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# Investigation of Sorghum (*Sorghum bicolor* L.) Variety Preferences of Farmers in the Potential Low Land Areas of North Shewa Zone, Amhara Region

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ABSTRACT

Sorghum is one of the major staple crops grown in the poorest and most food-insecure regions of Ethiopia. Sorghum production is predominantly based on local seeds with limited use of commercial fertilizer or other chemicals. This study is therefore aimed to demonstrate the improved sorghum variety with its improved management practices and to assess farmers' and extension workers' reactions. The newly released variety of Beletew was evaluated with the variety of Melkam. The experiments were implemented using a simple plot design with farmers' fields as a replicate. The result revealed that in both locations, the studied varieties showed nonsignificant variation in grain yield. Besides, all the participant farmers were agreed that the variety Beletew had compacted panicle, a larger number of spikes per panicle, stayed green character and yellow seed color. Similarly, about 78.3% and 65.6% of the participant farmers from Efratana gidim and Ensaro Districts respectively agreed that the variety Beletew had a larger panicle size than the variety Melkam and expected higher grain yields from it. Therefore based on the grain yield performance of the result of farmers' evaluation, the new variety of Beletew was recommended to be pre-scale on a wider scale to sorghum-growing lowland areas as an alternative shortmatured varieties.

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## Introduction

Sorghum (*Sorghum bicolor* L.) is the fifth most important cereal in the world preceded by wheat, rice maize, and barely (FAOStat, 2013). It is a major food security crop in sub-Saharan Africa and is the staple food for the most food-insecure people in the world (Bibi et al., 2010). Ethiopia is the center of origin and diversity for sorghum (Mekbib, 2006). It is widely distributed throughout Ethiopia and it is the most important cereal crop in the lowland areas because of its drought tolerance (Kebede, 1991). It is grown in drought-prone and marginal areas in semi-arid zones where other crops cannot grow reliably.

In Ethiopia, sorghum is a major staple food crop, ranking second after maize in total production. It ranks third after wheat and maize in productivity per hectare, and after tef and maize in area cultivated. It is grown in almost all regions, covering approximately 1.9 million ha area of land (CSA, 2018). With an annual production of approximately 5.1 million tons (CSA, 2018), sorghum is the third most important cereal produced in Ethiopia, accounting for 17% of the total cereal produced in the country and covering some about 15% of the total area under cereals. Sorghum production is predominantly based on traditional seeds with limited use of commercial fertilizer or other chemicals. In the lowlands of Ethiopia, the traditional farming practice relies entirely on a rain-fed crop production system, which is characterized by poor crop performance and low yields. The major factors responsible for poor yields include moisture stress, low soil fertility, *Striga hermonthica*, and limited access to improved seed and efficient production technologies (Gebretsadik et al., 2014).

Because of the significance of sorghum for food security in drought-prone areas, the development of earlymaturing varieties with reasonable yields has been the main focus of breeding programs in Ethiopia (Adugna, 2007; Mekbib, 2006). Indeed, one new variety named Beletew was released by the Debre Birhan Agricultural Research Center in 2019. On average 4.42 tons $ha^{-1}$ of grain yield was obtained from this new variety and had a yield

advantage of 21.8% when compared to the variety of Charie. The objective of this study is therefore aimed to demonstrate the improved sorghum variety with its improved management practices and to assess farmers' and extension workers' reactions.

## Materials and methods

### *Description of Study Sites*

The experiment was done in the low lands of North Shewa areas of Efiratana Gidim and Ensaro Districts, under the main growing season in 2020. Geographically, Efratana Gidim is bordered on the south by Kewet, on the southwest by Menz Mam Midir, on the west by Menz Gera Midir, on the north by Antsokiyana Gemza, and on the east by the Oromia Special Zone. Efratana gidim was located between $9^0$ 29' 60'' North and $39^0$ 39' 60'' East with an average altitude of 2048 meters above sea level. Ensaro is bordered on the south and west by the Oromia Region, on the north by the Jamma River which separates it from Merhabiete, on the northeast by Moretna Jiru, and the east by Siyadebrina Wayu. Ensaro District is located between 9º 42' 27''- 9º 57' 48'' N and 38º 47' 43'' - 39º 02' 10'' E. The altitude ranges between 1569 and 2640 meters above sea level.

The area is characterized by a unimodal rainfall pattern and receives an average annual rainfall ranging between 943 and 1199mm while the annual average temperatures range between 17.6 and 23°C. The soil type in Efratana gidim District was loam soil while it was light clay soil in Ensaro District. The production system in the study area is characterized as a mixed crop-livestock agricultural system. Sorghum, teff, and mung bean are among the major crops mostly grown in the area. Cattle, sheep, and poultry are also important domestic animals kept by the smallholder farmers integrated with crop production.

### *Materials and the Research Design*

The experiment was done using Beletew sorghum variety- the newly released improved variety evaluated with Melkam variety as a control. The experiments were laid out in a simple plot design with six farmers' fields as a replicate for each District. A unit plot size of $100m^2$ (10 m ×10 m) was used for each variety. The recommended spacing of 75 cm between rows and 15 cm between plants was applied. The recommended amount of phosphorus fertilizer was applied at a rate of 121 kg $ha^{-1}$ as a one-time application during planting. Nitrogen fertilizer was applied at the rate of 100 kg $ha^{-1}$ N as a split application. Half the rate of nitrogen was applied with phosphorus during planting and the remaining half was given a month after the emergence of sorghum. For both varieties, a seed rate of 10 kg per hectare was used. Two times hand weeding and cultivation were done.

Site selection was done jointly by the researchers and development agents. Volunteer farmers were selected as a host for the implementation of the experiment. The experimental land was accessed freely without payment from host farmers. Regular monitoring and evaluation were done with the farmers, experts, and development agents. In this study, about 120, of which 13 were women, farmers have actively participated during the entire field evaluation period in both environments. The farmers were selected purposively based on their experience of growing improved sorghum technologies. Farmers were grouped into two groups, one from each district. Prior to evaluating the varieties, the farmers were brainstormed how to evaluate the varieties, and asked to identify variety evaluation parameters. Hence, participant farmers have identified different varieties of evaluation parameters including panicle size, panicle shape, the maturity date (earliness), grain size (largeness), grain color (yellowness), number of spikes per panicle, number of seeds per spike, and expected grain yield.

### *Data Collection and Analysis*

Both farmers' selection criteria and yield and agronomic data were collected. Farmers' selection parameters include panicle size, panicle shape, the maturity date (earliness), grain size (largeness), grain color (yellowness), number of spikes per panicle, number of seeds per spike, and expected grain yield. Yield data were collected from randomly selected four rows from each variety. On the other hand, plant height, and panicle length were collected from randomly selected ten plants. Finally, the collected data of farmers' preferences and the agronomic data were analyzed using descriptive statistics. Independent Sample T-Test was employed to estimate the difference between the demonstrated varieties.

## Result and discussion

### *Yield and Yield Component Parameters*

The result of agronomic variables and yield components, i.e., grain yield, plant height, and panicle length for Ensaro, Efratana gidim Districts, and the combined result were summarized in Tables 1, 2, and 3, respectively. In both locations, the studied varieties showed nonsignificant variation in grain yield. ). On average, the variety of Rasa provided the highest grain yield with 3997.8 kg $ha^{-1}$ when compared with the local variety (3956.6 kg $ha^{-1}$). The lowest mean grain yield, on the other hand, was obtained with the variety Local in Ensaro District. Relatively, in Efrtana gidim District both the varieties were performed well most notably explained by the soil fertility variation and other environmental factors. The current result was found far better when compared with the national, regional, and zonal average productivity of 2690, 2658, and 3177 kg $ha^{-1}$, respectively, in the 2020 production season (CSA, 2021).

Plant height is an important feature that positively contributes to grain and biomass yields. The variation of tasted varieties for plant height generally ranged from 120 to 178 cm. Both the highest and the lowest plant height were recorded from the variety of Melkam. The average plant height of the varieties in Ensaro District were 143.8 and 158.9 cm for the variety Beletew and Melkam, respectively. Similarly, in Efratana gidim District, the higher average plant height (150.3 cm) was obtained from the variety of Melkam. The analysis of variance revealed that the varieties significantly differed in plant height in Ensaro and Efratana gidim District ($p<0.001$ and $p<0.1$), respectively in its above order. When combined the demonstrated varieties were varied highly significantly at $P<0.001$ for plant height. In panicle length performance, both the introduced varieties have significantly differed in

both locations. The mean value of genotypes in spike length ranged from 24.3 cm to 28.8 cm. The result revealed that in both locations the variety of Melkam had significantly a longer panicle.

***Perception of Farmers on the Introduced Varieties***

Today, due emphasis has been given to the role of participation of the farmers in agricultural research. Among the reasons for advocating, farmer involvement within the research process is that farmers are more aware of their problems than outsiders and hence are in a better position to evaluate and identify the technologies best suit their existing situations. A participatory approach uses the existing local skills and knowledge as a starting point and is built around a process that enables the farmers to control and direct research and development of technologies that meet needs prioritized by farmers themselves (Abbeam et al. 2018). The involvement of farmers would increase the relevance of research outcomes in the field and could enhance the acceptability of the technology developed. Many of the existing literature reported that farmers, who participated in on-farm trials, demonstrations, farmer research groups, and field day events adopted improved agricultural technologies more than others did (Asfaw et al. 2011; Chandio and Yuansheng, 2018; Krishnan and Patnam, 2014).

In the current study, in both locations, all the participant farmers were agreed that the variety Beletew had compacted panicle, a larger number of spikes per panicle, stayed green character and yellow seed color (Figures 1 and 2). As the farmers said yellow color was preferable in the market and had a good quality for preparing *Enjera*. Similarly, about 78.3% and 65.6% of the participant farmers from Efratana gidim and Ensaro Districts respectively agreed that the variety Beletew had a larger panicle size than the variety Melkam. Also, the participant farmers in both locations expected higher grain yields from the variety of Beletew. On the other hand, participants said that the variety Melkam was relatively early mature and the seed size was significantly larger when compared with that of the variety Beletew.

Table 1. Mean values of yield and yield-related attributes in Ensaro District

| Variety | Beletew | | Melkam | | Independent-Sample T Test |
|---|---|---|---|---|---|
| | Mean | Std. dev | Mean | Std. dev | |
| Plant height (cm) | 143.8 | 9.34493 | 158.9 | 12.233788 | 7.571*** |
| Head length (cm) | 24.9 | 3.44792 | 26.4 | 3.13586 | 2.465** |
| Grain yield (kg ha $^{-1}$) | 3675.7 | 238.89524 | 3424.6 | 765.56830 | 0.767 |

Table 2. Mean values of yield and yield-related attributes in Efratana gidim District

| Variety | Beletew | | Melkam | | Independent-Sample T Test |
|---|---|---|---|---|---|
| | Mean | Std. dev | Mean | Std. dev | |
| Plant height (cm) | 146.5 | 7.82847 | 150.3 | 9.54800 | 1.809* |
| Head length (cm) | 24.3 | 3.92661 | 28.8 | 2.71621 | 5.62*** |
| Grain yield (kg ha $^{-1}$) | 4319.9 | 482.7985 | 4488.6 | 738.3177 | 0.469 |

Table 3. Combined mean values of yield and yield-related attributes

| | Beletew | | Melkam | | Independent-Sample T Test |
|---|---|---|---|---|---|
| | Mean | Std. Deviation | Mean | Std. Deviation | |
| Plant height (cm) | 144.8 | 8.8619 | 155.6 | 12.0105 | 7.091*** |
| Head length (cm) | 24.7 | 3.62591 | 27.3 | 3.19112 | 5.283*** |
| Grain yield (kg ha $^{-1}$) | 3997.8 | 495.0225 | 3956.6 | 907.173 | 0.138 |

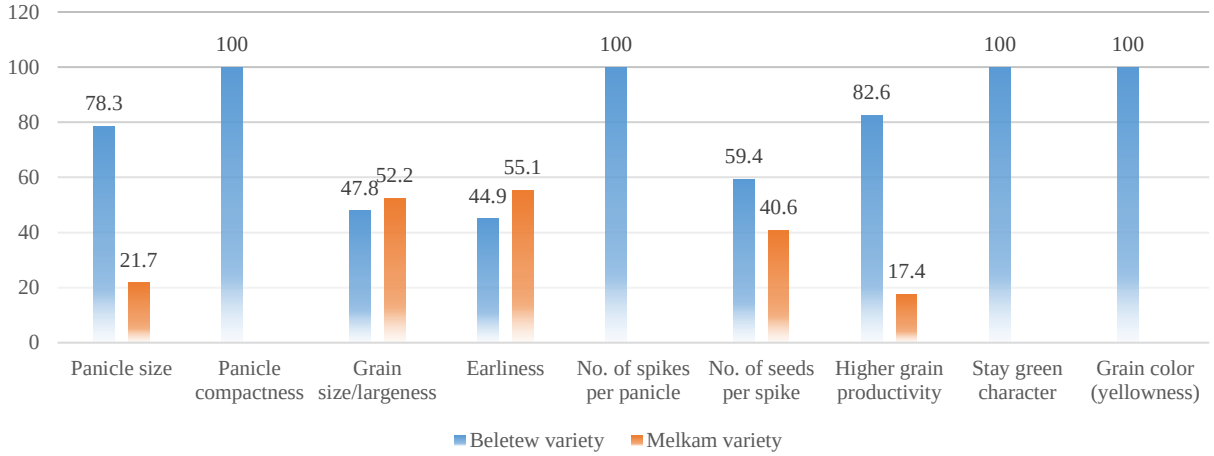


Figure 1. Variety evaluation criteria of the farmers in Efratana gidim District

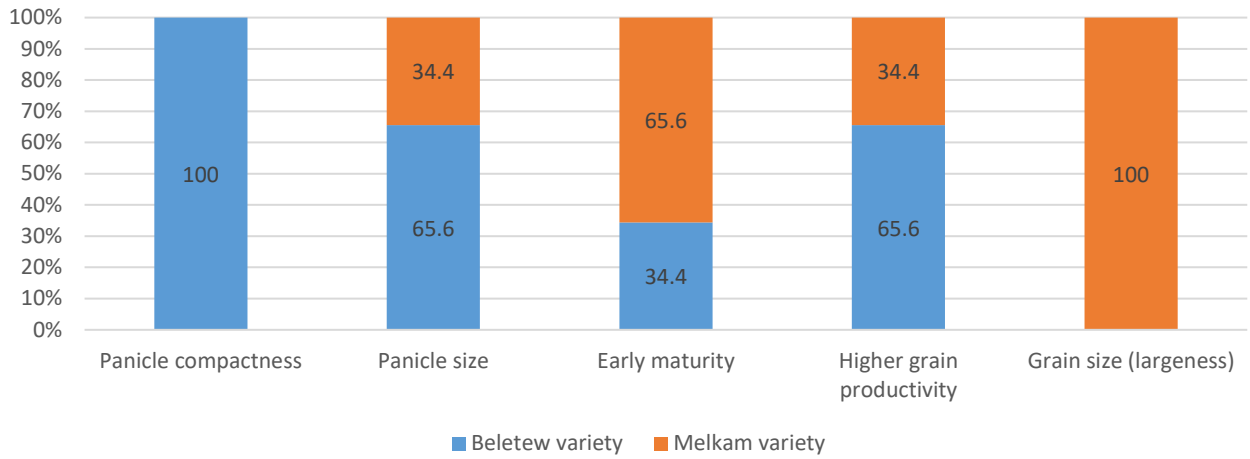


Figure 2. Variety selection criteria of the farmers in Ensaro District

Figure 3. The compacted panicle shape of the variety Beletew

Figure 4. Semicompacted panicle type of the variety Melkam

***Panicle Type of the Introduced Varieties***

The panicle shape and compactness of both the varieties had a significant difference (Figures 3 and 4). The variety Beletew had a relatively compacted panicle while the variety Melkam had a semi-compacted panicle. The panicle type was associated with grain yield and its shape for being used as an alternative host for different pests. For example, the compacted nature of the variety Beletew is suitable for Stem borer *(Chilo partellus)*. Also, farmers perceived that the compact- panicle types of sorghum varieties resulted in a higher grain yield. On the other hand, the variety Melkam was easily damaged by birds.

***Greeness Characteristics of the Variety Beletew***

The variety Beletew had a stayed-green character. Both of the varieties have almost the same maturity date. However, during harvest, the variety Beletew looks green. The farmers have preferred this character of the variety for animal feed and silage preparation. Feed shortage is a major issue for farmers in the low lands of the study areas, where the sorghum and tef production systems predominate. Figure 3, on the left, revealed the variety Beletew appears green during harvesting time.

At the end of the field evaluation, the participant farmers have connoted the Research Center to organize another field day program for the farmers to check the *Enjera* quality of these varieties.

## Conclusion and Recommendation

Sorghum is one of the major staple crops grown in the poorest and most food-insecure regions of Ethiopia. Sorghum production is predominantly based on local seeds with limited use of commercial fertilizer or other

chemicals. The result revealed that in both locations, the studied varieties showed nonsignificant variation in grain yield. The introduced varieties of Beletew and Melkam on average yielded 3997.8 and 3956.6 kg $ha^{-1}$, respectively. Besides, all the participant farmers were agreed that the variety Beletew had compacted panicle, a larger number of spikes per panicle, stayed green character and yellow seed color. Similarly, about 78.3% and 65.6% of the participant farmers from Efratana gidim and Ensaro Districts respectively agreed that the variety Beletew had a larger panicle size than the variety Melkam and expected higher grain yields from it. Most importantly, the improved variety of Beletew drew a lot of attention from farmers for its stay-green character for animal feed and silage preparation. Therefore based on the grain yield performance of the result of farmers' evaluation, the new variety of Beletew was recommended to be pre-scale on a wider scale to sorghum-growing lowland areas as an alternative shortmatured varieties. The result also suggested that the participation of farmers in technology development and the adaptation process was vital to boosting the technology adoption and diffusion rate. The participation of farmers would increase the relevance of research outcomes and will enhance the acceptability of the technology developed.

Figure 5. The variety Beletew on the left and Melkam on the right

Figure 6. One of the participant women farmer during field evaluation

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