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Research Article

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Participatory Evaluation of Faba Bean (*Vicia faba* L.) Varieties for Yield and Yield Components in the Kaffa zone, South-west, Ethiopia

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ABSTRACT
Faba bean (*Vicia faba* L.) is a versatile legume known for its high protein content and ability to improve soil fertility. Its production has been shown to reduce the carbon footprint of cereal-based agricultural production systems by fixing nitrogen that can be used by the succeeding cereal crop and by breaking the cycle of biotic stresses (Jensen et al. 2010). Productivity of improved varieties is higher (3.5 t/ha) than the country's average yield (1.8 t/ha). Participatory variety selection was conducted in the Kaffa Zone, Adiyo Woreda, and Boka Kebele, both at the farmer training centre (FTC) and on farmers' fields, during the 2021 main cropping season, to evaluate and select high-yielding faba bean varieties by participating farmers and other stakeholders. Seven released faba bean varieties (Walki, Dosha, Tumsa, Gora, Gabalcho, Degaga, and Hachalu), including a local check, were tested using Randomized Complete Block Design with three replications at one station of each trial site. The mother trial was done at the farmer training centre (FTC), whereas the baby trials were done at twenty farmers' fields in the districts. The ANOVA revealed that significant differences ($p<0.01$) were observed among varieties for plant height, pods per plant, seeds per pod, 100-seed weight, and grain yield. Among the tested varieties, the variety Walki (2729.5) and the variety gora (2505) $Kgha^{-1}$ are high-yielding varieties and also preference rankings for grain yield, plant height, pod number, disease resistance, and unelongated habitués. Thus, these two varieties are preferred by most of the farmers. Therefore, based on farmers' preference and biological data, the varieties walki and gora are identified as the best-performing and preferred varieties and recommended to the study area.
Keywords: Mother trial, baby trial, faba bean, participatory evaluation

INTRODUCTION

At present, faba bean is the third most important cool-season food legume in the world (Torres *et al*., 2006). In Ethiopia, faba bean is the leading protein source for rural people and is used to make various traditional dishes (Senayit and Asrat, 1994). The Ethiopian research system has so far developed over 25 improved varieties that can produce higher yields and have better disease resistance than farmers' varieties.

The conventional plant breeding scheme uses a narrow range of selection criteria that addresses issues related to yield, uniformity, and stability. Therefore, farmers' and other stakeholders' participation in setting breeding goals and varietal evaluation will remain critical for enhancing adoption and genetic diversity. This can be done through a participatory variety selection that enhances the development of demand-driven, client-oriented crop technologies, dissemination, and adoption. So this research is initiated to involve all stakeholders in the research program to speed up the adoption rate and give new insights for researchers to incorporate valuable traits.

In Ethiopia, pulse crops are grown annually on approximately 1 652 844.19 hectares of land; of these, 443 966.09 hectares were covered by faba bean, with an annual production of 8 486 545.69 quintals (CSA, 2016). In the Kaffa zone, faba bean production covers about 102312.5 hectares of land, within 82426 numbers of holders, with its production of 81617.25 quintals or 8.38 $qtha^{-1}$ (CSA, 2016). In spite of huge area coverage and its importance, the productivity of faba bean is about 1.912 tha-1, far below the crop's potential of > 5 tha-1 (CSA, 2016). This may be due to different biotic and abiotic factors, the use of old and low-yielding genetic potential of the wild-growing local cultivars, and the unavailability of high-yielding cultivars (Anteneh et al., 2018; Tafere et al., 2012). Participatory variety selection (PVS) is a more rapid and cost-effective way of identifying farmer-preferred varieties, and it ensures the adoption of new varieties (Witcombet et al., 1996).

In addition to this, farmers' participation in varietal selection provides adequate exposure to new varieties and a high rate of replacement and a strong extension network that generally gives farmers access to new

cultivars to maximize their productivity and to improve the livelihood of their families (Tafere et al., 2012). Moreover, participatory research increases the job efficiency of the scientists and farmers' knowledge that enables it to be retained effectively from year to year (Wondimu, 2016; Tafere et al., 2012). Therefore, this study was initiated to evaluate and select high-yielding faba bean variety/varieties through farmers' and other stakeholders' participation.

MATERIALS AND METHODS

Description of the Experimental Site

The experiment was conducted at the major faba bean producing areas of the Kaffa zone of southwestern Ethiopia, Adiyo woreda, Boka kebele, on both the FTC and the farmer's field. The district covers an area of 1748 km². It lies between 36°28'52" and 37°42'33.77" latitude and 35°45'52.34" and 36°44'45.44" East longitude and 42 km distance from the capital city of Kaffa Zone, Bonga town. The elevation of the woreda varies from 500 to 3000 above sea level. Sowing was done under rain feed condition on main cropping seasons; the soil character of the study area was clay loam.

Treatments and Experimental Design

Seven improved faba bean varieties (Gabalcho, Walki, Degaga, Dosha, Tumsa, Gora, and Hachalu) obtained from Holleta Agricultural Research Centre, including a local check, were arranged in Randomized Complete Block Design (RCBD) within three replications. Mother trials were planted at the FTC and farmer fields at each location, and twenty other farmer fields were planted with one replication each, considered as baby trials at each location. The trial was planted on a plot size of 3m * 2.4m, with six rows. Spacing between replication, plots, rows, and plants was 1 m, 0.6 m, 0.4 m, and 0.1 m, respectively. Sowing was done during the onset of rainfall with the application of NPSB fertilizer at the recommended rate of 100 kg/ha and a seed rate of 200 kg/ha. All necessary production packages were implemented based on national recommendations.

Data Collection and Measurements

Agronomic data were collected on a plot and plant basis from the mother trial. Hundred seed weight (g), plant height (cm), number of branches per plant, number of pods per plant, and number of seeds per pod were evaluated on five randomly taken plants from the middle four rows in each plot. Biomass (g) and grain yield (g) of the middle four rows in each plot were measured and converted to kilograms per hectare for analysis. Farmers' evaluation and selection data were collected on a plot basis from the baby trials of each trial location. The selection was carried out at two different growth stages (at the start of flowering and physiological maturing). 6 agricultural development agents, 12 men, and 2 women farmers have participated in the selection process. The ranking procedure was explained to agricultural development agents and farmer participants, and they discussed and set the selection criteria ranging from 1 to 5 (5 = very good, 4 = good, 3 = average, 2 = poor, and 1 = very poor) for each variety.

Statistical analysis

The recorded agronomic data were tested for assumptions of ANOVA, such as homogeneity and normality, before subjection for analysis. Analysis of variance (ANOVA) was performed using the Statistical Analysis System (SAS 9.1.3), and mean separation was carried out using the least significant difference (LSD) test at a 5% probability level. Farmers' selection data were analyzed using the simple ranking method. The ranking was done on consensus, where differences are resolved through discussion in accordance with the given value (De Boef and Thijssen, 2007).

RESULTS AND DISCUSSION

Analysis of Agronomic Traits, Yield Components, and Farmers' Preference

Agronomic traits, i.e., days to flowering, days to maturity, plant height, number of branches per plant, and yield components (number of pods per plant, number of seeds per pod, biomass, grain yield, and hundred seed weight), were analyzed. There is highly significance difference for days to 50% flowering ($p \leq 0.01$). Local variety took more days for flowering (92), followed by Gora (87) and Dosha (82). In contrast, the smallest day for 50% of flowering was recorded from the variety Degaga (73.33). This study agrees with Hiwotu et al. (2022), reporting yield variation among different faba bean varieties. Analysis of variance showed that a highly significant difference ($p \leq 0.01$) was observed among tested faba bean varieties in plant height. The highest plant height was recorded from the varieties Gora (148 cm), Local (146), and Dosha (146). The shortest plant height (126.6 cm) was recorded for the Degaga variety. This result was in line with the work of Teame et al. (2017), who reported that the Hachalu (120.70 cm) and Dosha (110.00 cm) varieties were the longest, and the local variety was the shortest in the southern zone of the Tigray regional state. The number of pods per plant and seeds per pod were significantly affected by varieties ($p \leq 0.01$).

The maximum number of pods per plant was recorded on the varieties Walki and Gora, with a mean score of 21.4 and 16.6, respectively, and the seed per pod of 3.3 and 3.2, respectively, but the lowest pods per plant, 11.3, were counted from the Degaga variety and the lowest seeds were counted from a local variety. Likewise, Teame et al. (2017) and Tafere et al. (2012) reported the significant difference among faba bean varieties with regard to the number of pods per plant and seeds per pod. The varieties significantly ($p \leq 0.01$) varied for 100 seed weight, indicating the variations among varieties. All tested varieties, Gora, Gabalcho, and Tumsa produced the heaviest seeds, with an average mean score of 100 g, 84.4 g, and 83.0 g, respectively. The reason might be due to prolonged dry matter content.

The lowest hundred-seed weight (59.00 gm)) was recorded from a Degaga variety. Ashenafi and Mekuria

(2015) and Beyene et al. also reported the significant difference among faba bean varieties in 100-seed weight. It may be due to a short period of dry matter accumulation. The statistical analysis showed that there was a highly significant ($P \leq 0.01$) difference among the tested varieties on grain yield. The maximum grain yield (2729.30 kgha^{-1})) was harvested from the Walki variety, followed by Gora (2505.0 kgha^{-1}) and Gabalcho (2348.70 kgha^{-1}), while the lowest grain yield (1788.7 kgha^{-1}) was recorded from a Degaga variety (Table 2). The Walki and Gora varieties had a yield advantage of 82.44% and 62.65% over the local variety. This result agreed with Teame et al. (2017), who reported that the highest grain yield was obtained on

The varieties Dosha and Tumsa were 3000 and 3437.00 kg ha^{-1}, respectively, and Dosha had a 55.45% yield advantage over the local variety. Ashanafi and Makuria (2015), Ertiro et al (2023), reported yield variation from 3703.7 to 4886.8 kg/ha and 360.2 to 4701.6 kg/ha in the Agarfa and Sinana trial sites, respectively.

Farmer's Variety Evaluation

Six (6) agricultural development agents, 12 men, and 2 women farmers have participated in the selection. They set the criteria—plant establishment, plant height, disease resistance, overall performance, stem strength, pod setting, earliness, grain yield, seed color, and seed size—to select the best variety. Gora (80.0) scored the highest value, and the lowest was scored by Degaga (45.0). Walki (65.0) and Dosha (63.0) were ranked as the second and third best varieties by farmers, respectively (Table 3). In line with this finding, Teame et al. (2017)) stated that Dosha was selected as the top-ranking or adapted variety by farmers' selection. The same variety had better performance and was a high yielder from the analysis of researchers' collected data.

Table 1. Mean grain yield and other agronomic traits of Faba bean PVS at Boka FTC.

Variety	DF	DM	PH(cm)	PPP	SPP	NBP	HSW(gm)	GY(kg)
Degaga	73.33b	124bc	126.66c	11.33b	2.33b	1a	59c	1788.7c
Tumsa	74b	123c	135abc	12b	3.2a	0.66a	83b	1995.3bc
Hachalu	74b	124.33bc	143.66abc	14b	2.33b	0.66a	80.33b	2199.0bc
Dosha	82ab	121c	146ab	12.33b	2.66ab	0.33a	79.33b	2370ab
Wolki	78.33b	125.33bc	145.66ab	21.33a	2.33b	0.66a	59c	2729.3a
Gabalcho	76.66b	123.66bc	129.33bc	16.66ab	2.66ab	0.66a	84.33b	2348.7bc
Gora	87ab	128ab	148a	14b	3.33a	0.66a	100a	2505.0ab
Local	92a	132a	146ab	15.33ab	2.33b	1.33a	79b	1968.3bc
Means	77.87	125.25	140	15.24	2.58	0.75	78	2200.54
Cv	9	2.16	7.27	11	0.84	10.6	5.33	13.54
Lsd (0.05)	12.33	4.75	17.84	8.24	0.78	NS	7.28	523.31

Note: DF=days to flowering, DM=days to maturity, PH=plant height, NBP=primary branches per plant, PPP = pods per plant, SPP= seeds per pod, GY=grain yield, HSW=100seeds weight.

Table2. Mean of farmers' preference criteria on faba bean PVS at Kaffa Zone Boka FTC

Varieties	Ranking of selection criteria for each variety at Adiyo Boka FTC.										
Relative weight	Grain yield	Disease resistance	Days to maturity	No. of branch	Plant height	Pod setting	Seed size	Seed color	Total score	Mean	Rank
	3	3	1	2	3	2	2	2	-	-	-
Degaga	2(6)	2(6)	4(4)	2(4)	3(9)	2(4)	3(6)	3(6)	45	5	8th
Tumsa	2(6)	3(9)	3(3)	2(4)	4(12)	2(4)	4(8)	3(6)	52	5.7	6th
Hachalu	3(9)	3(9)	3(3)	3(6)	4(12)	4(8)	3(6)	4(8)	61	6.7	4th
Dosha	4(12)	3(9)	4(4)	3(6)	4(12)	4(8)	3(6)	3(6)	63	7	3rd
Wolki	4(12)	4(12)	3(3)	3(6)	4(12)	4(8)	3(6)	3(6)	65	7.2	2nd
Gabalcho	3(9)	1(3)	3(3)	2(4)	3(9)	3(6)	4(8)	4(8)	50	5.5	7th
Gora	5(15)	3(9)	3(3)	4(8)	5(15)	5(10)	5(10)	5(10)	80	8.8	1st
Local	3(9)	2(6)	3(3)	4(8)	4(12)	3(6)	3(6)	5(10)	60	6.7	5th

CONCLUSION

Incorporating farmers' preferences in the selection of varieties in the breeding process may increase the adoption rate of new varieties. Farmers' exposure to evaluate and select new varieties provides an advantage to exploit their potential knowledge of identifying adapted varieties that best meet their interests. The interaction of researchers and farmers will also help to design research objectives, to overcome rejection of varieties developed by researchers alone, to enhance the acceptance of varieties, and to reduce costs associated with variety development. The present investigation showed that the promising varieties Walki and Gora gave the highest grain yield and showed the best performance in other agronomic traits compared to the tested varieties at the study area. Similarly, farmers selected Gora, Gabalicho and Walki as the promising and adapted varieties. The current selection process also

demonstrated that farmers were capable of selecting important traits for grain yield and identifying superior varieties adapted to their locality. Totally, PVS was effective and reliable for identifying appropriate cultivars through a partnership with resource-poor farmers.

Walki and Gora had recommended the Kaffa zone Adiyo woreda at the Boka district, and related agro-ecologies that faba bean disease management methods and resistant variety development activities should be done to increase the production and productivity of faba beans at the Adiyo woreda Boka district. For a wider environment, it is better to conduct the expert at multi location and multi environment.

CONFLICT OF INTEREST

The author here declares there is no conflict of interest in the publication of this article.

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