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# Large Scale Demonstration of Improved Tef [*Eragrostis tef* (Zucc.) Trotter] Technology in Cheaha District and Worabe Town Administration

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**ABSTRACT**

**Background and Objective:** Worabe agricultural research center conducted different activities related to tef adaptation and demonstration, and research endeavours. However, the dissemination of improved tef varieties that are preferred by farmers is very minimal. This raises the need to conduct further cluster-based large-scale demonstrations of improved varieties. The main aim of this study was to demonstrate and evaluate the performance of improved Tef (*Eragrostis tef*) technologies under farmers' conditions in the Cheaha District and Worabe Town Administration. **Materials and Methods:** Cluster-based large-scale demonstration of improved tef technology was conducted in Cheaha and Worabe Town Administration in 2024/2025. Accordingly, Wurerbar and Fuge Achiraye Kebele were selected from Cheaha District and Worabe Town Administration, respectively. One unit of farmers' research extension groups (FREG) and two units of FREGs were established in Cheaha and Worabe Town Administration, respectively. Training for the participant farmers, Das, extension experts, and researchers was given at each tef cluster site. The field day was organized by participating farmers, development agents, extension agents, researchers, unions, and decision-making bodies in both clusters. The Areka-1 variety was used in both locations. **Results:** The results of descriptive statistics revealed that the average yields of tef variety Areka-1 were 2246 and 1818 kg/ha in Cheaha and Worabe Town Administration, respectively. As the results of farmers' perception show that the variety in both locations is perceived positively based on the farmers' perception criteria. The yields obtained at each cluster site were greater than the national average yield and district production. **Conclusion:** Thus, it is recommended that it is better to disseminate and address wide areas of the community through extension systems in a sustainable manner, including agronomic practices. Farmers should use wheat in a clustered form for better management to increase their wheat production and generate more income to improve their livelihood.

**KEYWORDS**

Areka-1, Cheaha, extension, perception, yield, Tef (*Eragrostis tef*), improved varieties, technology demonstration, farmer adoption



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## INTRODUCTION

Agricultural sector is the most significant economic sector and plays a significant role in the country's overall agricultural development, led industrialization (ADLI) program[1]. For most people in the nation, it provides a source of job and income. Almost 90% of exports, 72.7% of jobs, and more than 35.8% of the nation's GDP are currently derived from agriculture[2]. However, the sector's current level of output, productivity, and efficiency is much below the global average[2].

*Eragrostis tef*, also known as tef, is a self-pollinating warm-season grain crop that is believed to have originated in Ethiopia. Since it is a warm-season cereal crop that is self-pollinating and thought to have originated in Ethiopia, tef (*Eragrostis tef*) is used all over the world for its high nutritional value as a grain for human consumption and as animal feed[3,4]. Under terms of ecology, it is more suited to Ethiopia's many agro-ecological zones and thrives under stressful conditions than wheat, barley, and other globally recognized cereals[5]. Because it can withstand low moisture levels, tef is sometimes seen as a "rescue crop" that thrives during the season when early-planted crops fail because of moisture stress. As a result, farmers view it as a low-risk crop. It needs a temperature range of 10-27°C, 750-850 mm of annual rainfall, and an elevation of 1800-2100 m.a.s.l. for optimal functioning[5].

Ethiopia now cultivates over 3.02 million hectares of land. In terms of geographical coverage, this places tef as number one among the nation's cereals. However, the average national yield of tef in the cropping season of 2021-2022 is only 1.91 tons/ha, accounting for 17.71% (5.8 million tons) of the total cereal grain produced[2,6]. Which is very low compared with the tef yield produced at research station 2.53 to 3.2 tons/ha and its yield potential[2]. Various adaptation and demonstration projects have been carried out in recent years at various sites and agro-ecologies, which constitute CEARI's mandate regions. One of the centers under the Central Ethiopia Agricultural Research Institute (CEARI) is the Worabe Agricultural Research Center (WARC), which has carried out many adaptation and demonstration research projects. However, there is virtually little spread of better types that farmers choose. This makes it necessary to carry out additional large-scale cluster-based demonstrations of better cultivars. Therefore, it is crucial to engage farmers and other stakeholders in participatory demonstration, promotion, and popularization of enhanced tef technologies in order to acquaint farming communities with better varieties.

Farmers in the region have been introduced to certain improved varieties, but they do not employ them with the required production, and despite the possibility of agro-ecologies in the area, productivity was below its potential[5]. The primary crop grown in the Gurage Zone's Midland Region is tef. The crop is typically planted following the harvest of other crops, such as haricot beans and maize. It is grown as a cash crop as well as for farmer consumption. The crop is utilized for double cropping, which boosts farmers' output and income, because it may be grown in the Meher and Belg Seasons[4,5]. Tef straw is also utilized to build homes and serves as the primary source of fodder for livestock during dry spells[4]. The first and most significant issue in the research area is that, despite the crop's crucial importance, there is limited enhanced tef technology with its entire packages. In order to boost production and productivity in the research area, this activity was started to show off enhanced tef technology at big and clustered farms by putting farmers in groups with its complete packages.

### Objectives:

- To create awareness among farmers and development agents about the improved tef technology and its packages
- To increase the production and productivity of the tef in the study area
- To gather the perception and feedback of farmers about the technology and its packages

## MATERIALS AND METHODS

**Description of the study area:** The Silte Zone is one of 6 zones of Central Ethiopia. It is situated South-East of Halaba Zone, South-West Hadiya, Oromia, as well as in the Northern, North Western, and North Eastern Gurage Zones. Silt Zone comprises 3000 $km^2$, accounting for 2.63% of the region's total area. Silte Zone is divided into three major climatic zones based on altitude, rainfall, and temperature: 20.6% Dega, 5% Kola, and 74.4% Woina-Dega of the region's total area. The average annual temperature is between 12 and 26 oc. The rainfall ranges from 700 and 1818 mm. The Zonal land use pattern shows that 63.6 $km^2$ are now cultivated. Agriculture is the primary economic activity, and the zone contains a variety of ecological zones ranging from lowland to mountain, allowing for the production of a wide range of crops. Worabe (supposedly derived from the Silti word for "hyena") is a town in South Central Ethiopia. Worabe Town is the administrative headquarters of the zone, which is located 173 km from Addis Ababa, Ethiopia. It is located in Central Ethiopia's Silte Zone.

Gurage Zone is one of the zones found in the Central Ethiopia Regional State of Ethiopia. It is located in the Western part of Central Ethiopia; it is bordered on the South by Hadiya, on the West, North and East by Oromia Region, Yem on South West and the Southeast by Silte Zone. The zone is divided into three agro-ecological zones, namely: Dega or Highland climate mid highland climate or Weina Deg and Lowland or Kolla climate. Most of the areas lie in the mid-highland division. The distribution of rainfall and temperature mainly follows this pattern. The annual average rainfall ranges from 200 mm/annum-1,400 mm/annum. The highest and lowest temperature records 32°C and 7°C, respectively. Cheha Woreda is located between 7.99-8.25 latitude North and 37.59-38.06 East. The mean max and min temperatures are 27 and 18, respectively. The Woreda receives a rainfall between 900-1500. It has a total of 64 Kebele populated by 237,722 people. It also covers a total of 43972 hectares. The majority of the area is part of the Weina Dega agro-climate zone, covering about 80% of the total land and followed by Dega with a total coverage of 20%. Cheha Woreda is bordered by Abeshge Woreda at the North, Geta and Enemor Woresa at the South, Ezha and Gumer Woredas at the East, and both Yem Special Woreda and Oromiya region at the West. Eheha Woreda is the second Woreda selected in the Gurage Zone. The Woreda is 460 km far from Hawassa and 185 km from Addis Ababa (155 km through the Addis Ababa-Jimma Asphalt Road and 30 km towards the southeast on the Wolkite-Hosanna Asphalt Road). Emdibir is the capital of Cheha Woreda. Cheha Woreda is found between 1750 and 2500 m.a.s.l.

**Site and farmers' selection:** This activity was conducted at Cheha Woreda from Gurage Zone and Worabe Town Administration from Silte Zone. The Woreda will be selected purposively due to its potential for tef production, being mandated by FSRP Woreda, and the high demand for the crop by the farmers. Selection of 2 potential Kebeles was carried out in collaboration with DAs, researchers, and experts. Farmers were selected based on, availability and accessibility of land in the cluster. Gender issue will be considered during farmer selection in each Woreda (with a total number 30% women and 70% male). Accordingly, the area of land coverage within each cluster is 20 ha (a total of 40 ha in two Woreda) will be covered. Selection of farmers research extension group (FREGs) members is based on farmers' willingness to be held as members, good history of compatibility with groups, genuineness, and transparency to share innovations with other farmers are criteria used to select the hosting farmers. Consequently, one FREG having 12 members with the composition of men, women, and youth farmers at each Kebele cluster will be established. Gender and youth balance in each farmers research extension group (FREG) unit is again strictly considered. Then, four representative hosting farmers from each FREG are selected at each Kebele cluster with the help of group members and DAs. Thus, a total of 8 hosting farmers were selected for this purpose. Farmers FREG members and other follower farmers are encouraged to participate in the physical activities from the beginning to the end of the demonstration activity.

**Implementation design:** Improved tef variety Areka-1 was used for the demonstration process by using a farmer's farm at the cluster base. It was planted on farmers' land within clusters at 20 ha in each Woreda and Kebele (total of 40 ha from two Woreda) in the 2024/25 main cropping (*Meher*) season with full recommended management packages by broadcasting. Inputs are provided by the center timely like seed 25 kilograms per hectare, NPS 100 kg per hectare, Urea 100 kg per hectare, and other necessary chemicals were applied by farmers according to up-to-date scientific recommendations. Before sowing, farmers prepared their land appropriately and sowed the variety on time, and the necessary management was done, like weed management and chemical application. The activity was weeded two times; first at one month after sowing and second at two months after sowing of improved bread wheat varieties. Farm operations (land preparation-ploughing four to five times using oxen plough, land leveling, planting, first and second weeding, harvesting, threshing are handled by hosting farmers, whereas activities such as delivery of input like seed and agro-chemical spray WARC.

Technology demonstration and evaluation techniques, FREGs members, and other follower farmers are encouraged to participate in different extension/promotional events organized at each demonstration cluster. These are mechanisms used to enhance farmer-to-farmer learning and information exchange, such as training, field visits/tours, experience sharing, and field days, because they are a participatory approach.

**Methods of data collection:** Both qualitative and quantitative data will be collected using appropriate data collection methods such as focused group discussion (FGD), direct field observation, and measurements. Data like grain yield per ha was recorded by taking a (1m×1m) by following the quadrant formula. The common quadrat sizes in field crops are 1 $m^2$ (most common for cereals like tef), and 1 $m^2$ makes calculations easier when extrapolating to kg/ha. Systematic sampling was used, which means placing a quadrat every 100 m in a grid pattern. The number of samples, at least 15-30 quadrats, is recommended for 20 ha to get statistically reliable data. The total number of farmers who participated in extension/promotional activities was collected. The total number of farmers who attended extension/promotional events such as training, field visits, and mini field days was reported by gender. Feedback on farmers' perceptions of the technology (likes and dislikes) and their perception of the technology's performance were also identified by ranking the average.

**Methods of data analysis:** The SPSS (version 26) was used to evaluate the collected data. Descriptive statistics, including mean, standard deviation, min, max, and a Likert scale (average score) were used to measure farmers' preferences. A Likert scale, which proposes an ordinal scale from poor to outstanding, was used to analyze the farmers' preferences. To evaluate farmer preferences, a number is assigned to each Likert scale response. The preferences under consideration were evaluated by assigning a numerical value to each of the five responses.

**Training and field day:** Training (both theoretical and practical) is very important for awareness creation and to bring improvement on the job after filling the gap in knowledge, skill, and attitude (KSA). Hence, stakeholders such as zone and district level Agriculture and Natural Resource Office, Unions, private service providers, zone and district level agricultural inputs regulations, quarantine experts, farmers, and DAs are invited and participate during the consultation meeting and training. A multidisciplinary team of researchers from Worabe Agricultural Research Center delivered training to the participants as shown below (Table 1). Training will be given on the following topics: Participatory agricultural research and promotion through FREGs, suitable agro-ecologies and weather conditions for maize production and management packages, agronomic practices, economic and nutritive importance of maize, post-harvest management, and storage of the crop. A field visit is arranged to create awareness and farmers' experience and knowledge.

Table 1: Awareness creation methods in Worabe Town administration and Cheha Woreda

| Awareness creation methods | Participants | Cheha woreda | | | Worabe town administration | | |
|---|---|---|---|---|---|---|---|
| | | M | F | Total | M | F | Total |
| Training | Farmers | 113 | 45 | 158 | 42 | 21 | 63 |
| | DAs | 1 | 1 | 2 | 1 | 1 | 2 |
| | Woreda experts | 8 | - | 8 | 2 | 1 | 3 |
| | Researchers | 4 | - | 4 | 2 | - | 2 |
| Total | | 126 | 46 | 172 | 47 | 24 | 71 |
| Field Day | Farmers | 57 | 20 | 77 | 43 | 13 | 56 |
| | DAs | 2 | 1 | 3 | 1 | 1 | 2 |
| | Woreda experts | 9 | - | 9 | 4 | - | 4 |
| | WARC researchers | 24 | - | 24 | 4 | - | 4 |
| | Media of communication | 6 | - | 6 | 2 | - | 2 |
| | Zone experts | 2 | - | 2 | - | - | |
| | CEARI | 1 | - | 1 | - | - | |
| Total | | 99 | 21 | 120 | 54 | 14 | 68 |

M: Male, F: Female, T: Total, DAs: Development agents, WARC: Werabe Agricultural Research Center, CEARI: Centre for Evaluation and Agricultural Research Innovation

Regular joint monitoring and evaluation (follow-up actions) and provision of technical advice are undertaken at different crop stages based on the necessary emerging knowledge/skill and technical advice needs. Field day is a method of motivating people to adopt new practices by showing what has already been achieved under field conditions. In other words, it is to show the performance and profitability of new practices and to convince of the applicability. Besides, it is a way of facilitating people to visit innovations for the purpose of bringing mass mobilization. Thus, mini field days are organized at each demonstration cluster to involve key stakeholders and enhance better linkage among relevant actors. Field days are organized at each demonstration cluster to involve key stakeholders and enhance better linkage among relevant actors.

During the field day, informed consent was obtained, and participants gave feedback. In addition to that, participants agreed on future directions for the seed exchange system, seed collection, and commercialization in the area.

**Ethical approval:** Ethics approval and consent to participate. No human or animal tissues were used in this study. The plagiarism result was evaluated and confirmed by the United Graduate School of Agricultural Sciences, before submission to the journal of TAS, Trends in Agricultural Sciences and Bioscience. Therefore, the manuscript was seriously evaluated to meet ethical standards before submission.

## RESULTS AND DISCUSSION

Under this part, the grain yield, farmers' perceptions, and feedback were discussed as follows: Accordingly, the average grain yield of the improved *tef* in Cheha district and Worabe Town Administration was 2246 and 1818 kg/ha, respectively (Fig. 1 and 2). The result of the Areka-1 variety indicates that it has higher yield potential than the national average tef yield in the Cheha District location. These results were due to the improved tef variety and good clustering approach with the best field management. The mean grain yield of the Arek-1 variety in Cheha district was greater than the mean grain yield of the national. Whereas the yield recorded in Worabe town administration was nearly equal to the national average yield[8]. Based on the grain yield, this finding is in line with the findings of previous studies[2,3,4,7,8]. On the other hand, the findings of the grain yield of the Areka-1 tef variety are less than those of this findings[9]. The following graph shows the mean yield of tef variety (Areka-1) in kg/ha at Cheha District and Worabe Town Administration.

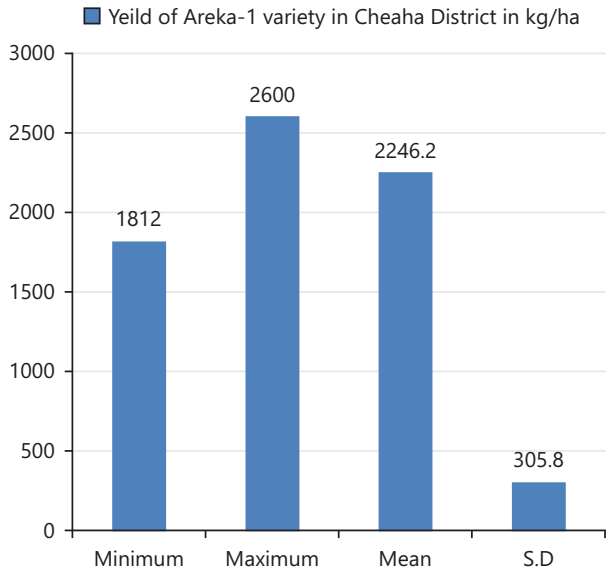


Fig. 1: Mean grain yield of Areka-1 tef variety in Cheha District

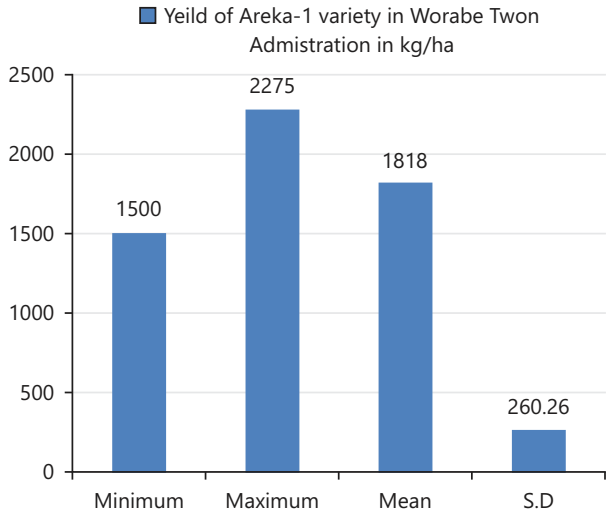


Fig. 2 Mean grain yield of Areka-1 tef variety in worabe town administration in kg/ha

Table 2: Farmers' perception regarding the LSD of tef technology in worabe town administration and Cheha District

| | | Responses (Cheha District N=26, Variety =Areka-1) | | | | | |
|---|---|---|---|---|---|---|---|
| No | Items | Strongly agree | Agree | Disagree | Strongly disagree | Mean score | Rank |
| 1 | Grain yield | 26 | 0 | 0 | 0 | 4.00 | 1st |
| 2 | Early maturity | 25 | 1 | 0 | 0 | 3.84 | 2nd |
| 3 | Tillering capacity | 21 | 6 | 0 | 0 | 3.23 | 6th |
| 4 | Disease resistance | 23 | 3 | 0 | 0 | 3.53 | 4th |
| 5 | Color | 22 | 4 | 0 | 0 | 3.38 | 5th |
| 6 | Lodging resistance | 19 | 5 | 2 | 0 | 2.92 | 7th |
| 7 | Marketability | 24 | 2 | 0 | 0 | 3.69 | 3rd |
| **Worabe town administration (N=43, Variety =Areka-1)** | | | | | | | |
| 1 | Grain yield | 40 | 3 | 0 | 0 | 3.72 | 3rd |
| 2 | Early maturity | 43 | 0 | 0 | 0 | 4.00 | 1st |
| 3 | Tillering capacity | 37 | 6 | 0 | 0 | 3.44 | 6th |
| 4 | Disease resistance | 38 | 5 | 0 | 0 | 3.53 | 5th |
| 5 | color | 39 | 4 | 0 | 0 | 3.62 | 4th |
| 6 | Lodging resistance | 35 | 6 | 2 | 0 | 3.25 | 7th |
| 7 | Marketability | 42 | 1 | 0 | 0 | 3.90 | 2nd |

**Farmers' perception of the technology:** Farmers have a broad knowledge base; they lack control treatment for comparison and statistical tools to test the hypothesis, and perception about demonstrated variety was consulted based on the desired criteria by themselves. The cluster demonstration was a very effective way in order to popularize the new technology in an observable way. The technology is demonstrated at the crop maturity stage and validated by farmers, agricultural experts, development agents, researchers, and other stakeholders based on the following selection criteria. The farmer's criteria were tillering capacity, early maturity, disease resistance, color, lodging resistance, and marketability (Table 2). Each selection and evaluation criteria were recorded, scored, and ranked using the total population. Likert scales are rating scales with several "anchors" that can be numerically or verbally displayed to allow measurements of a given item or question. Farmers were asked to give a rank from 1-4 on each attribute of the technology, where 4=strongly agree 3=agree 2=disagree, and 1=strongly disagree.

Researchers transfer scientific knowledge about the full packages of the technology, and again farmers share their indigenous knowledge with researchers. On the basis of the data collected from farmers through interviews, they reported that merging several small farms in a cluster (a large number of farmers and a large size of land) provides small landholding farmers an opportunity to obtain good profits for their produce. Strong integration among stakeholders (follow-up from Districts and Zonal experts, centers, researchers and institute leaders), the timely availability of sufficient input is a better platform for technology transfer and the cluster was effective. They also reported that the demonstration provided better opportunities to use full packages, i.e., fertilizer, seed rates, and chemical applications, to obtain better yields, which helps farmers obtain better knowledge of the commodity and opens doors to farmers to work together and share ideas and skills that they inquire from researchers and extension. They also reported that the demonstration helped them to share seeds from neighboring farmers (farmer-to-farmer seed sharing) in FREG and helps farmers to share ideas to work, weed, and apply chemicals on time. Due to the resource limitations, this study was not expanded to all the mandated woredas of the Central Ethiopia Regional State. In addition to that, forming the seed enterprise in the region to make the work sustainable. Therefore, for the other study, the expansion of these effective works to improve the food security and livelihoods of the smallholder farmers is recommended.

## CONCLUSION

In general, the demonstration of improved teff technology was carried out at Cheha District and Worabe Town Administration in the main season 2024/25. After the site and farmers' selection training was given to the farmers, development agents, experts, and researchers to develop the skill, attitude, and knowledge about the technology. The areka-1 variety has shown promising results at both locations (Cheha Woreda and Worabe Town). It was performed well in almost all the farmers' fields. The grain yield recorded at the Cheha Woreda was greater than the national average yield and the districts' productivity, while the grain yield of the Worabe Town Administration was similar to the national average yield. The results of farmers' perception criteria indicated that farmers perceived the technology positively at both Districts. Cheha and Worabe Town Districts should have ensured the timely availability of certified Areka-1 seeds, fertilizers, and crop protection inputs through cooperatives and agro-dealers. Expand the cluster-based approach to cover more Districts to enhance technology adoption and yield gains. Extension personnel should provide sustained training and advisory services to farmers on best agronomic practices to improve yield levels. Therefore, it is recommended that the variety Areka-1 can be promoted to similar agro-ecological zones across Ethiopia through extension programs, given its proven performance.

## SIGNIFICANCE STATEMENT

Tef is a self-pollinated and warm-season cereal crop; believed to have originated in Ethiopia, and is used throughout the world due to its high nutritional value as a grain for the human diet and as feed for livestock. The study demonstrates improved TEF technology in a large-scale demonstration base. The most important points of the tef variety 'Areka-1' are the high performing variety in the study area. The

Areka-1 variety showed a high yield and which was greater than the national local area production. Therefore, it is recommended that the variety Areka-1 can be promoted to similar agro-ecological zones across Ethiopia through extension programs, given its proven performance.

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