Journal of Agricultural Economics, Extension and Rural Development
Abbreviated Key Title: J. Agric. Econs. Extens. Rural Dev.
ISSN-2360-798X (Print) & Open Access
Vol. 12: (7): Pp.: 65-73

Volume-12 |Issue-6| July, 2024| DOI:10.54978 ***Full Length Research***

Desho Grass (Pennisetum glaucifolium Trin.) Varieties: On-Farm Evaluation and Pre-Extension Demonstration

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Abstract: Three districts (Negele Arsi, Shashemene and Wondo) in the West Arsi zone of Oromia regional state and one district (Wondogenet) in the Sidama regional state of Ethiopia were used to conduct on farm evaluation and pre-extension demonstration of recently released Desho grass varieties to evaluate the varieties on-farm agronomic and yield performance as well as to demonstrate, popularize and create awareness of the benefits of the tested grass varieties. Based on the forage production potential and accessibility for field visits and monitoring, three representative peasant associations were selected from each district. Within each peasant association, 15 farmers willing to accept and share forage production technology were purposively selected and grouped into a farmer research extension group. Three hosting (trial) farmers were selected from each farmer research extension group, with the remaining farmers becoming participants (visiting farmers) in each peasant association. The hosting farmers were selected based on their ownership of adequate and suitable land to accommodate trials, their capacity to manage planted forage crops, their willingness to share their experience with others, and proximity to roads, which increased the likelihood of many stakeholders visiting them. One potential farmer training center in each district was used as a demonstration site as well as a source of planting material for the future. Three Desho grass varieties (Areka, Kindu kosha, and Kulumsa) were evaluated and visited at the farmers' training center with a plot size of 10 m × 10 m in each district. Accordingly, Areka and Kulumsa gave a higher amount (57.33 and 52.33 tons ha-1) of fresh biomass yield and (13.49 and 12.56 tons ha-1) of dry matter yield, respectively while Kindu kosha produced (49.46 tons ha-1) and (11.66 tons ha-1) fresh biomass yield and dry matter yield at the study site, respectively. Based on the performance of the varieties and visiting farmers' feedback, further large-scale scaling of the two varieties (Areka and Kulumsa) should be conducted in the study area and areas with similar agro-ecologies. Thus, it could be concluded that Areka and Kulumsa varieties should be recommended to improve the constraint of feed shortage in the study area and in areas with similar agro-ecologies.

Keywords: Desho Grass; Dry Matter; Fresh Biomass; Varieties.

Quick Response Code

Citation: Diribi et al.: Desho Grass (Pennisetum glaucifolium Trin.) Varieties: On-Farm Evaluation and Pre-Extension Demonstration . *Agric. Econs. Extens. Rural Dev* 12(7) Pp 65-73, 2024

Journal Name
https://www.springjournals.net/jaeerd

INTRODUCTION

Ethiopia has a large livestock population [1]. However, the sector is poor in terms of production and productivity because of a number of constraints. Inadequate feed supply, in terms of quantity, quality, and seasonality, has been shown to be responsible for the lower reproductive and growth and reproductive performance of animals, particularly during the dry season [2-4]. According to [5], because various animals require varied feeds based on their growth and production stages, the efficiency and productivity of the livestock industry are challenged by the supply of high-quality fodder. According to the [1] report, natural pasture (57.77%), crop residue (29.75%), hay (6.66%), agricultural by-products (1.54%), and other feed resources (3.89%) were identified as major livestock feed resources in Ethiopia, whereas the share of improved forage crops was only 0.38%. However, natural pastures and crop residues have poor feed qualities that are required by animals [6]. As a result, the nutrient requirements needed for growth and reproduction are not met by existing feed resources. Thus far, improved forage has contributed to less than one percent of the nation’s overall feed supply [1]. Nevertheless, to boost livestock production and productivity in the country, integration of improved forage production into farming systems is compulsory. To alleviate nutritional constraints, the use of locally available forage varieties that are adaptable to local agro-ecological conditions and utilized as livestock feed resources is highly recommended, as they are familiar to smallholder farmers with low agricultural inputs [7]. Among such types of forage species, Desho grass (*Pennisetum glaucifolium Trin.)* has multi-layered advantages. The grass is indigenous to tropical Asia and tropical and subtropical Africa [4].

Desho (*Pennisetum glaucifolium Trin.)* grass is an indigenous cultivated multipurpose perennial forage crop that originated in the southern region of Ethiopia, is grown for animal feed and soil conservation practices in Ethiopia, and is regarded as the king of grass [8-10]. The grass has the potential to meet the challenges of feed scarcity because it provides more forage per unit area, ensures regular forage supply owing to its multi-cut nature, and can yield green herbage ranging between 30-109 tons per hectare [11]. Desho grass is suitable for intensive management and performs well at altitudes ranging from 1500 to 2800 m above sea level [10]. The ability of Desho grass to tolerate drought makes it adaptable to tropical environments. The merits of the grass to provide multi-cut forages suggest that it is a potential feed source in the dry season when feed availability in the tropics is critical. The combined benefits of the grass suggest the use of grass as a potential feed source, sold as fodder for income generation, and a means of soil conservation in the mixed crop-livestock production systems of Ethiopia.

In the past few years, different Desho grass collections have been tested at different agricultural research centers (Debrezeit, Kulumsa, Wondogenet, and Holeta) of the Ethiopian Institute of Agricultural Research for adaptation and fodder production. Among the tested collections, Areka/DZF-590, Kindu Kosha/DZF-491, and Kulumsa/DZF-591 were found to be adaptable from medium to highland aro-ecologies and were registered as varieties [12]. Even if these varieties were released by research centers for forage use and were found to be adaptable under on-station research conditions, to the best of the authors’ knowledge, they have not been demonstrated under on-farm conditions to verify the possibility of their adoption by smallholder farmers in the mixed crop-livestock production systems of Ethiopia. Therefore, the current study was conducted to evaluate the recently released Desho grass varieties at farmer fields and to demonstrate the merit of the grass to smallholder farmers in the study area.

MATERIALS AND METHODS

Study area

The study was conducted in one district of the Sidama regional state (Wondogenet) and three districts of the West Arsi zone of Oromia (Negele Arsi, Shashemene, and Wondo) in south-eastern Ethiopia.

Negele Arsi District is situated 250 km south of Addis Ababa, the capital city of Ethiopia. Geographically speaking, it is situated between 7°17′N and 7°66′N latitudes and between 38°43′E and 38°81′E longitudes. The yearly rainfall varies from 500 to 1200 mm, while the temperature ranges from 10 to 25 °C. The district has four different seasons: the main rainy season (June to August), short rainy season (March to May), dry season (December to February), and autumn season (September to November) [13]. The main livelihood of the community is mixed agriculture, with maize, barley, teff, and wheat as the main crops, and cattle, sheep, and goats as the dominant livestock [14].

The Shashemene district is topographically located in the West Arsi zone of the central Ethiopian Rift Valley [15] at a distance of 253 km from Addis Ababa, the capital city of the country, to the south, at latitudes of 70 04’50” to 70 22’45” N and longitudes of 380 23'00" to 380 48'00" E. The district is situated between 1683 and 2742 m above sea level [16]. The annual rainfall varies from 500 to 1200 mm, and the temperature ranges from 10 to 25°C. Four different seasons occur in the area: the major rainy season (June–August), short rainy season (March–May), dry season (December–February), and autumn season (September–November). The district has considerable agricultural potential, as evidenced by the variety of crops and cattle it produces for food and money [17].

Wondo district is situated 260 km from Addis

Ababa on the southeast escarpment of the Ethiopian Great Rift Valley at latitudes of 7°06-07′N and longitudes of 38°37′-42′E. The altitude ranges from 1,700 to 2,300 meters above sea level [18]. Agro-ecologically, 90% of the district is in the midland zone, whereas 10% is in the highland zone, according to the Wondo District Agricultural Office. The district has a bimodal annual rainfall pattern of 1210 mm annually. The rainy season ranges from March to September, and the comparatively dry period from December to February. The average annual temperature is 20°C. Fertile soil, water, forests, and wildlife are some of the natural resources bestowed on the district [19]. The valley plain of Wondo has fertile and loamy sand-textured soils that contain the most important nutrients and cover the area [20] to the south.

The Wondogenet district is located approximately 270 km South of Addis Ababa (the capital city of the country); 34 km East of Hawassa city, the capital of Sidama Regional State; and 14 km southeast of Shashemene, the capital of the West Arsi zone of the Oromia regional state. The geographical coordinates of the district are 7^{0}19’ N latitude and 38^{0} 38’E longitude, with a wide altitudinal range of 1600–1950 m above the sea level. The mean annual minimum and maximum rainfall were 709 and 2062 mm, respectively. The district has mean maximum and minimum temperature of 26^{o}c and 12°C, respectively. Wondogenet has a bimodal rainfall distribution, with short rains occurring from March to May and long rains occurring from July to October [21]. Livestock rearing, both rainfed and irrigation-based crop production, and small-scale trade accounted for 13%, 85%, and 2%, respectively [22].

Experimental site and experimental farmer selection

A total of twelve peasant associations (PA), the smallest administrative structure in the country, (three PAs) from each district, were selected based on livestock potential with the help of development agents and livestock experts. Fifteen farmers willing to accept and disseminate technology were purposefully selected from each PA and grouped into farmer research groups (FRGs). In each FRG, three hosting (trial) farmers were selected, with the rest being participant farmers in each PAs. Hosting farmers were selected based on their ownership of suitable and sufficient land to accommodate trials, proximity to roads to facilitate the chance of being visited by many stakeholders, ability to manage planted crops, and willingness to share their knowledge and experience with others. One potential farmer training center in each district was used as a demonstration site and as a source of planting material for the future.

Experimental treatments and treatment management

A vegetative root split of the chosen study materials (Areka, Kindu kosha and Kulumsa) Desho grass varieties were planted at a distance of 0.5m and 0.25m between rows and plants, respectively [10]. At PA, three trial farmers established one of the varieties in a 10 × 10 m plot area. Each trial farmer was considered as a replication. Nitrogen-phosphorus-sulfur blended fertilizer in the form of NPS was uniformly applied to all plots at a rate of 121 $kgha^{-1}$ at planting. After each harvest, all plots were top-dressed uniformly with 50 kg Nha^{-1}, of which one-third was applied at the first shower of rain and the remaining two-thirds were applied during the active growth stage of the plant. During the experimental period, the plots were maintained under uniform management to ensure that the root system remained intact during the long dry spells. All other crop management practices were used uniformly for all plots, as recommended.

Technology promotion approach

Farmers can participate in many ways in on-farm research activities to direct extension for the further promotion of varieties and agricultural technologies. Demonstrating this at trial sites as a learning point and extending the results to many farmers is the most popular approach to the agricultural extension system in Ethiopia. This activity also facilitated the farmer extension research approach by organizing farmers on plots as host (trial) farmers, and others will learn from them [23]. For proper technology transfer, an effective extension approach and method is mandatory to enhance farmers’ knowledge and skills, which can sustain and promote the production of improved varieties in agricultural farming [24].

Data collection and Analysis method

The trial plots were regularly observed during the experimental periods (2018/19-2020/21), and data on agronomic growth, such as survival rate, plant height at harvest, tiller number, leaf-to-stem ratio, and herbage yield, were recorded using observation, counting, and measuring methods during the second year as the first year was considered as establishment year. The plant survival rate of each variety was recorded and calculated as the ratio of the number of surviving plants per plot to the total number of plants planted per plot and then multiplied by 100. The number of tillers per plant was counted from five randomly selected culms in each plot. Plant height at forage harvest was measured from five culms randomly selected in each plot using a steel tape from the ground level to the highest leaf. Fresh biomass was taken from a 1m × 1m quadrant and then converted to a hectar basis and 300-gram fresh sub-sample was taken and dried at 105ºC for 24 h to determine the dry matter yield. Pearson's correlation, t-tests, and descriptive statistics were used to analyze the data. Tables and graphs were used to present the data.

RESULTS AND DISCUSSION

Agronomic performances of the tested Desho grass varieties

Number of plants survived

Grass establishment performance is an important consideration during forage crop cultivation because of its substantial effect on forage productivity [25]. The average survival rates of the tested Desho grass varieties across the experimental sites are shown in Figure 1. The results of the current study indicate that there was no statistically significant difference *(p>0.05)* among the tested Desho grass varieties at the study sites. The absence of variance showed that the varieties could adapt to a wide range of agro-ecologies, and that the environment and all experimental sites were favorable for it during the study period. Although there was no statistical difference between the tested Desho grass varieties, a large survival rate ranges from 81-91% was recorded across the study sites. The highest average survival rate of (91% and 90%) was recorded for Areka variety at Wondo and Wondogenet districts, respectively while the lowest (81%) was from Kindu kosha variety at Shashemene district followed by (82%) from Kindu kosha and Kulumsa at Negele Arsi and Shashemene districts, respectively. The current result was slightly different from the findings of Mereba [26], which was (90.06% for Kindu kosha), (88.06% for Kulumsa) and (86.06 for Areka) varieties in the highland area of the North Shewa zone, Oromia, Ethiopia. This difference might be due to agro-ecological differences, soil fertility, and agronomic management practices.

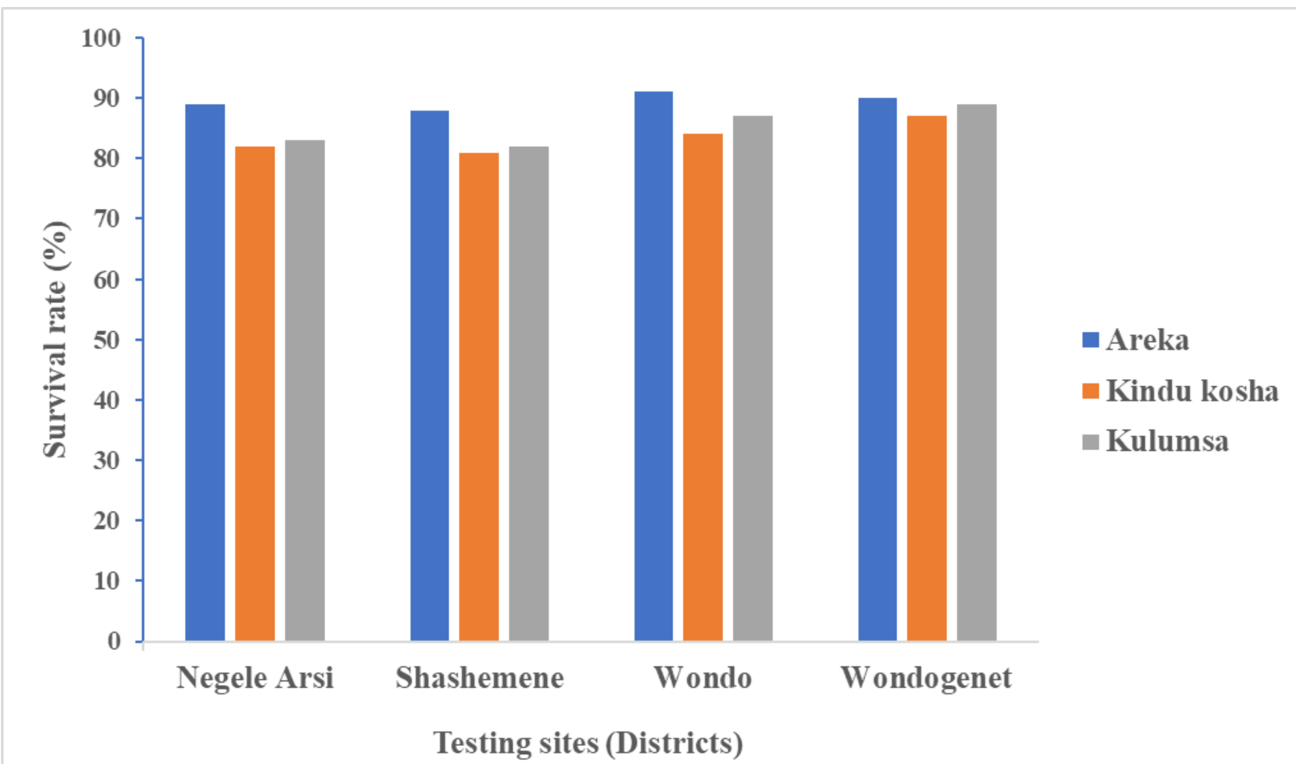

Fig 1. Average survival rate of the tested Desho grass varieties across the trial sites

Number of tillers per plant

Tillering performance is an important morphological characteristic that should be considered when selecting an appropriate forage crop species to improve production and productivity [27]. The present study showed no significant difference (*p>0.05*) between the tested Desho grass varieties and districts in terms of the number of tillers per plant (Table 1). This finding is similar to that of [28], who reported no significant difference (*p>0.05*) in the number of tillers per plant between Desho grass varieties tested in midland agroecology in the West Arsi zone, Ethiopia. The absence of statistical differences between the tested grass varieties and districts might be because of the adaptability of the grasses to a wide range of agro-ecologies and environments, and the experimental sites were favorable for the tested varieties. The combined mean result indicated that the maximum number of tillers per plant (95.42) was recorded for the Areka variety, followed by Kulumsa (85.95), while Kindu kosha exhibited the lowest (76.43). The current study disagrees with the findings of [26], who reported that, 74.80 and 83.56 number of tillers per plant were recorded for Areka and Kindu Kosha varieties, respectively, in the highland areas of the North Shewa zone of Oromia, Ethiopia. However, the value for the Kulumsa Variety was consistent with the findings of the same author (82.37). The similarities in the findings indicate the ability of Desho grass to adapt to different environments and soil types. This might be due to the indigenous ecotype of Desho grass in Ethiopia [29]. [30] and [28] reported a higher value (115.9,125.6, 131.8) and (117.17,102.17, 102.67) number of tillers per plant for Areka, Kindu kosha and Kulumsa Desho grass varieties at the midland and highland of east Hararghe and midland agro-ecology of West Arsi, Ethiopia, respectively. In contrast, lower values were reported by [31], which were 69.83, 51.83 and 49.17 for Areka, Kulumsa, and Kindu kosha varieties, respectively, under irrigation in the South Omo Zone, Southwestern Ethiopia. This difference might be due to altitude, soil type, agro-ecology, maturity (harvesting stage), weather conditions, study period, and other management practices.

Table 1: Average number of tillers per plant of the tested Desho grass varieties across the study sites

Variety	Location				Combined mean
	Negele Arsi	Shashemene	Wondo	Wondogenet	
Areka	98.73	93.27^{a}	89.93	99.73	95.42^{a}
Kindu kosha	76.33	67.53b	79.07	82.80	76.43b
Kulumsa	89.87	73.53^{b}	87.20	93.20	85.95^{ab}
Mean	88.31^{AB}	78.11^{B}	85.40^{AB}	91.91^{A}	85.93
CV (%)	19.50	7.40	7.51	15.20	14.89
LSD $_{(0.05)}$	39.04	13.00	14.54	31.66	10.65

NOTE: Means with the same letter(s) are not significantly different at P>0.05. CV= Coefficient of variation, LSD=Least significant difference.

Plant height at forage harvest

The least mean square of the current analysis indicated that there was no statistically significant difference (*p>0.05*) in plant height at harvest among the tested desho grass varieties (Table 2). This result agrees with a previous report by [30] and [28] that there were no significant differences (*p>0.05*) in plant height between Desho grass varieties tested at midland and highland of east Hararghe, and at midland agro-ecology of the West Arsi zone of Ethiopia, respectively. However, numerically different combined mean values (105.39, 100.70, and 95.68) were recorded for Areka, Kulumsa, and Kindu Kosha Desho grass varieties in decreasing order, respectively. The current combined mean value was in agreement with the previous report of Husein and Wana [30] that was 109.67, 103.67 and 105.50 for Areka, Kindu kosha and Kulumsa varieties at the midland agro-ecology of West Arsi zone of Ethiopia, respectively. Mereba [26] reported 82.70, 85.73 and 80. 35 plant height at harvest mean values which was lower than the current mean for Areka, Kulumsa and Kindu kosha Desho grass varieties at highland areas of North Shewa zone of Oromia, Ethiopia, that was lower than the current finding. However, [30] and Hidosa and Getaneh [31] reported the higher value (123.83, 124.33,115.00) and (133.2, 131,126.2) for Kulumsa, Kindo kosha and Areka varieties at under irrigation in South Omo Zone, Southwestern and midland and highland of east Hararghe, Ethiopia, respectively. The differences in plant height at forage harvest could be attributed to the agro-ecology, soil conditions, climatic patterns, and management practices applied during the experiment.

Table 2: Average plant height at forage harvest (cm) of the tested Desho grass varieties across the study Sites

Variety	Locations				Combined mean
	Negele Arsi	Shashemene	Wondo	Wondogenet	
Areka	103.95	107.00	103.20	107.40	105.39
Kindu kosha	94.12	86.07	99.00	103.53	95.68
Kulumsa	102.00	94.93	99.80	106.07	100.70
Mean	100.03	96.00	100.67	105.67	100.59
CV (%)	16.68	14.07	10.86	17.28	13.50
$LSD_{(0.05)}$	37.82	30.62	24.79	41.39	11.30

NOTE: Means with the same letter(s) are not significantly different at P>0.05. CV= Coefficient of variation, LSD=Least significant difference.

Yield performance of the tested Desho grass varieties

Fresh biomass yield

The result of fresh biomass yield of the tested Desho grass varieties are presented in Table 3. As indicated in the table, combined mean of the parameter was significantly different (*p<0.05*) among the tested grass varieties. Areka and Kulumsa varieties produced higher fresh biomass yields in both the Shashemene and Wondogenet districts than did the Kindu kosha variety. The combined mean value (57.33) was recorded for Areka, followed by 52.33 for Kulumsa while the lowest (49.46) was from Kindu kosha varieties. Our current result was higher than the previous reports of [32] that was 45.0, 39.6 and 37.9 for Areka, Kindu kosha and Kulumsa varieties, respectively at highland and midland areas of Guji Zone, Southern Oromia, Ethiopia. Another authors [33] reported similar mean value (49.78 tons ha^{-1}) for Kindu kosha and lower values (47.59 tons ha^{-1}) for Areka compared to the current finding at highland districts of Guji Zone, Southern Oromia, Ethiopia. The higher fresh biomass yield for the Areka and Kulumsa varieties in this study might be due to the higher genetic potential of these varieties to adapt to the tested environment than Kindu kosha. The differences with the previous scholars' findings might be due to differences in agro-ecology, soil conditions, applied management practices, and other related factors.

Table 3: Fresh biomass yield (ton ha^{-1}) of the tested Desho grass varieties across the study sites

Variety	Location				Combined mean
	Negele Arsi	Shashemene	Wondo	Wondogenet	
Areka	60.18	55.94^{a}	57.92	55.29^{a}	57.33^{a}
Kindu kosha	50.53	44.48^{b}	57.50	45.33^{b}	49.46^{b}
Kulumsa	51.35	54.97^{ab}	54.69	48.30^{ab}	52.33^{ab}
Mean	54.02^{AB}	51.80^{AB}	56.70^{A}	49.64^{B}	53.04
CV (%)	17.28	9.29	11.34	8.56	13.97
$LSD_{(0.05)}$	21.16	10.91	14.58	9.64	6.17

NOTE: Means with the same letter(s) are not significantly different at P>0.05. CV= Coefficient of variation, LSD=Least significant difference.

Dry matter yield

The combined analysis results for dry matter yields of the Desho grass varieties are presented in Table 4. The tested Desho grass varieties showed a significant difference (*p<0.05*) in dry matter yield only in the Shashemene district and combined analysis. The combined mean least square of the dry matter yield showed a mean value ranging from 11.66 -13.49-ton ha^{-1}. The highest dry matter yield (13.49 tons ha^{-1}) was obtained from Areka followed by 12.56 tons ha^{-1} from Kulumsa while the lowest 11.66 tons ha^{-1} was recorded for Kindu kosha varieties. The combined mean (12.57 tons ha^{-1}) dry matter yield in the current study was within the range of Mereba [26] and lower than those of Husein and Wana [30] and Jabessa [32] that was 11.89 tons ha-

^{1}, 25.96 tons ha^{-1} and 17.4 tons ha^{-1} at highland area of North Shewa, highland and midland areas of Guji Zone, and midland agro-ecology of West Arsi zone, Ethiopia, respectively. Our current study means 13.49 tons ha^{-1} for Areka, 12.56 tons ha^{-1} for Kulumsa and 11.66 tons ha^{-1}for for Kindu kosha varieties were in dis agreement with the finding of [29] that was 25.06, 24.93-, and 24.51-tons ha^{-1} for Kindu kosha, Areka and Kulumsa varieties, respectively in descending order at midland and highland of east Hararghe, Ethiopia. Other reports from [31] also indicates the highest value than the current that were 35.09, 25.42, and 22.86 tons ha^{-1} for Areka, Kulumsa and Kindu kosha varieties, respectively at under Irrigation in two Districts of South Omo Zone, Southwestern Ethiopia. The lower value from our study compared to previously reported studies by different scholars for the same Desho varieties might be due to differences in soil parameters, harvesting stage, irrigation effect, management, and agro-ecological differences [31].

Table 4: Dry matter yield (ton ha^{-1}) of the tested Desho grass varieties across the study sites

Variety	Location				Combined mean
	Negele Arsi	Shashemene	Wondo	Wondogenet	
Areka	14.06	13.37^{ab}	13.71	13.30	13.49^{a}
Kindu kosha	11.25	10.63^{ab}	13.62	11.13	11.66^{b}
Kulumsa	12.24	12.87^{a}	13.19	11.43	12.56^{ab}
Mean	12.52	12.29	13.51	11.95	12.57
CV (%)	18.80	9.07	10.25	9.15	14.35
LSD $_{(0.05)}$	5.34	2.53	3.14	2.48	1.50

NOTE: Means with the same letter(s) are not significantly different at P>0.05. CV= Coefficient of variation, LSD=Least significant difference.

CONCLUSION AND RECOMMENDATIONS

Food and feed are the most important components of agricultural production. As far as crop production requires the role of livestock for ploughing, threshing, transportation, improving soil condition in crop production is unnoticed, and the quality and quantity of feed determine the productivity of livestock. In addition, there is a high demand for livestock products (mainly milk and meat) by rural and urban communities. The amount of land covered by forage crops and grazing land decreased, while food crop cultivation land increased as a result of population growth. However, more land is covered by crop production and there is food insecurity in many households. Therefore, the production of forage for livestock is important to improve livestock production and productivity and obtain optimum livestock products for home consumption, as well as income generation that results in food security. Owing to the lack of livestock feed, both in terms of amount and in terms of quality, many livestock were not provided their optimum product. Furthermore, many livestock do not survive drought or diseases related to feed scarcity. Hence, the evaluation and demonstration of forage crops at the farm level are important to solve such problems.

The results of on farm evaluation and pre-demonstration showed that the Areka and Kulumsa varieties gave good fresh biomass and dry matter yields throughout the year. Therefore, cutting and carrying systems are important for feeding livestock at home (for fattening and/or milk production). Areka and Kulumsa varieties were good for all recorded parameters, and they could solve current feed shortages in the study areas and areas with similar agro-ecologies. The experimental and visiting farmers selected the Areka and Kulumsa varieties for forage production. Therefore, it is better to pre-scale these Desho grasses at the study sites and in areas with similar agro-ecologies. To understand the benefits of grass varieties as livestock feed, further research is needed on the nutritional composition of the grass and the effect of the grass on livestock productivity (milk and meat production).

REFERENCES

1. Central Statistical Agency (CSA) ,2022. Federal Democratic Republic of Ethiopia, Statistics Service. Agricultural sample survey, Livestock and livestock characteristics (Private Peasant Holdings), Volume II, Statistical Bulletin 594, Addis Ababa, Ethiopia.

2. Manaye, T., A. Tolera and T. Zewdu,2009. Feed intake, digestibility and body weight gain of sheep fed Napier grass mixed with different levels of Sesbania sesban. Livestock Science, 122(1), 24-29. https://doi.org/10.1016/j.livsci.2008.07.020

3. ILRI ,2009. Forage seed systems in Ethiopia: Fodder Round Table meeting, Addis Ababa, 12 March, 2009. Addis Ababa: ILRI. https://hdl.handle.net/10568/543

4. FAO,2010. Grassland Index. A searchable catalogue of grass and forage legumes Food and Agriculture Organization of the United Nations, Rome, Italy.

5. Rehman, A., L. Jingdong, A. A. Chandio and I. Hussain,2017. Livestock production and population census in Pakistan: Determining their relationship with agricultural GDP using econometric analysis. Information Processing in Agriculture, 4(2), 168-177. https://doi.org/10.1016/j.inpa.2017.03.002

6. Fekadu, D., S. Bediye and Z. Sileshi,2010. Characterizing and predicting chemical composition and in vitro digestibility of crop residue using near infrared reflectance spectroscopy (NIRS). Livestock Research for Rural Development. Volume 22, Article #29. Retrieved April 1, 2024, fromhttp://www.lrrd.org/lrrd22/2/feka22029.htm

7. Anele, U. Y., O. M. Arigbede, J. A. Olanite, I. O. Adekunle, A. O. Jolaosho, O. S. Onifade and A. O. Oni,2008. Early growth and seasonal chemical composition of three indigenous multipurpose tree species (MPTS) in Abeokuta, Nigeria. Agroforestry systems, 73, 89-98. https://doi.org/10.1007/s10457-007-9101-6

8. Welle, S., K. Chantawarangul, S. Nontananandh and S. Jantawat,2006. Effectiveness of grass strips as barrier against runoff and soil loss in Jijiga area, northern part of Somali region, Ethiopia. Agriculture and Natural Resources, 40(2), 549-558.

9. EPPO (European and Mediterranean Plant Protection Organization) ,2014. PQR database. Paris, France,EuropeanandMediterraneanPlantProtectionOrganization.http://www.eppo.int/databases/pqr/pqr.htm (accessed on 29 July, 2015). Ethiopia. 160p. Extension.

10. Leta, G., A. J. Duncan and A. Abdena,2013. Desho grass (*Pennisetum pedicellatum*) for livestock feed, grazing land and soil and water management on small-scale farms. NBDC Brief. ILRI, Nairobi, Kenya

11. Ecocrop, 2010. Ecocrop database. FAO. http://ecocrop.fao.org/ecocrop/srven/home. (Accessed 02, February 2015).

12. MoA ,2017. Plant Variety Release, Protection and Seed Quality Control Directorate. Crop Variety Register, Issue Nº. 20. Ministry of Agriculture and Livestock Resource. Addis Ababa, Ethiopia.

13. Belay, A., J. W. Recha, Woldeamanuel and J. F. Morton,2017. Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. Agriculture & Food Security, 6, 1-13. https://doi.org/10.1186/s40066-017-0100-1

14. Mekonnen, Z. ,2022. Intra-household gender disparity: effects on climate change adaptation in Arsi Negele district, Ethiopia. Heliyon, 8(2): 1-8. https://doi.org/10.1016/j.heliyon.2022.e08908

15. Alemu, Y. and D. Tolossa,2022. Consultation and Displacement in Large-Scale Agriculture Investment: Evidence from Oromia Region's Shashamane Rural District. Land, 11(9), 1384. https://doi.org/10.3390/land11091384

16. Hunduma, T., K. Assefa and T. Firomsa,2016. Soil Fertility Assessment and Mapping at Shashamane District, West Arsi Zone, Oromia, Ethiopia. International Journal of Research and Innovations in Earth Science, 3(5), 82-87.

17. Erbo, K. and A. Rabo,2023. Smallholder Farmers' Adaptation to Climate Change and Determinants of their Adaptation Decisions in Shashemene District, South Eastern Rift Valley of Ethiopia. J Earth Sci Clim Change, 14(9), 1-7.

18. Kebede, M., E. Yirdaw, O. Luukkanen and M. Lemenih,2013. Plant community analysis and effect of environmental factors on the diversity of woody species in the moist Afromontane Forest of Wondo Genet, South Central Ethiopia. Biodiversity Research and Conservation, 29(2013), 63-80.

19. Fantahun, S.,2017. Determinants of Agricultural Information Need and Access of Smallholder Farmers. The Case of Wondo Intaye District West Arsi Zone, Ethiopia. Proceedings of the 9th Multi-Disciplinary Seminar Research and Knowledge Management Office, St. Mary's University. Addis Ababa, Ethiopia.

20. Ango, T. G. ,2005. Prospects of sustainable natural resource management and livelihood development in Wondogenet area, southern Ethiopia (Master's Thesis, Addis Ababa University).

21. Duro, E. S. and Y. Tadesse,2022. Assessment of cattle breeding practice of the community in Wondo genet district, Sidama regional state Southern Ethiopia. Int. J. Adv. Res. Biol. Sci, 9(6), 39-50.

22. Somano, W. and T. Tefera,2015. Financial Analysis of Small-Scale Irrigation Based Vegetable Production in Wondo Genet District of Sidama Zone, Southern Ethiopia. Ethiopian Journal of Applied Science and Technology, 6(2), 35-52.

23. Dembi, K., K. Basha and A. Girma, 2020.Cluster Based Pre-Scaling Up of Improved Irish Potato Variety at Highland Districts of Guji Zone, Southern Oromia,

Ethiopia. International Journal of Food Science and Agriculture, 4(3), 323-329

24. Amare, G., B. Kebede, D. Korji and T. Bobo,2023. Pre-scaling up of Tef Variety in Midland Districts of Guji Zone, Southern Oromia, Ethiopia. American Journal of Agriculture and Forestry, 11(1), 18-22.

25. Bantihun, A., B. Asmare and Y. Mekuriaw,2022. Comparative evaluation of selected grass species for agronomic performance, forage yield, and chemical composition in the highlands of Ethiopia. Advances in Agriculture. https://doi.org/10.1155/2022/6974681.

26. Mereba, F. L.,2023. Desho grass (*Pennisetum pedicellatum*) varieties adaptation trial in highland areas of the North Shewa Zone, Oromia region, Ethiopia. agriRxiv, (2023), 20231620990. https://www.cabidigitallibrary.org/doi/epdf/10.31220/agriRxiv.2023.00220.

27. Asmare, B., Y. Mekuriaw and L. Tekliye,2017. Desho grass (*Pennisetum pedicellatum* Trin.) evaluation based on plant characteristics, yield and chemical composition under irrigation in Northwestern Ethiopia. Journal of Agriculture and Environment for International Development, 112(2), 241-251. https://doi.org/10.12895/jaeid.20182.704.

28. Husein, N. and D. Wana,2022. Evaluation of Desho (Pennisetum pedicellatum) grasses for A adaptability and Y ield Performance in Different Agro - Ecologies of East Showa and West Arsi Zone of Oromia, Ethiopia. RRJEAES, 10(01), 1-9.

29. Smith, G. ,2010. Ethiopia: Local solutions to a global problem. Retrieved from View.

30. Fikadu, T., W. Tesfaye, W. Bekuma and M. Furgasa, 2022.On farm Evaluation of Desho grass (*Pennisetum pedicellatum*) for Forage and Nutritional quality at Midland and Highland Agro-Ecologies of Eastern Hararghe, Ethiopia. Forage Research Journal, 47(4), 840-486. https://forageresearch.in/wp-content/uploads/2022/05/480-486.pdf.

31. Hidosa, D. and D. Getaneh,2021. Evaluation of desho (*Pennisetum pedicellatum*) grass varieties for dry matter yield and chemical composition under irrigation in two districts of South Omo zone, Southwestern Ethiopia. East African Journal of Sciences, 15(1),71-78. https://doi.org/10.20372/eajs.v15i1.1396.

32. Jabessa, T., K. Bekele and Z. Amare,2021. Evaluation of desho grass for their agronomic performances and nutritive values in highland and midland areas of Guji zone, Southern Oromia. Ethiopia. Sci. Res, 9(3), 35-40. https://doi.org/10.11648/j.sr.20210903.11

33. Kebede, B., T. Bobo, D. Korji and G. Amare,2023. Pre-Extension Demonstration of Improved Desho Grasses at Highland Districts of Guji Zone, Southern Oromia, Ethiopia. American Journal of Agriculture and Forestry, 11(1), 23-28. https://doi.org/10.11648/j.ajaf.20231101.14.