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Pre-Extension Demonstration of Elephant Grass (Pennisetum purpureum) Varieties at Midland Agro Ecologies of Guji Zone, Oromia, Ethiopia

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Abstract

Livestock products like meat and milk are highly demanded for household consumption. However, the shortage of quality and quantity of feed is affecting livestock production in midlands of Guji zone which needs research and development solutions. Hence, to get maximum livestock products demonstration and use of improved forage technology such as elephant grass, which can generate a bulky of biomass for livestock is important in the study areas. Zehone-02 and Zehone-03 varieties were demonstrated to evaluate the performance and to assess farmers' feedback on elephant grass varieties. Adola and Wadera districts were selected based on their suitability for monitoring and appropriate for elephant grass production. The varieties were demonstrated on 5mx5m plots of 14 experimental farmers. Training and mini-field day was used as promotion approach in study areas. The results of the demonstration showed that both elephant grass varieties were well performed on all experimental farmers. Despite numerical variation in plant height, number of tillers/plant and survival rate there was no significant difference between varieties. However, there was a significant difference at 5% on fresh biomass between varieties. Farmers preferred both varieties based on palatability, regeneration and drought tolerant traits of the grasses. Demonstrated elephant grasses can supply sustained and secured feed throughout the year from small plots; hence, small landholder farmers can benefit from producing the grasses. Therefore, either Zehone-02 or Zehone-03 elephant grass should be largely produced on farmers' lands to solve feed shortage in the midland areas of Guji zone. Further studies should focus on the effect of grazing elephant grass on improvement of livestock production in the study areas.

Keywords: Agricultural extension; Demonstration; Elephant grass; Fresh biomass; Livestock feed resource

Introduction

Ethiopian livestock populations have been reported as 70.3 million cattle, 52.5 million goats, 42.9 million sheep and 8.1 million camels [1]. In Ethiopia, the livestock sub-sector significantly contributes to the national income [2] and the livelihoods of households. Scarcity of animal feed and inadequate grazing land are the major problems in the country [3]. Natural pasture based feed supply being inadequate and generally of poor quality in Ethiopia, especially in the dry season, has been predominantly responsible for the low productivity of livestock [4,5]. On the other hand, the demand for livestock products by consumers in the country was projected at an accelerated rate and it is difficult to satisfy the demand of consumers under such conditions unless urgent measures are taken [6]. Improved feed production is required to increase livestock productivity in the agricultural system [7]. Among the recommended mitigation strategies of feed shortage in the country is the utilization of adaptable multi-purpose fodder species such as Elephant grass (Pennisetum purpureum) species [8,9]. Elephant grass, or Napier grass or Uganda grass, is one of the most important tropical forage crops [10]. This grass is a very versatile species, which can be grown under a wide range of conditions and providing valuable forage throughout the tropics [11]. Elephant grass is mainly used in cut-and-carry systems ("zero grazing") and fed in stalls, or made into silage or hay [12,13] and it can also be established as a perennial pasture [14]. Its high biomass production has led to it being a candidate species for biofuel produc-

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tion [15]. It also has a role in phytoremediation due to its rapid growth rate and ability to survive in soils contaminated with organic or heavy metal pollutants [16]. More recently, elephant grass is being promoted as a component in the push-pull strategy for insect pests in maize fields [17]. With these advantages, however, elephant grass is not promoted in Ethiopian livestock farming system in general and Guji midlands in particular.

Guji zone is known for livestock production [18] but there was lack of improved forage species due to lack of demonstration and multiplication of forage varieties in the zone. In Guji zone the major sources of feed are natural pasture, crop residue, leave, enset, etc. which are poor in carbohydrate, protein and vitamins which are very important to get good quality of milk and meat from animals. In addition, these feed sources were available only during wet season. Thus, during dry season there is no feed option. However, sustainable forage production during wet and dry season is needed. This is enhanced through cutting and carrying system of elephant grass which can be harvested many times in a year ensuring feed availability throughout the year. Therefore, demonstration of improved elephant grass varieties on farmers' land is important as feed resource for livestock husbandry. This demonstration was done on farmers plot to evaluate yield performance of improved elephant grass varieties under farmers' conditions, to assess farmers' feedback on demonstrated elephant grass varieties and to enhance knowledge and skill of farmers on production of improved elephant grass varieties.

Materials and Methods

Description of Study Districts

Adola Rede District is located in Southern part of Oromia at a distance of 468 km from Addis Ababa, the capital of Ethiopia. The district is located between 5º44'10"-6º12'38" latitudes and 38º45'10"-39º12'37" longitudes. The district is bordered by Ana Sora district in the North, Wadera district in the South and Odo Shakiso in the West and Girja district in the East directions.

The district has altitude range of 1350-2340 masl, annual mean of 1000mm rainfall and annual average of 28°C [19]. Wadera district is 535 km from Addis Ababa, and 60 km from the zonal capital town, Negele. Astronomically, the district is located between 5°39'5"-6°2'28" northing latitudes and 39°5'30"-39°27'52" easting longitudes. Wadera district is bordered by Bale zone to East, Girja district to North, Adola Rede and Odo Shakiso districts to the North West and South West respectively and Gorodola district to South East direction. The mean annual temperature ranges from 12 0C-34 0C.The annual rainfall ranges between 915-1900 mm and the altitude 950-1,900 masl [20].

Experimental Sites and Experimental Farmers' Selection

This study was conducted at two midland districts of Guji zone during 2021 and 2022/23 years. Adola and Wadera districts were purposively selected due to their elephant grass production and convenient for monitoring the activity. From each district two kebeles were selected.

Derartu and Kiltu Sorsa kebeles were selected from Adola Rede while Calo and Andewa Keno kebeles were selected from Wadera district. At Adola Rede there were 7 experimental farmers and one FTC (Farmers training Center) whereas at Wadera district there were 6 experimental farmers. The demonstration was conducted at 14 experimental farmers on plot size of 5mx5m.

Varieties and Recommended Packages Used

The selected experimental farmers planted Zehone-02 and Zehone-03 elephant grass varieties. For this demonstration the recommended 100kg/ha of NPS fertilizer was applied at planting and 50kg/ha of UREA was applied after establishment of the trial. Stem cuttings were planted 50 cm and 100cm for intra and inter row spacing respectively.

Technology Promotion Approach

The agricultural research system of Ethiopia focused on farmer-extension-research linkage pillar. There are many ways for farmers participate in on-farm research activities and direct the extension for further promotion of varieties/technologies. Demonstrating at some farms as learning point and extending the results to many farmers is the most popular approach of agricultural extension system of Ethiopia. This activity also followed farmer-extension-research approach by organizing farmers on some plot as a host and others will learn from the host farmers [21]. For proper technology transfer effective extension approach and method is mandatory to capacitate farmers' knowledge and skill which can sustain and promote the production of improved variety in agricultural farming [22]. One of technology promotion used for elephant grass was training of farmers, development agents and experts who can sustain elephant grass production in rural areas. In addition to training, exchange visit and mini field day was used for further promotion and demand of elephant grass in midland districts of Guji zone.

Data Collection and Analysis Methods

Observation, counting and measuring was used to collect the data. Survival rate was collected by farmers based on the rate of staying of elephant grass during wet and dry season. This is the reply of experimental farmers on demonstrated plot of elephant grass. Number of tillers was collected from a random of five elephant grasses planted on the plot area. Fresh biomass was taken from two times harvesting conducted in a year. Pearson Correlation, t test and descriptive statistics were used to analysis the data. Farmers' preferences were qualitatively analyzed in narration form. Tables and graphs were used to present the data.

Results and Discussions

Elephant Grass Promotion Approach in Target Areas

One of extension approach for promotion of variety/technology in rural community is training. For this activity training was given for 96 farmers, 14 development agents and 10 experts during 2021 and 2022/2023 years. The training topics were elephant grass importance, production, harvesting and utilization. Provision of variety/technology alone does not boast agricultural production. Rather it should be focused on improving knowledge and skills of farmers' by providing training on a new/improved variety/technology [23].

The participants of training were also trained on how to make hay from elephant grass. In addition, they were trained on how to store and feed during dry season.

Moreover, exchange visit and mini field day was organized for experience sharing on demonstrated varieties. Besides experience sharing mini field day was organized for further promotion of elephant grass under rural farming (Table 1).

Table 1: Number of participants on elephant grass promotion.

Years	Promotion approach	Number of participants											
		Farmers			Develop-ment Agents			Experts			Others		
		M	F	T	M	F	T	M	F	T	M	F	T
2021	Training	48	12	60	8	-	8	4	-	4	3	-	3
	Exchange visit	18	3	21	4	-	4	1	-	1	-	-	-
	Mini field day	13	7	20	3	1	4	2	-	2	-	-	-
2022/ 2023	Training	27	9	36	6	-	6	5	1	6	3	-	3
	Exchange visit	8	3	11	4	1	5	2	-	2	-	-	-
	Mini field day	43	8	51	6	-	6	6	-	6	2	-	2
Total	Training	75	21	96	14	-	14	9	1	10	6	-	6
	Exchange visit	26	11	37	8	1	9	3	-	3	-	-	-
	Mini field day	56	15	71	9	1	10	8	-	8	2	-	2

M=Male, F=Female, T=Total

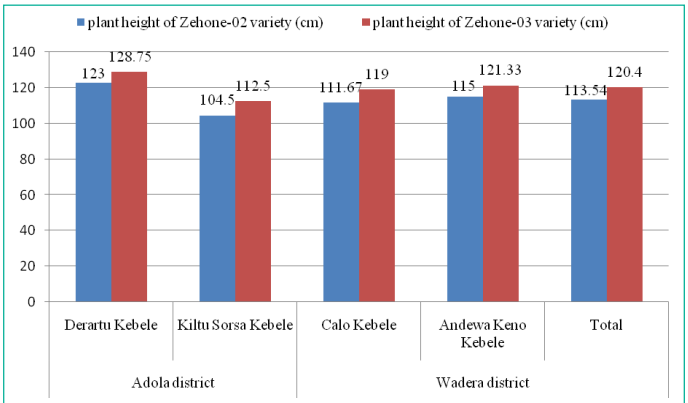

Figure 1: Performance of plant height across locations.

Performance of Elephant Grass Varieties on Farmers' Land

Elephant grass can grow to extreme height which cannot be easily harvested by farmers and not suitable for feeding and may be exposed as host for wild animals which can negatively affect crop and livestock in rural areas. Therefore, harvesting at early stage of elephant grass is important to get quality feed. From demonstrated varieties on average taller height (120.43cm) was recorded from Zehone-03 variety while lower (113.57cm) was from Zehone-02 variety (Table 2). The result of plant height of this demonstration was not similar to Gezahagn *et al.,* 2016 [24] who reported that Zehone-02 variety was taller than Zehone-03 variety. This variation could be due to variation in rainfall, climatic condition and biotic factors. For instance, by irrigation Zehone-03 height was 2.29m and by rain fed it was 2.34m [25]. Height is an important trait in elephant grass production as more height provides more chopped amount which increase feed amount for livestock and it should be harvested as much as possible to get good quality elephant grass. The plant height is among the important agronomic practices, which is used to determine appropriate harvesting stage and biomass yields for elephant grass varieties for on-time-utilization by animals [9,25].

More number of tiller cover the land and provide bulky of feed for livestock. In this demonstration, more number of tillers (6.93) was obtained from Zehone-02 and Zehone-03 provide lower tillers/plant (6.21) (see Table 2) which was contradicting the result of [26] who reported Zehone-03 had more number of tillers/plant than Zehone-02. Laidlaw [27 mentioned that number of tiller is an important characteristic of elephant grass as it increases the chances of survival and amount of herbage forage. In this study lower plant height and higher number of tillers was obtained from Zehone-02 variety. This could indicate that plant height and number of tillers was negatively correlated trait in elephant grass. This is mainly due to competition of light and nutrients. More number of tillers tends to the more competition to resources for growth. In less number of tillers/plant there is no competition for resources so that plant height might be higher than densely populated tillers where resource competition is high.

The aim of elephant grass production was either to feed as fresh during wet season or as hay during dry season. Elephant grass can be harvested three times in a year based on availability of rainfall. During this activity, fresh biomass was collected two times in a year. Better fresh biomass yield (8.30 t/ha) was harvested from Zehone-02 variety than Zehone-03 variety (6.61 t/ha) (Table 2). Another researcher, Tesfaye [28] mentioned that the farmers' first choice for elephant grass was biomass in this demonstration biomass issue was highly expected from elephant grass varieties. The fresh biomass yield is important parameters, which allow farmers and pastoralists for cut and carry system for using the herbage yield of forage and defoliation frequencies are very important to improve dry matter yield and nutritive values of this plant [25]. In this study, dry matter was not focused due to lack of oven dry at demonstration stage. However, the result of adaptation of currently demonstrated variety showed that Zehone-02 had more dry matter than Zehone-03 [26,29]. High dry matter indicates there is a less moisture in the grass and reduce the rate at the grass deterioration when stored [30]. Elephant grass Zehone-02 can generate a dry matter of 28.04 t/ha by supplementary irrigation [31] and can ensure livestock feed during dry season. The dried elephant grass forage could be mixed with legume forage to increase quality and palatability of feed for livestock.

Table 2: Performance of demonstrated elephant grass varieties.

Parameters	Variety	N	Minimum	Maximum	Mean	Std. Deviation
Plant height (cm)	Zehone-02	14	85	145	113.57	19.07
	Zehone-03	14	95	145	120.43	14.64
Number of tillers/ plant	Zehone-02	14	4	14	6.93	2.65
	Zehone-03	14	3	12	6.21	2.26
Fresh biomass (t/ha)	Zehone-02	14	5	13	8.30	2.34
	Zehone-03	14	5	9	6.61	1.50
Survival rate (%)	Zehone-02	14	60	98	81.71	13.41
	Zehone-03	14	60	96	78.43	12.97

Figure 2: Performance and data collection of elephant grass demonstration at Derartu Kebele.

Ability to survive after planting and after harvesting can determine the sustainability of elephant grass in rural farming. Besides, tolerance disease infection, tolerance to frost and drought tolerance of elephant grass influence its production by farmers. Experimental farmers rated the survival of elephant grass by observing the varieties on the plot. Accordingly, Zehone-02 variety had more survival rate (81.71%) than Zehone-03 variety which had 78.43% survival rate (Table 2). This variation is due to different accessions, soil types and moisture with environmental factors [26]. The result of survival rate of this demonstration was similar to Teshale [26] who mentioned that Zehone-02 variety survived more than Zehone-03 variety. More survival of elephant grass showed that elephant grass can provide feed throughout the year. This implies that elephant grass could minimize the feed insecurity during wet and dry seasons.

Performance of Elephant Grass Varieties Across Locations

At Adola and Wadera districts Zehone-03 elephant grass had more plant height than Zehone-02 (see Fig. 1). From the four kebeles Zehone-03 elephant grass had the highest plant height at Derartu Kebele followed by Andewa Keno Kebele and the least plant height was recorded at Kiltu Sorsa, Adola ditrict. At Derartu Kebele, both elephant grass varieties gave the highest plant height than other locations (Figure 1). This indicated that Derartu Kebele was most suitable for elephant grass production. At Adola district Zehone-02 and Zehone-03 elephant grass varieties gave a fresh biomass of 8.84 t/ha and 8.17 t/ha respectively and lower was harvested at Wadera district in both varieties. This could be due to variation in field management by farmers and mainly due to shortage rainfall at Wadera district during demonstration season. The average of fresh biomass of Zehone-02 was higher at Derartu kebele followed by Andewa Keno Kebele while at Kiltu Sorsa and Calo Kebeles there was lower fresh biomass from demonstrated elephant grass varieties (Figure 4). Zehone-02 elephant grass had the highest survival rate at Andewa Keno (87.33%) Kebele followed by Derartu Kebele (86.75%). At Calo and Kiltu Sorsa Kebeles the survival rate of both varieties were lower than at other locations (Figure 5). This might be due to frost, drought, soil and variation differences in the management of the trial by farmers at the various locations [32]. In addition, performance of forage species varies across locations due to differences in temperature and amount and distribution of rainfall [33]. However, Mijena and Getiso (2023) [24] found that there were no substantial variations between Pennisetum purpereum grass genotypes on establishment performance and the lowest plant survival percentage was seen in Zehone-03.

Comparison of the Mean of Elephant Grass Varieties Parameters

The independent t test revealed that there was a significant difference at 5% in fresh biomass yield between Zehone-02 and Zehone-03 varieties. However, there is no statistical difference in the mean of plant height, number of tillers/plant and survival rate of both varieties though there was a numerical variation between varieties (Table 3). This indicted that both varieties have similar plant height, number of tillers/plant and survival rate across locations. Hence, farmers can produce either Zehone-02 or Zehone-03 elephant grass for livestock feed in the midland districts of Guji zone.

Correlation of Elephant Grass Traits

The result of Pearson's correlation coefficient showed that all elephant grass traits have positive correction with each other and the correlation was highly significant at the 0.01 level (2-tails). Fresh biomass yield has large coefficient and positively correlated with number of tiller/plant (.774) followed by survival rate (.722) and plant height (.677) than others relations (Table 4). As the number of tillers/plant increase the fresh biomass would increase by .774. The result of this study was contrast to Mijena and Getiso [34] who mentioned that number of tiller plant and plant height at harvest of Pennisetum purpereum grass genotypes were negatively correlated. This could be due to more tillers led to competition for radiant energy and more height depresses the growth of new plant tillers. However, the current result was similar to the result of [35] as the biomass yield per plant had positive and highly significant genotypic correlation with branches per plant and plant height on variability study of Sesame. Farmers also ranked the most important trait of elephant grass. Accordingly, fresh biomass was ranked first followed by survival rate and number of tillers/plant. This showed that farmers' attention in elephant grass production was the amount of fresh biomass obtained from varieties and survival rate of grasses on the farmers land.

Table 3: The results of independent samples test.

Parameters	t-test for Equality of Means			
	T	Df	Sig. (2-tailed)	Mean Difference
Plant height (cm)	-1.067	26	0.296	-6.857
	-1.067	24.38	0.296	-6.857
Number of tillers	0.768	26	0.449	0.714
	0.768	25.38	0.449	0.714
Fresh biomass (t/ha)	2.287	26	0.031	1.696
	2.287	22.12	0.032	1.696
Survival rate (%)	0.659	26	0.516	3.286
	0.659	25.97	0.516	3.286

Figure 3: Performance of elephant grass demonstration at Andewa Keno Kebele.

Farmers' Preference on Elephant Grass Variety Production

Demonstrated varieties have similar characteristics so that farmers were preferred to use varieties for livestock feed. In this demonstration, farmers' preference on elephant grass traits was similar to the studies of (Umer and Usmane, 2020; Tesfaye, 2023) Both Zehone-02 and Zehone-03 varieties were palatable for animals. Cow, oxen, sheep and goat were liked to eat elephant grasses on plot as well as cutting and carrying system.

Table 4: Pearson correlation of elephant grass traits.

Traits	Plant height (cm)	Number of tillers/plant	Fresh bio-mass (t/ha)	Survival rate (%)	Rank
Plant height (cm)	1				4
Number of tillers/plants	.652**	1			3
Fresh biomass t/ha	.677**	.774**	1		1
Survival rate in %	.619**	.645**	.772**	1	2

**Correlation is significant at the 0.01 level (2-tailed).

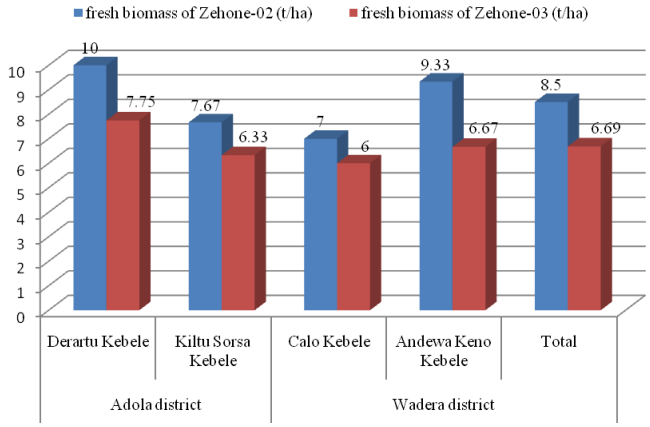

Figure 4: Performance of fresh biomass of demonstrated elephant grass across locations.

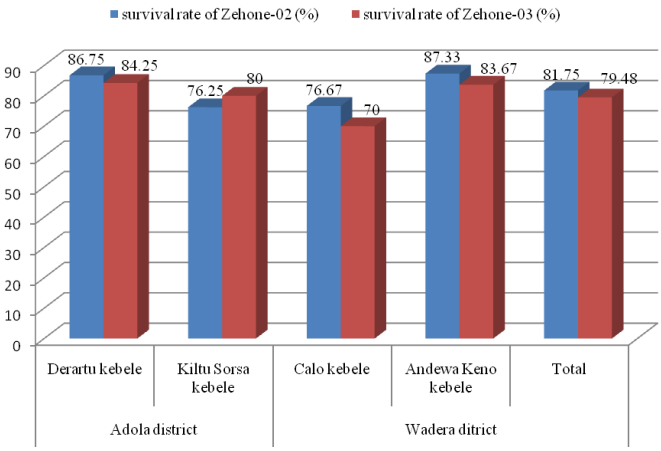

Figure 5: Survival rate (%) of demonstrated elephant grass across locations.

Experimental farmers also preferred elephant grass production due its regeneration capacity. Once it was harvested the demonstrated elephant grass varieties regenerate quickly and can minimize feed shortage for livestock production. It provides a bulky of fresh biomass within a season. Unlike other natural grasses which affected by drought occurred during demonstration, elephant grasses shown on farmers plot were not affected by drought. With low moisture the varieties were regenerated and served as feed source. Such regeneration nature of demonstrated elephant grasses of Zehone-02 and Zehone-03 get attention from farmers view. Moreover, demonstrated varieties showed themselves as drought tolerant on the field. The effect of drought is threating in midland areas of Guji zone. However, this demonstration of elephant grasses encouraged farmers as a means for minimizing the effect of drought on grasses and livestock when multiplied on larger areas. In addition to their use as a livestock feed, elephant grass was used as a fence to make homestead green when planted as hedges around the home farm. Generally, experimental farmers preferred to grow improved elephant grasses due to their multifunctional and good characteristics of regeneration and drought tolerance at moisture stress areas.

Conclusions and Recommendations

The result of this demonstration showed that Zehone-02 and Zehone-03 improved elephant grass varieties performed well on farmers' lands. The zehone-02 variety was of better height than the Zehone-03 variety. Having such height is important as the chopped of elephant grass increased the amount of feed for livestock. High number of tillers/plant was obtained from Zehone-02 variety and gradually covered the plot abundantly which led to give ample amount of feed. The zehone-02 variety generates fresher biomass yield than the Zehone-03 variety, indicating a higher yield of feed from Zehone-02 variety production.

This fresh biomass can be used either during wet season where other forages are also available or can be stored and used as hay during shortage and dry season. Such form of elephant grass feeding system can sustain feed supply and secure feed throughout the year. Furthermore, experimental farmers preferred the demonstrated elephant grass varieties because they are palatable to different animals and they have capacity of regeneration and provide more feed for livestock. Demonstrated elephant grasses were drought tolerant as they regenerated in moisture stress areas and got attention from farmers in mitigating the climate change on grass production. This indicated that elephant grass is important to solve feed shortage at midland districts of Guji zone. Therefore, either Zehone-02 or Zehone-03 elephant grass variety should be largely produced on farmers' lands to solve feed shortage in the midland areas of Guji zone.

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