 Participatory on Farm Evaluations and Selection of Improved Faba Bean (Vicia faba L.) Varieties in Four Districts of South Ethiopia

Yasin Goa and Eresaal Kambata
Areka Agricultural Research Center, Wolayta, Ethiopia

Abstract

Participatory variety evaluation and selection trials involving farmers in Southern Ethiopia were conducted in farmer’s field in the districts of Duna, Doyogena, Angacha and Sodo zuria in Meher season of 2016/17. Farmers were provided with five improved varieties, which they compared with their own ones or respective local variety were evaluated and selected for desirable attributes following a randomized complete block design. In this participatory approach, farmers used different criteria to assess faba bean varieties at the flowering, maturity and harvest crop growth stages. Major selection criteria included stand establishment, plant height, maturity, seed size, leaf shading, suitability for intercropping, number of pod, number of branches, stem strength, disease and pest resistance, straw yield and grain yield. Farmers preferred faba bean varieties Dasha, Bobicho-04, Tumsa and Gabalicho for their high yielding, large seed size and disease tolerance. The combined analysis showed Dasha was the best yielder with seed yield 2850 kg/ha followed by Bobicho-04 (2800 kg/ha), Tumsa (2733.3 kg/ha), Gabalicho (2716.7 kg/ha), Walki (2416.7 kg/ha) and local variety (1816.7 kg/ha). The yield advantage range from 33% (variety walki) to 56.9% (variety Dasha) over the local variety. Overall, the results showed that farmers had knowledge to make decision of the preferred superior varieties compared to the ones currently grown by farmers. Farmers mostly preferred varieties which combined high yield, disease resistance, large seed size and resistance to lodging. Thus, the selected varieties need to be multiplied and distributed to farmers in order to improve adoption and varietal diversity.

Keywords: Faba bean; Selection; Varieties; Criteria; Participatory approach

Introduction

Faba bean is one of the most important cool-season food legumes grown in the highlands of Ethiopia. The crop has a multipurpose use and is consumed as dry seeds, green vegetable, or as processed food. Its products are a rich source of high-quality protein in the human diet, while its dry seeds, green haulm and dry straw are used as animal feeds [1]. It is dominant pulse crop in Ethiopia in terms of area coverage and amount of production [2]. In Ethiopia, faba bean is the most important protein source for the rural people and used to make various traditional dishes. In addition to this, Desta [3] reported that it can restore soil fertility through fixing atmospheric nitrogen and provides large cash for producers and foreign exchange for the country.

Even though faba bean is important crop as national and internationally, the production and productivity of faba bean in Southern Ethiopia is low 1.64 t/ha [2] due to poor participation of farmers in the selection process, lack of improved varieties, poor agronomic practice, diseases and insect pests. Some improved faba bean varieties has been released by the different regional and federal research centers in the nation but farmers are still stress on few local faba bean varieties. Farmers have little information about the released varieties both agronomic practice and their economic importance because the varieties were released without the involvement of farmers and the released varieties had not yet evaluated in the study area. To improve the problem, participatory variety selection is the better option to fit the crop bring together of both target environments and user preferences. Participatory varietal selection is being conducted in many crops like chickpea, common bean, Bread wheat and Maize [4-8]. Danial et al. [9] reported that farmer’s selection criteria vary with environmental conditions, traits of interest, ease of cultural practice, processing, use and marketability of the product, ceremonial and religious values. Farmers in Duna and Sodo zuria as well as farmers Cooperatives of Angacha and Doyogena districts are highly demanding better yielding varieties to maximize their production and to multiply in large scale, which consecutively increase income and improve the livelihood of their families or members. Therefore, the objectives of this study were to evaluate and select best performing faba bean variety/ies and to identify farmers’ preferences and selection criteria to the study sites of Southern Ethiopia with the participation of farmers.

Materials and Methods

Description of experimental sites

On farm experiments were carried out at the mandate areas of Areka Agricultural Research center, Duna, Angacha, Doyogena and Sodo zuria of South Ethiopia during the 2016/2017 Meher season of each site. Duna (Andegna Otoro kebele) is located about 42 km far from the Hosanna town (the capital of Hadiya zone) at 0720.70’N; 03735.55’E; above sea level with an altitude of 2,666 m. It receives mean annual rainfall of 1196.22 mm and the temperature range from 10°C to 18°C in a wet season and 20°C to 25°C in a dry season [10]. Doyogena is located 171 km in south west of Hawassa, the capital city of the region of SNNP and 258 km south of Addis Ababa and lies at a latitude 7°18’25”N-7°21’49”N, longitude 37°45’33”E-37°48’51”E with an altitude ranging from 2300 to 2800 meters above sea level. It receives mean annual rainfall of the area ranges from 1200 to 1800 mm

Adv Crop Sci Tech, an open access journal
ISSN: 2329-8863
Technology evaluation and selection methods

South seed enterprise were participated in the PVS process during group of farmers; seed multiplying farmer’s cooperative; Agricultural Data collected in each of the four districts. 1961 m above sea level and Angacha represent mid to high altitude at range of 1501-3000 masl. Average annual rainfall is ranging between 1051.9 mm and 1341.5 mm for sodo zuria, 1000 mm to 1400 mm for Angacha. The annual mean temperature is 15.3°C for Sodo zuria and the mean annual temperature ranges from 12°C to 16°C for Angacha [12,13].

Experimental materials

In the study five improved faba bean varieties (Dosha, Walki, Bobicho-04, Tumsa and Gabalicho) including the local variety were evaluated for their adaptation and yield during 2016/17 main cropping season across four districts.

Experimental design

The experiment was planted in a randomized complete block design on three farmer’s fields where each farmer’s field was used as replicate in each of the four districts. The experimental land size of each farmer was 21 m x 17 m with a plot size of 10 m x 5 m. The spacing between rows was 40 cm and within rows was 10 cm. The spacing between plots, rows and plant was 1 m, 40 cm and 10 cm, respectively. The planting was done by farmers under Areka pulse crops Research team guidance. The trials were managed by host farmers, Researchers and occasionally agricultural extension officers monitored the progress of the trials in the respective districts.

Technology evaluation and selection methods

The participatory on farm participatory variety evaluation and selection experiment was conducted on farmer’s field at four sites were implemented on farmer’s fields to create awareness about the faba bean varieties. The participatory variety evaluation and selection of the trials was followed participatory approach by involving individual/or a group of farmers; seed multiplying farmer’s cooperative; Agricultural extension officers, Agricultural transformation Agency (ATA) and South seed enterprise were participated in the PVS process during field day/visit. Farmers and relevant stake holders have evaluated and ranked the cultivars/varieties at different growth stages of the crop. They used parameters like stand establishment, branch number, disease and pest resistance, pod number, seed number, seed size, Straw yield (animal feed), stem strength, Earliness/maturity and grain yield to evaluate the cultivars. The activity was jointly monitored by researchers, woreda agricultural experts, Durame seed quality control and development agents (DAs).

Data collected

Agronomic data were collected on plant and plot basis from PVS trial. The data on number of pods per plant, number of seeds per pod and plant height (cm) were taken and evaluated on five plants from each plot. Data like days to 50% flowering, days to maturity and seed yield (g) were collected from whole plot area. Farmers’ preference data were collected.

Data analysis

All data recorded by farmers in the different districts were synthesized and compiled for analysis using SAS package. The analysis of variance and means were separated using the Least Significant Differences (LSD) at 0.05 probability level.

Results and Discussion

Performance evaluation of faba bean varieties

Mean grain yield of the tested varieties ranged from 1933.3 Kg/ha for local variety, to 3466 Kg/ha for Tumsa with over all mean value of 2744.4 Kg/ha at Duna. The grain yields obtained from Dosha, Tumsa, Bobicho-04 and Gabalicho was significantly (P<0.05) higher than that from local variety. At Angacha among the tested varieties; mean grain yield (kg/ha) ranged from 3200 for variety Dosha to 1933.3 for local variety. In Doyogena district, the highest grain yield was recorded by Dosha (3733.3 kg/ha) followed by Bobicho-04 (3533.30 kg/ha); whereas the lowest was recorded by local variety (2200 kg/ha). Similarly at Sodo zuria woreda varieties Walki (1866.7 kg/ha), Gabalicho (1800 kg/ha) and Tumsa (1733.3 kg/ha) had the maximum grain yield than the rest of the varieties (Table 1).

| Varieties            | Yield(kg/ha) |
|----------------------|--------------|
|                      | Duna         | Angacha     | Sodo zuria | Doyogena |
| Bobicho-04           | 2866.7ab     | 3133.3ab    | 1666.7ab   | 3533.3a  |
| Walki                | 2266.7bc     | 2200cd      | 1866.7a    | 2533.3b  |
| Tumsa                | 3466.7a      | 2600bc      | 1733.3a    | 3400a    |
| Dosha                | 3000ab       | 3200a       | 1466.7b    | 3733.3a  |
| Local                | 1933.3c      | 1933.3d     | 1066.7c    | 2200b    |
| Gabalicho            | 2933.3ab     | 2666.7abc   | 1800a      | 3466.7a  |
| GM                   | 2744.4       | 2622.2      | 1600       | 3144.4   |
| CV (%)               | 18.56        | 12.11       | 9.13       | 12.38    |
| LSD                  | --           | --          | --         | 16.39    |
followed by Tumsa (33.55) whereas the lowest was recorded by local variety (30.04). The mean number of seed per pod ranged from 3.06 for local to 3.83 for Walki and Tumsa (Table 2).

Table 2: Means of Yield and Yield Component traits of Faba bean PVS across districts in 2016/17. Where: **=highly significant at 1% probability level, *=significant at 5% probability level, ns=non-significant at 5% probability, YAL=yield advantage over local, DF=days 50% flowering, DM=days to physiological maturity, PLH=plant height, NPP=number of pod per plant, SPP=number of seed per pod and YKG=grain yield (Kg/ha).

**Association among the studied characters**

Grain yield is the most complex trait and it is influenced by genetic and environmental factors that determine productivity of the cultivars. Therefore, understanding of inter-relationships of grain yield and other traits are highly important for formulating selection criteria. Correlation coefficients among phenological and agronomic traits of the tested faba bean varieties are indicated in Table 3. Days to 50% flowering had positive and significant correlation with days to physiological maturity (r=0.51**) and grain yield (r=0.52**). Days to 50% flowering had positive and non-significant association with plant height (r=0.11ns) and number of pod per plant (r=0.067ns). Grain yield had positive and highly significant correlation with number of seed per pod (r=0.28**). These results gave a clear indication that the yield components were mutually very closely associated. This is in agreement with those obtained by Taddese et al. [15] and Yassin [16]. Grain yield had positive and highly significant correlation with plant height (r=0.51**), days to 50% flowering (r=0.52**), days to maturity (r=0.38**), number of seed per pod (r=0.28**) (Table 3). This result was in close agreement with previous findings by several authors (Taddesse et al., Yassin) [15,16] where grain yield was reported to have been strongly associated with the major yield components. Similarly, the findings of Vandana and Dubey [17] in respective of positive association of seed yield per plot with plant height, pods/plant and number of seeds/plant are in line with the present study.

### Table 3: Simple correlation coefficients (r) for agronomic traits of the tested faba bean PVS across districts in 2016/17.

|             | DF   | X | 0.51** | 0.11ns | 0.067ns | 0.27 | 0.52** |
|-------------|------|----|--------|--------|---------|------|--------|
| DM          | X    | 0.12ns | 0.46** | 0.58** | 0.38 |
| PLH         | X    | 0.14ns | 0.22ns | 0.51** |
| NPP         | X    | 0.35** | 0.21ns |
| SPP         | X    | 0.28 |
| YKG         | X    |    |

Field days/visits were conducted in the four districts, 390 farmer’s, cooperatives and other stake holders individually or in a group scored the faba bean varieties in different sites. There were 150 (17 women and 133 men), 180(147 men and 33 women), 20 (18 men and 2 women) and 40 (37 men and 3 women) farmers, cooperatives and relevant stake holders involved in scoring of the trials in Doyogena, Angacha, Duna and Sodo zuria sites. Farmers and farmers cooperative evaluating and selecting different faba bean varieties (Figure 1). Considering practicality and more farmers included in the evaluation, small groups of 10-15 farmers were formed. About three farmer’s cooperative members (Amacho wato; Hawora Arara and Ute cooperatives) and Zeret Union officials and five farmers cooperatives namely Mesena, Hambaricho wasara, Bondena, Tambo Otona and Pandide cooperatives were involved in variety selection at Doyogena and Angacha districts, respectively. The key criteria used by farmers to evaluate and select the preferred varieties were grain yield, disease resistance, grain size and lodging resistance. Farmers, Agricultural...
experts and Researchers visiting six faba bean varieties in Duna (Figure 2).

Figure 1: Participants evaluating and selection faba bean PVS during field day.

Figure 2: Farmers, Researchers and extension workers visiting Faba bean PVS plot in Andegna Otoro and Dunaa.

Grain yield was considered as the most selection criteria for each faba bean varieties and this is also in agreement with varietal selection of faba bean reported by Bekele [14] and Alemayehu and Rahel [6] for common bean varietal selection. Based on farmers selection criteria comparison was conducted among the tested faba bean varieties. Preference scores varied greatly among the farmers for each variety in each district (Table 4). Based on mean overall score the most preferred varieties were Tumsa, Dosha, Bobicho-04 and Gabalicho for Duna district; Dosha, Bobicho-04, Gabalicho and Tumsa for Doyogena; Walki, Bobicho-04, Dosha and Tumsa for Sodo Zuria and Bobicho-04, Dosha, Gabalicho and Tumsa in Anagacha (Table 4). In the Sodo zuria district, a greater number of farmers selected faba bean variety Walki as a better choice than other test varieties. This underlines the importance of testing of improved varieties in farmer's fields across districts.

| Varieties     | Duna         | Angacha     | Soddo zuria | Doyogena     |
|---------------|--------------|-------------|-------------|--------------|
|               | Total score  | Mean score  | Rank        | Total score  | Mean score  | Rank        | Total score  | Mean score  | Rank        | Over all rank |
| Bobicho-04    | 47           | 3.6         | 4           | 33           | 2.36        | 2           | 39           | 2.8         | 3           | 2            |
| Walki         | 51           | 3.9         | 5           | 76           | 5.1         | 6           | 31           | 2.2         | 1           | 58           |
| Tumsa         | 30           | 2.3         | 1           | 64           | 4.3         | 5           | 47           | 3.36        | 4           | 54           |
| Doshia        | 33           | 2.5         | 2           | 32           | 2.1         | 2           | 46           | 3.29        | 3           | 26           |
| Local         | 64           | 4.9         | 6           | 60           | 4           | 4           | 70           | 5           | 6           | 70           |
| Gabalicho     | 43           | 3.3         | 3           | 45           | 3           | 3           | 54           | 3.86        | 5           | 34           |

Table 4: Ranking and scoring of faba bean variety selection criteria (1-15) by farmers at four districts. Scoring of farmers selection criteria was based on a ranking scale from 1-6, with 1 as the most important to 6 as the least important, NB: 1-15 farmers’ selection criteria set; 1=Stand establishment, 2=Branch number, 3=Pod number, 4=Seed number, 5=Plant height, 6=Earliness/maturity, 7=Disease resistance, 8=Leaf shading, 9=Aphid resistance, 10=Stem strength, 11=Seed size, 12=Grain yield, 13=Marketability, 14=Suitability for intercropping and 15=Straw yield (animal feed).

In overall scoring and ranking of faba bean PVS variety Doshia was considered as best variety followed by Bobicho-04, Gabalicho and Tumsa (Table 4). The local variety was the least ranked variety because of susceptibility to chocolate spot diseases and less productivity per unit area. Variety Doshia ranked first because of higher productivity, stem strength, disease resistance and tilling capacity. Most faba bean varieties ranked significantly superior to local variety in each district. The farmers always ranked the improved varieties significantly superior to local variety for grain yield, yield components and disease resistance. The faba bean varieties were identified for their morphological performance and pairwise ranked as indicated in Table 5. Hence, in pair wise ranking of faba bean varieties Doshia was considered as best varieties, whereas the local variety as the least preferred variety by farmers (Table 5). Overall preference score based on data from all sites showed the most preferred genotypes were Doshia, Bobicho-04, Gabalicho and Tumsa, while the least varieties was local variety (Tables 4 and 5). Walki had an average preference in terms of mean score but the scores were inconsistent among the groups of farmers. This result indicated that Doshia, Bobicho-04, Gabalicho and Tumsa were farmers’ and Researchers best preferred and top
performed variety which can be considered as a promising variety to be widely produced by faba bean farmers.

| Characters | Bobicho-04 | Gabalicho | Walki | Tumsa | Dossa | Local variety |
|------------|------------|-----------|-------|-------|-------|---------------|
| Bobicho-04 | X          | Bobicho-04| Bobicho-04 | Bobicho-04 | Dossa | Bobicho-04   |
| Gabalicho  | X          | Gabalicho | Gabalicho | Dossa | Gabalicho |               |
| Walki      |            |           | X      | Tumsa | Dossa | Walki        |
| Tumsa      |            |           | X      |       | Dossa | Tumsa        |
| Dossa      |            |           |        |       |       | X             |
| Local variety |          |           |        |       |       |               |
| Total score | 4         | 3         | 1     | 2    | 5    | 0             |
| Rank       | 2          | 3         | 5     | 4    | 1    | 6             |

Table 5: Pairwise ranking of faba bean varieties based on farmer’s selection criteria.

Conclusion and Recommendation

Farmers used different parameters and methods to evaluate the tested faba bean varieties. For fast adoption and dissemination the new variety/ies considering the preferences of farmers and consumers are necessary, otherwise it is less likely to be widely adopted or accepted by the farming community. In this study farmers’ and breeders’ evaluation and selection were confirmed that Dosha, Bobicho-04, Tumsa and Gabalicho were found good for yield potential and other agronomic traits among the six tested genotypes based on both farmer’s and researchers evaluation. According to the analysis result and farmers’ selection variety Dosha, Bobicho-04, Tumsa, and Gabalicho were best performing with grain yield and yield components. All the selected varieties have large seed size which has good marketability. Therefore, these selected varieties will be scale up for the next cropping season at the tested area and similar agro ecology.

Acknowledgement

The authors extend their gratitude to the International center of Agricultural Research for Dry land areas (ICARDA) for the financial support towards this research, the USAID-ICARDA through the Malt barley-faba bean project. My deep gratitude and acknowledge goes to South Agricultural Research Institute and/or Areka Agricultural Research Center for facilitate the process and the farmers for participating in the trials.

References

1. Sainte M (2011) The magazine of the European Association for Grain Legume Research. Model Legume Congress, France; p: 56.
2. CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia), 2014/15.
3. Beyene D (1988) Biological nitrogen fixation research on grain legumes in Ethiopia. In: Bec DP, Materons LA (eds.). Nitrogen Fixation by Legumes in Mediterranean Agriculture. ICRADA, Martinus Nizhoff, Dordrecht, Boston, pp: 73-78.
4. Goa Y, Basa D, Gezahagn G, Chichaybelew M (2017) Farmers Participatory Evaluation of Chickpea Varieties in Mirab Badwacho and Damot Fullasa Districts of Southern Ethiopia. Hydrol Current Res 8: 264.
5. Gurmu F (2013) Assessment of Farmers Criteria for Common Bean Variety Selection: The case of Umbullo Watershed in Sidama Zone of the Southern Region of Ethiopia. Ethiopian E-Journal for Research and Innovation Foresight 5: 4-13.
6. Balcha A, Tigabu R (2015) Participatory Varietal Selection of Common Bean (Phaseolus vulgaris L.) in Wolaita, Ethiopia. Asian Journal of Crop Science 7: 295-300.
7. Demelash A, Desalegn T, Alemayehu G (2013) Participatory Varietal Selection of Bread Wheat (Triticum aestivum L.) Genotypes at Marwold Kebele, Womberma Woreda, West Gojam, Ethiopia. Int J Agron Plant Prod 4: 3543-3550.
8. Tadesse D, Medhin ZG, Ayalew A (2014) Participatory Varietal Selection of Improved Maize Varieties in Chilga District of North Western Ethiopia. Int J Agric Forest 4: 402-407.
9. Danial D, Parlevliet J, Almekinders C, Thiele G (2007) Farmers participation and breeding for durable disease resistance in the Andean region. Euphytica 153: 385-396.
10. Tadesse T (2015) Factors Affecting Utilization of Maternal Health Care Service. In: Woreda D, SNNPR, MSc Thesis, Addis Ababa University, Ethiopia.
11. Demalo TF (2014) Farmers’ perception on erosion problem and adoption of soil and water conservation structures: the case of ojoje watershed doyogena woreda, kambata tambaro zone, Ethiopia. MSc Thesis, Addis Ababa University, Ethiopia.
12. Dolaso AA, Zemedu L (2013) Determinants of Adoption of Improved Wheat Varieties By Smallholder Farmers: The Case of Angacha Woreda, Kembata Tembaro Zone, Southern Nations, Nationalities and Peoples Region, Ethiopia. MSc Thesis. Haramaya University, Ethiopia.
13. Koisha BS (2013) The assessment of root crops contribution to household food security: The case of Soddio zuria woreda, wolaite zone, SNNPR, Ethiopia. MSc Thesis. Addis Ababa University, Ethiopia.
14. Bekele W (2016) Participatory variety selection of Faba Bean for yield components and yield at highlands of West Hararghe, Eastern Ethiopia. Int J Plant Breeding Crop Sci 3: 99-102.
15. Tadesse T, Fikere M, Legesse T, Parven A (2011) Correlation and path coefficient analysis of yield and its component in faba bean (Vicia faba L.) germplasm. Int J Biodivers Conserv 3: 376-382.
16. Yassin TE (1973) Genotypic and phenotypic variances and correlations in faba bean (Vicia faba L.). J Agric Sci 81: 445-448.
17. Vandana K, Dubey DK (1993) Path analysis in faba bean. FABIS 32: 23-24.