiaria* grasses are being used in 'push-pull' technology developed by the ICIPE and its partners. The technology uses carefully selected plants as intercrops which either repel or attract Stem borer moths and also control Striga, resulting in significant improvements in yield of cereal crops (Khan et al. 2008; Midega et al. 2014).

This technology has been the most successful control strategy for integrated management of the above mentioned two important constraints to cereal cultivation, with the added advantages of simultaneously improving soil fertility and agro-ecosystem integrity (Khan et al. 2014), while also allowing its integration with livestock husbandry as the companion plants used are valuable and nutritious fodder (Murage et al. 2015).

Despite its multiple benefits, the sustainability of the conventional push-pull technology, which uses Napier grass (*Pennisetum* sp.) as the trap crop and silver leaf *Desmodium* as the intercrop has been affected by the global effects of climate change and Napier grass is also threatened by the emergence of stunt and smut diseases

(Mureithi and Djikeng 2016); which has also limited its expansion to drier areas. In a new strategy termed 'climate-smart push-pull', the cereal crops are intercropped with the drought-tolerant green leaf *Desmodium* species which can withstand heavy grazing than *Napier* grass and *Brachiaria cv mulato* (*Brachiaria* spp.) is planted as a border crop (Khan et al. 2014). Push-pull technology has widely been disseminated and accepted by smallholder cereal farmers in East Africa, and it has been termed as a low-cost conservation technology (Murage et al. 2015). Over 80,000 smallholder farmers of Kenya are using this technology, with reports showing two to three-fold increase in maize yields (Khan et al. 2008). Regarding Ethiopia, the push-pull technology has progressed tremendously since its introduction in the country five years ago, with over 8,000 farmers now using the technology by ICIPE (International Centre of Insect Physiology and Ecology, Nairobi, Kenya) collaboration with various partners (ICIPE 2017).

In order to meet the demand for livestock products, there is a need to assist farmers to improve feed supply that meets animal requirement to match livestock productivity (Njarui et al. 2016). The problem of feed shortage can be addressed through identification and promotion of forage species with nutritive value which are also adapted to drought and low soil fertility (Ghimire et al. 2015). Although *Brachiaria* grass has been introduced in some areas of Ethiopia as animal feed, part of push-pull technology and for soil conservation by different organizations, i.e., ICIPE, LIVES Project (Livestock and Irrigation Value-chains for Ethiopian Smallholders), Wollo University and MoANR (Ministry of Agriculture and Natural Resources of Ethiopia), there is no information on how farmers are actually using it. Hence, this assessment was conducted to understand farmers' perception and utilization status of *Brachiaria* spp. in selected areas of Ethiopia.

MATERIALS AND METHODS

Description of the study area

The study was conducted between April and June 2017 in selected sites of Amhara and Oromiya regions of Ethiopia (Figure 1).

Amhara National Regional State (ANRS)

Amhara is located in the northwestern, eastern and central parts of Ethiopia. Geographically, it is situated between latitude 9°-13°45'N and longitude 36°-40°30'E. According to the 2007 population and housing census, Amhara region has a population of 17,214,056, with an annual growth rate 2.9 between 1994 and 2007. It is bounded by the Afar, Benishangul, Oromiya and Tigray regions in the east, south-west, south and north, respectively, and by Sudan in the west. The total area of the region is estimated at 170,152 km^2, which is about one-sixth of the country's total area (BoA 1997). The region ranges from 600 meters above sea level (m asl.) at Metema, to 4520 m asl. at Ras Dashen, which is also Ethiopia's highest point. The wide range of altitude is a major factor in determining the temperature range of the region. At altitude ranges from 600 to 1400 m a.s.l., the mean annual temperature range is· 21-27°C while in the cold to very cold moist zone, where the altitude ranges from 2800 to 4200 m asl., the mean annual temperature varies from 7.5°C to 16°C (CEDEP 1999).

Oromiya National Regional State (ONRS)

Oromiya is one of the biggest Regions of Ethiopia; Covering 363,136 km^2 stretching from the western border in an arc to the southwestern corner of the country, accounting for about 34.3% of the total area of the country. Geographically, the Region extends from 3°24'20"-10°23'26"N latitudes and 34°07'37"-42°58'51"E longitudes. According to the 2007 population and housing census, Oromiya region has a population of 27,158,471, with an annual growth rate 2.9 between 1994 and 2007. The topography and climate of the region are characterized by high plateau and very limited lowland areas. The altitude of the region ranges from below 500 m asl. at the rift valley to 4377 m asl. at mountain Tullu Dimtu. The region experiences an annual temperature ranging from 10°C to 30°C, with mean annual temperature of 19°C (Ahmed Hussein 2011).

Sampling techniques and sample size

Study sites were selected purposely based on the level of scale-up of the climate-smart push-pull technology since *Brachiaria* grass is not yet well known as a forage grass to farmers in Ethiopia. The study employed a multistage sampling method where the regions, zones, and districts were purposively sampled from each agro-ecological classification. The household heads were selected with assistance from respective areas frontline extension staff working in the villages. A total of 280 respondents were selected for this study of which 120 were from Amhara NRS and 160 were from Oromiya NRS.

Data sources and methods of data collection

Both primary and secondary sources of data were used for the study. Primary data was collected from the selected respondents, using pre-tested semi-structured questionnaires. Secondary data was obtained from the district agricultural offices. The semi-structured questionnaires were administered as personal interviews with the selected respondents in each study area. The questionnaires focused on information on farmers' socioeconomic characteristics (e.g., age, gender, education and family size), farm characteristics and, most importantly, on their personal perception of production and utilization of *Brachiaria* grass.

Data analysis

The collected data was properly sorted, coded and analyzed to interpret the result. Descriptive statistics, mean comparisons, and percentage values and tabular presentation were used to characterize farmer's perceptions and utilization status of *Brachiaria* grass, employing SPSS v.16 computer software.

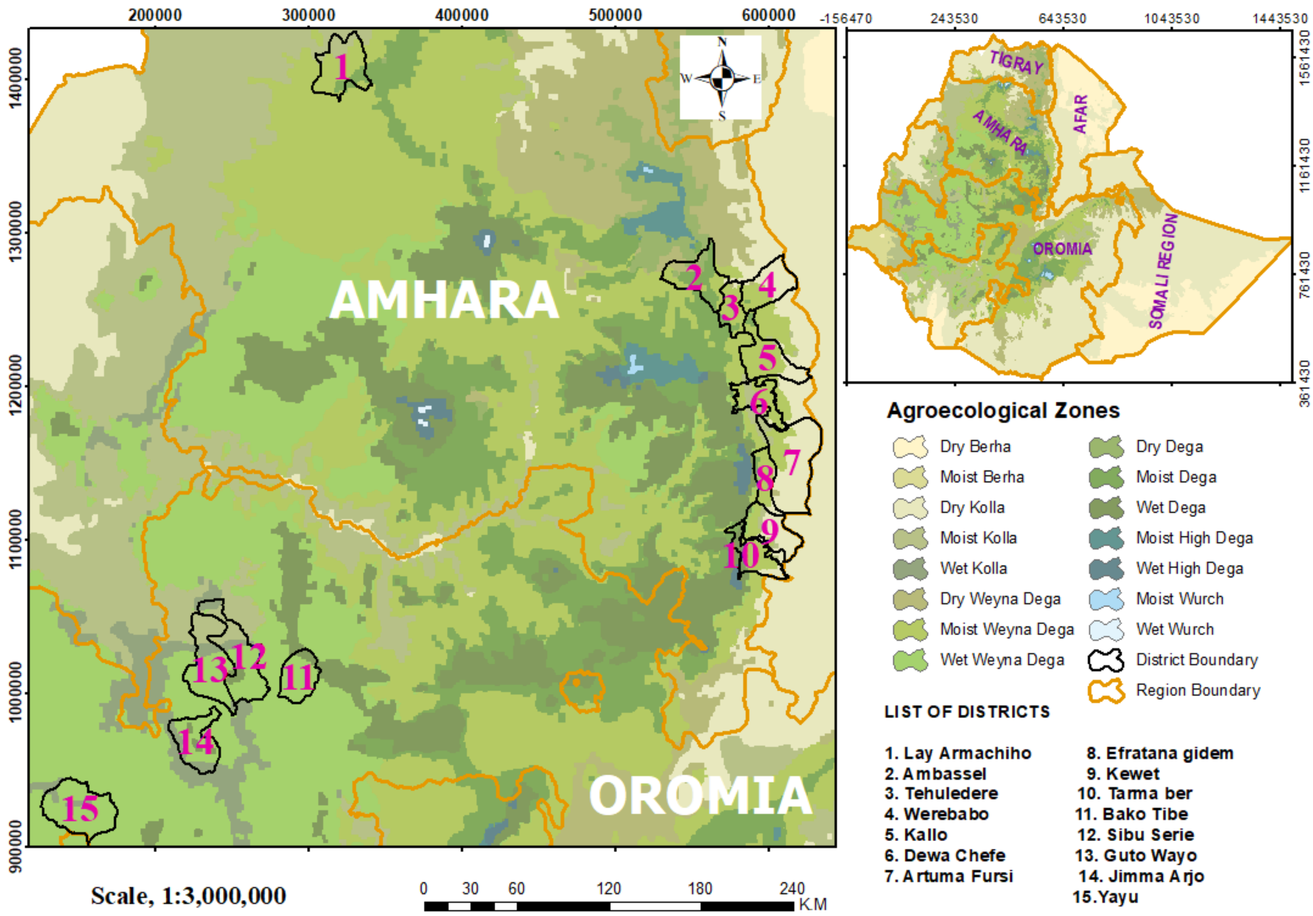

Figure 1. Map showing study regions and districts in Amhara and Oromiya regions of Ethiopia

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

As presented in Table 1, the majority of respondents were male-headed households for in both Oromiya and Amhara Regional States study areas. In all regions and agro-ecologies, about 43-51.7% of respondents were with the productive age (41-50 years) category followed by 31-40 years old groups. This result is in agreement with the result of 44.9 years reported as an average household head age of farming community in Burie Zuria District of northwestern Ethiopia (Belay et al. 2016).

The overall educational level of respondents indicated that majority of respondents in the lowlands of both regions (52.8% in Oromiya and 54.1% in Amhara) were unable to read and write and this percentage was higher than the figures recorded for Midland and Highland locations of both regions. Higher percentage of literate class promotes acceptance of new technologies. On the contrary, low education level of the households can have a negative influence on the transfer of agricultural technologies and their participation in development (Mulugeta 2005).

Family size and land holding of respondents

The average family size of the surveyed households in Oromiya and Amhara regions was 6.93±0.16 and 6.16±0.16 respectively (Table 2). The result was lower than 9.92 persons per household reported for Adami-Tullu Jiddo-Kombolcha district (Dawit et al. 2013), but higher than the national average of 4.9 persons per household reported for rural areas of Ethiopia (Tegene et al. 2015).

The average land holding per household in lowland, midland and highland were 2.95±2.57, 2.16±1.61 and 1.73±1.38 ha in Oromiya and 1.20±0.98, 1.10±1.19 and 1.08±0.59 ha in Amhara regions, respectively which included land available for crop production, pasture production, forest, fallow land, and garden. Land holding per household in the Oromia region was higher than the national average of 1.6 ha reported by Urgecha (2012) for Ethiopia whereas it was lower than the national average in Amhara region. There are significant differences statistically between Oromiya and Amhara regions at 0.05 level of significant in family size and Landholding, except fallow land holding.

Livestock holding

The average livestock holding of respondents, in Tropical Livestock Unit (TLU) per household, is presented in Table 3. The result shows that cattle are the dominant livestock species reared in the study areas. This may be due to the high demand for cattle for cultivation and other farm activities in the areas. When the regions are compared, there is significant variation with regard to cattle The overall mean livestock holding per household in the present study was lower than results of Guyo and Tamir (2014) reported for Burji and Segen Zuria districts, but, comparable to the results of Demeke et al. (2017) reported for North Achefer District, Ethiopia. Statistically, there are significant differences between Oromiya and Amhara regions at 0.05 level of confidence in cattle and poultry production, but there is no significant difference in sheep, goat, donkey, and mules between the regions.

Table 1. Socioeconomic characteristics of respondents by region and agro-ecology

Variables	Oromiya Highland (N=49)	Oromiya Midland (N=58)	Oromiya Lowland (N=53)	Amhara Highland (N=30)	Amhara Midland (N=53)	Amhara Lowland (N=37)
Percentages%						
Gender						
Female	12.2	15.5	9.4	26.7	22.6	16.2
Male	87.8	84.5	90.6	73.3	77.4	83.8
Age of respondents						
18-30 years old	12.2	1.7	5.7	6.7	7.5	10.8
31-40 years old	18.4	17.2	20.8	23.3	28.3	35.1
41-50 years old	40.8	51.7	43.4	43.3	43.4	43.2
51- 60 years old	14.3	20.7	17.0	16.7	20.8	10.8
More than 60	14.3	8.6	13.2	10.0	-	-
Education level of the respondents						
Cannot read and write	24.5	13.8	52.8	23.3	28.3	54.1
Can read and write	42.9	27.6	18.9	50.0	18.9	27.0
Elementary and Junior secondary school (1-8)	22.4	44.8	9.4	20.0	43.4	13.5
High school (grade 9-10)	8.2	12.1	11.3	6.7	7.5	5.4
Preparatory (grade 11-12)	2.0	1.7	7.5	-	1.9	-

Table 2. Details of families' size and land holding

Parameter	Oromiya			Amhara			Overall		Sig
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)	Oromiya	Amhara	
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	
Family size	7.10±2.36	6.78±2.04	6.92±1.82	6.87±1.87	5.92±1.79	5.92±1.62	6.93±0.16	6.16±0.16	.001
Landholding (ha)	1.73±1.38	2.16±1.61	2.95±2.57	1.08±0.59	1.10±1.19	1.20±0.98	2.29±0.15	1.12±0.09	.000
Crop production	1.35±1.10	1.68±1.09	2.32±2.17	0.84±0.51	0.83±0.81	0.79±0.81	1.79±0.12	0.88±0.07	.000
Pasture production	0.27±0.18	0.27±0.25	0.32±0.25	0.10±0.08	0.15±0.17	0.13±0.17	0.29±0.02	0.13±0.01	.000
Forest	0.17±0.10	0.34±0.29	0.22±0.08	0.13±0.08	0.18±0.21	0.11±0.06	0.24±002	0.14±0.019	.002
Fallow land	0.11±0.07	0.18±0.09	0.31±0.27	0.13±-	0.38±0.22	0.50±-	0.23±0.03	0.35±0. 09	.226
Garden	0.21±0.10	0.20±0.25	0.30±0.26	0.10±0.13	0.13±0.11	0.16±0.14	0.23±0.03	0.12±0.01	.002

Note: N = Number of respondents interviewed, Significant at 0.05 levels between the regions

Table 3. Livestock (TLU) and poultry holding (Mean±SE) of respondents by region and agro-ecology

Parameter	Oromiya			Amhara			Overall		Sig
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)	Oromiya	Amhara	
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	
Cattle	5.86±3.65	5.81±7.10	5.39±4.36	3.71±3.88	2.73±1.54	4.80±4.69	5.69±0.42	3.58±0.28	.000
Sheep	0.30±1.49	0.24±1.12	0.33±1.62	0.36±1.57	0.29±0.99	0.36±2.35	0.29±0. 15	0.33±0.26	.070
Goat	0.32±1.72	0.28±1.37	0.34±1.69	0.46±4.22	0.41±2.57	0.41±2.54	0.31±0.17	0.42±0. 51	.009
Donkey	0.57±0.38	0.81±0.88	0.80±0.73	0.5±0.00	0.60±0.45	0.65±0.826	0.77±0.10	0.58±0.10	.013
Mules	0.80±0.00	0.80±0.00	0.80±0.00	-	3.20±-	0.80±0.00	0.80±0.00	1.40±0.75	.030
Poultry	0.10±9.01	0.11±7.23	0.11±8.98	0.10±6.54	0.07±5.15	0.07±4.40	0.11±0.68	0.08±0.57	.004

Note: N = Number of respondents interviewed

Purpose of keeping animals

The purposes of livestock keeping by the households in the present study are shown in Table 4. Majority of the respondents (of both regions) in the present study ranked traction as the 1st major purpose of keeping cattle, in all agro-ecological zones. Sale of products was ranked as the 2nd major purpose of keeping animals in all agro-ecological zones of both regions, except the midland of Amhara region where it was ranked 3rd.

Crop and livestock production system

The agricultural farming system in the study area was characterized by dominance of crop-livestock production system (Table 5). However, the degree of interdependence of crops and livestock and the priority given by farmers varies in the study areas. Except in midland of Amhara region (90.6%), in all other agro-ecologies of Oromiya and Amhara, crop-livestock production is practiced by all farmers (100%). Mixed crop and livestock production system was ranked 1st in highland and lowland of both Oromiya and Amhara regions in Ethiopia, the vast majority of rural people comprising 85% of the total population depend on animal power for cultivation, weeding, threshing and transportation (Birara and Zemen 2016). According to the same authors similarly, livestock by-products play a significant role in maintaining soil fertility, increases soil organic matter and improves soil texture. However, crop production system was ranked 1st in the midland of both regions.

Cultivated improved forages in the study area

Brachiaria, Desmodium, Rhodes grass (*Chloris gayana*), Elephant grass (*Pennisetum purpureum)*, *Desho* grass (*Pennisetum pedicellatum Trin)*, and *Sesbania sesban* were the major improved forages being used as livestock feed resources in the study area. *Brachiaria* grass followed by Desmodium was the dominant forages in all the three agro-ecologies of both regions. Besides, ***Sesbania sesban***, *Lablab purpureus (Lablab***)**, *Leucaena leucocephala*, *Cajanus cajan* (Pigeon pea), vetch and Oats were observed by the researchers to be cultivated in the study area. The finding is in agreement with earlier reports by Gizachew and Mergia (2012).

Constraints of improved forage expansion

The major constraints for improved forage cultivation in the present study are shown in Table 6.

In all study areas, there were no adequate grazing resources for animals. The majority of the respondents ranked land shortage as the 1st major constraint. Free grazing ranked as the 2nd main constraint in midland and highland of both regions, while in lowland free grazing ranked as 3rd (43.4%) in Oromiya and 3rd and 4th equally (29.7%) in Amhara region. Lack of and high cost of planting materials (forage seeds and/or cuttings) ranked as the 3rd main constraint in all agro-ecologies except in lowland of Oromiya region, whereas lack of awareness was ranked 4th in all agro-ecologies of Amhara region, while in

Table 4. Major purpose of keeping animals by region and agro-ecology

Parameter	Oromiya			Amhara		
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)
For traction						
1st	81.6	55.2	62.3	93.3	73.6	62.2
2nd	14.3	20.7	32.1	3.3	18.9	21.6
3rd	2.0	15.5	5.7	-	3.8	5.4
4th	2.0	8.6	-	3.3	3.8	10.8
Sale of products						
1st	-	29.3	28.3	6.7	20.8	24.3
2nd	51.0	43.1	37.7	36.7	32.1	45.9
3rd	10.2	10.3	7.5	20.0	35.8	16.2
4th	38.8	17.2	26.4	36.7	11.3	13.5
Sale of live animals						
1st	-	1.7	-	-	3.8	10.8
2nd	12.2	12.1	13.2	36.7	32.1	18.9
3rd	57.1	62.1	58.5	43.3	47.2	51.4
4th	30.6	24.1	28.3	20.0	17.0	18.9
Home consumption (for egg, meat and milk production)						
1st	18.4	10.3	9.4	-	1.9	5.4
2nd	22.4	31.0	26.4	26.7	18.9	13.5
3rd	30.6	15.5	26.4	36.7	15.1	24.3
4th	28.6	43.1	37.7	36.7	64.2	56.8

Note: N = number of respondents interviewed

Table 5. Farming system practiced by region and agro-ecology

Parameter	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)
Major agricultural activities						
Crop-livestock production	100.0	100.0	100.0	100.0	90.6	100.0
Crop production only	-	-	-	-	1.9	-
Livestock production only	-	-	-	-	7.5	-
Agricultural activity contributes most to						
Crop production	34.7	58.6	37.7	40.0	49.1	35.1
Livestock production	2.0	5.2	-	-	13.2	2.7
Mixed crop and livestock	63.3	36.2	62.3	60.0	37.7	62.2

Note: N = number of respondents interviewed

Table 6. Major constraints for improved forage production in the study area

Parameter	Oromia			Amhara		
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)
Do you have adequate grazing resources for your animals?						
Yes	12.2	17.2	13.2	20.0	11.3	5.4
No	87.8	82.8	86.8	80.0	88.7	94.6
Land shortage						
1st	71.4	70.7	69.8	80.0	79.2	62.2
2nd	16.3	22.4	24.5	13.3	13.2	21.6
3rd	12.2	3.4	3.8	6.7	7.5	10.8
4th	-	3.4	1.9	-	-	5.4
5th	-	-	-	-	-	-
6th	-	-	-	-	-	-
Free grazing						
1st	16.3	29.3	3.8	20.0	22.6	16.2
2nd	63.3	53.4	20.8	70.0	67.9	29.7
3rd	16.3	10.3	43.4	3.3	9.4	29.7
4th	2.0	-	11.3	3.3	-	5.4
5th	2.0	6.9	3.8	3.3	-	8.1
6th	-	-	17.0	-	-	10.8
Lack and high cost of planting material						
1st	-	-	5.7	-	-	5.4
2nd	10.2	6.9	13.2	6.7	13.2	27.0
3rd	49.0	44.8	9.4	63.3	64.2	35.1
4th	20.4	34.5	43.4	20.0	18.9	24.3
5th	16.3	6.9	15.1	6.7	-	5.4
6th	4.1	6.9	13.2	3.3	3.8	2.7
Lack of awareness						
1st	14.3	-	-	-	-	-
2nd	4.1	6.9	-	-	-	2.7
3rd	10.2	15.5	9.4	13.3	7.5	8.1
4th	26.5	15.5	20.8	36.7	47.2	35.1
5th	18.4	32.8	39.6	16.7	32.1	29.7
6th	26.5	29.3	30.2	33.3	13.2	24.3
Drought						
1st	-	-	20.8	-	-	16.2
2nd	2.0	6.9	41.5	6.7	-	18.9
3rd	8.2	19.0	24.5	6.7	5.7	18.9
4th	18.4	37.9	9.4	13.3	22.6	8.1
5th	40.8	17.2	3.8	50.0	43.4	27.0
6th	30.6	19.0	-	23.3	28.3	10.8
Poor extension service						
1st	-	-	-	-	-	-
2nd	-	3.4	-	-	3.8	-
3rd	8.2	6.9	9.4	10.0	5.7	-
4th	30.6	8.6	13.2	26.7	11.3	21.6
5th	24.5	37.9	37.7	23.3	24.5	29.7
6th	36.7	43.1	39.6	40.0	54.7	48.6

Note: N = number of respondents interviewed

the lowland (39.6%) and midland (32.8) ranked as 5th and in the highland of Oromiya region (26.5%) was ranked in 4th and 6th equally. Drought was ranked 5th as the major constraint in all agro-ecologies (27.0% lowland, 43.4% midland and 50.0% highland) of Amhara regions and highland (40.8%) of Oromiya regions while it was ranked 2nd and 4th in the lowland (41.5%) and midland (37.9%) of Oromiya region respectively. On the other hand, poor extension service was ranked 6th in all agro-ecologies of both regions. Overall, land shortage, free grazing, lack and high cost of planting materials, lack of awareness, drought, and poor extension service were ranked 1st, 2nd, 3rd, 4th, 5th and 6th respectively by the respondents as the constraints for improved forages cultivation. The finding agrees on low forage adoption as a result of factors such as shortage of land, lack and high cost of planting materials, lack and unadoptable forage technologies, poor extension services, reluctance of most smallholder farmers and size of livestock ownership and farm size (Beshir 2014).

Feed shortage and mitigation strategies

The feed shortage mitigation strategies of respondents in the study area are shown in Table 7. More than 90% of the respondents face feed shortage for their livestock. In highland of both regions and lowland of Amhara, all respondents (100%) experience feed shortage. The shortage is felt mainly during the period of long dry season (February-May). Quantitative and qualitative shortage of forages is widespread in sub-Saharan Africa, especially during the dry seasons (Djikeng et al. 2014; Njarui et al. 2016).

On the other hand, in the midland of Amhara region, 45.3% felt shortage mainly during long rainy season (June-August), whereas in the lowland agrological zone of Oromiya and Amhara regions, 30.2% and 24.3% respectively faced scarcity during short rainy season (September-November). Different agro-ecologies used different strategies to mitigate the scarcity of livestock feeds. In lowland of both Oromiya and Amhara regions and also highland of Amhara, purchasing of feeds was the main solution for feed scarcity, whereas reduction of livestock was the major method in the highland of Oromiya. In midland of Oromiya and Amhara use of crop residues and fodders was the major mitigation measure. Few numbers of respondents also responded more than one.

Methods *Bracheria* grass production

A *Brachiaria* grass production strategy of respondents is shown in Table 8. Knowledge about the *Brachiaria* grass cultivars used was relatively more in Oromiya region than in Amhara. All respondents in the Oromiya and highland of Amhara region used only mullato II hybrid cultivar of *Brachiaria* grass because 100.0% of the respondents were obtaining planting material and training from ICIPE (Table 12), whereas in lowland and midland of Amhara region, both mullato II and decumbens cultivars were grown. This may be due to the training and planting material provided by different organizations (ICIPE, LIVES Project, Wollo University and MoANR) as animal feed, push-pull technology, soil conservation and to earn money. The planting materials used in the study area were both seeds and seedlings (tiller); however, use of seed alone as planting material is higher (51.8% average) than use of seedling (tiller) alone (2.9% average). This may be because cultivation by vegetative material is labor intensive and is more expensive than by seed, which can easily be mechanized (Maass et al. 2015). Furthermore, it indicates that use of *Brachiaria* (Mulato II) grass by farmers in Ethiopia is at infant stage as push-pull has progressed tremendously in Ethiopia since its introduction in the country five years ago (ICIPE 2017).

Planting and harvesting seasons of *Brachiaria* grass

Majority of the respondents in lowland, midland and highland areas of Oromiya and Amhara use the long rainy season, mainly from June to August to plant and effectively grow *Brachiaria*, although very few respondents experienced in planting *Brachiaria* during long dry season and short rainy seasons (Table 9). The higher number of respondents *in* Oromiya planting *Brachiaria during* the long rainy season than in Amhara was mainly due to the objective of ICIPE distributing *Brachiaria* grass in Oromiya as a trap plant of stem borer during sorghum growing season , but in Amhara region in addition to ICIPE (push-pull technology) the grass was disseminated by different organization like LIVES Project and Wollo University as animal feed, earn money and soil conservation without integrated to push-pull technology (Table 12), so that farmers plant any time when they obtained the planting materials. Majority of the respondents in both region mentioned that they were harvest *Brachiaria* grass as feed for their livestock during short rainy season (September-November) after four months.

Table 7. Feed shortage mitigation strategies of respondents by agro-ecological zones (%) and mean of the regions

Parameter	Oromiya			Amhara			Overall
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)	(N=280)
Livestock feed shortage experience (%)							
Yes	100.0	91.4	98.1	100.0	90.6	100.0	96.1
No	-	8.6	1.9	-	9.4	-	3.9
Season when feed shortage happened (%)							
Short rainy season (September-November)	6.1	3.4	30.2	-	1.9	24.3	7.4
Long rainy season (June-August)	2.0	-	-	10.0	45.3	-	13.8
Short dry season (December-January)	-	-	-	-	1.9	5.4	1.9
Long dry season (February-May)	91.8	87.9	67.9	90.0	41.5	70.3	77.0
Measure taken to alleviate problems of feed shortages (%)							
Purchasing feeds	6.1	39.7	52.8	53.3	11.3	62.2	36.8
Use of crop residues and fodders	16.3	46.6	39.6	30.0	49.1	27.0	37.5
Purchasing feed and use of crop residue	18.4	-	3.8	10.0	20.8	8.1	10.4
Reducing the number of stock	59.2	5.2	1.9	6.7	9.4	2.7	15.2

Note: N = number of respondents interviewed

Table 8. Methods and place of planting *Brachiaria* by region and agro-ecology

Parameter	Oromiya			Amhara			Overall
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)	(N=280)
Appropriate place of planting *Brachiaria*							
Backyard	12.2	6.9	-	10.0	28.3	8.1	11.1
In the border of push-pull technology of maize fields	53.1	63.8	73.6	53.3	20.8	37.8	51.1
Backyard and on the border of push-pull technology	-	-	-	10.0	-	-	1.1
In the border of push-pull, soil bund, roadside and stock exclusion	34.7	29.3	26.4	26.7	50.9	54.1	36.8
Methods of planting *Brachiaria*							
Used seed	34.7	74.1	49.1	50.0	52.8	43.2	51.8
Used seedling (tiller)	2.0	-	3.8	3.3	7.5	-	2.9
Used seed and seedling (tiller)	63.3	25.9	47.2	46.7	39.6	56.8	45.4
Farmers response for the awareness of *Brachiaria* they use							
Yes	93.9	93.1	100.0	66.7	39.6	54.1	76.4
No	6.1	6.9	-	33.3	60.4	45.9	23.6
The local name given for *Brachiaria*							
Mullato II	100.0	100.0	100.0	100.0	52.4	90.0	94.4
Decumbens	-	-	-	-	47.6	10.0	5.6

Note: N = number of respondents interviewed

Management practice of *Brachiaria* grass in the study area

Management practice of *Brachiaria* such as applying fertilizer, weeding, and use of irrigation during dry condition was common in Oromiya than Amhara region**.** It is well known that land preparation, weeding, and fertilizer application during forage establishment and development are important to have good stand and to produce quality forage.

Regardless of the deference in agro-ecology, majority of the respondents in Oromiya region reported that they practiced fertilizer application during planting and growing of *Brachiaria* grass (Table 10). However, fertilizer application experience was very limited (about 25%) in Amhara region which might be due to the high cost of fertilizer, poor awareness and the belief that the soil is fertile enough for the growth of forages. Almost all of the respondents in Oromiya and very few in Amhara had practiced weeding. Use of irrigation was also better in Oromiya than Amhara region. In general, there was a better managing practice in planting and growing of *Brachiaria* grass in Oromiya region than Amhara region, probably due to intensive training and high supervision given by ICIPE and also good extension service of the region.

Table 9. Planting and harvesting seasons of *Brachiaria* by region and agro-ecology

Parameter	Oromiya			Amhara			Overall
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)	(N=280)
Planting seasons (%)							
Short rainy season (September-November)	8.2	-	-	-	-	-	1.4
Long rainy season (June-August)	91.8	98.3	100.0	73.3	83.0	94.6	91.4
Long dry season (Feb-April)	-	1.7	-	26.7	17.0	5.4	7.1
Harvesting seasons (%)							
Short rainy season (September-November)	34.7	93.1	73.6	86.7	79.2	83.8	74.6
Long rainy season (Jun-August)	12.2	5.2		6.7	13.2	13.5	8.2
Short dry season (December-Januaryuary)	34.7		15.1	6.7	7.5	2.7	11.4
Long dry son (February- April)	18.4	1.7	-	-	-	-	3.6
All year round except Jan. to March	-	-	11.3	-	-	-	2.1

Note: N = number of respondents interviewed

Table 10. Management practice of *Brachiaria*

Parameter	Oromiya			Amhara		
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)
Irrigation practice for *Brachiaria* production						
Yes	24.5	20.7	13.2	10.0	9.4	5.4
No	75.5	79.3	86.8	90.0	90.6	94.6
Feasibility and economical status of irrigation (%)						
Yes	8.3	90.9	75.0	33.3	100.0	100.0
No	66.7	9.1	25.0	33.3	-	-
I do not know	25.0	-	-	33.3	-	-
Fertilizer application practice for *Brachiaria production* (%)						
Yes	100.0	79.3	94.3	40.0	9.4	27.0
No	-	20.7	5.7	60.0	90.6	73.0
Type of fertilizer applied (%)						
Artificial fertilizer	75.5	38.3	20.0	91.7	50.0	30.0
Manure	24.5	21.3	20.0	8.3	50.0	70.0
both artificial and manure		40.4	60.0			
Weeding practice (%)						
Yes	98.0	98.3	100.0	26.7	5.7	27.0
No	2.0	1.7	-	73.3	94.3	73.0

Note: N = number of respondents interviewed

Uses and production problems of *Brachiaria* grass in the study areas

The study revealed that *Brachiaria* grass is a multipurpose grass in the study area, used for various purposes such as source of animal feed, trap plant in push-pull technology, to earn money and also for soil conservation. The majority of the respondents of Oromiya (95.6%) and Amhara (85.8%) mentioned that *Brachiaria* has special advantages over other types of grasses they know. The advantages of *Brachiaria* grass as mentioned by respondents are: useful as a trap of stem borer, having high biomass, increased milk yield, high palatability, evergreens, it is a source of income and soil conservation.

Several authors have previously reported that grasses in the genus *Brachiaria* have advantages over those in other genera, including adaptation to infertile acidic soils and production of high dry matter yield (Rodrigues et al. 2014); reduced greenhouse gas emission (Peters et al. 2012) and contribution to carbon sequestration (Djikeng et al. 2014). Several authors have also reported that Mulato II cultivar shows high DMY production (Nguku et al. 2016); has excellent herbage production performance and benefits to livestock productivity (Peters et al. 2012; Ondabu et al. 2017). In addition, the advantages of using the *Brachiaria* genus in the integrated systems is that the species produce abundant roots which contribute to the collection of water, soil aggregation and aeration (Kluthcouski et al. 2004). They have also shown 15 to 40% increase in milk production in Kenya (Ghimire et al. 2015).

This study has revealed that *Brachiaria* can grow in a wide range of environmental conditions, ranging from lowland to highland. Maass et al. (2015) also stated that *Brachiaria* species are probably the most widely grown forage grass species in the tropics. It is a perennial grass native to East and Central Africa which is widely grown in South America to sustain the dairy and beef industries (FAO 2015).

Table 11. Utilization of *Brachiaria* grass by farmers

Parameter	Oromiya			Amhara		
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)
Purpose use *Brachiaria* primarily						
Source of animal feeds	-	-	-	-	13.2	10.8
Stem borer control as a trap plant in push-pull technology	18.4	24.1	1.9	13.3	3.8	24.3
As animal feed, earn money and soil conservation	-	-	-	26.7	15.1	-
Source of animal feed, as trap plant in push-pull technology, to earn money and soil conservation	81.6	75.9	98.1	60.0	67.9	64.9
Does *Brachiaria* have special advantages over other types of grass you know?						
Yes	93.9	94.8	98.1	83.3	79.2	97.3
No	2.0	1.7	1.9	13.3	11.3	2.7
I do not know	4.1	3.4		3.3	9.4	-
If yes, what are the advantages of *Brachiaria?*						
As a trap of stem borer	69.6	20.0	15.4	36.0	4.8	19.4
Have high biomass, increase milk yield, palatable and evergreen	21.7	52.7	36.5	40.0	54.8	55.6
As a trap, income and soil conservation	8.7	27.3	48.1	24.0	40.5	25.0
Do you face any problem in *Brachiaria* production?						
Yes	83.7	51.7	64.2	46.7	18.9	35.1
No	16.3	48.3	35.8	53.3	81.1	64.9
If yes, what problems you faced in *Brachiaria* production						
Late and poor germination	26.8	60.0	35.3	64.3	30.0	69.2
Free grazing, thief and the grass visited by wild animals	12.2	30.0	32.4	-	40.0	7.7
The seed does not stay long period on mother plant and not matured uniformly	2.4	3.3	26.5	7.1	10.0	-
Seed eaten by birds	24.4			14.3		23.1
Difficulty of weed control at early stage of growth	34.1	6.7	5.9	14.3	20.0	-
Do you face any problem in *Brachiaria* utilization?						
Yes	8.2			26.7	1.9	10.8
No	91.8	100.0	100.0	73.3	98.1	89.2
If yes, what utilization problem do you face?						
Attached to our cloth during collection and feeding	100.0	-	-	100.0	100.0	100.0

Table 12. Trainers and type of training offered

Parameter	Oromiya			Amhara			Overall (N=280)
	Highland (N=49)	Midland (N=58)	Lowland (N=53)	Highland (N=30)	Midland (N=53)	Lowland (N=37)	
Training taken on *Brachiaria* production and utilization (%)							
Yes	98.0	100.0	98.1	90.0	75.5	78.4	90.7
No	2.0	-	1.9	10.0	24.5	21.6	9.3
Topics or areas of the training (%)							
Use of *Brachiaria* for animal feed, to earn money and soil conservation	2.1	13.8		3.7	42.5	3.4	11.0
For push-pull technology	66.7	50.0	73.1	55.6	12.5	20.7	49.2
how to plant and manage the grass as a trap of stem borer, animal feed, soil conservation and income generation	31.2	36.2	26.9	40.7	45.0	75.9	39.8
Source of training (%)							
ICIPE	100.0	100.0	100.0	100.0	10.0	65.5	81.9
LIVES Project and MoANR	-	-	-		25.0	17.2	5.9
Wollo University and MoANR	-	-	-		50.0	3.4	8.3
MoANR	-	-	-		15.0	13.8	3.9
Extra (further) training demand (%)							
Yes	91.8	94.8	96.2	86.7	96.2	83.8	92.5
No	8.2	5.2	3.8	13.3	3.8	16.2	7.5

Note: N = number of respondents interviewed

On the problems associated with production and utilization of *Brachiaria* grass, as experienced by the farmers in the study area, are also presented in Table 11. Some of the major problems mentioned by the respondents are: late and poor germination, free grazing, theft, wild animals, birds, lodging, seeds not staying on mother plants, seeds do not mature uniformly and difficulty of weed control at early stages of growth.. *S*ome also claimed that they faced difficulty in collection of grass and very few respondents opined that they attached to their cloth during collection and feeding of animals.

Extension service in the study areas

About 99 and 81% of respondents in Oromiya and Amhara region, respectively regardless of the difference in agro-ecology have received training. The training given in both regions pertains to how to plant and manage the grass as a trap of stem borer, animal feed, for soil conservation and income generation. Push-pull technology was the main focus of training in Oromiya region. All farmers (100.0%) of Oromiya region and of highland of Amhara region obtained planting material of *Brachiaria* (Mullato II) grass from ICIPE. Majority of the respondents in lowland of Amhara region (65.5%) also obtained material from ICIPE whereas 50.0% of midland farmers obtained from Wollo University and MoANR (Table 12).

In conclusion, the study revealed that *Brachiaria* grass is a multipurpose grass which can be used as a source of animal feed, as a trap plant in push-pull technology, to earn money and for soil conservation strategies in both regions of the country. The grass has been well perceived by respondents that it has comparative advantages over other forages they know in terms of its push-pull importance, producing high biomass yield, better feed value and being green during dry season. Moreover, the grass has been valued as important forage in terms of soil water conservation and land rehabilitation. However, the grass was not highly expanded under farmers condition particularly in Amhara regions which were due to lack of awareness, planting material, and poor extension services. Therefore, awareness creation, intensive training, and provision of planting material are mandatory to motivate the expansion of the multipurpose climate-smart *Brachiaria* grass in the country.

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