

On-farm Improved Common Bean Variety Demonstration and Evaluation in Central Rift Valley of Ethiopia: Case of Bora and Adami Tullu Jido Kombolcha Districts

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Abstract

Common bean played a vital role in the national economy and used as food and cash sources for the smallholder households. Various common bean varieties were developed by the national lowland pulse research program. Nevertheless, most of the farmers had little chance to know and make their own choice from the ranges of available common bean varieties developed. This study was, therefore, proposed to introduce improved common bean technologies to farmers in major common bean growing areas in the central rift valley of Ethiopia, particularly in Adami Tullu Jido Kombolcha and Bora districts. The districts were purposively selected based on their common bean production potential and variety releasing and the registration committee's recommendation regarding suitable areas for which the demonstrated improved common bean varieties can be adapted. The target demonstration kebeles and sites were further selected purposively depending on their common bean production potential and accessibility of the site for researchers' monitoring, evaluation and other non-host farmers' visit, respectively. The farmers' selection was based on landholding and ownership of the farmers, willingness of the farmers to conduct experiments properly under the regular follow-up of the researchers and their capability to transfer knowledge and create awareness about the varieties among their neighbor and surrounding non-host farmers. Three improved common bean varieties namely, KAT-B1, KAT-B9 and Batu (standard check) were demonstrated side by side on an area of 200m² each. The result shows that KAT-B9 and KAT-B1 give a yield of 1300 and 1250 Kg/ha which is significantly higher than that of the standard check (940kg/ha). The varieties are preferable over the standard check regarding to yield, early maturity, tolerance to disease and insect infestation, drought tolerance and food test. Hence, promotion and popularization of the varieties in the study areas and areas with the same agroecology should be given an emphasis.

Keywords: Common Bean, Demonstration, Preference Score, Standard Check

Introduction

Common Bean is one of the most important pulse crops grown in different parts of Ethiopia; Oromia, Amhara and Southern Nations (SNNP). Area under common bean

production in Ethiopia in 2007/2008 was 231,443.06 hectares and has reached 306,186.59 hectares in 2017/2018 with production of 2,414,17.6.4 and 5,209,79.3. tons, respectively (CSA, 2018). Ethiopia ranked third in common bean

production in Eastern and Southern Africa. The country exports 40 percent of its total common bean production in 2010 (FAOSTAT, 2015). Common bean producers (farmers) prefer the crop because of its fast-maturing characteristics that enable households to get the cash income required to purchase food and other household needs when other crops have not yet matured (Berhanu *et al.*, 2018). Moreover, the crop is preferred by most farmers, since it is an important cash crop and source of protein for farmers in many lowlands and mid-altitude zones.

Market-oriented production system as a way to increase smallholder farmer's income has been in a policy spotlight of many developing countries including Ethiopia (Tufa *et al.*, 2014). Thus, Agricultural Research Institutes plays an important role in releasing and disseminating an improved agricultural technologies which are significant to enhance the growth and development concerns of the agricultural sector (Logan, 2014). Ethiopian Institute of Agricultural Research (EIAR) is one of the institutes working in agricultural sector in Ethiopia which contributes to the sector through development of a wide range of the high-yielding and multi-disease resistant bean varieties to enhance production and productivity for both domestic and export markets.

Varietal adaptation under the Ethiopian Institute of Agricultural Research

resulted in the release of high-yielding improved common bean varieties that are potentially suitable for a range of agro-ecologies, from lowlands to highlands (Teha *et al.*, 2006). So far, many common bean varieties were developed by the national lowland pulse research program in collaboration with the national and international partners in different parts of the country which are suitable for common bean production including the central rift valley of Ethiopia with the objectives of addressing both market and consumer demand. Nevertheless, newly released common bean technologies with better yields and relatively good traits like early maturity, disease resistance, less susceptibility to insects and tolerance to stressed conditions (drought) are not sufficiently introduced and promoted to the potential production sites and most of the farmers had little chance to make own choice from the ranges of available common bean varieties developed. On the other side, most of the farming community had little chance to know and make their own choice from the ranges of available common bean varieties developed. Farmers' selection criteria for the common bean varieties were not sufficiently evaluated and assessed in the study area. Therefore, this research was designed to evaluate the performance of the newly released common bean varieties through on-farm variety demonstration, to assess farmers' variety selection criteria (trait preference) and recommend the most important criteria or traits for future

the research in common bean variety development and improvement.

Material and Methods

Description of the study area

The demonstration was conducted in Adami Tullu Jido Kombolcha and Bora districts. Adami Tullu Jido Kombolcha district is found in the east shewa zone of Oromia region at about 168Km south of Addis Ababa. The district is located in the central rift valley of Ethiopia with an elevation of 1636 meters above sea level. The lean area of the woreda is estimated to 1487.6 Km² which is divided into 38 administrative rural kebeles and five towns. Batu town is the administrative center of the woreda. It is bordered by Southern Nations, Nationalities and Peoples' Regional State (SNNPRS) in the West and North West, Dugda district in the north, Arsi Zone in the east and Arsi-Negele district in the south. According to the 2007 national census report, the district has a total population of 141, 405 of which 85.2% live in rural areas. Crop production is the dominant agricultural practice in the area. Maize and common bean are the major crops grown in the smallholding subsistence farming system in the district. Maize is used mainly for food while, haricot bean is used as a cash crop.

Bora district is located in east shewa zone of Oromia regional state. The total area of the district is estimated to 48, 469 hectares. Alemtena is the administrative center of the district which is located at 117Km south of

Addis Ababa. The district has a latitude of 8.30°N and a longitude of 38.95°E. with an elevation of 1611meter above sea level. It is bordered by Lume, Lake Koka and Dodota in the east, Dugda woreda in the west, Liben in the north and Zeway Dugda and lake zeway in south. According to the national census report of 2007, the district has a total population of 58,748 of which 30, 487 were male and 28, 261 were females. Of the total population 47, 345 were living in rural areas. The district is mostly known for the production of vegetable crops, wheat, maize, common bean and teff.

Description of the varieties

KAT-B1(Ada)and KAT-B9 (Dandesu) are improved common bean varieties which released in 2013 and were demonstrated alongside the standard check (Batu) which was released in 2008. The seed color of the varieties is yellow and red, respectively. The varieties have acceptable grain size and weight Moisture stress areas and short rainy season areas of the central rift valley and lowland areas of Ethiopia were the main adaptation areas of the varieties. The varieties are expected to perform well at an altitude of 1300-1650 m above sea level and rainfall of 400-750 mm. The recommended seed rate used was 100 kg per hectare with the recommended spacing of 40cm between rows and 10 cm between plants (MOA, 2014). It matures within 75-78 days and is tolerant to major diseases such as Common

Bacterial Blight (CBB), Hallow Blight (HB) and rust.

Identification of demonstration site and participant farmers.

The demonstration was conducted in central rift valley of Ethiopia, Adami Tulu Jido kombolcha and Bora districts. Two kebeles from each district and a total of four kebeles were addressed. The demonstration was conducted on each kebele for two consecutive years. The districts were selected purposively depending on the potential of bean production and crop adaptation area. Target demonstration kebeles further selected purposively depending on their common bean production potential and accessibility for researchers' monitoring, evaluation and other non-host farmers' visit. Accordingly, Anano Shisho, Gerbi Wedana from Adami Tullu Jido kombolcha and Dalota Mati and Tuka Langanu kebeles from Bora district were selected for demonstration. The farmers' selection was based on landholding and ownership of farmers, willingness of the farmers to conduct experiment properly under the regular follow up of the researchers and their capability to transfer knowledge and create awareness about the varieties among their neighbors and surrounding non-host farmers. Three improved varieties of common bean namely, KAT-B1 (Ada), KAT-B9 (Dandesu) and Batu (standard check) were demonstrated.

Design of the demonstration activity

The varieties were demonstrated side by side. A plot of 600 m² was used for demonstrating the three varieties in which each variety was demonstrated on area of 200 m². The demonstration was replicated on 4 four farmers in each target location (Kebeles) for the consencutive two years. A total of 32 farmers participated in demonstration.

Data collection and analysis

The type of data collected includes grain yield and farmers' feedback on the technologies (varieties) regarding different parameters or traits like yield, early maturity, drought tolerance, tolerance to disease and food tests.

Descriptive statistics were employed to anlyze the data. Graphs and tables were used to illustrate the result. T-test was employed to understand the existence of a significant mean yield difference between the improved common bean varieties and the standard check. A three-point Linkert scale method used to determine the farmers' perception score regarding the trait preference of the varieties. The perception level of a given statement is evaluated based on the comparison between the median of the Likert scales (levels) and the mean perception score of that statement (Nguthi, 2007). The farmers' level of variety and varietal trait preference was based on the median of the three-point Linkert scale. Therefore, two is the median of the three-pint Likert scale, which is used as a cut point to

say whether the variety is better or poor in a given trait.

Results and Discussion

The overall yield performance of different common bean varieties

KAT-B9 (Dandesu) was performed best and an outstanding variety in grain yield than all other varieties of common bean demonstrated. KAT-B1

(Ada) was also good in grain yield next to KAT-B9. The mean yield of KAT-B1 (Ada) and KAT-B9 (Dandesu) is 12.3Qt/ha and 13Qt/ha with the standard deviation of 5.0 and 5.7 respectively. The mean yield of Batu (standard check) is low when compared with the mean yield of the other two varieties which is 9Qt/ha with a standard deviation of 5.20 (Table 1).

Table 1. Yield performance of different common bean varieties in Kg (n=31)

Variety	Min.	Max.	Mean	Std. Deviation	Mean difference	t	Sig.(2-tailed)
KAT B-1	350	2400	1230	4961	330	3.693	0.001
KATB-9	300	2300	1300	5672	400	3.930	0.000
Batu	300	2100	940	4989	<i>Comparison group: Batu. df=30</i>		

Source: Demonstration data

As indicated in table 1, there is a significant mean yield difference among the varieties. The mean yield of KAT-B9 was significantly higher than that of the standard check (Batu). KAT-B1 gives significantly higher than that of the standard check (Table1). This shows that improved common bean varieties have a significant yield advantage over the standard check. The resulting match with Dembele E. and Ashenafi D, (2018) who reported that the improved common bean varieties had a significant yield advantage over the local variety or the standard check. The finding is further in line with Kassahun A., Asmamaw K., (2021) who found that KAT B-9(Dandessu) had the best yield performance since, it is tolerant to major biotic and abiotic factors mainly diseases such as Common Bacterial Blight (CBB), Hallow Blight (HB) and rust.

Yield performance across locations

KAT-B9 performed outstanding variety in yield than all other varieties of common bean in all locations. However, it gave a higher mean yield in Bora than Adami Tullu Jido Kombolcha. KAT-B1 was also given a higher mean yield in all locations next to KAT-B9 (Dandessu). However, the standard check (Batu) was giving a lower mean yield than KAT-B9 and KAT-B1 varieties across all locations (Fig 1). The finding is consistent with Teame et al., (2017) who stated that improved common bean varieties are the high-yielding varieties with better performance than the local variety. Furthermore, the result is in agreement with Gurmu (2007), who stated that low common bean yield is mainly attributed to lack of improved common bean varieties

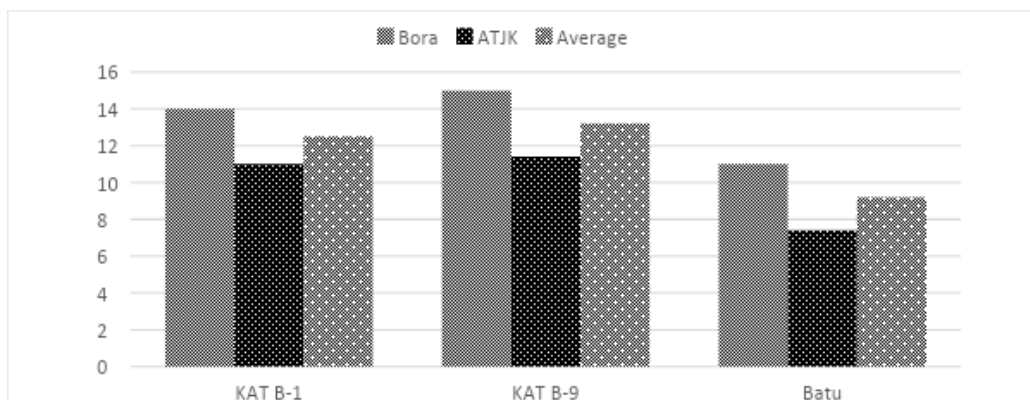


Figure 1. Yield performance of improved common bean varieties across locations in qt/ha

Trait preference of farmers (host and non-host) for different common bean varieties

The demonstration farmers were aware of the selection criteria and they know how to select and rank the varieties. They prefer best-performed varieties among different varieties of common bean depending on different parameters used for comparisons such as insect pest resistance, disease resistance, drought tolerance, food test, grain yield and others. Both the demonstration host farmers and non-host farmers were contacted at field day events and asked how they perceive the demonstrated common bean varieties concerning the above

criterion. Most of the farmers prefer KAT-B1 over other varieties for its drought tolerance, food test, tolerance to disease, seed size and seed color. KAT-B9 is also preferred by most of the farmers next to KAT-B1 in relation to all of the above parameters. KAT-B9 is preferred by most of the farmers over the other two varieties (KAT-B1 and Batu) about Yield, Early maturity, withstanding shattering problems and susceptibility to insect infestation. KAT-B1 is also preferred by the farmers next to KAT-B9 about all of the above parameters. However, Batu was not preferred by the farmers as the other two varieties (KAT-B1 and KAT-B9), since it performed less with regard to the given parameters.

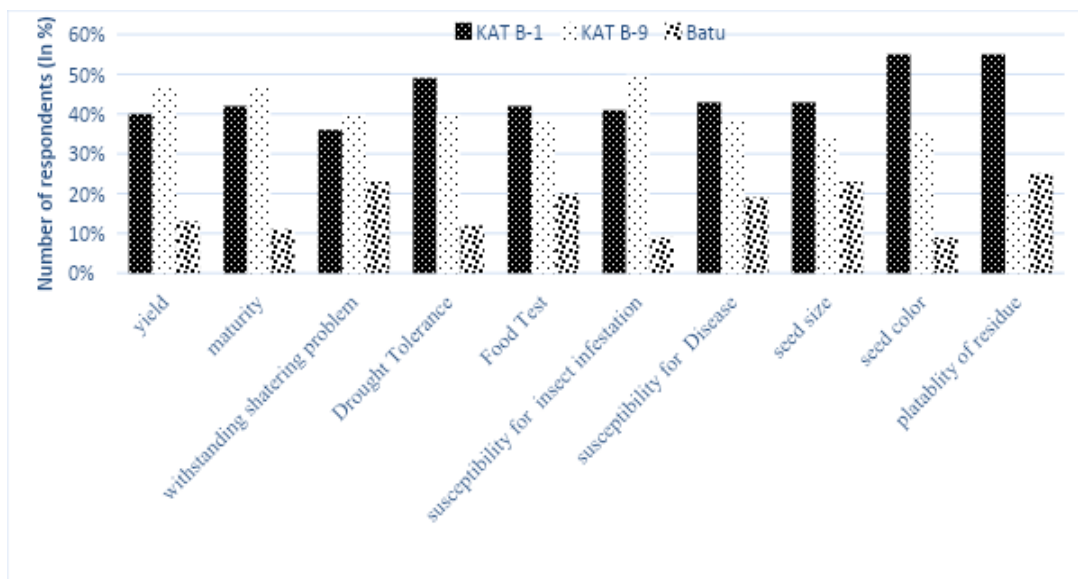


Figure 2. Farmers' variety preference based on set of parameters/criterion

As shown in figure 2, KAT-B9 is preferred in yield, early maturity and tolerance to insect infestation. Fifty percent of the respondents indicated that, KAT-B9 is not easily susceptible to insect infestation like the rest two varieties. A larger proportion of the respondents (47%) preferred this variety over the other two in grain yield. It was also preferred by 47% of the respondents in early maturity relative to the other two varieties (KAT-B1 and Batu). KAT-B1 is also preferred by 40% and 42% of the respondents in yield and early maturity, respectively next KAT-B9 (Dandessu). On the other hand, KAT-B1 takes a leading position in drought tolerance, seed size, seed color and food test. It was preferred by 43% and 42% of the respondents by seed size and food test respectively. A larger proportion of the sample (55%) preferred this variety due to its yellow seed color.

From the result, it was understood that the demonstration farmers select KATB-1 and KAT B-9 based on their selection criteria. This is substantiated by the report of Gemechu et al., (2002), who reported that farmers have their common know-how in best-performed variety selection which should be effectively exploited in the research process. Furthermore, the finding agrees with Teame et al., (2017) who stated that farmers can select the top-ranking and adapted variety based on their own selection criteria. The finding is further supported by Fekadu (2013), who reported that the farmers preferred the best performed common bean varieties based on its seed color, seed size, early maturity drought tolerance, disease and pest resistance and market demand for the variety.

Demonstration host farmers' overall varietal preference

The demonstration host farmers were giving more weight for yield from the

existing parameters. Accordingly, KAT-B9 (Dandessu) was preferred by the majority (55%) of the farmers due to yield potential as compared to other two varieties (KAT-B1 and Batu). KAT-B1 (Ada) was also preferred by

43% of the farmers next to KAT-B9 (dandessu). However, Batu (standard check) was less preferred than the two varieties. It was preferred only by two percent of farmers.

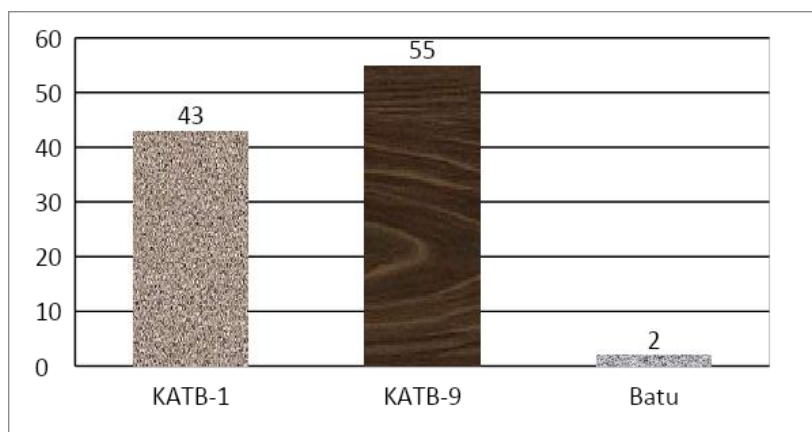


Figure 3. Overall preference of host farmers for each common bean variety

Farmer's preference ranking of the varieties

Farmers gave less score (1.08) for Batu variety for yield trait. This shows that Batu has less yield potential as compared to the other two varieties. However, it is better than the other two varieties in early maturity with the highest perception score of 2.73 (Table 3). The demonstration host farmers' perception scores on all of the given variety traits of KAT-B1 and KAT-B9 were higher than the median of a given three-point Likert scale (2). This implies that KAT-B1 and KAT-B9 were the preferred common bean varieties over the standard check (Batu) in relation to all of the variety traits except for early maturity. The overall mean perception score of KAT-B9 and KAT-B1 was 2.26

and 2.24, respectively (Table 2). The standard check recorded the mean perception score of 1.67 which is lower than the other two varieties (KAT-B9 and KAT-B1). Based on the overall perception score indicated, KAT-B9 and KAT-B1 given the first and second preference rank, respectively. Hence, the farmers are given a rank for the varieties based on the relative importance of each criterion or trait they consider during their evaluation. This is in conformity with Shiferaw et al., (2020) who reported that the farmers select the common bean varieties based on the relative importance of the important traits like yield, pod load and filling, drought-tolerant, seed color, size and shape, earliness, insect and diseases resistance, food taste and cooking time.

Table 3. Farmer's preference ranking for the varieties with respect to different criterion, Year

Criteria	KAT B-1				KATB-9				Batu			
	1	2	3	score	1	2	3	score	1	2	3	score
Yield	2(2)	10(20)	14(42)	2.46**	1(1)	13(26)	12(36)	2.42**	23(23)	2(4)	1(3)	1.15*
Maturity	2(2)	12(24)	12(36)	2.38**	3(3)	9(18)	14(42)	2.42**	1(1)	5(10)	20(60)	2.73**
Drought tolerance	5(5)	11(22)	10(30)	2.19**	5(5)	10(20)	11(33)	2.23**	22(22)	1(2)	3(9)	1.30*
Disease resistance	9(9)	6(12)	11(33)	2.08**	8(8)	8(16)	10(30)	2.08**	16(16)	2(4)	8(24)	1.70*
Food taste	6(6)	12(24)	8(24)	2.08**	7(7)	8(16)	11(33)	2.15**	17(17)	4(8)	5(15)	1.54*
Mean score	4.8(4.8)	10.2(20.4)	11(33)	2.24**	4.8(4.8)	9.6(19.2)	11.6(34.8)	2.26**	15.8(15.8)	2.8(5.6)	7.4(22.2)	1.68*
Rank	2				1				3			

Notice: preference ranking based on scores out of 3 points with 1= low score (not preferred in trait), 2= Moderate score (fair in trait) and 3= high score (preferred in trait). **= preferred in trait, *= Not preferred in trait. Figure in parenthesis shows the perception score for the given statement on each given level of Likert scale

Source: Farmers' feedback.

Conclusion

Common bean is one of the most important pulse crops grown in different parts of Ethiopia. The crop is preferred by the farmers due to its maturing characteristics that enable the household to get an immediate cash source required to purchase food and other household needs when other crops have not yet matured. It is one of the most important cash crops and used as a source of protein for farmers. Common bean is widely intercropped with other crops like maize and sorghum to supplement the farmers with an additional income and to maintain soil fertility.

Melkassa Agricultural Research Center releases common bean varieties having better production and productivity, to address the technology gap and fulfill both the bean market and consumer demand. A wide range of improved common bean technologies was released and disseminated to farmers in Central Rift Valley and other major common bean growing areas of Ethiopia. Nonetheless, the technologies were not sufficiently introduced to the potential production sites and most of the farmers had little chance to know and make their own choice from the ranges of available common bean varieties developed.

Based on the above facts, two improved common bean varieties (KAT-B9 and KAT-B1) were demonstrated alongside the standard check (Batu) on the area of 600m² in which each variety was allocated with

200m² of land. A total of 32 farmers have participated in demonstration. The result indicates that KAT-B9 and KAT-B1 give a higher yield than the standard check. The result shows that KAT-B9 and KAT-B1 give a yield of 1300 and 1250 Kg/ha which is significantly higher than that of the standard check (940kg/ha). The farmer's feedback on the variety shows the varieties are preferable over the standard check based on parameters such as yield, drought tolerance, tolerance to disease and food taste. A higher mean perception score was given to KAT-B9 and KAT-B1 as compared to the standard check (Batu). The varieties are preferable over the standard check regarding the farmers' selection criteria such as yield, early maturity, tolerance to disease and insect infestation, drought tolerance and food test. This indicates that the varieties are suitable for the study area and areas with similar agro ecologies.

Recommendations

The demonstrated improved common bean varieties are preferred by most the farmers over the standard checks based on set of parameters such as grain yield, disease resistance, resistance/tolerance to insects, drought tolerance, food test, seed size and seed color. This draws an implication regarding the need of advancing towards the preferred traits during the variety development.

Research should exert further effort in the creation of awareness about the

varieties among the non-host farmers by demonstrating the varieties in other areas with the same agroecology, preparing farmers' field visit exchange, field days, training and an inclusive stakeholders' platforms. Moreover, the government agricultural extension should work in strong linkage with research for the further promotion and popularization of the varieties among wider farmers in major common bean growing areas of Ethiopia. The non-governmental organization working on agricultural sector with a special focus on improving productivity, production and livelihood of smallholder common bean producers should intervene in promotion and dissemination of the varieties in common bean growing potential areas. Furthermore, different stakeholders which engaged in seed sector like seed enterprises at different levels should work with full effort to secure the farmer's access to quality seeds of the varieties.

The farmers were aware of the selection criteria and they know how to select and rank the varieties. They want the variety that best fits to their criteria and needs. Hence, the research should consider the farmer's participation in the common bean improvement and variety development program so that it considers farmers' selection criterion and trait preference to develop farmers-need based varieties that can be widely disseminated and easily adopted by the farmers.

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