Transfer of Early Maturing Sorghum Technologies through Participatory Evaluation in Eastern Amhara Region of Ethiopia

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Abstract

The low or non-adoption of improved agricultural technologies might be resulted from inadequate participation of farmers at all stages of the process of benefiting farmers. The current study was conducted in the representative sorghum producing areas of Wollo with the objective of assessing farmers' preference towards improved sorghum varieties and providing a menu of sorghum technologies. Both inferential and descriptive statistics was used to analyze the data. Farmers' perception was assessed using preference ranking and narration. Moreover, Agricultural events such as field days and experience sharing were prepared to capture farmers' perception about the technologies. GenStat v.18th was used to analyze the data. Analysis of variance was employed to test the mean difference of yield among varieties. The result of ANOVA showed that improved sorghum varieties Dekeba and ESH1 gave the highest grain yield at respective sites. In kalu and Dawa chefa, farmers preferred Argiti whereas in Raya Kobo, Melkam was the variety preferred by the farmers. From the analysis of Spearman's rank correlation, there was evidence on coincidence of farmers' preference and the actual data. Therefore, the analysis of farmers' preference and yield data jointly confirm that improved varieties Melkam and Argiti can be promoted in the respective districts of the study area.

Keywords: Transfer of Technology, Sorghum, Participatory evaluation, Ethiopia.

Introduction

In Ethiopia, agriculture contributes about 42 percent of the GDP, serves about 85 percent of the labor force. About 90 percent of the total export earnings of the country is emanated

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from this sector. The sector is dominated by over 15 million smallholders producing about 95 percent of the national agricultural production (CSA, 2017). Of the total grain crops produced, cereals play a significant role both in terms of land coverage and production (81.39%) for small holder farmers (CSA, 2018).

Sorghum and millets are the most important cereal crops for food security in semi-arid and arid areas of the world due to their high nutritional quality, tolerance to stresses (abiotic and biotic) and their performance in marginal lands with relatively low fertility. (Prasad and Scott, 2009). In this regard, the eastern Amhara area of Ethiopia is characterized by erratic and erosive rainfall.

In Ethiopia, sorghum is cultivated in all regions (14 of the 18 major agro-ecologies) with an altitude between 400m and 2500m (MOA, 1998). From the total cereal production in the country, sorghum took the largest share (14.38%). Nationally, the three regions, Oromiya, Amhara and Tigray are the major producers of sorghum in the last five years (CSA, 2014-2018). More specifically, from the top sorghum producing zones of Ethiopia three of them are found in Amhara region i.e. North Wollo, South Wollo and North Gondar (CSA, 2014). Therefore, Sorghum is one of the focus areas of research and development in Eastern Amhara especially in the lowlands of Wollo. Developing improved sorghum technologies has to be the major solution for the actors involving in the development and research agenda in the area.

Sorghum is one of the focus areas of research for Sirinka Agricultural Research Center. Due to this, the center has devoted to improve the productivity of sorghum in its mandate areas of Wollo. Despite the efforts both by national and regional research centers, the national average productivity of sorghum in Ethiopia is still 2.23 tons/ha (CSA, 2014) which is far below the global average of 3.2 tons/ha (FAO, 2005). This can be resulted from various factors related to bio physical or socioeconomic variables. Of many others, the yield gap might be resulted from the low or non-adoption of improved sorghum technologies. Likewise, the non-adoption of improved technologies is resulted from the deficiency or inadequate participation of farmers in all stages of technology development and promotion (Puskur et al., 2008). Hence developing and evaluating nationally and regionally released sorghum varieties with the participatory approach can contribute a lot in reducing the yield gaps in the area. Therefore, the current study was conducted with the following objectives.

Objectives

* To provide farmers a menu of improved sorghum technologies
* To assess farmers and development agents perception towards improved sorghum technologies
* To enhance participation of farmers in sorghum technology evaluation

Materials and Methods

Description of the study area

This study was conducted in the sorghum producing areas of Wollo i.e. Raya kobo, Kalu and Dawa chefa districts of Eastern Amhara Region. The detailed description of the areas is indicated in Table 1.

Table 1. Study Area Description

	Woredas	Latitude	Longitude	Elevation (masl)
1.	Kobo	12° 08' 60.00" N	39° 37' 59.99" E	1468 m
2.	Kalu	11° 00' 0.00" N	39° 49' 59.99" E	1492m
3.	Dawa chefa	10° 55' 00" N	39° 47' 00" E	1424 m

Source: (District office of Agriculture, 2019)

Figure 1. Location map of the study area

Source: Ethio GIS shape file

Site Selection and Experimental Design

For this participatory technology evaluation, sites and farmers were selected in collaboration with each woreda and kebele office of agriculture. During site selection, interest of farmers and proximity to the main road were considered as the criteria. Prior to the implementation, trainings/orientations were given for experts and development agents regarding the specific activities to be carried out in the field. Both FTCs and farmers' fields were used to conduct the activity. The number of FTCs in each woreda was determined based on their potential and functionality. Based on accessibility, the total area allocated for all treatments ranges from 400-1600m2. The variation of plot sizes across the sites was emanated from the scarcity and fragmentation nature of the land in the study areas. Four improved sorghum varieties were evaluated using the participatory method. Agronomic practices were employed based on the recommendation. NPS fertilizer was applied once while Urea was applied in split application of 50% at planting and 50% at knee height. Weeding and other crop protection measures were conducted by farmers with close supervision with development agents and researchers. Thinning was done at knee height to control weed and improve soil water holding condition.

Data Collection

Data were collected through the formats prepared for this purpose. Both agronomic and perception data were collected for achieving the objectives stated above. Field observation and group discussion were held to gather the required data in the field.

Data Analysis

Both inferential and descriptive statistics was used to analyze the data. Mean comparison of yield data were analyzed using Genstat software version 18th. On the other hand preference ranking was used to analyze perception of farmers towards sorghum varieties. Ranking was used to identify the best varieties preferred by farmers using the following procedure.

* Identifying selection criteria used to evaluate varieties
* Prioritizing selection criteria using pairwise ranking (Russell, 1997)
* Ranking each variety using the criterion identified
* Determining final acceptability rank

Spearman's rank correlation coefficient was determined to see if the actual rank of varieties coincides with those of the farmers' preference rank (Hwang, 2018).

Results and Discussions

Performance of Sorghum Varieties Across Study Sites

Of many others, yield is one of the major parameter for a given crop variety which determines its acceptability by the farmers. In this study, Kalu and Dawa chefa were considered as one site as a replication. As shown below in Table 2, the highest yield (3.9 ton ha-1) was recorded by variety Dekeba in kalu and Dawa chefa districts and the mean difference is significant at 5% significance level. In Raya kobo, the highest yield was recorded from variety ESH1 (5.13 ton ha -1) and the difference is significant at less than 1% significance level. This result is in agreement with Ademe Mihretu et al. (2018) who reported the highest grain yield from ESH1 in Abergele district.

Table 2. ANOVA Test for Grain Yield Differences Among Varieties

Treatments	Kalu and Dawa chefa	Raya Kobo
	Grain yield ton^{-ha}	Grain yield ton^{-ha}
Dekeba	3.907 ^{a}	3.518 ^{b}
Argiti	3.630 ^{ab}	3.654 ^{b}
Melkam	3.300 ^{bc}	4.666 ^{a}
ESH1	2.973 ^{c}	5.138 ^{a}
Grand mean	3.452	4.24
CV (%)	3.2	8.7
p- value	0.003	<.001
LSD(0.05)	0.3504	0.569
SED	0.14	0.276

Source: (Own data, 2019)

Farmers' Perception Towards Sorghum Varieties Across Locations

Participation of farmers on farm-level technology testing can improve information feedback about the technologies and identify existing constraints (Ashby & Gracia, 1993). In this regard, farmers' participation in variety selection process has a paramount role to identify farmers' preferred traits in promoting sorghum varieties. For this study, a total of 153 participants were presented to evaluate sorghum varieties at farmers' fields and farmers training centers. The detailed description of participants in the evaluation process is depicted below in Table 3.

Table 3. Number of participants in evaluation sorghum varieties

		Raya Kobo	Kalu and Chefa
Farmers	Male	45	38
	Female	28	19
	Total	73	57
Development agents	Male	7	5
	Female	1	2
	Total	8	7
Researchers	Male	4	4
	Female	-	-
	Total	4	4
Total participant		85	68

Discussion was held with farmers to help them in identifying selection criterion. Accordingly the following criteria were identified with their own justification.

* Earliness: in areas where the rainfall distribution is very erratic and erosive cultivating early maturing varieties is one of the mitigation strategies which is identified by farmer.

* Plant height: apart from grain yield, sorghum is the source of feed for animals and fuel

* Seed size: used as a proxy measure for marketability

* Productivity: farmers' were able to compare the varieties productivity through visual observation on the field

* Compactness: birds unless protected timely, they can bring a significant damage on the yield of sorghum. Therefore the variety with compacted head can relatively tolerate from bird damage.

* Seed color: the color of sorghum variety highly matters in determining its market price and demand. Usually white color is sorghum is preferred to mix with teff.

* Marketability: Besides home consumption in different food stuffs, farmers have the experience to sell sorghum both as grain and seed. Hence, this criterion highly matters on the variety's preference.

The next step was to rank the criteria so as to easily prioritize each criterion for the selection process. Productivity, earliness and head compactness were found to be the top three priorities of sorghum variety selection by the farmers in Raya kobo (Table 4). Following the procedures, Melkam variety was preferred by farmers in Raya Kobo whereas in Dawa chefa and Kalu sites, variety Argiti was preferred by farmers. Detailed description of the ranking method is in the following tables (Table 4 - 6).

Table 4. Ranking Criteria for Farmer Preference at Raya Kobo

N	Criteria	Earliness	Plant height	Productivity	Seed size	Compactness	Seed color	Marketability	Total	Rank
1	Earliness	X	Earliness	Productivity	Earliness	Earliness	Earliness	Earliness	5	2
2	Plant height		X	Productivity	Seed size	Compactness	Plant height	Plant height	2	4
3	Productivity			X	Productivity	Productivity	Productivity	Productivity	6	1
4	Seed size				X	Compactness	Seed color	Marketability	1	5
5	Compactness					X	Compactness	Marketability	3	3
6	Seed color						X	Seed color	2	4
7	Marketability								2	4

Table 5. Final Acceptability Rank (Criteria Given for the Criterion Multiplied by the Ranks Given) at Kobo (82 Participants)

	Earliness (2)	Plant height (4)	Productivity (1)	Seed Size (5)	Compactness (3)	Seed color (4)	Marketability (4)	Total	Rank
Argity	6	4	3	15	3	12	12	55	3
Melkam	4	12	1	5	9	4	4	39	1
Dekeba	8	16	4	20	6	16	16	86	4
ESH1	2	8	2	10	12	8	8	50	2

Table 6. Final Acceptability Rank of Varieties at Kalu and Dawa Chefa

Variety	Earliness (2)	Plant height (4)	Productivity (1)	Seed size (5)	Seed color (2)	Compactness (3)	WLR (6)	Marketability (5)	Total	Rank
Argiti	6	4	1	5	2	3	6	5	32	1
Melkam	4	16	3	10	6	9	18	15	81	3
Dekeba	8	12	2	20	4	6	12	10	74	2
ESH1	2	8	4	15	8	12	24	20	93	4

*Where, WLR= water lodging resistance

Table 7. Coincidences of Farmers Rank and Actual Rank

		Raya kobo		Kalu and Dawa Chefa	
	Varieties	Farmers' rank	Actual rank	Farmers' rank	Actual rank
1	Argiti	3	3	1	2
2	Melkam	1	2	3	3
3	Dekeba	4	4	2	1
4	ESH 1	2	1	4	4
Spearman's r		0.8		0.8	

Field days and Participants Feedback

Agricultural events are the means for accelerating technology transfer for the beneficiaries in the farming system by creating the opportunity to share responsibilities in technology transfer and providing feedbacks in the process. Besides the field days, experience sharing was held in Oromia zone about utilizing Farmers' Training centers for technology demonstration. During field day farmers have forwarded their suggestion about the likes and dislikes of each variety (Table 8 below). At the end of the field day session stakeholders have reached agreement to share responsibility in promoting the selected sorghum varieties.

Table 8. Summary of Specific Feedbacks Given for Each Variety

Varieties	likes	dislikes
Argity	Head compactness, seed size, color, better stalk	Relatively late maturing
Dekeba	Head compactness, green stay	-
Melkam	Early maturing, uniform head	-
ESH1	Too early	Threshability problem

Figure 2. Field performance of varieties

Figure 3. FTCs Experience sharing at Kamisie, Amhara Region

Conclusion and the Way Forward

The study aimed at evaluating four sorghum varieties in three representative districts of Wollo i.e Kalu, Raya Kobo and Dawa chefa. Improved varieties, Melkam and ESH1 were found to be superior both in terms of grain yield and farmers' evaluation criteria at Raya kobo. In Dawa chefa and Kalu, Argiti variety showed better performance and got an acceptance by farmers. Moreover, there exists a strong association between farmer' evaluation result and the actual rank of varieties. Therefore, based on the yield performance and farmers' preference, Argiti and Melkam should be promoted in the respective areas.

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