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Evaluation of Improved Napier Cultivars as Livestock Feed Under Farmers Conditions in West Hararghe Zone, Oromia Region, Ethiopia

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Abstract: This study was conducted to evaluate the forage production and farmers preference as livestock feed under farmer's conditions in West Hararghe Zone of Oromia region, Ethiopia. Four improved Napier grass cultivars (ILRI cultivar number: 16801, 16800, 16798, and 16840) and local check were planted in a Randomized Complete Block Design (RCBD) with six replications during the main cropping season of 2018/19. The dry matter (DM) yield, fresh biomass yield, plant height, leaf length and leaf-stem ratio and other agronomic data were measured at harvest. Farmers preference of the Napier grass cultivars as livestock feed was collected through visual and hand evaluation of the multiple ranking criteria of the cultivars based on phonological nature. The results shows that, ILRI cultivar no. 16800 was higher (P<0.01) in the leaf to stem ratio than other Napier grass cultivars tested under farmers conditions. Similarly, ILRI cultivar 16800 was higher in DM yield and fresh biomass yield (P<0.05; 16.6 t/ha and 99.40 t/ha) respectively than ILRI cultivar 16798 (11.65 t/ha and 64.53 t/ha) respectively, but similar with other cultivars. According to the farmer's and developmental agent (DA) preferences, ILRI cultivar No. 16800 scored highest (4.56) followed by ILRI cultivar No. 16840 (4.00) and ILRI cultivar No. 16801 (3.89). The lowest score was given to ILRI cultivar No. 16798 (3.11) followed by local check (3.67). The results indicated that all Napier grass cultivars was ranked beyond good performance score (>3), as an indicator for livestock feed. From this study, it is concluded that Napier grass cultivars No. 16800, 16840 and 16801 were found promising in terms of agronomic traits, DM yield and fresh biomass yield than others during main rainy season (July to September) that needs further evaluation during dry season to demonstrated and popularized as an alternative feed resources under smallholder conditions in the study areas and other places of east and West Hararghe zones of Oromia region with similar climatic and edaphic conditions.

Keywords: Dry Matter Yield, Fresh Biomass Yield, Local, Preference

1. Introduction

Ethiopia has the largest livestock population in Africa, about 59.5 million head of cattle, 30.7 million sheep, 30.2 million goats, 8.4 million donkeys, 2.03 million horses, 0.4 million mules, 1.2 million camels, 56.5 million poultry and 5.9 million beehives [9]. Livestock production in Ethiopia contributes about 45% agricultural output, 25% of total agricultural growth domestic product (GDP), 15 - 17% the overall growth domestic product (GDP), [4], above 21% of all the national growth domestic product (GDP), 34% and 32% milk and meat contribution at smallholder farmers level Shapiro *et al*. [30] and about 80% used for traction to plough their fields [6]. At the household level, livestock plays a critical economic and social role in the lives of pastoralists, agro-pastoralists and smallholder farm households that fulfills an important function in coping with shocks, accumulating wealth and serving as a store of value in the

absence of savings (financial) institutions and factor and output markets [5].

Although livestock has many roles in the household and national economy of the country, current contribution of this subsector is below its potential (earning foreign exchange, country overall GDP and households contribution) due to various technical and non-technical problems. Among technical issues, shortage of improved and natural pasture both in quantity and quality is the one [8]. Abdi *et al.* [1] reported that inadequate supply of feed in both quantity and quality are a problem responsible for the low production of the livestock in West Hararghe. Fekede *et al.* [12] and Fikadu and Asfaw [14] also reported that livestock production reduced from time to time due to various factors like shortage of grazing land, drought, lack of improved animal breeds for all livestock type and grazing land conflict among tribes. Some of the constraints such as the frequent occurrence of drought, overpopulation, and cropland expansion account for the major causes of feed resource shortage in West Hararghe.

West Hararghe has a great opportunity for cattle production due to the availability of diversified breeds, good fattening weather, good indigenous knowledge of fattening, the recent introduction of some improved forage varieties such as (Desho grass, Braccharia and Rhodes grass), the popularity of fattened Harar bull in the country. But cattle fattening requires both quality and quantity feeds. In contrast, this in West Hararghe feed shortage is accounts 75.7%, Animal health (4.8%) and feed cost (3%) [1]. Previous studies in various parts of West Hararghe Zone Fekede *et al.*[12]; Fikadu and Asfaw [14] and Muleta *et al.* [26] reported that the major constraints of cattle keepers showed that feed shortage is ranked the first constraint of livestock production. In addition, Muleta *et al.* [26] showed that feed shortage due to cropland expansion that results in a shortage of grazing lands. Fikadu and Asfaw [14] also reported that the major feed resources of livestock such as grasses, trees, and shrubs obtained from enclosed forest area and in turn serve as incentives for the households.

Hence, promoting forage development through different strategies such as an intercropping, backyard, around farm edges and river basin, on soil bunds, on sloping land areas and roadsides are some of the options for enhancing feed resources availability in the area [26]. So, it is important to introduce improved forages to the area under smallholder farmers so as to alleviate the problems. Amongst the improved forage crops Napier grass (*Pennisetum purpureum* (L.) Schumach) could play an important role in providing a significant amount of quality forage, both for the smallholder farmer as well as intensive livestock production systems with appropriate management practices [3].

Objectives
1) To evaluate the forage production potential of improved Napier grass cultivars under smallholder farmers in the highland part of Western Hararghe Zone and
2) To assess farmers preference for the improved Napier grass cultivars as a feed for livestock production in the area.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in West Hararghe zone high land parts which include Chiro, Tulo and Gemechis districts. These districts were selected purposively depending on agro-ecology (high land parts of the zone) which describes as follow.

Chiro district is located at 8°55′N and 40°15′E. It is bordered on the south by Gemechis, on the west by Guba Koricha, on the northwest by Mieso, on the north by Doba, on the northeast by Tulo, and on the east by the Galetti River which separates it from Mesela and the East Hararghe Zone. *Chat* is an important cash crop of this district, but because it is a very perishable commodity and must be cultivated not too far from major markets or good roads, it is grown along the main road. Coffee is another important cash crop, with over 5,000 hectares is planted with this crop [14]. The district is mainly characterized as steep slope and mountains with rugged topography, which is highly vulnerable to erosion problems [13]. It has maximum and minimum rainfall of 1800 and 900 mm respectively [21]. Rainfall type is bimodal and erratic in nature. Main rainy season is from June to September for the high land areas and from March to April midland and that of lowland around July. The amount of rainfall is relatively adequate in the highland and midland than the lowland [13]

Tulo is one of the districts in the West Hararghe Oromia Regional State, of Ethiopia. Tulo is bordered on to the north by Doba to the south by Mesela, to the east by the West Hararghe and to the west by Chiro. Coffee is an important cash crop of this district, with over 50 square kilometers being planted with the crop. Tulo district has 45,670 ha of land area and located at 370 km southeast of Addis Ababa. The average altitude of the district is 1750m above sea level with a mean annual rainfall of 1850 ml and mean annual temperature of 23°C. The production system is a mixed type in which extensive husbandry management of livestock have been practiced [24].

Gemachis district is also found in West Hararghe Zone, Oromia National Regional State, and eastern part of Ethiopia. The district is located about 343 km southeast of Addis Ababa and 17 km from Chiro town, the capital of West Hararghe Zone. It shares a border with Chiro district in the West and North, Oda Bultum district in the South and Mesala district in the East directions. It is located at 9° 0′ 44.992″ latitude in the North and 6° 39′ 50.42″ longitudes in the East. The district covers an area of 77,785 ha and it has 35 rural *kebeles* and 3 urban administrative towns [16]

Mixed farming (crop production and livestock rearing) is the predominant sources of livelihood for the majority of the population in the area. The major crops produced in Gemachis district are sorghum, maize, barley, wheat and *teff* among food crops, haricot bean, faba bean pea and *noug* among oil and pulse crops, and horticultures (fruits, vegetables, root and tuber crops) are potatoes, banana, onion, hot pepper, head cabbage, carrot, and sweet potato. Moreover,

livestock rearing is another agricultural activity practiced in the district. The major livestock reared in the districts are cattle, goats, sheep, and poultry [16].

The district is found within 1300 to 3400 meter above sea level (m.a.s.l). The minimum and maximum annual rainfall is 800 mm and 1200 mm with an average of 850 mm. The district has bi-modal distribution in nature with small rains starting from March/April to May and the main rainy season extending from June to September/October. The minimum and maximum temperature 15°C and 30°C with the average temperature is 22°C [16]. The district categorized into three agro-ecologies. These are highland, midland and lowland agro-ecologies which cover 15%, 45% and 40% of the district, respectively [14]
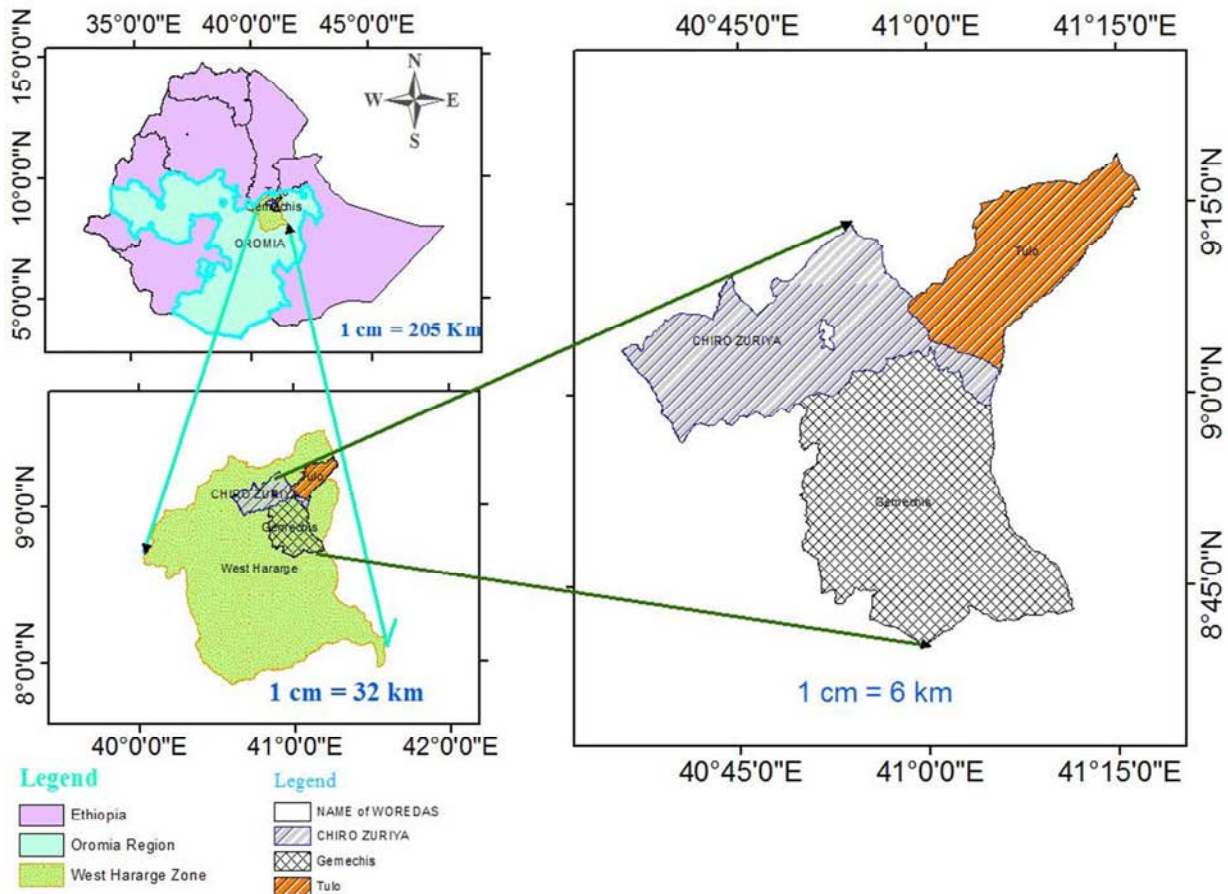
Source of the map: Ethio-GIS shape file, 2016

Figure 1. *Map of the study area.*

2.2. Experimental Design and Treatments

The experiment was conducted under field conditions during the main cropping season of 2018/19 in selected districts of West Hararghe zone. Accordingly, three districts, which includes Gemechis, Chiro Zuria and Tullo were selected and used to conduct this experiment. These districts were purposively selected based on agro-ecology (high land parts of the zone). The planting material used for this was Napier grass cultivars which include (*ILRI#*16801, ILRI#*16800, ILRI#*16798, ILRI#* 16840 and local check*) were collected from Mechara Agricultural Research Center (McARC). In order to start this activity, two farmers from each district were selected based on their voluntariness, have a practice of soil bund in their crop farm and suitableness for the activity to be conducted. After the farmers have been selected, they were started to prepare the land starting from the mid of April to the last week of June for three times. The last week of June, uniform adapted root of Napier grass was taken from McARC and planted in the above selected districts. This material was planted in two rows (0.4 m and 0.5m between plant and row respectively) along the soil bund of the selected farmers and 2 m X 0.6 m plot size using a randomized complete block design (RCBD) with six replications (each farmer was used as replication or farmers as a block). Uniform root split of Napier grass was planted to a depth of 15-20 cm [29] at an angle of 45 degrees [19]. A total of ten (10) uniform split roots were planted per plot as plants from root splits make more rapid early growth and give high herbage yields than from stem cuttings [33]. Fertilizer application was uniformly applied to all plots in the form of nitrogen, phosphorous and sulfur blended fertilizer (NPS) at the rate of 100 kg/ha at the time of planting. All other crop management practices were done uniformly to all plots as required.

2.3. Data Collection

Total green forage yield per plot was totally harvested at forage harvesting stage from total plot next to the guard of 10 to 15 cm above the ground level and weighted using sensitive balance when Napier grass cultivars reach the age of 3 months maturity level [32]. The weight of the total fresh biomass yield was recorded to determine fresh biomass yield. Plant height was based on ten culms taken randomly selected and measured in centimeters (cm) using a steel tape from the ground level to the end of meristem leaf and the average height of all the plants was taken as a height of plant at each plot. Leaf height and leaf width were taken simultaneously also from ten plants randomly selected and measured in centimeters (cm) and the average height of all leaf and width was taken as a height and width of leaf respectively from each plot. It was taken first leaf height and then dividing the same leaf into equal at the center starting from the base and then leaf width was measured.

Five plants in each treatment were randomly selected to record a number of tillers per plant (NTPP), basal circumference per plant (BCPP) and the total number of leaves per plant (TLPP). Plant survival rate was calculated as the ratio of the number of a live plants planted per plot to the total number of plants planted per plot and then multiplied by 100. Data of top leaf hair (TLH), bottom leaf hair (BLH) as leaf hairiness: 0 = no hair, 1 = sparse and 2 = dense; bottom leaf roughness (BLR) and top leaf roughness (TLR) as roughness: 0 = smooth, 1 = rough and 2 = very rough and as well as sheath color (SC) and leaf color (LC) as 0 = yellow, 1 = pale green, 2 = green and 3 = dark green as [28] recorded. Five plants were taken randomly from each plot to determine the number of leaves per tiller [35]. Farmers and DA's preference and perception was collected from six experimental farmers, ten key respective kebeles farmers and six DA's of the respective kebele's independently through ranking (1st, 2nd, etc ranks giving the score 5 = Best; 4 = Very good; 3 = Good; 2 = Average and 1 = Not good) [17] on the criteria of fast growth, survival rate, fresh biomass yield, leafiness, easy to manage (growth habit: erect or tuft), easy for maintain, reduce soil loss and soil bund stabilizer. Preferences also collected through a selection of ten key kebele's farmers with the help of DA's through group discussion of ranking in the same manners.

2.4. Statistical Analysis

Data on agronomic yield and leaf characteristics was analyzed using ANOVA by the general linear model procedure of SAS, 2002 version 9.0.

Means were separated using Least Significant Difference (LSD) at 5% significant level.

The model was $Y_{ijk} = \mu + T_i + B_j + e_{ijK}$ where

Y_{ijk} = individual observation

μ = the overall mean

T_i = the effect for being in treatment i

B_j = the effect for being in block j and

e_{ijK} = experimental error

3. Results and Discussion

3.1. Agronomic Traits of Napier Grass Cultivars

Plot cover, survival rate, Leaf-stem ratio (LSR) and plant height of Napier grass cultivars were presented in (Table 1). Plot cover showed a significant (P<0.05) difference among Napier grass cultivars. The best plot cover was recorded from ILRI#*16800 (90%) followed by ILRI #*16840 (86.67%) cultivars and the lowest plot cover was recorded from ILRI#*16798 (77.50%). Cultivar ILRI#*16798 has both the lowest survival rate and plot cover percentage. This is might be due to this cultivar is not appropriate for this environmental, soil type and other environmental factors as environment has main effect on cultivar adaptability [20]

Significant difference observed in survival rate. The survival rate (number of life) of local Napier grass was higher (P<0.05) than cultivars of ILRI#*16801 and ILRI #*16798 but not statistically (P>0.05) difference with cultivars ILRI#*16800 and ILRI #*16840 which in contrast with [11] who reported that number of surviving individuals were not significantly different but in line with [33] showed a significance difference. The highest 83.33% of survival rate was recorded from the local variety and 80% was recorded from cultivars ILRI #*16800 and ILRI #*16840. The lowest was recorded from ILRI #*16801 and ILRI#*16798 which was 68.33%. This value was lower than [33] that reports from 79.8 to 100%. The higher survival rate of local variety might be due familiarities with the environment than the newly introduced cultivars.

Plant height of Napier grass cultivars used for the present study has significance (p<0.01) variation among cultivars at 3 month age of harvesting. From present result, the minimum height of 114.85 cm was recorded from cultivar ILRI#*16798 while the maximum height of 135.87 cm was recorded from ILRI#*16800 which is in contrast with [10] that height of Napier grass accessions has no significant difference at 2 month age and the similar result with [19] that Napier grass genotypes tested over locations showed significant difference. The difference might be due to the varietal difference. [18] Reported that at 2 months of age Napier grass accessions attained the optimum plant harvesting stage (1-1.5 m) for forage and [10] found that 1 - 1.3 m at the age of 2 months. The findings by [38] also revealed that the height of the Napier grass accessions at the end of the establishment year varied from 1.4 m to 4.2 m. [22] also reported that significant differences among varieties in plant height. According to [25] studies, Napier grass is a tall perennial grass that grows to 2-5 m tall, rarely up to 7.5m.

There was a significant (P<0.01) difference in LSR of among the cultivars. The LSR of Napier grass cultivar ILRI #*16800 was higher (p<0.01) than cultivar ILRI #*16840 but not statistically (P>0.05) difference with cultivars ILRI #*16801, ILRI #*16798 and local revealed that cultivars ILRI #*16800, ILRI #*16801 and local contained higher nutrients than other and the performance of animals is closely related to the amount of leaf in the diet because leaf is generally of higher nutritive value than stem [10]. The

present result was supported by [40] who reported that the leaf-to-stem ratio (LSR) was significantly affected by cultivar and harvesting age. The same result obtained from these findings that cultivars had higher leaf fraction than stem fraction [41]

The leaf to stem ratio (LSR) is one of the criteria in evaluating the quality of the pasture because the higher proportion of leaves compared to stem indicate a better nutritive value [40]. In the present study, the LSR ranged from 0.86 to 1.00 were different from the range of ratio reported by [28] who reported that 1.7 to 3.1 and [33] reported 0.8 to 8.7 was might be due to varietal differences of Napier grass and the present findings have the same range with [10 and and 36] who reported that 0.31 to 1.03 and 0.41 to 1.13 respectively. [22] also reported the leaf-stem ratio of 0.68 to 1.63. Cultivar ILRI #*16840 recorded the lowest (0.86) LSR but the highest (1.0) of all the cultivar were similar to the trend reported from western Kenya [28].

Table 1. *Leaf to steam ratio, plant height (cm), Plot cover and survival rate of Napier grass.*

Cultivars	ED	Sur R%	Plot cov%	PH	LSR	BCPP
ILRI #*16801	17.67	68.33[b]	84.17[ab]	122.90[bc]	0.88[ab]	55.22[ab]
ILRI #*16800	17.00	80.00[ab]	90.00[a]	135.87[a]	1.00[a]	52.77[b]
Local	17.67	83.33[a]	83.33[ab]	123.27[bc]	0.96[ab]	56.26[ab]
ILRI #*16798	18.17	68.33[b]	77.50[b]	114.85[c]	0.94[ab]	60.78[a]
ILRI #*16840	16.33	80.00[ab]	86.67[a]	129.8[ab]	0.86[b]	54.68[ab]
Mean	17.37	76.00	84.33	125.34	0.93	55.95
CV	17.13	16.38	7.95	6.86	12.33	11.52
LSD	3.58	1.50	8.07	10.36	0.138	7.76
p-value	NS	*	*	**	**	*

Means followed by different superscript letters within a column are significantly different each other at $P < 0.05$. ED = Emergency date, PH = Plant height, Sur.R% = Survival Rate, plot Cov.= Plot cover, LSR = Leaf-stem ratio, BCPP = Basal circumference per plant, NS = Non significant, * = significant, ** = very significant

Fresh biomass yield, Dry Matter Yield, number of tillers, tiller length and total leaf per plan of Napier of Napier grass cultivars were presented in (Table 2). There was a significant (P<0.05) difference in DM yield among Napier grass cultivars. The highest yield was recorded from ILRI #*16800 (16.55 t/ha) followed by ILRI#*16840 (15.45 t/ha) and the lowest recorded from ILRI #*16798 (11.65 t/ha) followed by ILRI#*16801 (13.11 t/ha). This value was less than the yield obtained during adaptation trial at Mechara Agricultural Research Center on station that was 31.17 t/ha from ILRI#16800 and 30.04 t/ha from ILRI#16840 at the age of 8 months [43]. This might be due to the harvesting age difference, soil physio-chemical variation, and management difference. This result was supported by [39 and 33] reported that as maturity advanced, dry matter yield increases

The mean DM yield of the present result 14.13 t/ha was higher than the previous finding of 12.77 t/ha at 2 months age as reported by [10] and lower than the other findings of which was 41.05 t/ha at 4 months age as reported by [44] which might be due to the proportional increment of dry matter yield with advance in age of cutting [32]. [45] findings also showed that the dry matter yield of the wild Napier grass at first cut (harvest) ranged from 7.00–11.33 t/ha and [46] reported that yields depend on agro-ecological zone and management but on average Napier grass can give 12 to 25 t/ha of dry matter yield.

The higher dry matter recorded for cultivars ILRI#*16800, ILRI#*16840 and ILRI#*16801 suggested that these cultivars were competent with local cultivar and less moisture is present in the grass and will, therefore, reduce the rate at which the grass deteriorate when stored [44]. Cultivars ILRI#*16800 and ILRI #*16840 was produced longest Plant height that has higher dry matter yield which similar findings with [22] where the taller varieties showed higher dry matter yields.

There was no significance (P>0.05) variation observed in tiller number per plant between cultivars at age of 3 months of first harvesting. The results of tillers per plant for second round of harvesting after 60 days (2 months) of first harvesting was recorded and statistically (P<0.01) difference between in tiller number per plant was observed (Table 2). The tiller number ranged from 17.32 to 19.48 at first harvesting and at second harvesting it was ranged from 30.83 to 43.83. The variation in tiller number between different cultivars was also observed by [47; 36; 22 and 48].

There was no significance (P>0.05) difference in leaf number per plant at first harvesting time but the difference (P<0.05) was observed at second harvesting time after 60 days (2 months) of first harvesting. The maximum leaf number per plant was recorded from cultivar ILRI #*16800 at both harvesting time and the minimum was recorded from ILRI #*16798 both times. The present result was higher than [48] who reported that ranged from 70.6 to 104.5 per plant at stages of maturity and similar with [37] during the establishment year that ranged from 206.21 to 264.76 in different plant populations and [39] reported that cultivars had a significant effect on the number of leaves/plant.

Statistical (P>0.05) difference not observed in tiller length at harvesting time. The longest tiller was recorded from cultivar ILRI #*16840 (67.00 cm) followed by ILRI #*16800 (63.08 cm) and the shortest tiller was recorded from local (54.13 cm) followed by ILRI #*16798 (57.30 cm) which in line to [28] who reported that the longest tiller was 68.9 cm and the shortest was 38.5 cm.

There was statistical (P<0.05) variation among the cultivars in terms of fresh biomass yield. The fresh biomass

of Napier grass cultivar ILRI #*16800 was higher (p<0.05) than Napier grass cultivars ILRI#*16798 but no statistically (p>0.05) difference with cultivars ILRI#*16800, ILRI#*16840 and local at 90 days of harvesting. A similar result was obtained at second harvesting after 60 days of regrowth which shows that fresh biomass increases with the range of 5.44% to 10.88%. [49] reported that Cuttings can be made at 45-90 day intervals, depending on location. Several comparative studies on the effect of harvesting age showed that the optimal harvesting ages of Napier grass were within 5 to 9 weeks old [41]. The highest fresh biomass was recorded from ILRI #*16800 both at first and second

harvesting which was (89.65 and 99.40t/ha) followed by ILRI #*16840 which was (81.73 and 83.98t/ha) respectively and the lowest was recorded from ILRI #*16798 both at first and second harvesting which was (61.20 and 64.53t/ha), respectively. The result obtained from present findings was less than the fresh biomass obtained during adaptation trial at Mechara Agricultural Research Center on a station that was 163.17t/ha from ILRI#16800 and 157.3 t/ha ILRI#16840 at the age of 8 months [43]. [45] reported that similar result that wet weight of Napier grass ranged from 55.67±4.67 to 86.67±6.39 t/ha) and [17] reported 18.6 kg/m^2 which is equal to 186 t/ha.

Table 2. *Fresh biomass yield, Dry Matter Yield, number of tillers, tiller length and total leaf per plan of Napier.*

Cultivars	FBMY Htha		DMYt/ha	NTLPP		NTLPP		TL	GH
	1sthar	2nd har		1sthar	2nd har	1st har	2nd har		
ILRI #*16801	71.50^{ab}	75.43^{b}	13.11^{ab}	17.32	30.83^{b}	173.93	243.85^{b}	58.13	1.67^{a}
ILRI #*16800	89.65^{a}	99.40^{a}	16.55^{a}	19.20	43.38^{a}	188.05	286.05^{a}	63.08	1.00^{b}
Local	74.25^{ab}	72.57^{b}	13.87^{ab}	19.48	32.68^{b}	181.52	247.82^{b}	54.13	1.17^{b}
ILRI #*16798	61.20^{b}	64.53^{b}	11.65^{b}	18.33	33.12^{b}	173.15	240.85^{b}	57.30	2.00^{a}
ILRI #*16840	81.73^{ab}	83.98^{ab}	15.45^{ab}	19.85	37.40^{ab}	183.13	261.88^{ab}	67.00	1.00^{b}
Mean	75.67	79.18	14.13	18.83	35.32	180.16	256.09	58.26	1.37
CV%	29.21	28.13	26.94	12.63	16.99	11.01	10.80	19.40	20.70
LSD 5%	26.62	23.01	4.58	2.86	7.26	23.88	33.31	13.61	0.34
p-value	*	*	*	NS	**	NS	*	NS	***

Means followed by different superscript letters within a column are significantly different each other at P < 0.05. NS = Non significant, * = significant, ** = very significant, *** = highly significant, FBMY Htha = Fresh biomass yield at harvesting tonnes per hectare, 1sthar = at first harvesting, 2ndhar = at second harvesting, DMYt/ha = Dry Matter Yield tonnes per hectare, TL= Total leaf per plant, GH = Growth habit; 1 = erect, 2 = tufted, har = harvest

Leaf characteristics of five Napier grass cultivars were presented in (Table 3). Leaf hairiness was assessed on both the top and bottom parts of the leaf [28]. There was statistical (P<0.01) difference on top leaf hairiness and (P<0.001) bottom leaf hairiness. On top of the leaves, the hairiest cultivar was ILRI #*16798 whereas sparse hair was recorded from ILRI #*16801, ILRI #*16800, Local and ILRI #*16840. On the bottom part of the leaf which may affect the comfort of handling by smallholder farmers, ILRI #*16800 was less hair (sparse hair) which was similar with [28] most species had sparse hairs on their leaves and ILRI #*16798 were the hairiest. This result shows that all the Napier grass cultivars used for the present study have hair both at the top and bottom of the leaf. [28] reported that the hairiness of the leaves varied not only between cultivars but also within cultivars and some cultivars being practically glabrous (free from hair) while others had very dense hairs due to varietal difference.

The longest leaf was recorded from cultivars ILRI#*16840 (96.33 cm) followed by ILRI #*16800 (95.83 cm) whereas the shortest leaf was recorded from local (92.02 cm) (Table 3) that cultivars with longer leaf length give high dry matter yield [28]. [25] also reported that leaves of Napier grass can long as 30–120 cm and [34] reported from 20.9 to 74.4 cm.

There was significance (P<0.001) difference in leaf width among the cultivars. The cultivars with the widest leaves were ILRI#*16800 (4.67 cm) followed by ILRI#*16801 (4.62 cm) and the narrowest leaves were ILRI #*16840 (4.27 cm) followed by ILRI #*16798 (4.37 cm). The present leaf

width finding was higher than [28] who reported that the widest leave was 2.7 cm and the narrowest leave was 2.3 cm and [25] also reported that leaves could broad 1-5 cm and leaf variation characteristics due to the varietal difference. This variation might be due to cultivars difference, environmental difference and soil nutritional and structural difference.

Figure 2. While measuring leaf width (left side) and measuring leaf length (right side).

There was no significance (P>0.05) difference in sheath hair that most cultivars have sparse hair similar findings with [28] who reported that most species had sparse sheath hair and also most of the cultivars had a green leaf. Top leaf roughness has significance (P<0.001) difference. The most top leaf roughness was recorded from cultivar ILRI #*16798 followed by ILRI #*16801 whereas sparse hair was recorded from ILRI #*16800, ILRI #*16840 and local. There was also a significance (P<0.01) difference bottom hair leafiness

among the tested cultivars. The most bottom roughness was recorded from cultivar ILRI #*16798 whereas the sparse roughness was recorded from cultivar ILRI #*16800.

Figure 3. Experimental farmers evaluate Napier grass leaf roughness and hairiness on the far.

Table 3. Leaf characteristics of five Napier grass cultivar.

Cultivars	Characteristics							
	LL	LW	TLH	BLH	SH	TLR	BLR	LC
ILRI #*16801	95.06	4.62[a]	1.17[b]	1.00[b]	1.00	0.83[bc]	0.83[b]	2.17[ab]
ILRI #*16800	95.83	4.67[a]	1.00[b]	0.83[b]	1.00	0.67[c]	0.50[b]	2.5[a]
Local	92.02	4.53[ab]	1.00[b]	1.00[b]	1.33	0.50[c]	0.67[b]	1.5[b]
ILRI #*16798	95.05	4.37[ab]	2.00[a]	2.00[a]	1.33	2.00[a]	1.67[a]	1.5[b]
ILRI #*16840	96.33	4.27[b]	1.00[b]	1.17[b]	1.50	1.17[b]	0.83[b]	1.67[ab]
Mean	94.84	4.49	1.23	1.2	1.23	1.03	0.90	1.87
CV%	2.61	6.03	42.37	37.57	34.40	33.05	4.08	37.88
LSD 5%	2.98	0.32	0.63	0.54	0.51	0.41	0.44	0.85
p-value	NS	***	**	***	NS	***	**	*

Means followed by different superscript letters within a column are significantly different each other at P < 0.05. Scores were: Leaf hairiness 0 = no hair, 1 = sparse and 2 = dense; roughness 0 = smooth, 1 = rough and 2 = very rough; colour 0 = yellow, 1 = pale green, 2 = green and 3 = dark green, NS = Non significant, * = significant, ** = very significant, =*** highly significant, LL = Leaf Length, LW = Leaf Width, TLH = Top leaf hair, BLH = Bottom leaf hair, SH = Sheath hair, TLR = Top leaf roughness, BLR = Bottom leaf roughness and LC = Leaf color

3.2. Farmer's Perception Towards Napier Grass on Soil Bund

3.2.1. Ranking Napier Grass According to Animal Feed Importance

Results from six experimental farmers, ten respective kebele's key farmers and DA's scores for Napier grass cultivars along the soil bund and perceptions for Napier grass as animal feed importance in different criteria's were presented in (Table 4). The values reflected the perceived degree of importance of Napier grass based on their criteria like fast growth, biomass yield and leafiness of the grass. The visual and hand evaluation of the farmers and development agents (DA) was very critical for ranking of this cultivars. Accordingly, the average rank showed that farmers gave the

highest total score for cultivars ILRI#*16800 (4.56) followed by ILRI #*16840 (4.00) and ILRI #*16801 (3.89) and farmers and DA's gave the lowest total score for ILRI #*16798 (3.11) followed by local which was (3.67). They ranked first, second, third and fourth in order of ILRI#*16800, ILRI #*16840, ILRI #*16801 and local. The last and least rank was given for ILRI#*16798. The result also indicated that all Napier grass cultivars were ranked beyond good performance score (> 3). The Napier grass cultivars were found extremely superior to the other introduced grasses species in terms of different farmers' criteria.

The discussion with farmers showed that Napier grass was highly valuable in soil bund stabilization. They said the

Napier grass is fast growing, easy to establish and maintain, needs lesser management, high biomass yield, has higher palatability and harvesting frequency than the others similar to [39] reported that Napier grass possesses a number of attributes including high biomass yield, rapid re-growth potential, and ease of propagation. Farmers strongly agreed that Napier grass can alleviate animal feed shortage than other feeds due to growth on soil bund and fast growth. [1] reported that feed shortage is the major constraint of livestock production ranking first in West Hararghe.

3.2.2. Survival and Plot Cover of Napier Grasses on the Soil Bund

A comparison of the survival and plot cover or vigorcity of five Napier grass cultivars along soil bund was shown in (Table 4). Farmers and development agents (DA) were evaluated Napier grass cultivars according to their criteria's of survival and plot cover. They ranked firstly cultivars ILRI #*16800 and local; secondly cultivars ILRI #*16840 and ILRI#*16801 in terms of survival and plot cover and the least score for ILRI #*16798 was given. Farmers strongly believed that plot cover is the most criteria for giving a high yield of biomass yield.

and reduce soil losses was presented in (Table 4). Accordingly, performances of individual Napier grass cultivars on soil bund stabilizing and reduce soil loss were variable. Generally, farmers and DA's gave scores based on the multipurpose nature of the Napier grass as reported [17] the farmers reflected the perceived degree of importance of each soil and water conservation practices based on their criteria. Farmers were selected cultivars ILRI#*16798 as first in terms of soil bund stabilizing and reduce soil loss due to its tufted growth habits and covers over the bund of the soil. But they did not prefer such kind of grass due to its extent over the soil bund and compete for land with other crops.

The farmers choice Napier grass along the soil bund rather than planting it alone due to land shortage as [14] reported mean land holding size per household of Gemechis district is 0.39ha and 0.5ha for Chiro as reported by [21] that is below national average land holding size per household which accounts 1.14ha in 2014/15 [7] and 1.14ha for the Oromia region. The farmers agreed that Napier grass has advantage soil bund stabilizing similar with [42] who reported that suitable stabilizers, grasses or shrubs, are needed to compensate the yield losses caused by the construction of soil bunds and re-enforce the structures. [17] findings also revealed that grasses can be used as animal feed, stabilize physical measures to reduce maintenance cost and reduce soil erosion. The same findings reported by [27] forages used by smallholder farmers in the soil conservation of northwestern Ethiopia were Napier grass (*Pennisetum purpureum*) have the potential to minimize rates of erosion, keep clay materials in its original place, and capture eroded clay materials [31].

Figure 4. Experimental Farmers selecting Napier grass cultivars based on uses for animal feed and soil bund stabilizing.

3.2.3. Farmer's Perception Towards Napier Grass as Soil Bund Stabilizer

A result of Napier grass cultivars on soil bund stabilizing

Figure 5. Key selected Farmers evaluating Napier grass cultivars as used for animal feed and soil bund stabilizing.

Table 4. *Farmers' average scores of different Napier grass cultivars based on different evaluation criteria.*

Criteria of comparison	Preference ranking of Napier grass accessions				
	ILRI #*16800	ILRI #*16798	Local	ILRI #*16801	ILRI #*16840
Survival Rate	5	3	5	4	4
Fast growth	5	3	4	4	4
Fresh biomass	5	2	3	3	5
Leafiness	5	3	4	4	3
Easy to manage (Growth habit)	5	2	3	3	4
Reduce soil loss	3	5	4	4	4
Stabilizing the bund	3	5	4	4	4
Plot cover	5	2	3	4	4
Easy for maintenance	5	3	3	4	4
Average	4.56	3.11	3.67	3.89	4.00

Scores: 5 = Best; 4 = Very good; 3 = Good; 2 = Average; 1 = Not goo

3.2.4. Farmer's Perception of Napier Grass Maintenance and Management

The perception and preference of farmers and development agents (DA) towards the maintenance and management of Napier grass cultivars along soil bund were presented in (Table 4). Most farmers preferred Napier grass other than local and introduced grasses on soil bund structure because of fats growth, easy to manage and maintain and have no nature of evasive. Easy propagation, fast growth, high forage yield, good palatability, effective restraining of soil particles, quick recovery of roots after damage/complete burial, capacity to establish on diverse environmental conditions and insect/pest free characteristics make Napier (*Pennisetumpurpureum*) superior and preferred species for forage production and soil conservation in the watershed than Stylo, Molasses and Broom grass [23].

According to their selection criteria, they prefer cultivars that have erect growth both leaves and stems. This is because tufted growth nature covers larger land and not suitable for management. [50] reported that due to the fact that most smallholder livestock producers predominantly own small and fragmented pieces of land, grasses such as Napier grass offer a best-fit alternative to other feed options, as these are high yielding forages which require a minimum amount of inputs and land. [17] findings also revealed that grasses can be used as animal feed, stabilize physical measures to reduce maintenance cost and reduce soil erosion. Farmers were very eager for Napier grass to use along soil bund, the border of their land to separate one farm from the others, uses as a windbreak in the farm as well as around the compound or houses.

4. Conclusions

Napier grass cultivars respond differently for agronomic performance under farmer condition of West Hararghe zone. The measured agronomic traits such as plant survival rate, plot cover, leaf-stem ratio, plant height, basal circumference, forage DM yield, fresh biomass yield, and Leaf characteristics showed statistical variations among the cultivars. On the other hand, total leaf per plant, leaf length and emergency date were not showed statistical variation.

The highest DM yield and fresh biomass yield was obtained from cultivar ILRI #*16800 followed by ILRI #*16840 and locally adapted and the lowest DM yield and fresh biomass yield was recorded from ILRI #*16798 cultivar. Farmers gave the highest total score for cultivar ILRI #*16800 (4.56) followed by ILRI #*16840 (4.00) and ILRI #*16801 (3.89) and the lowest total score for ILRI #*16798 (3.11) followed by local which was (3.67). The farmers choice Napier grass along the soil bund rather than planting it alone due to land shortage, have on evasive nature and they agreed that Napier grass has an advantage of soil bund stabilizing, reduce maintenance cost and soil loss and alleviate animal feed shortage in both quality and quantity. From this study, cultivars ILRI #*16800 and ILRI #*16840 are recommended for West Hararghe zone, high land districts. Generally, Napier grass cultivars such as ILRI #*16800, ILRI #*16840 ILRI #*16801 and locally adapted are recommended for wider cultivation due to better agronomic performance and preferred by local farmers.

Conflict of Interests

The authors have not declared any conflict of interests.

Acknowledgements

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