Original Research Article

FTC-based forage demonstration of elephant grass technology in central highlands of Ethiopia: Evidence from Ginchi, Wonchi and Debrelibanose district

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Abstract

The study was conducted in three dairy potential areas of Ginchi, Wonchi, and Debrelibanose districts of the Oromia region of Ethiopia, with the objective of demonstrating promising elephant grass materials to smallholder dairy farmers. As a methodology, a participatory extension approach is employed in this particular study to select a demonstration site and a total of 6 FTC were selected with an area of $10m^2$x $20m^2$ plot sizes from each district. Elephant grass with Accession numbers (ILRI14794) material as a candidate and along with the check were demonstrated and evaluated for their biomass yield across tested sites. During the implementation phase, on-spot training comprising both theoretical and practical was provided to smallholder farmers, development agents, and agricultural experts of respective districts. The finding of this research revealed that there was a statistically significant difference in dry matter yield of demonstrated candidate material (ILRI14794) over the local check at ($p<0.01$) probability level. And the dry matter yield of the candidate (ILRI14794) ranged from 13.50 to 4.92 t/ha with a mean of 9.21 t/ha while the check provided 8.75 t/ha and 3.91 t/ha dry matter yield across the tested site. Moreover, Elephant/Napier grass materials responded differently across the tested sites because of differential responses of the climatic and biotic factors. The highest average yield of the candidate (ILRI14794) was recorded at Ginchi district (10.40 t/ha) and followed by Debrelibanose district (8.87 t/ha) as compared to Wonchi district due to field management and other climate variability. Thus, the study recommended that it's paramount to promote (ILRI14794) elephant grass accession with its recommended production package for further scaling up and popularization in the study area under similar agroecology with the joint effort of the district office of agriculture, non-government organizations and by other concerned stakeholders.

Keywords: Demonstration; District; Elephant grass; Forage; FTC

INTRODUCTION

Ethiopian smallholder is engaged in a mixed crop-livestock farming system and the natural grazing land and crop residue is the sole source of livestock feed. natural pasture and crop residues and crude estimations of the available feed in different parts of the country depict a deficit of 35 – 57% even for maintenance [4] It is unlikely to improve livestock productivity via the commercial orientation of the production system without the concomitant intensification in feed production. Research efforts over the last four decades have identified and recommended various high-yielding and adaptable forage species in different agro-ecological zones of the country.

There is also a growing demand for livestock products in the international markets. The huge livestock resource base and the strategic position of Ethiopia make it of regional importance for livestock production, in providing those neighboring and Middle East countries, which are dependent on imported livestock and livestock products. Despite the opportunity of growing demand for livestock products both domestically and in the international markets, the rate of return from livestock production has severely lagged behind the expectation in Ethiopia.

The low productivity of the livestock sector is a result of several limiting factors among which feed is the major one [10] Despite serious problems of feed shortage and a large number of livestock in the Ethiopian highlands, the adoption, and popularization of forage crops is very poor [10] Various efforts have been made by different organizations, often with the support of externally funded projects to promote improved fodder crops to the farming communities. However, the adoption of improved fodders by the farming community has so far been very limited and their potential for sustainable feed supply is largely untapped in the country.

Sustainable livestock production is highly reliant on the accessibility of quality feed and forage resources. Napier grass, also known as an elephant or Uganda grass, is one of the very important tropical forage crops. It is extensively used in cut and carries feeding systems [1] and is of growing importance in other agricultural systems. Napier grass has many desirable characteristics, including high yield per unit area, tolerance to intermittent drought, and high water use efficiency making it forage of choice. It can

persist with repeated cutting and will rapidly regenerate, producing palatable leafy shoots [2].

Sowing a new pasture or improving an existing natural pasture needs a reliable source of seed or vegetative material or species recommended and adopted for the area [5]. Inadequate nutrition and feeding are major limitations to livestock production in sub-Saharan Africa (SSA). Feeds (usually based on fodder and grass) are either unavailable in sufficient quantities due to changing weather conditions or are available but in poor quality that they do not provide adequate nutrition [6]. These limitations result in low milk and meat yields, high mortality of young stock, longer inter-calving intervals, and low animal weights [7]. Usage of improved forages crops would reduce pressure on natural pasture, improve soil fertility and erosion of marginal lands, improve carbon sequestration to mitigate climate change, support the system substantially and enhance natural assets and system reliance [7, 8], for instance, some of the improved forage species can be used for these above services are Desho grass, elephant grasses, sesbania sebabe, Rhodes, oats, cow pea and others [3]. Therefore, to overcome livestock feed shortage and boost production using alternative feed resources like Napier/Elephant grass are indispensable. Hence, this research activity was proposed to improve livestock feed resources in the study area through Napier/ Elephant grass demonstration at the farmer's training center with the following objectives.

OBJECTIVES OF THE STUDY;

1. To demonstrate the technology to the visited a large number of farmers and other stakeholders ;
2. To avail source of planting material in the study area;
3. To assess the farmers' perception of the technology; and
4. To create alternative feed sources for the farmers to improve their livestock production and productivity

3. METHODOLOGY

3.1. DESCRIPTION OF THE STUDY AREA

The study is executed under three districts of west, north, and southwest shewa of the Oromia region, Ethiopia

Debrelibanose district;

Debre Libanose is one of North Shewa's thirteen Woredas. Geographically the woreda is found between latitudes of 09043' 30" N longitudes and 38051'0"E latitudes. It's located approximately 104 kilometers from the capital of Ethiopia and 14 kilometers from Fiche town, the capital of the North Shewa Zone. (Debre Libanose District communication Bureau, 1999).The area is characterized by heterogeneous landscape, flora, fauna, and habitat types. The land has extremely steep slopes leading up to a strip of the plateau. Its bi-modal rainfall pattern starts from 800 mm to 1200 mm with five months of rain (May-September). The season is from December to March. The annual average maximum and minimum temperature of the study area are 230 c and 150 c, respectively (Tittarelli, 1990).

According to the population and housing census by [9], the entire population of the woreda is 62,830. The rural population is 49,776 (79.2%) and therefore the urban population is 13,054 (20.8%). This shows the bulk of the population lives within rural areas and rests on crop farming. An oversized number of individuals are settled, and also the population is more evenly distributed on the plateau than within the rugged areas where unevenly distributed settlements are common. (April 2017/North Shewa Zone Culture Tourism Office).

There is about 81,796 head of cattle, 8480 goats, 24923 sheep, 10200 equines, and 80,305 poultry within the districts of Debre Libanose woreda where the town is Debre Tsige. All of those livestock species are reared mainly by smallholder farmers under intensive, semi-intensive, and extensive production systems. The district is divided into 11 administrative PAs and 15,000 liters of milk is collected from Debre Tsige town (DWLFO, 2014).

The district's overall area is around 27,500 hectares, with agriculture, pastureland, forest land, and other usage accounting for 23,960 (87.1%), 2,547 (9.3%), 833 (3.0%), and 166 (0.6%) hectares, respectively. (North Shewa Zone Culture Tourism Office, April 2017). The soil texture sorts of the Debre Libanose district are composed of clay soil, silt soil, and

sandy soil (10%). The predominant soil texture of the district is silt soil which has 57% coverage followed by clay soil (33%) and sandy (10%) (April 2017/ North Shewa Zone of Oromia regional state Culture Tourism Office)

Ginchi district;

Ginchi is the second district which is a rural area in the Oromia region, which is just 80 kilometers far from the capital city Addis Ababa. According to the data obtained from [9] Ginchi district has a relatively higher population density. Agriculture is the majority's main source of income. of the people. The main crops grown in the district include maize, teff, wheat, barley, peas, bean, and various types of seeds. Based on figures published by the Central Statistical Agency (CSA) in 2007, this district has an estimated total population of 255,896, of whom 129,226 are men and 126,670 are women. The same source indicated that 29,602 (11.57%) of its population are urban dwellers, which is less than the Zone average of 12.3%. With an estimated area of 1,549.07 square kilometers, Ginchi has an estimated population density of 165.2 people per square kilometer, which is greater than the Zone average of 152.8.

Wonchi district;

Wonchi is the third district located South West of Addis Ababa the capital city of Ethiopia. It is one of the administrative regions of the Oromia regional national state's South West Shoa Zone. Wonchi district is 155 km from Addis Ababa. The study area's topography ranges from gently sloping to steep hills, with ridges and valleys in between. The district is located between 8°40′ N and 37°55′ E, with elevations ranging from 1700 meters to 3380 meters above sea level. The rainy season is bimodal, with the long rainy season lasting from June to September and the short rainy season lasting from March to April, with the peak record occurring in July and August. The average annual rainfall is between 1650 and 1800 mm, with typical lowest and maximum temperatures between 10 and 30 degrees Celsius, respectively. The study district has a total surface area of 475.6 km2 and a population of 1, 19736 people, with 58,671 men and 61065 women. (District Agricultural and Rural Development office, 2013). Two agro-ecological zones are identified in the Wonchi district. These are High land (Dega) accounts for 40% of the district, while mid-high land (weynadega) accounts for 60% of the district. The major soil types found in the district are black soil 11%, red soil 46%, and mixed soil 43%. Teff (Eragrostis teff), barley, wheat, maize, sorghum, chickpea, bean, pea, lentil, and haricot bean are the main crops grown in the district.

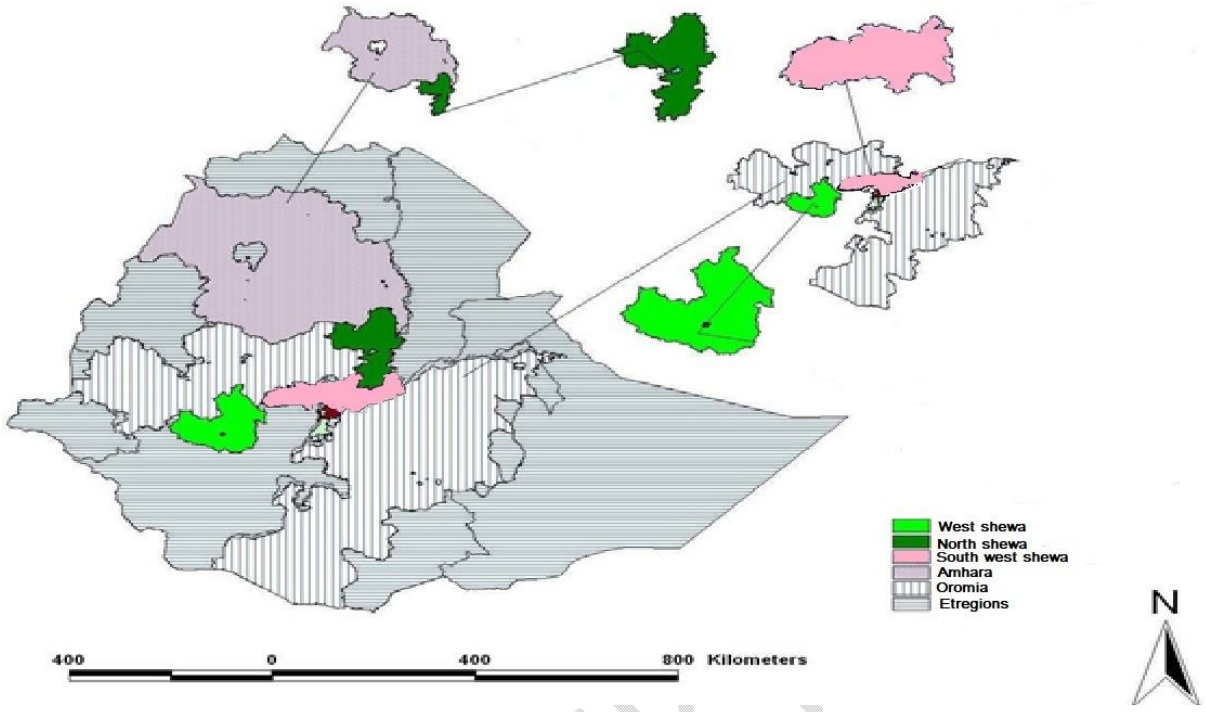

Figure 1: Map of Ethiopia together with Oromia zones and indicating the study sites West, North, and South West Shewa Zone.

3.2. SITE AND FARMERS' SELECTION

The FTC as research sites were selected purposively based on the potentiality, and appropriateness of the area by considering free from open grazing, well fenced, access to road, and suit for frequent monitoring and evaluation in the progress of planting to harvesting, accordingly, Ginchi from west shewa, Wonchi from southwest shewa and Debrelibanose from north shewa were selected.

3.3. RESEARCH DESIGN AND IMPLEMENTATION

The demonstration activity is planted in three dairy potential areas namely Ginchi, Wonchi, and Debrelibanose. 2 FTC from each woreda which is a total of 6 FTC have been used for the on-farm demonstration of the technology. The demonstration elephant grass (Accession# 14794 and local check) was established inside the FTC area with ($10m^2$ * $20m^2$) recommended spacing of 1m b/n row and 0.5m b/n plants.

Elephant grass root splitting of (Accession # 14794 and local check) was used for this demonstration purpose because Accession # 14794 variety was adaptable in a tested

environment when it was tested on a research station for adaption. Then, root splits of elephant grass were prepared in form of at least 0.5m-1m (in number 400 -500 root split per FTC in a total of 2400-2500 root splits) and were planted on a plot size of ($10m^2$ * $20m^2$) in respect to 0.5 meters between plants and 1meter between rows on farmers training centers.

Figure 2: photos during elephant grass planting operation inside FTCs

3.4. DATA COLLECTION

Both quantitative and qualitative data were collected. Quantitative data is collected using a data collecting sheet, whereas qualitative data is collected using a checklist and personal field observation, individual interviews, and Focus Group Discussions.

3.4.1. AGRONOMIC DATA COLLECTION AND MEASUREMENTS

Measurements during the experiment season were plant height and forage DM yield. Plant height was determined by measuring five culms at random in each plot from the ground level to the highest leaf using steel tape. For determination of biomass yield, accessions were harvested at the forage harvesting stage from two rows next to the border rows of 5 to 10 cm above the ground level. Each plot in the field was weighed to determine the total fresh biomass yield, and a 300g sample was taken from each plot to the laboratory. Each plot's sample was weighed to determine the sample's fresh weight, and then oven dried for 24 hours at 105°C to measure the dry matter yield.

3.5. DATA ANALYSIS

Quantitative data were analyzed using simple descriptive statistics (Mean, Frequency and Percentage) while the qualitative data (Data on farmer perceptions and preferences) were collected and subjected to a pairwise ranking technique.

4. RESULTS AND DISCUSSION

Generally, the experiment has been done under six farmers' training centers with a total of 1200m^2 areas of land in the Ginchi, Wonchi, and Debrelibanose districts respectively as shown below in (Table 1). The performance of each demonstration was evaluated by pre-harvest, post-harvest, and perception parameters.

Table 1: Summary of selected FTC site and area coverage of the experiment.

District	FTC's	Area covered
Ginchi	2	
Wonchi	2	Each $10m^2$x$20m^2$
Debrelibanose	2	
Total	6	1200m^2

Source: Own computation 2018/19.

4.1. TRAINING ORGANIZED

Training has been provided to farmers, DAs, and agricultural experts on elephant grass field management/agronomic practice in general and on planting, spacing, and plant population density (thinning), major elephant grass diseases with their control management, post-harvest management, and feeding practice in particular. 80.6 percent of the participated stakeholders were male farmers, while 19.4 percent were female farmers.

Table 2: On-spot training of farmers and other stakeholders on elephant grass demonstration.

S/N	Participants	Male	Female	Total
1	Farmers	48	13	**61**
2	DAs	4	0	**4**
3	District Agri experts	2	0	**2**
	Total	54	13	67

Source: Own computation 2018/19.

Figure 3: Photos of practical and theoretical training delivered at the vegetative stage of the plant**.**

4.2. AGRONOMIC AND YIELD PERFORMANCE

The following table describes the yield performances of the demonstrated Elephant/Napier grass varieties across the study site. The yield performances of the improved varieties (Accession #14794 and local) were 10.40, 8.28, 8.87, and 7.69, 5.52, 5.27 ton/ha at Ginchi, Wonchi, and Debrelibanose respectively (Tables 3). The highest average yield of the Accession #14794 Elephant/ Napier grass was recorded at Ginchi 10.40 ton/ha and Debrelibanose 8.87 ton/ha as compared to local varieties across the tested FTC sites. This indicates that this material (Accession #14794) is very adaptable and suits the existing environmental conditions in these sites. And there was a yield

difference in the varieties across the tested sites and this variation could be due to rainfall, soil type, management, climatic and other conditions.

Table 3: Yield performance of improved elephant grass varieties across districts on FTC.

Districts	Accession Number	No FTC	Std. Deviation	Mean Dry matter (ton/ha)	Maximum	Minimum
Ginchi	14794	2	1.950	10.40	13.50	7.30
	Local	2	1.568	7.69	8.75	6.63
Wonchi	14794	2	1.698	8.28	10.83	5.73
	Local	2	1.690	5.52	7.13	3.91
Debrelibanose	14794	2	1.955	8.87	12.48	4.92
	Local	2	0.339	5.27	6.32	4.21
Total			1.925	5.75	13.50	3.91

Source: Own computation 2018/19.

4.3. YIELD ADVANTAGE

The result indicated that ILRI 14794 variety has a better yield 9.18 ton/ha when compared with the local check (6.16 ton/ha). Accordingly, there was a yield advantage of ILRI 14794 variety over local check that is 49.1% as depicted in (Table 4)since there was a yield of 3.02 ton/ha in comparison and a statistical significance different at $p<0.01$.

The yield advantage of the demonstrated varieties was calculated using the following formula.

Yield advantage % = Yield advantage of a new variety – Yield advantage of st; check X 100 Yield advantage of a standard check.

Table 4. Summary of yield performance in study areas.

Accession Number	Average yield ton/ha	Yield difference ton/ha	The yield advantage over the local check (%)
ILRI 14794	9.18	3.02	49.1
Local check	6.16		
Statistically significant @ 1% probability level			

Source: Own computation 2018/19.

4.4. FARMERS' OPINION/PERCEPTION

Farmers set criteria after having awareness about the variety and by using those criteria they gave ranks for the varieties with reasonable remarks during variety demonstration that were: biomass, survival, adaptability, palatability by livestock, and drought tolerance. As a result, most of the farmers selected the ILRI14794 variety and the vicinity farmers started establishing the material on their farm, backyard, and soil and water conservation structures. Selection criteria were set as depicted in the following (Table 5).

Table 5: Ranks of the varieties based on farmers' selection criteria.

Accession/ Varieties	Farmers rank	Reasons	Remarks
14794	1st	Good biomass, good survival, adaptable, good palatability, and drought tolerant	Biomass was measured by Balance in tons, counting the established plants and matured cuttings(survival measurement), given to livestock(palatability measurement) and produced with existing rainfall
Local check	2nd	Good biomass, good survival, adaptable, good palatability, and drought tolerant	

Table 6: Pair-wise ranking matrix results to rank a variety of traits.

S/N	Traits	Biomass	Survival	Adaptability	Palatability	Drought tolerant	Frequency	Rank
1	Biomass		1	1	1	1	4	1st
2	Survival			2	2	2	3	2nd
3	Adaptability				3	3	2	3rd
4	Palatability					4	1	4th
5	Drought tolerant						0	5th

Moreover, farmers evaluated these two varieties (IRLI14794 and local) at different stages based at the FTC level based on their criteria: good biomass, good survival, adaptability, good palatability, and drought tolerant, accordingly, ranked the IRLI149794 variety on

the first rank as compare to local as shown on (Table 5) and even evaluated these criteria by pair-wise ranking, as result, ranked biomass first with the rest as on (Table 6). Based on these above results and discussion the following conclusion recommendations were derived.

5. CONCLUSION AND RECOMMENDATIONS

The yield performance of the demonstrated elephant grass varieties across the study sites was 9.18 ton/ha for (ILRI14794) and 6.16 ton/ha for the local variety, with a yield difference of 3.02 ton/ha, and the candidate accession (ILRI14794) has a yield advantage of 49.1% over the local check. As a result, farmers preferred the candidate (ILRI14794) accession due to its high biomass yield, adaptability, palatability, drought tolerance, and other traits.

Demonstration of this material in FTC sites has already created an opportunity for planting material availability or a source of elephant grass to the respective districts. So that, they can utilize elephant grass (ILRI14794) accession as an alternative forage source to overcome the critical feed problem both in quantity and quality in the study area, by employing different improved forage production strategies (backyard production and Contour forage strips). Thus, from this research finding it is recommended that ((ILRI14794) elephant grass material with its recommended production package should be scaling up and popularized in the study area under a similar agro-ecology for mass end users through a scale-up extension approach with the joint effort of the district office of agriculture, non-government and other concerned stakeholders.

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