Asian Journal of Research in Crop Science

Volume 9, Issue 3, Page 15-21, 2024; Article no.AJRCS.121569
ISSN: 2581-7167

On-Farm Potentials of Common Bean and its Contribution for Smallholder Farmers' Livelihood and Income

Fitsum Miruts [a*], Samir Hashim [a], Tamirat Fekadu [a] and Belay Roba [a]

[a] *Ethiopian Institute of Agricultural Research, Melkassa Agricultural Research Centre, P.O. Box 436, Adama, Ethiopia.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ajrcs/2024/v9i3284

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/121569

Original Research Article

Received: 19/06/2024
Accepted: 21/08/2024
Published: 26/08/2024

ABSTRACT

To enhance the gain yield and utilization of common bean, many challenges were observed. To tackle the challenges, this experiment evaluated five recently released common bean varieties through farmer's participation. The varieties used for the evaluation were SAB-632, DAB-372, SER-119, SER-125 and KAT-B1. The study showed farmers can harvest a maximum of 2.6 t ha^{-1} using the improved common bean varieties. This can bridge about 60% of the yield gap observed compared with the farmers' practice. When cultivating the improved varieties farmers can also harvest more than 119,222 birr from one hectare. To compare the value of the benefits and the costs of producing common bean, a benefit-cost ratio (BRC) was calculated and found a 1.57 ratio. Thus, in Sire and similar agro-ecologies that cultivate common beans, it is advised to scale up the SER-119 variety to improve production and profitability.

**Corresponding author: E-mail: fitsummiruts@gmail.com;*

Cite as: *Miruts, Fitsum, Samir Hashim, Tamirat Fekadu, and Belay Roba. 2024. "On-Farm Potentials of Common Bean and Its Contribution for Smallholder Farmers' Livelihood and Income". Asian Journal of Research in Crop Science 9 (3):15-21. https://doi.org/10.9734/ajrcs/2024/v9i3284.*

Keywords: Cost of production; farmers' preference; feasibility; participatory evaluation; sensitivity analysis.

1. INTRODUCTION

Common bean is one of the main pulse crops cultivated by smallholder farmers in Ethiopia. Currently it is cultivated on an estimated area of 600,000 hectare [1]. According to Tebeka et al. [2], common beans are a significant source of dietary protein, as well as essential micronutrients like iron and zinc. Farmers cultivate common beans for both food and income, and in Ethiopia, it is also an important crop for export [3].

Common bean farmers in Ethiopia harvest low grain yield despite the high potential of research released improved varieties. The improved varieties potential is around 4.0 t ha-1. Whereas common bean farmers harvest not more than 1.7 t ha^{-1} [1,4]. Studies showed that the grain yield of common bean can be improved when farmers adopt the improved varieties with recommended agronomic practices. According to Fitsum et al. [4], common bean grain yield were improved by 27% when farmers utilize the recommended technologies.

The national lowland pulse research program with its collaborative institutions achieved a remarkable milestone. The program registered a high grain yield and disease resistant varieties for the last decades [5]. Understanding this, an experiment on the participatory evaluation of improved common bean varieties were conducted in Sire district. The objective was to evaluate the best-performing ones and recommend for scaling ups.

2. MATERIALS AND METHODS

2.1 Site Description

We implemented the experiment in the Sire district of Oromia regional state, Ethiopia. In the district, farming is the major economic activity. Cereals and pulses are the major crops cultivated by the farmers. The district is characterized by an altitude range of 1000 to 2500 meters above sea level. The annual rainfall ranges from 800mm to 1200mm. From the district common bean producer kebeles, Biqa kebele was selected randomly. From the kebele, twelve farmer fields were used to lay out the experiment during the 2023 main rainy season.

2.2 Experimental Design and Managements

In order to replace the low-yielding local varieties grown by farmers, five recently released improved common bean varieties were evaluated using a participatory approach. The varieties used for the evaluation were SER-119 and SER-125 (red seed color), KAT-B1 (yellow color), and SAB-632 and DAB-372 (speckled or sweet bean). Using the target farmers' fields as replications, a randomized complete block design (RCBD) was employed to set up the experiment on farmers' land. The seeds were planted at a rate of 100 kg ha^{-1}, with 40 cm x 10 cm (row x plant) spacing during mid-July, 2023. NPS fertilizer was used at the rate of 100 kg ha^{-1} during planting.

2.3 Data Collection

The data collection involved gathering a wide range of agronomic and demographic data, including plant height, flowering and maturity times, seed weight, pod and seed counts, grain yield, as well as demographic details such as age, family size, sex, education level, and farm size. Additionally, feedback from farmers on their trait preferences, input usage, incurred costs, and selling prices were also documented. Pairwise ranking and weight scores methods were used to assess the farmers' preference for the traits identified.

2.4 Data Analysis

2.4.1 Analysis of variance and descriptive analysis

The researchers utilized ANOVA to evaluate differences among the varieties, calculated a 5% significance level to compare performance, and used pairwise ranking and weight scores to assess farmers' preferences for identified traits. Finally, in order to assess the common bean production feasibility in the study area, benefit-to-cost ratio was calculated.

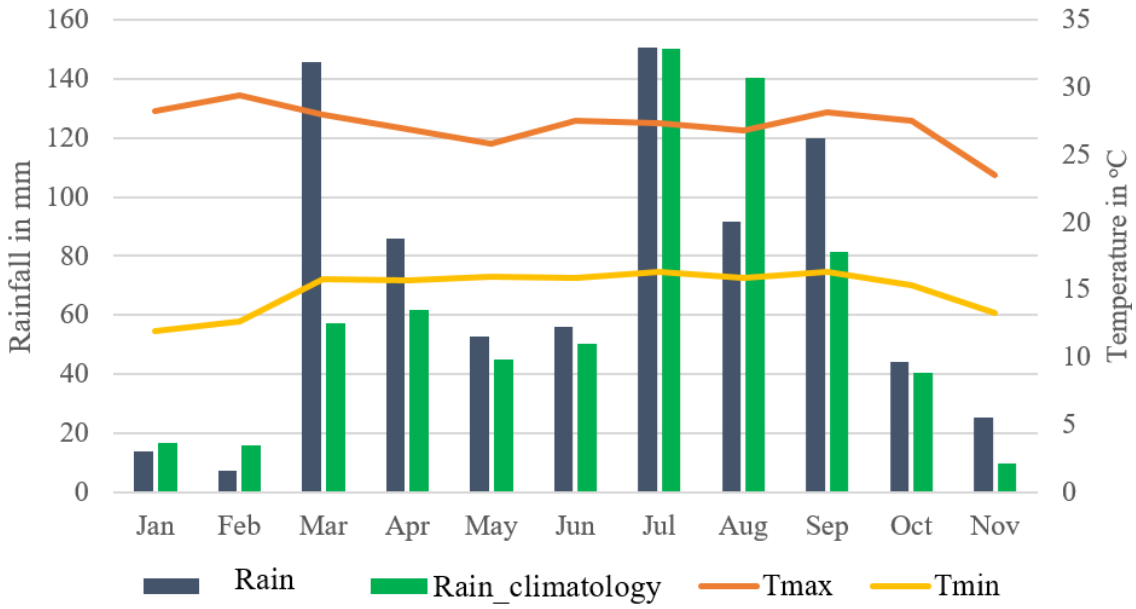

Fig. 1. Temperature and rainfall distribution of the study area

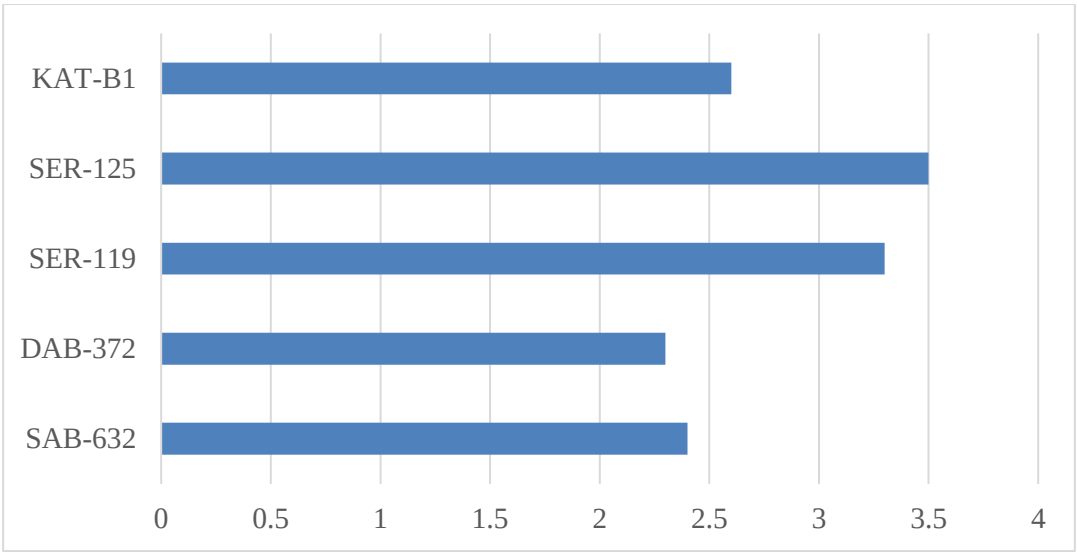

Fig. 2. Research field grain yield performance of common bean varieties (t ha^{-1})

Picture 1. Demonstrated and evaluated varieties

3. RESULTS AND DISCUSSION

3.1 Target Farmers Characteristics

Farmers targeted to conduct the experiment were 40 years of old on average, and they had larger families (7 members) and more land (3 hectares) compared to the national average (5.1 family members and less than 1 ha). On average, the farmers had 6 years of education. The majority of the farmers selected to host the experiment were male (63%), which was approximately double the number of females.

3.2 On-farm Performance of Common Bean

The study showed the common bean varieties differed significantly ($p<0.001$) in all measured traits. This suggests the evaluated varieties are better performing and they can increase the chance of farmers to select one. The common bean varieties were found to have a significant variation in plant height (43.85 cm to 49.23 cm), days to maturity (82.54 days to 85.46 days), number of pods per plant (13.25 to 16.45), number of branches per plant (6.76 to 9.45) and 2.1 ton to 2.3 t ha^{-1} for grain yield (Tables 1 and 2). The highest plant height (49.23 cm) was recorded by SAB-632 variety. A variety with a short plant height was KAT-B1 with 43.85 cm. Based on the maturity date, the early maturity variety was KAT-B1. It took only on average 82 days for maturity. The highest number of branches per plant and higher grain yield was recorded by SER-119, which is 9.45 and 2.3 t ha-^{1}. The lowest (2.1 t ha-^{1}) grain yield was recorded by KAT-B1, suggesting a positive correlation between short-maturing behavior and a lower yield. The result showed the presence of significant genetic variability among common bean varieties and their traits. These findings are in line with those of Kassahun and Asmamaw [6] and Gebre-Egziabher et al. [7], who reported significant variations in grain yield and related trait among different varieties of bean. Similarly, Haile et al. [8] documented marked differences in plant height and maturity dates among common bean varieties. However, lower variations were observed in traits such as days to flowering, seeds per pod, and pod length.

3.3 Participatory Evaluation

The participatory evaluation was conducted during the harvesting time by farmers who cultivate common bean. The farmers were grouped, and a focus discussion was conducted. First, farmers were asked to list the preferred traits of common bean. They identified high grain yield, disease resistance early maturity, less shattering and drought resistance traits as their priority traits. Based on this trait identified, farmers evaluated the demonstrated varieties. It is found that the SER-119 variety is the most preferred one by the common bean farmers. This is due to its high yield, disease-resistant character, less shattering problem and drought-resistance traits. Next to SER-119, farmers selected the SER-125 variety as their second choice. Similar findings were also reported by Fekadu [9] and Takele et al. [10]. According to Walker [11], voting for the best varieties can be associated with a high likelihood of varietal adoption. Thus, there is a high probability of the SER-119 variety being adopted by the farmers.

3.4 Cost of Common Bean Production

A research report by Walelign [12] identified various farming activities involved in common bean production. According to the findings of this study, the highest cost incurred was for labor, accounting for approximately 68% of the total cost (see Fig. 3).

Farmers earned an average of 41,152.4 birr per hectare from common bean farming. The highest gross margin came from the SER-119 variety. The cost analysis showed a mean total revenue of 119,222 birr/ha with a total variable cost of 78,069 birr/ha. According to Baumol et al. [13], a business is considered profitable and sustainable if its earnings exceed its expenditures. This suggests that growing common beans presents a viable economic opportunity in the study area [14].

Table 1. Common bean varieties and their agronomic traits

Variation	df	PH	DTF	DTM	PPP	SPP	PL	NBPP	GY
Variety	4	56.34*	6.62^{ns}	14.73**	25.33*	0.77^{ns}	4.72^{ns}	15.12**	100664**
Replication	12	27.05	3.74	1.69	19.43	0.53	3.08	2.85	52058
Error	48	22.80	2.55	2.13	6.22	0.48	3.03	2.46	23504

*** = Significant P≤0.01 probability level; PH= Plant height; DTF = Days to flowering; DTM = Days to maturity; PL= Pod length; SPP=Seed per pod; PPP = Pod per plant; N BPP= Number of branches per plant; GY = Grain yield*

Table 2. Mean performance of common bean varieties

Varieties	Plant height (cm)	Flowering date	Maturity date	Pod per plant	Seed per pod	Pod length (cm)	No branches per plant	Grain yield (kg)
DAB-372	46.54a	39.92a	85.46a	13.25a	5.38a	11.77a	7.62a	2288.30
KAT-B1	43.85	39.69a	82.54	13.85a	4.81	10.73	6.76a	2119.20
SAB-632	49.23	40.54b	84.62a	14.29	5.37a	12.16	8.16	2325.20
SER-119	47.31a	40.92b	84.23b	16.45b	5.36a	11.87a	9.45a	2338.80
SER-125	48.46	40.77b	84.31b	16.03b	5.25a	11.04a	9.02a	2255.70
Mean	47.08	40.37	84.23	14.77	5.24	11.51	8.20	2265.44
LSD	3.77	1.26	1.15	1.97	0.55	1.37	1.24	120.91
CV	10.14	3.96	1.73	16.89	13.33	15.14	19.13	6.77

Means with the same letters in the same column are not significantly different at a 5% level of significance

Table 3. Preferred traits of common bean by farmers

Preferred traits	SER-119	SER-125	KATB-1	DAB-372	SAB-632
High yield	33	28	21	10	8
Disease resistance	34	27	18	9	12
Early maturity	10	11	37	22	20
Less shattering	31	24	17	12	16
Drought resistance	31	35	15	10	9
Average score	27.8	25	21.6	12.6	13
Rank	1st	2nd	3rd	5th	4th

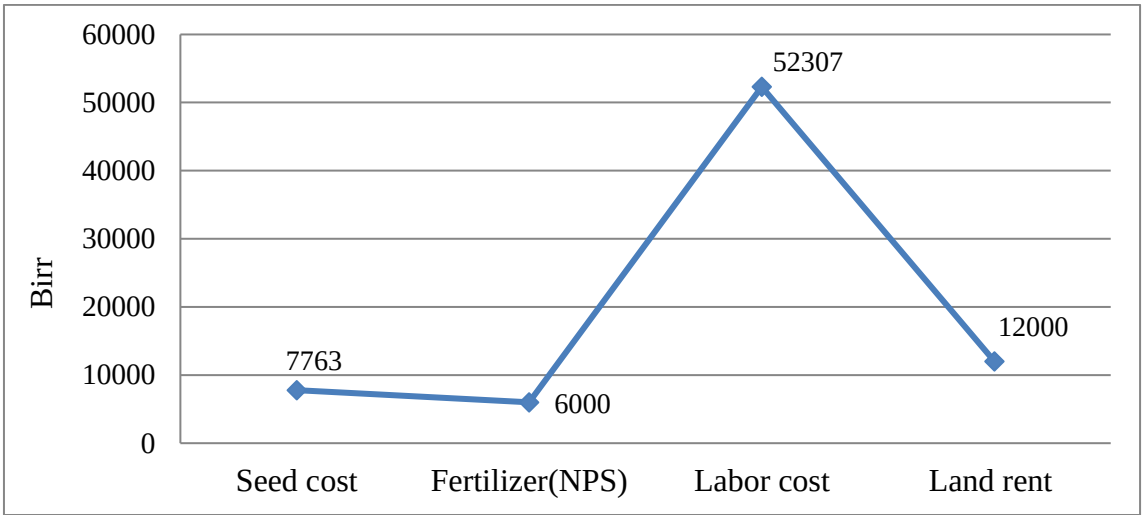

Fig. 3. Cost of common bean production

Table 4. Benefit cost ratio

Benefit-cost analysis	SAB-632	DAB-372	SER-119	SER-125	KAT-B1
Grain yield (kg)	2325.2	2288.3	2338.8	2255.7	2119.2
Grain price (birr/kg)	50	50	50	50	50
Grain revenue (birr)	116,259.5	114,416.5	116,941.5	112,786.0	105,957.5
Straw yield (kg)	2500	2350	2300	2400	2350
Straw price (birr/kg)	2.5	2.5	2.5	2.5	2.5
Straw revenue (birr)	6250	5875	5750	6000	5875
Total revenue (birr)	122,509.5	120,291.5	122,691.5	118,786.0	111,832.5
Grain cost production (birr)	78,069.8	78,069.8	78,069.8	78,069.8	78,069.8
Gross margin (birr)	44,439.7	42,221.7	44,621.7	40,716.2	33,762.7
Benefit Cost Ratio (BCR)	1.57	1.54	1.57	1.52	1.43

Table 5. Sensitivity analysis of common bean production (birr/ ha)

Scenario	Gross revenue	Total Cost	Gross Margin	Profit margin (%)
Base case scenario	119222.2	84069.8	41152.4	48.9
Grain yield increase by 20%	141876.6	84069.8	57806.8	68.8
Production cost increase by 20%	83577.7	78789	4788.7	5.7
Price increase by 30%	153203.9	84069.8	69134.2	82.2
Grain yield decrease by 10% & price decrease by 20%	87506	84069.8	3436.2	4.2
Production cost decrease by 20%	119222.2	67255.8	51966.4	77.3

3.5 Sensitivity Analysis

The study includes a sensitivity analysis of common bean due to production changes. To check the sensitivity different scenario were taken. Scenario 1 assumes, if the grain yield increases by 20%, as a result the profit margin increased by the same percent, keeping other factors constant. On the contrary, as production cost increases by 20%, the profitability of common bean production decreased by 43.2% compared to the base case scenario. A 10% decrease in the expected yield and a 20% decrease in price may cause a 44.7 % decrease in the profit margin from the base case scenario. Keeping other factors constant, reducing grain yield and prices has a highly negative effect on the profit margin. From the sensitivity analysis, yield and market price are the most influential factors on a farmer's profit [15].

4. CONCLUSION AND RECOMMENDATIONS

The study found a significant variation among the evaluated common bean varieties in grain yield and yield contributing traits. Based on the result of the experiment, SER-119 was selected for its superiority in grain yield and yield contributing traits. The study showed that farmers could obtain higher returns by cultivating SER-119. The maximum benefit can be achieved when using the SER-119 variety. Among the factors influencing farmers' profit from common bean production, the amount of grain yield harvested and market price are the major ones. The benefit-cost ratio also showed that common bean farming is profitable business in the study area. Thus, in Sire and similar agro-ecologies that cultivate common beans, it is advised to scale up the SER-119 variety to improve production and profitability.

5. LIMITATIONS OF THE STUDY

The study used cross-sectional research design whereby the experiment was implemented for one year in limited areas. Although the data enables generalization of the findings, it prevented close investigation of several aspects of the relationships in this study.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. CSA (Central Statistical Agency). Reports on area and production of crops. Private peasant holdings. Meher Season, Volume I. Statistical Bulletin 578. Addis Ababa, Ethiopia; 2022.
2. Tebeka YA, Katungi E, Rubyogo JC, Sserunkuuma D, Kidane T. Economic performance of community based bean seed production and marketing in the central rift valley of Ethiopia. African Crop Science Journal. 2017;25(2):189-205.
3. Kidane T, Buruchara R, Beebe SE. Common bean strategies and seed roadmaps for Ethiopia. Grain legumes strategies and seed roadmaps for selected countries in sub saharan Africa and South Asia, TL-II Project Report, ICRISAT, India. 2014;3-11.

4. Fitsum M, Bedru B, Abebe T, Birhanu F. On-farm performance and farmer participatory evaluation of newly released common bean varieties in Oromia Regional State, Ethiopia. Ethiopian Journal of Crop Science. 2021;9(1).
5. Kidane TJC, Negash K. Sustainable access to quality seed by small holders: The case of decentralized seed production of common bean in Ethiopia. Community Seed Produc on. 2013;9:150.
6. Kassahun A, Kassahun A. Participatory variety selection for released white common bean varieties in South Gondar Zone, Ethiopia. Heliyon. 2021;7(12).
7. Gebre-Egziabher Murut GEM, Hadush Tsehaye HT, Fetien Abay FA. Agronomic performance of some haricot bean varieties (*Haseolus vulgaris* L.) with and without phosphorus fertilizer under irrigated and rain fed conditions in the Tigray and Afar regional states, northern Ethiopia. Momona Ethiop. J. Sci. 2014;6(2):95-109.
8. Haile M, Mekbib F, Zelleke H. Performance and farmers' evaluation of released common bean varieties in Dawro zone, Southwestern Ethiopia. Journal of Crop Improvement. 2012;26(2):197-210. Available:https://doi.org/10.1080/15427528.2011.625516
9. Fekadu G. 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 sight. 2013;5(2):4-13.
10. Takele Atnafu, Dirshaye Hailu and Yaregal Fekadu. Evaluation of newly released improved haricot bean (*Phaseolus vulgaris* L.) varieties under smallholder famers' condition in metekel zone, Northwestern Ethiopia. Evaluation. 2021;12(20).
11. Walker TS. Participatory varietal selection, participatory plant breeding, and varietal change. Washington, DC: World Bank; 2006.
12. Walelign Worku. Haricot bean production guide: with emphasis on southern Ethiopia (Amharic version); 2015.
13. Baumol WJ, Litan RE, Schramm CJ. Good capitalism, bad capitalism, and the economics of growth and prosperity. SSRN Electronic Journal; 2007. Available:https://doi.org/10.2139/ssrn.985843
14. SAS Institute. The SAS System for Windows. Release 9.2, SAS Inst., Cary, NC; 2008.
15. VSN International. A guide to ANOVA and design in GenStat, in: VSN International, 2 Umberside, Wood Lane Hemel Hempstead, Hertfordshire, eighteenth ed., HP2 4TP, UK; 2015.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/121569