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# Faba Bean (*Vicia faba* L.) Participatory Variety Selection for Selected Districts of the Central Ethiopia Region

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## ABSTRACT

**Background and Objectives:** Utilization of improved varieties plays an important role in increasing faba bean production. Despite this, farmers in the Central Ethiopia Region were still using local varieties, which are low-yielding. The objective of this study is to evaluate and identify superior faba bean (*Vicia faba* L.) varieties through a participatory variety selection (PVS) approach, involving local farmers in selected districts of the Central Ethiopia Region. **Materials and Methods:** In this study experiment, five improved and one local faba bean varieties were used. Mother and baby design through Randomized Complete Block Design with three replications was used. Agronomic, yield, and farmers' perception data were collected. The data was analyzed using SAS software version 9.0. **Results:** The combined Analysis of Variance results showed a highly significant variation for variety interaction with locations. At both locations, highly significant variations were observed for yield and agronomic traits. The highest grain yield was measured for Naman and Tumsa varieties at both locations. The Naman and Tumsa varieties had 33.71 and 21.60% yield advantages over the local variety at the Albizer site and 48.94 and 39.12% yield advantages over local varieties at the Gumer District, respectively. The farmers also preferred the Naman variety, followed by Chalew and Tumsa, based on their settled criteria. **Conclusion:** Naman and Tumsa varieties had higher yield, a yield advantage over local varieties, and were preferred by the farmers. Therefore, those varieties should be expanded through pre-extension and demonstration for tested and similar agroecological areas.

## KEYWORDS

Faba bean varieties, participatory variety selection, improved varieties, grain yield, farmer preference, central Ethiopia region



## INTRODUCTION

The faba bean (*Vicia faba* L.) is a diploid crop with 12 chromosomes. It is one of the most palatable legumes in the world, and is one of the most vital food legumes, ranking fourth in the world after garden pea, chickpeas, and lentils. It is cultivated in the temperate and subtropical regions of the world[1].

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Faba bean is a versatile legume and a primary protein source for rural communities in Ethiopia[2,3]. It plays a crucial role in enhancing soil fertility through nitrogen fixation[4]. Additionally, it contributes to the country's foreign currency earnings[5,6]. According to Singh *et al.*[7], Faba bean is the third most significant pulse crop in the world, both in terms of the amount of land coverage and the amount of food it produces annually. However, productivity in terms of yield in Ethiopia is still far below its potential. One important reason is that farmers are largely dependent on their local landraces[8]. The faba bean is considered to be a crop species that is well-suited to a wide range of agricultural climates and soil types[9]. The highlands of Ethiopia (1800-3000 m.a.s.l.) are where faba beans are produced because they meet the requirements for low temperatures[10]. There is a high yield gap between the national average yield and the potential yields of improved faba bean varieties[11,12]. The major factors of low productivity in the area were encountered by different biotic and abiotic factors. Among them, limited utilization of improved varieties was a major problem for the reduction of yield[13]. Farmers in the Central Ethiopia Region were still using local varieties, which were low-yielding as compared to the improved faba bean varieties. Therefore, this research was conducted to identify and evaluate high-yielding and farmer-preferred varieties in the area.

## MATERIALS AND METHODS

**Description of experimental sites:** In the Central Ethiopia Region, the Gumer and Worabe Districts hosted this experiment in 2023. From Gumer and Worabe Districts, Burdana-Denber and Albizer site were used. Those Kebeles were selected randomly by communicating with Districts and Kebeles agricultural experts. The description of the experimental site is given in Table 1.

**Experimental material and design:** In this experiment, a randomized complete block design with three replications (mother and baby trial) was used. In the mother trial, all sets of experiments were sown at the farmers' training center, and in the baby trial, three farmers were used as a replication at each district. Ashebeka, Chalew, Naman, Tosha, Tumsa, and local varieties were used. Those varieties were sourced from the Holeta and Sinana Agricultural Research Centers, Ethiopia. The plot size was 4.8 $m^2$, and the spacing used for this experiment was 40 cm between rows and 10 cm between plants.

**Collected data and analysis methods:** Agronomic data like pod per plant, seed per pod, plant height, and primary branch per plant were collected and measured from five randomly selected plants at the field level. Twenty farmers (10 male and 10 female) participated in this selection. Awareness was created for the farmers about the faba bean production methods. Farmers were given criteria, and the faba bean varieties were selected based on those criteria.

Yield, pod per plant, seed per pod, and tiller number were the criteria settled by those farmers. Those farmers were given scores from 1 to 5 on each trait, where 1 = Very poor, 2 = Poor, 3 = Good, 4 = Very good, and 5 = Excellent[14].

Grain yield and hundred-seed weight were measured. Yield and agronomic data were analyzed by using SAS software version 9.0; Means were compared by using the least significant difference at the 1% and 5% levels of significance[15].

$$\text{Yield advantage (\%)} = \frac{\text{Yield of improved} - \text{Yield of local variety}}{\text{Yield of local variety}} \times 100$$

Table 1: Description of the experimental sites

| Region | Districts | Altitude m.a.s.l | Latitude | Longitude |
|---|---|---|---|---|
| Central Ethiopia region | Gumer | 2907 | 7°58'24"N | 38°04'42"E |
| Central Ethiopia region | Albizer | 2305 | 7°52'21"N | 38°08'42"E |

## RESULTS AND DISCUSSION

The combined Analysis of Variances (Table 2) showed that highly significant variation was observed for variety with location interactions.

The ANOVA results showed significant effects of Location ($F = 1280.67$; $p<0.0001$), Varieties ($F = 43.49$; $p<0.0001$), and their interaction ($F = 6.99$; $p = 0.0006$). Replication was non-significant. The experiment had a CV of 5.63%, indicating good precision.

This indicates that the performances of these varieties varied across locations, and a specific analysis is needed. Similarly, Mukerem *et al.*[16] and Sokolovic *et al.*[17] reported significant variation in faba bean varieties across locations.

Specific analysis of variance results indicated highly significant variation for seeds per pod, pods per plant, branches per plant, hundred seed weight, and grain yields of faba bean varieties at both locations (Table 3 and 4). This indicates that the performance of those varieties varies for those traits, suggesting a possibility for farmers to increase faba bean productivity. Gereziher *et al.*[18], Gemechu *et al.*[19], Mogiso and Mamo[20], Kindie and Nugusie[21] and Derese[22] also reported significant variation among faba bean traits in line with this result.

Table 2: Combined analysis of variance for a yield of faba bean varieties

| Source of variations | Degree of freedom | Mean square value | F value | Pr>F |
|---|---|---|---|---|
| Locations | 1 | 30601641 | 1280.67 | <.0001 |
| Replication (location) | 4 | 8078.61 | 0.34 | 0.849 |
| Varieties | 5 | 1039306 | 43.49 | <.0001 |
| Location* Varieties | 5 | 167032.6 | 6.99 | 0.0006 |
| Error | 20 | 23895.12 | | |
| Coefficient of variation (%) | | 5.63 | | |

Table 3: Mean performances of yield and yield-related traits of faba bean varieties at Albizer site

| Varietie | HSW (g) | GY (kg/ha) | PH (cm) | Br. (No) | SP (No) | PP (No) |
|---|---|---|---|---|---|---|
| Ashebeka | 69.2$^{d}$ | 1571.5$^{b}$ | 93.3 | 2.0$^{bc}$ | 4.8$^{a}$ | 19.0$^{c}$ |
| Chalew | 73.1$^{c}$ | 1757.1$^{b}$ | 95.8 | 2.4$^{ab}$ | 3.7$^{b}$ | 26.7$^{ab}$ |
| Local | 88.7$^{a}$ | 1693.4$^{b}$ | 106.1 | 2.1$^{bc}$ | 3.8$^{b}$ | 15.7$^{c}$ |
| Naman | 74.7$^{c}$ | 2264.3$^{a}$ | 100.5 | 2.8$^{a}$ | 4.5$^{a}$ | 26.3$^{ab}$ |
| Tosha | 66.7$^{e}$ | 1597.3$^{b}$ | 109.4 | 1.8$^{c}$ | 4.6$^{a}$ | 20.7$^{bc}$ |
| Tumsa | 76.5$^{b}$ | 2059.2$^{a}$ | 96.9 | 2.9$^{a}$ | 4.0$^{b}$ | 28.0$^{a}$ |
| LSD (5%) | 1.72** | 261.0** | 15.3 NS | 0.6** | 0.5** | 6.24** |
| GM (kg/ha) | 74.8 | 1823.8 | 100.3 | 2.3 | 4.2 | 22.7 |
| CV (%) | 1.3 | 7.9 | 8.4 | 13.75 | 6.16 | 15.1 |

where **Significant difference at $p\leq0.01$, NS: Non-significant difference, small letters level of significant difference within two treatments, HSW: Hundred seed weight, GY: Grain yield, PH: Plant height, SP: Seed per pod, PP: Pod per plant, GM: Grand mean and CV: Coefficient of variation

Table 4: Mean performances of yield and yield-related traits of faba bean varieties at Gumer District

| Varietie | HSW (g) | GY (kg/ha) | PH (cm) | Br. (No) | SP (No) |
|---|---|---|---|---|---|
| Ashebeka | 68.0$^{e}$ | 3487.5$^{b}$ | 13.3 | 2.3$^{bc}$ | 3.7$^{bc}$ |
| Chalew | 70.7$^{d}$ | 3531.3$^{b}$ | 115.0 | 2.7$^{ab}$ | 3.4$^{c}$ |
| Local | 88.3$^{a}$ | 3023.5$^{c}$ | 127.7 | 2.0$^{c}$ | 3.2$^{c}$ |
| Naman | 73.0$^{c}$ | 4503.2$^{a}$ | 118.3 | 3.1$^{a}$ | 5.0$^{a}$ |
| Tosha | 65.0$^{f}$ | 3254.8$^{bc}$ | 130.7 | 1.8$^{c}$ | 4.8$^{ab}$ |
| Tumsa | 76.7$^{b}$ | 4206.3$^{a}$ | 126.7 | 2.3$^{bc}$ | 4.1$^{a-c}$ |
| LSD (5%) | 1.96** | 300.1** | 20.6** | 0.6** | 1.2** |
| GM | 73.61 | 3667.73 | 121.94 | 2.37 | 4.02 |
| CV (%) | 1.46 | 4.50 | 9.30 | 14.96 | 16.29 |

where **Significant difference at $p\leq0.01$, NS: Non-significant difference, small letters level of significant difference within two treatments, HSW: Hundred seed weight, GY: Grain yield, PH: Plant height, SP: Seed per pod, PP: Pod per plant, LSD: Least significant difference, GM: Grand mean and CV: Coefficient of variation

Table 5: Yield advantages of improved faba bean varieties over the local variety at both districts

| | Albizer site | | Gumer | |
|---|---|---|---|---|
| | Yield (kg/ha) | Yield advantage (%) | Yield (kg/ha) | Yield advantage (%) |
| Ashebeka | 1571.50 | -7.20 | 3487.50 | 15.35 |
| Chalew | 1757.10 | 3.76 | 3531.30 | 16.80 |
| Local | 1693.40 | - | 3023.50 | - |
| Naman | 2264.30 | 33.71 | 4503.20 | 48.94 |
| Tosha | 1597.30 | -5.67 | 3254.80 | 7.65 |
| Tumsa | 2059.20 | 21.60 | 4206.30 | 39.12 |

Table 6: Farmers' preference data for the faba bean varieties trial

| Varietie | Pod per plant | Tillering capacity | Seed per pod | Grain yield | Total | Average | Rank |
|---|---|---|---|---|---|---|---|
| Ashebeka | 4 | 2 | 4 | 2 | 12.0 | 3.0 | 5 |
| Naman | 5 | 5 | 3 | 5 | 18.0 | 4.5 | 1 |
| Chalew | 5 | 3 | 3 | 4.5 | 15.5 | 3.9 | 2 |
| Tosha | 2 | 4 | 5 | 4 | 15.0 | 3.8 | 3 |
| Local | 3 | 4 | 4 | 3 | 14.0 | 3.5 | 4 |
| Tumsa | 4 | 5 | 3 | 3.5 | 15.5 | 3.9 | 2 |

The yield performances of those varieties ranged from 1571.5 to 2264.3 kg/ha at the Albizer site and 3023.5 to 4503.2 kg/ha at the Gumer District. At the Albizer site, the Naman (2264.3 kg/ha) and Tumsa (2059.2 kg/ha ) varieties gave the highest grain yield. Similarly, Naman and Tumsa varieties were given 4503.2 and 4206.2 kg/ha at the Gumer District, respectively (Table 3 and 4). Mogiso and Mamo[20] experimented on faba bean varieties, reporting a yield ranging from 3970 to 6140 kg/ha .

The yield advantages of improved faba bean varieties over the local variety (Table 5) results indicated that three varieties at Albizer and all tested improved varieties at the Gumer District had 3.8-33.7 and 7.65-48.94% yield advantages measured, respectively. At the Gumer District, the Naman and Tumsa varieties had the highest yield advantage, 48.94 and 39.12%, respectively. Similarly, at the Albizer site, the Naman and Tumsa varieties also had the highest yield advantage, 33.71 and 21.60%, respectively. This indicated that the utilization of those improved varieties increased the productivity of faba bean at a significant level. In line with this result, Gemechu *et al*.[19] and Kindie and Nugusie[21] reported higher yield advantages of improved faba bean varieties over local. Farmer preference data indicated (Table 6) that farmers were given scores for those faba bean varieties based on settled criteria. Farmers' settled criteria were pod per plant, seed per pod, tillering capacity, and yield. Based on this result, the Naman variety had the highest score, followed by the Chalew and Tumsa varieties. In line with this result, Kindie and Nigusie[21] and Kassa *et al*.[23] reported that farmers preferred improved faba bean varieties over local ones based on different criteria.

## CONCLUSION

The combined analysis of variance indicated that significant variation was observed in the variety-location interaction. Based on a specific analysis of variance, a highly significant variation was observed for grain yield, hundred seed weight, pod per plant, seed per pod, and branch per plant. The Naman and Tumsa varieties had the highest grain yield, yield advantages, and preference by the farmers at both locations. The farmers also preferred the Naman variety, followed by Chalew and Tumsa, based on their settled criteria. Therefore, Naman and Tumsa varieties should be promoted based on farmers' preferences and yield performances through pre-extension and demonstrations in tested and similar agro-ecological areas.

## SIGNIFICANCE STATEMENT

This study identified high-yielding and farmer-preferred faba bean varieties, particularly Naman and Tumsa, which could be beneficial for enhancing faba bean production and productivity in the Central

Ethiopia Region. Naman was most preferred by farmers, followed by Chalew and Tumsa, indicating their potential for wider adoption in similar agroecologies such as Gumer and Albizer. This study will assist researchers in uncovering critical areas of varietal adoption, farmer preference, and yield stability that have remained unexplored by many. Consequently, a new theory on participatory variety selection and its impact on legume crop improvement may be developed.

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