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Selection of Common Bean (*Phaseolus Vulgaris*) Varieties Using Participatory and Mother-Baby Methodology in Gedeo Zone at Wonago, Ethiopia

Tamrat Chisha (1st), Takele Mebratu (2nd) and Alem Alemayehu (3rd)

1 & 2 Hawassa Agricultural Research Centre, Southern Agricultural Research Institute, P.O. Box 06, Sidama Region, Hawassa, Ethiopia

3 Dilla Universty P.O.Box, 419, Dilla, SNNPRS, Ethiopia

Corresponding Author: Tamrat Chisha, Hawassa Agricultural Research Centre, Southern Agricultural Research Institute, P.O. Box 06, Hawassa, Ethiopia

Abstract

Common bean (Phaseolus vulgaris L.), is a short season annual crop, which is under production in both main (meher) and short (belg) growing seasons. It is produced by over 4 million smallholder farmers in Ethiopia. Common bean is one of the most important food legume crops which has high starch, protein and dietary fiber and is an excellent source of minerals and vitamins including iron, zinc, calcium, thiamine, vitamin B6, and folic acid. Large Red speckled seed common beans are more demanded over the white beans at Dilla Zuria district. However the farmers mainly depend on the local varieties and other species like lima bean. Therefore, farmer's participatory varieties evaluation and selection methods were applied to identify preferred common bean variety in Dilla Zuria district. Fourteen released common bean varieties were planted in Randomized Complete Block Design as mother trial replicated with three at Dilla on station to identify farmer's selection criteria; to popularize the variety and to enhance seed produces capacity in managing varieties portfolios. Twenty surrounding farmers were selected for the baby trials for qualitative evaluation. Farmer's preference related data was collected for seven common bean traits. Common bean pre harvest traits such as earliness, seed per pod (>5 seed per pod), pod load, up right growth habit and height of basal pod from the soil are identified as the best descriptors to accept and reject the varieties. Uniformity of red speckled seed colour was identified as major decisive criteria for accepting and rejecting common bean variety after harvest. Gegeba and Remeda were variety scored the best ranks for all criteria. Farmers selected and discarded the varieties at various stage of common bean growth with fairly high degree of precision.

Keywords: Common bean; Pre-harvest traits; Uniformity

1. INTRODUCTION

Common bean (*Phaseolus Vulgaris L.)* is one of the most important cash and protein source crops of farmers in many lowlands and hot-humid, as well as, mid altitudes of Ethiopia (Tamene and Tadese, 2014). Pulses, mainly, common bean has , recently, became an important export crop and diversifying source of foreign currency from the agricultural sector. Common bean is the largest agricultural export crop after coffee and sesame (mekuria , 2015). Common bean in Ethiopia is second in area of production of pulses, next to Faba bean, and fifth in national average yield (1.6 t ha^{-1}), following soya bean, chickpeas, faba bean and grass peas. In southern nation's nationalities and people's regional state

(SNNPRS), common bean is first in area coverage of 117,967.97 ha. And total production of 170,163.42 tones followed by faba bean, field peas and chickpeas (CSA, 2016).

So far, the lowland pulse Breeding programs of Ethiopia have released 57 improved common bean varieties with yield potentials of 2.5 to 3.5 t ha^{-1} at research fields (MoANR, 2016). However, the national average yield of common bean of 1.6 t ha^{-1} is far below its potential (CSA, 2016). This wider yield gap is due to several production constraints. The most important ones are drought, disease, poor agronomic practices and insufficient availability of quality seeds of the improved varieties suited for the major common bean production agro-ecologies. Tafere *et al.* (2012) reported that low crop production in Ethiopia is, mainly, attributed to inadequate availability of quality seeds of improved varieties for majority of the farmers. CSA (2012) reported that the supply of quality seeds through the formal seed system is below 10%. Most farmers, especially, in remote areas depend on locally available seeds, either recycled from their harvest or bought from the local markets.

In Ethiopia, recommendation of varieties for release has been based, mainly, on their average yield across experimental locations. Almekinders and Elings(2001) reported that formal crop improvement in developing countries focused on the development of varieties for favorable and high input agriculture, with the expectation that the improved varieties would also be productive in low-input and drought prone environments. Farmers in potential areas, and those who use improved agricultural inputs, have been more benefited from the formal crop improvement than the poorest farmers (Ceccarieli and Grando, 2007). The formal crop improvement programs have been criticized for ignoring indigenous knowledge of the farmers on crop species, varieties and cropping systems important for their specific areas. The less emphasis on improving crops for the poor productive environments of the smallholder farmers might result in slow progress of yield on marginal areas (Atline *et al* , 2001). On the other hand, the skill of farmers in identifying varieties that well adapt to their production environments has been recognized and utilized by many plant breeders. Farmers have abroad knowledge on their environment, crops and cropping systems, and do experiments on their farms and generate innovations (Baziger and Cooper, 2000). Participating farmers in the process of crop improvement and variety evaluation also fasten variety identification and adoption, increase crop and variety diversity, yield and farmers' income, facilitate farmers learning and empowering, and strengthen collaboration between breeder and farmers (Almekinders and Elings, 2001).

Common bean (*Phaseolus vulgaris)* is an integral part of agriculture in the country. It is mainly produced in the low to medium altitude areas (1000-2200) for home consumption, local and exports market. Its production is very diverse in terms of agro-ecology and cropping system. This diversity of production environments and systems demands diverse varieties that effectively target the environment and users need. Conventional breeding with multi-location on-station trial cannot effectively address the bean production environments, which constitutes a myriad of microenvironments and social settings. Hence, more decentralized breeding approaches are needed that exploit, rather than ignore, genotype by environment interaction, making use of specific adaptation and the active participation of farmers with their indigenous knowledge.

Lack of access to improved technology and low prices for their product is major challenge in crop production. To deal with this integrated effort will be required to disseminate the available technologies widely and develop mechanisms through which farmers get those technologies easily in their locality on sustainable basis. Cooperative based technical package dissemination can help to reach many farmers with improved technologies and information on agriculture and rural development.

The current procedure for the development of varieties under selection and evaluation are under high input management systems usually used in experiment station and finally verification of promising varieties under farmers' management before recommendation for wider use. However, the reason for failure and less adoption of varieties generated is due to the fact that varieties requires resource in which most of the growers can't afford and also the role of farmers is at final stage and it's also minimal (Gemechu *et al.,* 2004). In addition the classical plant breeding faces two major obstacles, First new varieties can be disappointing to farmers while undesirable traits are observed in farmers field which is undetected during breeding process. Secondly, breeder necessarily discard many crosses and verities during the selection process because of traits considered undesirable however, these traits may actually be of interest to farmers and all this illustrate the gap between breeder and farmers (Girma *et al*.2005).

To meet this challenge and bridge the gap there is a broadly accepted techniques called participatory crop improvement which involves scientists, farmers, consumers, extensionist, vendors, industry and rural cooperatives in plant breeding research (Sperling *et al*,. 2001). Terms commonly used interchangeably include; collaborative plant breeding (CPB), farmers participatory breeding (FPB), participatory plant breeding (PPB) and participatory crop improvement (PCI) and the latter sometimes divided into two areas, one for work with stabilized materials, termed participatory varietal selection (PVS) and another referring exclusively to work with variable or segregating materials, confusingly also sometimes termed PPB (sperling *et al*,. 2001).

Participatory plant breeding /selection has shown a success in identifying more number of preferred varieties by farmer in shorter time than the conventional system in accelerating their dissemination and increasing cultivars diversity (Girma *et al*,. 2005; Oriz-ferrara *et al*., 2001). When scientists and farmers work together, they learn from each other and begin to understand the differences in their views and knowledge systems and this gives way to great potential for adoption and for achieving positive change in farming system (Weltzien *et al.*, 1998; Witecombe *et al.,* 2006) and also systematic testing of locally popular cultivars help to define their domain and provide seeds of new cultivars to farmers (Joshi and Witicombe, 1996). Moreover financial analysis revealed that very high internal rates of return are possible from investment in participatory varietal selection (Witicombe *et al*., 1999).

To insure the new varieties that satisfy farmer's preferences and suit their socio economic situations, new approach of participatory experiment method called Mother and baby trial was developed (De Groote *et al.,* 2002). This approach consists a central researcher-managed " mother trial" comprising all tested varieties and the satellites or "baby" trials, which are farmers managed and test a subset of varieties form mother trial and placed nearby the area where the mother trial grown.

Therefore, this experiment was proposed to obtain farmers' input and feedback on the selection of new Common bean varieties that are released from Hawassa research center and the national centers using mother and baby methodology.

2. Objective

2.1 General objective

- Participatory Selection of common bean released varieties using Mother-Baby methodology

2.2 Specific objective

- To select best variety and recommend for farmers using mother-baby methodology.

- To obtain feedback and understand farmers' criteria in evaluating improved Common bean varieties.

3. MATERIALS AND METHODS

3.1Description of the Study Area

The experiment were carried out at Wonago district by comprises one kebele (village). Namely; Tumicha chercha Gedio Zone in SNNPR Region. The District is found at 380 km distance from Addis Abeba, the capital city of Ethiopia. The altitude ranges from 1600 to 2000 m.a.s.l. The rainfall has bimodal pattern with two rainy seasons. These are the short rains between March and May and the long rains between June and October. The dry season usually occurs between November and February. However, the short season is ideal for early maturing crops and variety like common beans, sweet potato & other crops. The area known by Agro-forestry cropping system dominantly growing perineal crops like Enste and Coffee. The scattered coffee shade trees are also the part of the system .It has also Bimodal rain fall which use to grow different crops under the system in both mehere and Belg seasons. The farmers in the woreda use some local common bean varieties from nearby woreda & kebele that have very low productivity.

3.2. Experimental Materials

The materials was required for this research were fourteen common bean (*phaseolus vulgaris*) varieties, fertilizer and also equipment's like rope, spade, meter, hoe etc.

3.3. Treatment and Experimental Field Layout

In the mother trial, fourteen common bean released varieties in three market class small red (Hawassa Dume, Rori, SER-125, SER119) white pea beans market class (Wajo, Batu, Awash2, DAB-736, KAT-B-9) Red speckled market class (Gegeba, Ibado, Remeda, DAB-632, Tatu) was used. The experiment was laid out in randomized complete block design (RCBD) with three replications. There were 42 experimental plots. Each experimental unit was an area **1.6**m length and 2m width. The distance between plot and block was 40cm and 1m respectively. The total experimental areas were 8m*27.6m is 220.8m$^{2.}$

- Plot size=2m×1.6m.
- Space b/n block=1m
- Inter row spacing= 40cm
- Intra row spacing =10 cm
- Number of rows per plot=4
- Space b/n plot=40cm
- Border effect for plant=0.20cm
- Total experimental area=220.8m^2

3.3.1. Experimental Procedures

The experimental field was selected and all unwanted materials like stones, straw and other unwanted substances were removed. The land was prepared very well by digging two or more than two times and pulverizes. The levels of surface were softened with water.

The experimental field was prepared manually with the help of land tools. Plots were level before the field layout done. Improved common bean varieties were used as a test crop. The crop was sown through recommended spacing method after land preparation. Other non-experimental variables were used as per the recommendation, i.e. fertilizer rate of 100 Kg NPS ha. All agronomic practices, weeding and hoeing activity was under taken.

3.4. Data collection

Agronomic data were collected on plot and plant basis. Plant height (cm), number of pods per plant, number of seeds per pod and hundred seed weight (g), was evaluated on five randomly taking plants from the middle two rows in each plot. Days to flowering, days to maturity, grain yield (g) of the middle two rows in each plot was measured and converted to kilogram per hectare for analysis. Farmers' evaluation and selection were on plot basis and parameters like ground cover, vigorsity, earliness, lodging, pod setting and free of disease were scored.

3.5. Farmer's Selection

The Farmers evaluated and selected the varieties were representative to the area and most of them had long experience in farming. The evaluated farmers were most interested in some of the parameters depending on their criteria's from the initial trial. The criteria's were Ground cover, vigrousity, Earliness, Pod setting, Lodging and free from any diseases. The ranking procedure was explained for participant farmers and each selection criterion was ranked from 1 to 5 (1 = Very poor, 2 = Poor, 3 = Average, 4 = Good and 5 = Very good). Then farmers were given the chance to rank each variety based on the attributes listed by them. During selection process out of 24 farmers almost half of the farmers (11 females) had been incorporated so as to avoid gender bias.

3.6. Data Analysis

The collected data were subjected to SAS. 9.4 for quantitative data and SPSS 16.0 for qualitative data analysis. Mean separation was caring out using Least Significant Difference (LSD) test at 5 % probability level (Steel and Torrie, 1980). Farmer's selection data were analyzing using simple ranking method in accordance with the given value (De Boef and Thijssen, 2007).

3.7. Data was collected by researcher

- Emergence date
- Stand count after thinning
- Stand count at harvest
- Grain Yield (qt/ha)
- 1000 seed weight

Data was collected for Participatory method was set by farmers and it was let for them to rank each genotype on the basis their criteria.

4. Result and Discussion

The mean grain yield revealed SER-125 & SER-119 were given the highest value 2600.4kg/ha & 2608.5kg/ha from the small red market class, however the Wajo (2651.7kg\ha) and Awash-2(2535.5kg/ha) from white pea bean market class. The red speckled Varity Ibado was the highest yielder Varity by the mean grain yield 2635.5kg/ha, Gegeba also the second Varity with 2588.0kg/ha in this market class (Table 1). Similarly, Alemayehu and Rahel (2015) reported that farmers preferred common bean varieties with red-speckled seed color in Wolayta area.

In Contrasting the farmers were set their own selection criteria at different crop growth stages, at pre planting selection based on Seed colour, Seed size & Market demand. From the Three market class Small red beans , Large Red speckled beans & White beans .Farmers were set selection Criteria Seed colour, Market demand , Food value , Drought tolerance, Yield ,Adaptation (Meher & Belg)&Growth habit .Based on their criteria they select Large red speckled bean(Gegeba) & white beans(Batu) were preferred for market & food purpose and Small red beans(SER-125) were preferred for high yield determinate growth habit and drought tolerance . The same result also found among the tested genotypes, SER-119 was the best adopted genotype followed by SER-118 for number of pods per plant (10.6), number of seeds per pod (5.3), number of seeds per plant (42.7), hundred seed weight (17.5 gm) and grain yield (1794.4 kg/ha).Alemayeh B., (2014) and Netra *et al*., (2019)

4.1. Farmers Evaluation

Representative farmers from the study area were participated in the baby trials and evaluated the PVS trial. The evaluated farmers were most interested in some of the parameters like Pods load, Earliness, yield, seed size, red color, market value, seed shape, maturity period, diseases resistance, Insect resistance, pod appearance and green leaf (Table 2). At flowering, maturity stage and at harvest, the farmer evaluated PVS trials at Wonago district, Tumicha chericha kebele on station. Generally farmers responded positively to the common bean varieties they have assessed. In the study common bean varieties farmers' evaluation showed that there was a matching with researcher. Moreover, farmers ‘evaluations and testing farmers field both show variance. Table 2 Farmers’ entire evaluations indicate that varieties Gegeba, Remeda and Ibado were the top from the test common bean varieties. The Batu variety had showed poor performance and least preferences by farmers in most cases.

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Table 1. Mean grain yield fourteen genotypes kg/ha at Wonago District Tumicha Chiricha Kebele (2022)

Treatments	Varieties	Market class	Wonago (kg/Ha)	Farmers Rank
1	SER-125	Small red beans	2600.4	1
2	SER-119		2608.5	2
3	Hawassa Dume		2440.7	3
4	Rori		1483.9	4
5	Batu	White beans	1163.7	3
6	Wajo		2651.7	2
7	Awash-2		2535.5	1
8	DAB-736		2099.6	4
9	KATB-9		1887.5	5
10	Gegeba	Red speckled beans	2588.0	1
11	Remeda		2146.8	5
12	DAB-632		1682.6	3
13	Tatu		2482.7	4
14	Ibado		2635.5	2
	Mean		2214.8	

Table2. Rank of the best preferred criteria used by men and women farmers at Wonago District Tumicha Chiricha Kebele (2022)

Selection criteria	**Men**	**Women**
Pod loading	4	2
Number of seed /pod	5	5
Shattering	7	6
Diseases resistance	5	4
Seed color	3	3
Maturity	6	4
Growth habit	8	8
Seed size	2	7
Yield	1	1

5. CONCLUSION

Results of PVS research at Wonago District Tumicha Chiricha Kebele**,** indicated that Gegeba, Remeda, and Ibado consistently produced higher yields both in mother and baby trials. These varieties' also got high farmers' overall preference) scores. They had better earliness and farmers expressed their opinion to cultivate those in double cropping. Baby trial was found equally effective to mother trial but that was much easy to conduct and less expensive to execute. Farmers' emphasized more on simultaneous selection rather than empirical selection on yield only. Farmers 'selected varieties were extending very rapidly and increasing varietal diversity. Most importantly, it was noted that farmer's adoption of new crop varieties came during and after the implementation of PVS as revealed by the fact that collaborating farmers in participatory approaches had higher adoption rates than non-participating farmers. Farmers to farmers seed transfer were found very effective in scaling-up seed transfer and increase varietal diversity.

6. RECOMMENDATIONS

Developed participatory approaches solve many constraints related to farmers‟ participations, set parameters, select superior varieties, evaluating the performance of better varieties, and identify better varieties and accelerating the dissemination of farmers‟ selected varieties in the target areas. Once identified, the seed of farmer-preferred cultivars needs to be rapidly multiplied and cost-effectively supplied to farmers. Farmers‟ exposure to evaluate and select new varieties is an advantage to exploit their potential knowledge of identifying adapted varieties that best meets their interest which further helps to include such selections in their varietal portfolio for seed production. Most farmers also recognized well that improved cultivars will perform better if accompanied by recommended cultural practices. Hence, interaction of researchers and farmers will also help to design research objectives to overcome rejection of varieties developed by researchers alone, enhances the acceptance of varieties and reduces costs associated with variety development. Moreover, as women have an important role in post-harvest quality assessment, in spreading new genetic materials, biological yield and indigenous knowledge systems are important considerations while developing new crop varieties to enhance varietal adoption and diversification.

From the findings, I need to carry out: Promotion of selected varieties with their agricultural practices in trials implemented sites. Designing seed multiplication and distribution technique to make seeds of these varieties sustainability available to farmers

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