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# On-Farm Participatory Evaluation and Demonstration of Improved Shallot Varieties under Supplementary Irrigation

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**ABSTRACT**

On-farm participatory evaluation of improved shallot varieties was carried out during the 2021/22 cropping season in the Sekota district under supplementary irrigation. The objectives of the experiment were to evaluate and demonstrate the performance of different improved shallot varieties with the involvement of farmers and stakeholders, and to record their feedback. The host farmers were selected based on their willingness and motivation to implement the experiment according to the research recommendations. Theoretical and practical training was provided for the host farmers and FREG members. Two shallot varieties (Yheras and shallot 'DZ-91-2B') were evaluated on a 100 m² plot of land, and t-tests were used to determine whether there were statistically significant differences in yield and other quantitative data between the varieties. The average seed yields for Yheras and shallot 'DZ-91-2B' were 820 and 770 kg $ha^{-1}$, respectively. In terms of earliness, the Yheras and shallot 'DZ-91-2B' varieties matured at 125 and 130 days, respectively. Additional farmer preferences—such as disease and pest tolerance, umbel head size, and other important attributes—were assigned weighted scores by the farmers, and the varieties were ranked based on the total weighted values. From these results, the Yheras variety provided the highest seed yield and also received the highest overall score for preferred attributes. Participation by farmers and stakeholders increased interest and motivation for adopting the introduced shallot varieties for improving food self-sufficiency and generating income. Therefore, the dissemination and promotion of the improved Yheras shallot variety, along with the recommended production practices, should be encouraged for the irrigable midland areas of the Waghimra zone by the respective Agricultural Office.

## Introduction

Shallot (*Allium cepa* var. 'aggregatum') belongs to the family Alliaceae and has played important roles in the human diet and health promotion since historical times (Forotaghe et al., 2021). It is an important alliaceous crop cultivated in many tropical countries as a substitute for bulb onions (Hailu et al., 2014). The use of shallot seeds is an innovation with the potential to boost crop yields and reduce the risk of disease transmission, which is frequently spread through traditional bulbs (Arham et al., 2024). In Ethiopia, shallot is one of the horticultural commodities with a high economic net return. It is a favored and widely grown condiment crop, commonly utilized as a spice and for culinary purposes, and its pungency makes it more preferred than onion (Getahun et al., 2003; Hailu et al., 2014; Woldetsadik et al., 2003). Traditionally, it has been cultivated by subsistence farmers in mid- to high-altitude areas for use as a spice in local cooking and as a source of income for smallholder farmers (Degewione et al., 2011; Getachew et al., 2009; Moges and Masrie, 2019). The crop exhibits a wide range of climatic and soil adaptability and is cultivated under both rain-fed and irrigated conditions. Although it shares similar agro-climatic requirements with bulb onion, it is better adapted to rain-fed production and is relatively tolerant to leaf diseases that commonly affect bulb onion during the rainy season (Degewione et al., 2011).

Shallot is propagated vegetatively using bulbs as planting material (Getahun et al., 2003; Tabor, 2018). Nevertheless, despite its effects on growth and overall performance, traditional methods of bulb placement or planting practices are still commonly used in Ethiopia. Although bulb onions can also be grown in tropical regions, farmers in many tropical countries prefer shallot due to its ability to propagate vegetatively. It is additionally preferred for its shorter growth cycle, better tolerance to disease and drought stresses, longer storage life compared to common onion, and its distinct flavor that persists after cooking (Woldetsadik et al., 2003). It is used daily in most households as a flavoring spice in the preparation of local dishes such as *wot* (a stew), and it is rare to find a meal in Ethiopia that does not include this vegetable (Degewione et al., 2011).

Despite its importance, shallot production has been declining and is becoming increasingly dominated by onion. One major constraint to shallot production in Ethiopia is the need for a high amount of planting material, 1.5–2 t $ha^{-1}$ of edible bulbs, which accounts for about 40% of the production cost, compared to only 4–5 kg $ha^{-1}$ when true seed is used (Lemma and Yayeh, 1994). Furthermore, the yield and quality of existing shallot varieties are often low, primarily due to the poor quality of mixed local varieties varying in size, color, shape, and storability; high disease and insect pest pressure favored by vegetative propagation; lack of improved varieties; and suboptimal pre- and post-harvest management practices (Moges and Masrie, 2019; Shimeles, 2014; Tekalign et al., 2012; Woldetsadik et al., 2003). Additionally, many farmers continue to rely on bulbs as planting material, further restricting the dissemination of improved production technologies.

The Waghimra zone is an area where rain-fed production of common field crops is not very effective. As a result, crop yields are low and often insufficient to meet household consumption needs or to generate income through local market sales. Moreover, even in regions with favorable environmental conditions for producing shallots, productivity often remains low and fails to meet market demand (Tagele et al., 2017). In the Waghimra zone, some farmers cultivate shallots using vegetative propagation despite the aforementioned constraints. Therefore, introducing improved, high-yielding shallot varieties with the capacity to produce true seeds would be highly beneficial. Such varieties would support farmers in generating income and achieving greater food self-sufficiency and food security.

To solve these problems, the Sekota Dryland Agricultural Research Center, under its horticulture research division, has been conducting several adaptation trials under supplementary irrigation to identify the best-performing shallot varieties that fit the agro-ecological context. Accordingly, the shallot varieties Yheras and DZ sht-91-2B, evaluated with their full production packages, were found to be better and more promising for the district in terms of adaptability and higher yield. However, this recommendation emerged from trials designed and implemented at research stations, where breeders' motivation, interest, management practices, and close follow-up played a significant role. As a result, the research outputs were not easily accepted by farmers, since their effectiveness had been measured mainly in terms of yield and not in relation to other farmer preferences, such as financial feasibility and social settings. Moreover, the recommendation process did not involve active farmer participation. Therefore, this participatory study approach is helpful in providing additional considerations beyond biological traits and in promoting farmer-based evaluation and adoption of new varieties when appropriate. The current study was conducted primarily to evaluate and demonstrate different improved shallot varieties under supplementary irrigation. This participatory evaluation enables farmers to select financially feasible, technically efficient, and socially acceptable shallot varieties using their preferred selection criteria.

## Materials and Methods

### *Description of the study area*

This on-farm participatory evaluation and demonstration trial was conducted during the 2021/22 cropping season under supplementary irrigation at Sekota district, northeastern Ethiopia. Sekota District (Woleh) is located at 1384757N longitude and 505143E latitude and is located at 2119 meters above sea level, having an erratic rainfall pattern with the annual average rainfall of 774.2 mm, and the mean annual maximum temperature of the district ranges from 23.1 to 28.6 °C (Asresu and Tarekegn, 2025b). The dominant soil type of the district is loam clay soil and black sandy soils (Own GPS reading, 2020; Asresu and Tarekegn, 2025). The main crop types produced in the study areas are teff, wheat, faba bean, and Sorghum according to their area coverage (CSA, 2020 and SWoA, 2021).

### *Sample farmer's selection and training*

The district and host farmers were selected purposively based on their willingness and motivation to implement the research recommendations, as well as their potential to serve as role models for other farmers and support future scaling-up activities. The Farmers Research Groups (FRGs) approach is a valuable strategy and mechanism that plays a great role in promoting agricultural technologies through participatory methods (Dembi et al., 2021). To strengthen participatory evaluation and technology transfer, farmers' research groups consisting of twenty-five members were established, including 30% female-headed households. The group is expected to assign a chairman and a secretary responsible for coordinating team members and activities in collaboration with researchers and extension workers in the district (Abeje et al., 2016). In addition, a couple approach was applied to reduce gender bias by involving six couples (farmers and their wives) (Mihiretu and Asresu, 2022). The group members were selected from different social segments in the community (male, female, young, old, etc.). From the beginning of the experiment, a strong linkage among the multidisciplinary team (extension workers, farmers, and researchers) created a common understanding of the experiment. Therefore, the FREG members and host farmers were provided with training on basic agronomic practices and technology package implementation, with both theoretical and practical sessions (Table 1).

**Table 1.** Composition of stakeholders in terms of training provided and participation.

| Year | Training provided | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Experts | | | Host farmers | | | FREGs | | |
| 2021/22 | M | F | T | M | F | T | M | F | T |
| | 2 | 1 | 3 | 6 | 6 | 12 | 15 | 10 | 25 |

Where, M = male; F = female and T = total.

### *Treatments, experimental design, and farmers' participation*

Five voluntary farmers from the FRG members were selected to host the trial. The experimental treatments were arranged in an unreplicated simple block design, considering farmers as replications. Each experiment consisted of two side-by-side plots, each with an area of 100 m$^2$. The 'Yheras' variety was evaluated under improved management (YIM), whereas the shallot variety DZ-91-2B was evaluated under normal management (2BIM). The experimental plots were provided to farmers at no cost, while all other trial expenses were covered by the research center. Fertilizers were applied according to the research center's recommendations used in the adaptation trial: 200 kg ha$^{-1}$ of NPS and 150 kg ha$^{-1}$ of urea. Planting spacing followed the standard recommendation of 40 cm between water furrows and 20 cm between rows on the ridge (Moges and Masrie, 2019). Land preparation (three plowings), weeding (twice), and watering were also conducted according to recommended practices. Seed bulb production from true shallot seed was carried out using mini-bulbs weighing 2–3 g, produced as propagules through shallot multiplication. Shallot bulbs were dismantled, prepared, and processed as seed rhizomes, followed by a two-month dormancy period before planting. Planting took place in mid-August, and supplementary irrigation was provided using the furrow method at 5-day intervals during dry periods. In the study area, furrow irrigation once per week is the recommended practice for watering seedlings (Mihiretu and Asresu, 2023). Farmers and experts were actively involved throughout the entire process, including plot layout, planting, fertilization, field management, and performance evaluation, to enhance the potential for wider dissemination of the technology.

### *Data collection and analysis*

Both quantitative and qualitative data were collected using checklists and focus group discussions (FGDs). Qualitative social data, such as farmers' preferences and their level of acceptability for each technology, were gathered during the FGDs. Secondary data were also obtained from various published and unpublished sources to triangulate and support the findings from the experiment.

Quantitative biological data, including grain yield and days to maturity, were collected at the plot level. Descriptive statistics (means, standard deviations, and percentages) were used to summarize the biological data. A t-test was conducted using SPSS (version 22) to compare the means of the two independent treatment groups and to determine whether statistically significant differences existed between them. Agronomic records served as explanatory variables in these comparisons.

For participatory evaluation, farmers and their spouses were divided into sex-disaggregated groups, and each group was assigned to visit two trial sites. Farmers independently indicated their evaluations based on observations made during several round trips to the assigned replications. Afterward, each group conducted a brainstorming session to identify the evaluation criteria to be used for selecting shallot varieties at both the vegetative performance stage and the physiological maturity stage. The evaluation criteria most commonly identified by farmers included umbel/head size, number of umbels per plant, earliness, grain yield, vegetative performance, and disease/pest tolerance, listed in order of importance (Mihiretu et al., 2019).

To summarize these rankings, the weighted scoring method was applied. The first through sixth ranks were assigned weighted values of 6, 5, 4, 3, 2, and 1 points, respectively (Table 2). Farmers compared the treatments directly and assigned scores based on the agreed-upon criteria. Each treatment's rank score was multiplied by the corresponding weight to generate a weighted ranking matrix (Gashu and Beyene, 2024; Zewdu et al., 2020). The weighted scores were then aggregated across treatments to determine the final selection, where the lowest total indicated the top-ranked treatment (Russell, 1997, cited in Mihiretu et al., 2019).

Spearman's rank correlation was employed to assess the degree of concordance between farmers' preference rankings and the actual value rankings of the measured agronomic attributes, following the formula provided in Ferdous et al. (2016).

$$rs = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

Where, $r_s$ = correlation coefficient; Σ = Sum; d = difference in the ranks assigned to the same phenomenon and n = number of phenomena ranked. Finally, a mini field day was organized in the district to create awareness about the technologies in general and the improved varieties in particular.

**Table 2.** T-test on differences in grain yields and days to maturity in the district.

| Treatment | Trt | Mean kg ha$^{-1}$ | Std. Err. | Std. Dev. | t- value |
|---|---|---|---|---|---|
| Years | 5 | 820 | 1.067708 | 2.387467 | t = 0.5 |
| DZ sht–91-2B | 5 | 770 | .5147815 | 1.151086 | |
| Combined | 10 | 795 | .5649484 | 1.786524 | |

Trt: Treatments, Std. Err.; Standard error, Std. Dev., Standard deviation.

# Results

## *Grain yield performance*

The results showed that the 'Yheras' shallot variety with improved management (YIM) out-yielded the 'DZ-91-2B' variety (2BIM) under full-package management in the district. The 'Yheras' variety consistently produced the highest mean grain yield (Table 2). However, the t-test revealed no statistically significant difference between the two treatments in grain yield or days to maturity ($P > 0.05$).

The average grain yield of the 'Yheras' variety was 820 kg ha$^{-1}$ with a standard deviation of 2.38, while the DZ Sht-91-2B variety produced 770 kg ha$^{-1}$ with a standard deviation of 1.15. The physiological maturity period was 125 d for 'Yheras' and 130 d for DZ Sht-91-2B.

## *Farmers' preference parameters and choices*

Farmers in the study area identified six key preference parameters through a two-stage evaluation process, from vegetative growth to physiological maturity, to select their preferred shallot variety (Table 3). These parameters were weighted according to their relative importance and used as criteria for comparing the varieties. The most important attributes identified were umbel/head size, number of umbels per plant, earliness, grain yield, vegetative performance, and disease/pest tolerance.

**Table 3.** Farmer's preference parameter.

| No | Farmers preference criteria | Rank (Weight) |
|---|---|---|
| 1 | Umbel (head) size | 3 |
| 2 | No of umbels per plant | 2 |
| 3 | Earliness of the variety | 4 |
| 4 | Vegetative performance | 6 |
| 5 | Disease tolerant | 5 |
| 6 | Grain yield | 1 |

# Discussion

## *Grain yield performance*

Producing true shallot seed is a valuable opportunity for smallholder farmers to enhance economic self-sufficiency. As shown in Table 3, no significant difference was observed between the two varieties in terms of grain yield and earliness. However, the 'Yheras' variety (YIM) was the best-performing in the district for both mean grain yield and days to maturity, providing a 50 kg ha$^{-1}$ yield advantage over the DZ Sht-91-2B variety under supplementary irrigation. This result aligns with the findings of Wubet et al. (2022), who reported that improved agricultural technologies are more cost-effective compared to traditional farmer practices. Despite its acceptable yield performance, the DZ Sht-91-2B variety reached maturity later than 'Yheras', making it less preferred by farmers due to delayed earliness, which is a critical attribute in the study area.

### *Farmers' preference parameters and choices*

The active participation of farmers in on-farm technology evaluation is essential for the successful dissemination and long-term adoption of agricultural innovations. For demand-driven and sustainable scaling-up of technologies, incorporating farmers' preference criteria is indispensable (Mihiretu et al., 2019). Consistent with this principle, the overall weighted ranking matrix revealed that farmers ranked the 'Yheras' variety as the most preferred shallot option based on all evaluated attributes.

Moreover, Spearman's rank correlation was used to assess the degree of agreement between farmers' preference rankings and the actual measured trait rankings. The results showed a 100% coincidence for grain yield and earliness in the district (Table 4), indicating strong alignment between farmers' subjective evaluations and the objective agronomic measurements.

**Table 4.** Spearman's correlation between farmers' preference rank and actual measured traits rank for treatments.

| **Treatments** | **Grain yield (kg ha$^{-1}$)** | **Rank** | | | **Days to maturity** | **Earliness rank** | | |
|---|---|---|---|---|---|---|---|---|
| | | **Actual** | **Farmers** | **d $^2$** | | **Actual** | **Farmers** | **d $^2$** |
| Years | 820 | 1 | 2 | $(1-2)^2$ | 150 | 1 | 2 | $(1-2)^2$ |
| DZ sht – 91-2B | 770 | 2 | 1 | $(2-1)^2$ | 160 | 2 | 1 | $(2-1)^2$ |
| Spearsons'correlation | | | | rs = 100% | | | | rs = 100% |

At the physiological maturity stage, mini field days were organized in the district, involving key stakeholders including farmers, researchers, and experts from zonal and district-level agricultural development offices. During these events, participating farmers and experts jointly evaluated each treatment. Ultimately, the improved 'Yheras' variety (YIM) was preferred due to its superior umbel (head) size, number of umbels per plant, earliness, grain yield, vegetative performance, and disease/pest tolerance (Table 5).

**Table 5.** Summary of farmers' evaluation criteria and preference rank for different treatments.

| **Weighted parameter** | | **Treatments** | |
|---|---|---|---|
| | | **DZ sht–91-2B** | **'Yheras'** |
| Umbel/head size | *Score* | 2 | 1 |
| | *Weight* | 3 | 3 |
| | *Score X weight* | 6 | 3 |
| Vegetative performances | *Score* | 1 | 2 |
| | *Weight* | 6 | 6 |
| | *Score X weight* | 6 | 12 |
| Number of umbels per plant | *Score* | 1 | 2 |
| | *Weight* | 2 | 2 |
| | *Score X weight* | 2 | 4 |
| Disease/pest tolerant | *Score* | 2 | 1 |
| | *Weight* | 5 | 5 |
| | *Score X weight* | 10 | 5 |
| Grain yield | *Score* | 1 | 2 |
| | *Weight* | 1 | 1 |
| | *Score X weight* | 1 | 2 |
| Earliness | *Score* | 2 | 1 |
| | *Weight* | 4 | 4 |
| | *Score X weight* | 8 | 4 |
| ∑(score x weight) | | 33 | 30 |
| Rank | | 2 | 1 |

Where; 1 = V.good and 2 = Poor

## Conclusion

The overall on-farm evaluation demonstrated that the improved 'Yheras' shallot variety, when implemented with its full production package, provided superior grain yield, with a mean yield of 820 kg ha$^{-1}$ in the district. Based on the actual measured traits, 'Yheras' (YIM) and DZ sht–91-2B (2BIM) ranked first and second, respectively, in grain yield and earliness. Likewise, the preference ranking matrix showed that farmers consistently ranked 'Yheras' as their first choice, while DZ sht–

91-2B was ranked second across all selection parameters. Spearman's correlation analysis further confirmed a 100% correspondence between the actual measured traits and farmers' preference rankings. The successful implementation of the technology strengthened farmer confidence, stimulated strong demand for the improved variety, and enhanced collaboration among farmers, extension workers, and researchers. Therefore, the 'Yheras' improved shallot variety, along with its full production package, is recommended for wider scaling-up under supplementary irrigation in the midland areas of the Waghimra zone by the respective Agricultural Office.

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**Author Contributions**
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**Conflict of Interest**
The authors indicate no conflict of interest in this work.

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