Participatory Evaluation of Early Maturing Sorghum Technologies 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 i.e. Raya kobo, Kalu and Dawa chefa with the objective of assessing farmers’ preference towards improved sorghum varieties and providing a menu of sorghum technologies. The study was conducted in 2019 cropping season having one year duration. Both inferential and descriptive statistics were used to analyze the collected 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.18® 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, based on the analysis of farmers’ preference and yield data, improved sorghum technologies Melkam and Argiti can be promoted in the respective districts of the study area.

Keywords: agricultural events, pairwise ranking, participatory, preference, sorghum

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 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 smallholder 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, 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, 2017). 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.
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 in Ethiopia as true shallot seed adopted in Indonesia (Purba et al., 2020). In the study area, Farmers during long rainy seasons usually grow local cultivars. Likewise, the non-adoption of improved technologies resulted from the deficiency or inadequate participation of farmers in all stages of technology development and promotion (Puskur et al., 2008; Muliarta and Purba, 2020). 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 to provide farmers a menu of technologies, assess farmers and development agents’ perception towards improved sorghum technologies and enhance participation of farmers in sorghum technology evaluation.

**METHODS**

**Experimental Location**

This study was conducted in major sorghum producing areas of Wollo where Sirinka agricultural research center has intervened in technology generation and promotion i.e. Raya kobo, Kalu and Dawa chefa districts of Eastern Amhara Region (figure 1 and 3). The experiment was laid out in a simple randomized plot with the area of 100m² for each treatment. 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     | 1,424 m          |

Source: (District office of Agriculture, 2019)

**Site selection and experimental design**

For this participatory technology evaluation, sites and farmers were selected in collaboration with each District and Kebele office of agriculture. Kebele is the smallest administrative unit next to district in Ethiopia. Host farmers were selected based on willingness to provide their land for the experiment and suitability of the soil to conduct the experiment. Prior to the implementation, training/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 weeds and improve soil water holding condition. Finally, neighbor and host farmers were selected to evaluate the technologies at maturity stage of the crop.
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. Both primary and secondary data were employed to achieve the objectives of the paper. Field observation and group discussion were held to gather the required data in the field.

Data analysis

Data were collected and analyzed by analysis of variance (ANOVA). Means were compared by the least significance difference (LSD) at 5% levels of significance (Gomez & Gomez, 1984; J. Shrestha, 2019). Statistical software used for data analysis was Gen Stat version 18th. Both inferential and descriptive statistics was used to analyze the data. 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 specifically for the third objective. Thus, selection criteria were identified first, then ranking was given for each criterion and finally acceptability rank was determined. Then, 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 DISCUSSION

Performance of sorghum varieties across study sites

Of many others, yield is one of the major parameters 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 and figure 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 e             | 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 computation, 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 the 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 in table 4 with their own justification. 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 criteria by the farmers in Raya kobo (table 5). 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 5-6).
Table 4. Identifying selection criterion of the farmers

| No | Criteria    | Justification                                                                 |
|----|-------------|-------------------------------------------------------------------------------|
| 1  | 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 farmers. |
| 2  | Plant height| Apart from grain yield, sorghum is the source of feed for animals and fuel.   |
| 3  | Seed Size   | Used as a proxy measure for marketability.                                    |
| 4  | Productivity| Farmers’ were able to compare the varieties productivity through visual observation on the field. |
| 5  | Compactness | Birds unless protected timely, they can bring a significant damage to the yield of sorghum. Therefore, the variety with a compacted head can relatively tolerate from bird damage. |
| 6  | 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. |
| 7  | 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. |

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 feedback 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 9). At the end of the field day session stakeholders have reached agreement to share responsibility in promoting the selected sorghum varieties.

Figure 2. Field performance of varieties

Figure 3. FTCs Experience sharing at Kamisie, Amhara Region
### Table 5. 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 | Seed color | Productivity| Productivity | 6     | 1    |
| 4  | Seed size      |           |              |              |           | X           | Seed color | Marketability | 1     | 5    |
| 5  | Compactness    |           |              |              |           |             | Compactness| Marketability | 3     | 3    |
| 6  | Seed color     |           |              |              |           | X           | Seed color | Seed color    | 2     | 4    |
| 7  | Marketability  |           |              |              |           |             |            | Seed color    | 2     | 4    |

### Table 6. Final acceptability rank (Criteria given for the criterion multiplied by the ranks given) at Kobo (82 participants)

| Variety          | 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 7. 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 8. Coincidences of farmers rank and actual rank

| 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

Table 9. 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        |
CONCLUSION

Based on the agronomic performance and farmers’ evaluation, improved varieties, Melkam and ESH1 were found to be superior both in terms of grain yield and farmers’ evaluation criteria at Raya kobo. Whereas, in Dawa Chef and Kalu, Argiti variety showed better performance and got an acceptance by farmers. Moreover, there exists a strong association between farmer’s evaluation results and the actual rank of varieties. Therefore, based on the yield performance and farmers’ preference, Argiti and Melkan should be promoted in the respective areas.

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