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Participatory Demonstration of Mid Land Sorghum Technology through FRG System in Metta District of East Hararghe Zone

Abdulaziz Teha
Oromia Agricultural Research Institute, Fedis Agricultural Research Centre,
P.O. Box 904, Harar, Ethiopia

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ABSTRACT: *Pre-extension demonstration and evaluation of early maturing sorghum varieties was conducted in 2019-2020 with the objectives of promoting and popularize improved midland sorghum technologies and to create awareness through giving training and enhance stakeholder's participation. A total of ten (10) trial farmers were selected from two potential sorghum growing kebeles of Metta District. Two FRGs having 30 farmers were established. Two improved sorghum varieties (Dibaba and Adele) and with local check were planted on the plot of 10mx10m per trial farmers. Training on which a total of 67 participants took part were organized at Metta. The midland Sorghum varieties were evaluated based on their early maturity, yield, Disease tolerance, seed color, seed quality, biomass, and stalk length and food test. The ANOVA of yield performance of the improved varieties (Dibaba, Adele and local) showed 37.73, 34.39 and 24.10 qt/ha at Dursitu bilisuma of Metta district respectively. The average yield performance of Dibaba higher than Adele at 5% probability level and at 1% probability level than local check. As a result Dibaba variety preferred well and better to promote it on wider area and number of farmers*

KEY WORDS*:* sorghum, demonstration, Dibaba, Adele, Metta

INTRODUCTION

Sorghum (*Sorghum bicolor*) is the fifth largest most important cereal in the world agricultural economy, after wheat, maize, rice and barley, and the second (after maize) in sub-Saharan Africa. In 2013, the global area cropped with sorghum was 42.3 million hectares and the worldwide production was 61.5 million metric tons; the USA, Nigeria, Mexico, India and Ethiopia are the main producers (FAOSTAT, 2014). It grows in a wide range of agro ecologies most importantly in the drought prone parts where other crops can least survive and food insecurity is rampant (Adugna.A, 2007) which make sorghum preferable by farmers in drought prone areas due to its tolerance to drought and harsh environments. Sorghum is an essential to diets of poor people in the semi-arid tropics where droughts cause frequent failures of other crops. Eastern Ethiopia is generally characterized by different agro-ecology where different sorghum varieties are cultivated in highland, mid-highland and lowland parts. It is produced not only for its grains but also for its

use as a source of animal feed, fuel wood and construction material. It is grown mainly under rain fed condition (Tegene.S, 2013).

Together with millet, sorghum represents a main source of energy and protein for about one billion people in the semi-arid region of tropics and it is part of the staple diet of more than 300 million people in developing countries, representing their major source of energy and nutrients (Taylor, J.R.N, 2003). Sorghum is a basic staple food for many rural communities, especially in drought prone areas, characterized by shallow and heavy clay soils; thus, it is a subsistence food crop for many food insecure people (DuPlessis, J.2008).

Besides providing calories, sorghum has actual nutritional value in principle, because of its content of protein, vitamins, fat-soluble (D, E and K) and of B group (except for B12), as well as minerals, such as iron, phosphorus and zinc. In particular, a recent study classifies sorghum genotypes as source of vitamin E but highlight how the analyzed genotypes showed low contents of carotenoids (De Cardoso, L.M, 2015). In composition, sorghum grain compares favorably with some other cereals: it has a similar protein content to wheat but higher than maize and rice, while the essential amino acid composition of sorghum is comparable to maize or wheat due to the limited content of threonine, arginine and, especially, lysine(Henley, E.C.2010). Thus, this proposal initiated to demonstrate and promotes improved highland sorghum varieties in the study areas.

Objectives

To evaluate yield performance of midland sorghum varieties under farmers' condition
To create awareness on importance of improved midland sorghum production technologies
To develop knowledge and skill of farmers and other stalk holder have on midland sorghum technologies
To collect feedback on demonstrated midland sorghum varieties

MATERIALS AND METHODS

Description of the Study Area

This study was conducted in Kombolcha district of the Eastern Hararghe Zone, Oromia National Regional State (ONRS). According to the report of (CSA) (2008).Meta woreda is located in East Hararghe zone of Oromia region. It is bordered to the southwest by Deder woreda, to the northwest by Goro Gutu woreda, to the north by the Somali regional state, to the northeast by Kersa woreda, and to the southeast by Bedeno woreda. The administrative capital of the Woreda is Chelenko.The Woreda is characterized by valleys in pocket areas, and rugged topography with many hills. There are some permanent rivers in the Woreda. Notable among these is the river that supplies water to the town of Chelenko. Besides, there are many perennial springs originating from below the mountains and crossing the valleys. One lake is also found. Groundwater resources are always there. Mixed crop production and livestock rearing characterize the farming system of the Woreda. The major crops produced in the Woreda include sorghum, maize, wheat, and haricot bean, vegetables of different kinds and fruit trees. Although there is no meteorological station for recording rainfall, the rainfall pattern in the Woreda is bimodal.

Site and farmers' selection

Metta was selected purposively based on the potentiality, appropriateness of the area by considering slop land scape and accessibility, suit for repeatable monitoring and evaluation. Thus Dursitu bilisuma kebele from Metta was selected and one FTC from the kebele was also selected as demonstration site to reach other farmers that visit FTC. Farmers were selected by studying their profile with the participation of Development Agents and community leaders. The selection was done purposively based on farmers' interest, land provision for this activity, interest in cost-sharing and willingness to share experiences for other farmers. The selected farmers were grouped in a form of Farmers Research Group (FRG) with the member of 15 farmers per kebeles in consideration of gender issues (women, men and youth). .Within one FRG 5 members were trial farmers (3 male trial farmers and two female trial farmers) and the rest 10 farmer work with trial farmers. Two FRGs (2FRG/ kebele) from one 15 farmers and a total of 30 farmers were organized at Metta district.

Table 1: Summary of selected site and farmers with area coverage of the experiment

District	PAs	No. of trial farmers	Area covered
Metta	Dursitu Bilisuma	10	10mx 10m for each plots
	Total	10	

Research design

Two improved treatment of high land sorghum varieties (Dibaba and Addelle) and one local check, will be replicated across ten trial farmers per kebeles. 10m*10m plot size of land from individual trial farmer will be used for each experiment/ varieties. Each variety planted at the Plot Size: 10mx10m, Seeding rate 10 kg/ha, Spacing 75cm*25cm (Between row and plant), Fertilizer rate: NPS 100kg/ha and Urea 50kg/ha

Technology evaluation and demonstration methods/technique

The evaluation and demonstration of the trials were conducted on farmers' fields to create awareness about the sorghum varieties. The evaluation and demonstration trials followed process demonstration approach by involving FRGs, development agents and experts at different growth stage of the crop. The activity was jointly monitored by FRGs, researchers, experts and development agents.

Data Collection

Both quantitative and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. Types of collected quantitative data were number of farmers participated in FRG, yield performance, economic analysis and number of stakeholders participated on the training. While qualitative data were farmers' perceptions towards the new technology and ranked using pair wise ranking and Matrix ranking.

Data analysis

Quantitative data was summarized using descriptive statistics (percent, mean and standard deviation), while the qualitative data collected using group discussion and field observation and oral histories were analyze using narrative explanation and argument. Moreover, for significance checking t-test were used for this activity. Finally data from different sources were triangulate to get reliable information.

RESULTS AND DISCUSSION

Training of farmers and other stalk holders

Training was organized to participating farmers before commencing the trial Multidisciplinary researchers ; crop, extension and socio-economic discipline and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge about sorghum production, management, post-harvest handling and marketing and journalists for the sake of publicity of the work done.

Table 2: Type of profession and number of participants on the training at Dursitu Bilisuma

		Bilisuma		
No.	Participants	Male	Female	Total
1	Farmers	33	15	48
2	DAs	10	3	13
3	District expert	6	0	6
	Total	39	18	67

Source: Own computation 2019/2020

Among the training participant stakeholders, 71.6% were farmers. From those farmers, 31.2% are female farmers. During the training 45 leaflets and 30 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. More over different questions, opinions and suggestions were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved sorghum technology production because of better yield and earned income by selling it for different stakeholders (neighbors' farmers and Non-Government Organizations). Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Table 3: Type of profession and number of participants on the Mini-field day at Dursitu Bilisuma

		Bishan Bahe		
No.	Participants	Male	Female	Total
1	Farmers	32	13	45
2	DAs	2	0	2
3	District experts	3	0	3
	Total	37	13	50

Source: Own computation 2019/2020

Agronomic and yield performance

The following table describes the yield performances of the demonstrated sorghum varieties across the study site. The yield performance of the improved varieties (Dibaba, Adele and local) were 37.73, 34.39 and 24.10 qt/ha at Dursitu bilisuma respectively. The yield performance of the improved varieties (Dibaba, Adele and local) showed 37.73, 34.39 and 24.10 qt/ha at Dursitu bilisuma of Metta district respectively.

Table 4.Yield performance of improved sorghum at Dursitu Bilisuma on Farmers land

PA	Varieties	N	Std. Deviation	Mean (qt/ha)	Maximum	Minimum
D/Bilisuma	Adele	10	1.21	34.39	35.70	33.00
	Dibaba	10	1.41	37.73	38.40	35.70
	Local	10	.88	24.10	25.30	22.50
	Total	10	6.01	32.07	39.40	22.50

Table.5 ANOVA

Between Groups / Within Groups	Sum of Squares	df	Mean Square	F	Sig.
	1009.38	2	504.69	356.25	.000
	38.25	27	1.41		
Total	1047.63	29			

Yield Advantage

Yield advantage of the demonstrated varieties was calculated using the following formula.

$$\text{Yield advantage \%} = \frac{\text{Yield advantage of new variety} - \text{Yield advantage of st; check}}{\text{Yield advantage of standard check}} \times 100$$

Table. 6 Yield Advantage

Varieties	Average yield qt/ha	Yield difference qt/ha	Yield advantage over the local check (%)
Adele	34.39	10.29	42.69
Dibaba	37.73	13.63	56.55
Local	24.10		

Economic Analysis of sorghum production

The followed table describes the financial costs and returns of the improved sorghum varieties across two demonstration sites for 2019/20 production year the calculation used 2000 birr as farm gate price for a quintal of sorghum grain. Thus the profit per hectare gained from Adele and Dibaba varieties were 62,692 and 56,012 ETB at dursitu bilisuma kebeles respectively.

Table 7: Financial analysis for Sorghum varieties across the districts

Financial analysis			
Location: Meta(Dursitu Bilisuma)			
Parameters	Varieties		
	Dibaba	Adele	Local
Yield qt/ha(Y)	37.73	34.39	24.10
Price(P) per quintal	2000	2000	2000
Total Revenue (TR)=TR=Y*P	75,460	68,780	48,200
Variable costs			
Seed cost	200	200	200
Fertilizer cost	1,418	1,418	1,418
Labor cost	7,150	7,150	7,150
Total Variable costs(TVC)	8,768	8,768	8,768
Fixed costs			
Cost of land	4,000	4,000	4,000
Total fixed costs (TFC)	4,000	4,000	4,000
Total cost (TC) =TVC+TFC	12,768	12,768	12,768
Gross Margin (GM) = TR - TVC	66,692	60,012	38,432
Profit=GM-TFC	62,692	56,012	35,432

Results of Knowledge Test

A simple knowledge test items were developed based on the contents of training and production package practices and knowledge level of participant farmers regarding improved sorghum production technologies was measured before and after implementation. Score of 1 is given for correct answers and 0 for incorrect answers. As one can observe from the table 4 below, the percentage of respondents for correct answers is increased after intervention. As a result, the percentage of respondents for incorrect answers is decreased.

Table 8. Percentage of Respondents for each knowledge Items

No	Test items	Respondents' percentages			
		Before		After	
		Correct	Incorrect	Correct	Incorrect
1	The Name of improved Variety sorghum used	53.3	46.7	73.3	26.3
2	Ploughing frequency	63.3	36.7	76.7	23.3
3	The recommended seeding rate of improved sorghum	43.3	56.7	63.3	36.7
4	The Maturity date of sorghum	43.3	56.7	56.7	43.3
5	The symptom of disease that affect sorghum	56.7	43.3	66.7	33.3
6	The disease tolerant varieties	60	40	66.7	33.3
7	The chemicals used for sorghum disease	46.7	53.3	60	40
8	The season that sorghum severely occurred	30	70	33.3	66.7
9	Yield per hectare of improved sorghum	40	60	63.3	36.7
10	Market price of sorghum	30	70	70	30
11	Exact Source of improved sorghum seed	43.3	56.7	53.3	46.7

Source: from own computed data (2021**)**

The mean score for knowledge test before intervention and after intervention is 5.4 and 6.7 respectively. The result of paired-sample t-test indicates a significant difference between the mean score for knowledge test before intervention and after intervention at 1% significant level. This implies an improvement of farmers' knowledge regarding the improved sorghum technologies due to technological intervention.

Table 9. Results of paired-sample t-test for knowledge test

	Mean	**St.Dev**	**t-value**
Total score before	**5.4**	**1.43**	**4.34**
Total score After	**6.73**	**1.36**	

Note: ***: refers to significance at 1% level, respectively
Source: computed from own data (2021)

Farmers' Opinion/Perception

Farmers' in the study area selected the best performing improved sorghum varieties by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they could select the varieties at harvest time. The opinion of those farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were early mature, yield, disease tolerance, seed color, seed performance throughout growing stage, palatability of stalk as feed, good nutritional value and food test .Therefore, most farmers selected both improved sorghum varieties to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the varieties

Table.10 Ranks of the varieties based on farmers' selection criteria

Varieties	Farmers rank	Reasons
Dibaba	1st	Early mature, high grain yield, Disease tolerance, Red seed color, Good seed quality, Very good performance , palatability of stalk, Very good in injera test,Elastic injera(easily pick able from Eele).
Adele	2nd	Early mature, high grain yield, Disease tolerance, white seed color, seed size, Very good performance, palatability of stalk , Very good in injera test, Elastic injera(easily pick able from Eele).
Local	3rd	late mature, low yield, Disease tolerance, Good seed color, Small seed size, low performance, palatability of stalk feed,good injera test, Elastic injera(easily pick able from Eele).

CONCLUSION AND RECOMMENDATION

In the study areas, sorghum production is dominantly experienced with traditional farming and use of local varieties by substance smallholder farmers. Using improved sorghum varieties and management practices increases sorghum yield and also reduces the maturity period of sorghum. Early maturity has an advantage for farmers to produce. On the other side, during farmers' evaluation, palatability of sorghum Stover for animals was preferred by farmers. In the study area, sorghum Stover is usually used as a major livestock feed source during the dry season. The overall harvested mean yield of Dibaba, Adele and local variety was 37.73 qt/ha, 34.39 qt/ha and 24.10qt/ha respectively. The average yield performance of Dibaba higher than Adele at 5% probability level and at 1% probability level than local check. As a result Dibaba variety preferred well and better to promote it on wider area and number of farmers In general, the improved sorghum varieties Dibaba and Adele had higher yield advantage of 56.55 %, 42.69 and social acceptable than local one. Both Dibaba and Adele varieties was selected and recommended for pre-scaling up activity on wider plot (at least 0.125ha per trial farmer) for popularization. Strengthening the linkage among stakeholders is paramount to achieve the desired goal.

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