



Research Article

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Pre extension demonstration and evaluation of common bean technologies at midlands of Guji Zone, Oromia, Ethiopia

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Abstract

Common beans are a legume crop that farmers and the nation utilize to generate cash through exports and for domestic consumption. Promoting such an advantage crop is so essential. The purpose of this activity was to demonstrate new common bean varieties. Ten farmers in the Adola Rede districts were sown the new common bean varieties, Hegere and Duromsa, alongside a local variety. In order to promote the new common bean varieties, a mini-field day and training session were arranged. Data on farmers' preferences, yield, and cost of production were gathered through measurement and interviews. Likert scale, descriptive statistics, and net benefit were used to analysis the gathered data. As opposed to the local variety's output of 20.60 qt/ha, the recently released common bean varieties Hegere and Duromsa produced better yields of 29.55 qt/ha and 33.85 qt/ha, respectively. Hegere and Duromsa varieties produced more profitable than the local variety. Duromsa offers 40,650 birr/ha, Hegere variety 61,600 birr/ha, and 26,450 birr/ha that may be obtained. As a result, the Hegere variety outperformed the local variety in terms of net income. The use of varieties in agricultural production can be governed by farmers' preferences. According to the varieties' production performance, disease resistance, and market demand attributes, farmers in this demonstration rated Hegere and Duromsa above the local variety in order of preference. So, the Hegere and Duromsa varieties should be expanded to broad areas in the midlands of Guji zone because to their greater production, superior return and farmers preference.

Keywords: Demonstration, Farmers' preference, Hegere, Duromsa.

INTRODUCTION

To achieve household food security, Ethiopia's rural development policy and strategy emphasized expanded access to and increased use of agricultural technologies, diversity and specialization in production systems [1]. According to Ruzzante *et al.* [2], achieving sustained gains in agricultural productivity and output would need a broad adoption and dissemination of new technologies. Given the restricted prospects for area growth, wide farming is becoming an increasingly difficult agricultural activity to grow production consistently [3]. Consequently, policies that enable farmers to intensify their production via agricultural activities, such a variety of improved agricultural technology, would be necessary to address the food crisis [4,5].

Common beans (*Phaseolus vulagris* L), often referred to as dry beans and haricot beans, are an important self-pollinating legume crop that is farmed all over the world [6]. Asia accounts for 49.5% of global production of common beans, followed by Africa (25.7%) and the Americas (24.8%). Brazil, India, and Myanmar are the top three producers worldwide. According to FAOSTAT [7], Ethiopia, Kenya, and Uganda produce the most in Africa. Oromia, the Southern Nations, Nationalities and Peoples (SNNP), and the Amhara regions are Ethiopia's main regions for producing common beans [8].

In Ethiopia, common beans are a crop that thrives in low- and mid-altitude regions and is becoming essential for both economic and food security [9,10]. According to Bulyaba *et al.* [11] and Afeta *et al.* [12], common beans are rich in nutrients and beneficial amino acids. The crop also contains high protein, vitamins (including folate), and minerals including iron, calcium, copper, manganese, magnesium, and zinc. As to Fekede and Nimona [13], beans are customarily seen as a dietary item for the impoverished.

Common beans are rapidly spreading legume crops that are essential to many Ethiopians' daily diets and sources of income abroad [14,15]. The Ethiopian government announced many efforts and encouraged farmers to produce more common bean varieties in response to the growing demand in both local and international markets. It is expected that Ethiopia's agricultural research and extension system would help feed the country's growing population, realize the advantages of better agricultural technology demonstration and promotion to harvest surplus production.

Due to their early maturity, moderate resistance to drought, and risk aversion in areas of the nation that are vulnerable to drought, common beans are grown by the majority of Ethiopian farmers [10,14,16]. The common bean holds additional significance in Ethiopia due to its potential to be used for double and intercropping systems. This guarantees that smallholder farmers with limited land may produce more common beans on a fixed area of land.

Farmers can increase production by intercropping common beans with other crops. The enhancement of soil fertility is another benefit of common beans. Due to their legume status, common bean plants also improve soil fertility by fixing nitrogen [17,18].

Despite importance for nutrition, economy, and the environment, the actual output of common bean in Ethiopia is still below 1700 kg/ha, significantly less than their potential yield of 4000 kg/ha [19]. The main causes of the low productivity of common beans include inadequate agronomic recommendations, a lack of improved varieties, and a lack of acceptance of new technologies [13,14,20]. To address these issues, over fifty enhanced common bean varieties have been made available for various altitude ranges and specialized features [21]. Ethiopia grows several different varieties of haricot beans, varying in size, color, and maturity. According to Tekalign *et al.* [22], Halake and Galgaye [14] and Fekede and Nimona, 2024 [13], red-colored common beans are mostly utilized for domestic use, whereas white-colored varieties are primarily used for commercial purposes.

Similar to other regions of Ethiopia, the Guji zone's lowlands and mid-altitude farming communities rely mostly on common beans as their main source of protein and cash crop. Additionally, the biological nitrogen fixation that occurs during the production of common beans restores soil fertility and can boost crop yield [10,12]. Although common beans are commonly grown in the Guji zone's midland districts, their productivity and production are extremely low because of inadequate management techniques and a lack of better varieties [23]. In order to address this issue and boost farmers' productivity and output of common beans, the Bore Agricultural Research Center has released new varieties of the bean for the Guji zone's lowland and midland areas. The introduction and release of new varieties alone is not sufficient to increase farmers' yields; these must be evaluated, and the recommended technologies must be shown on farmers' land [24,25]. This study aimed to show and analyze the yield performance of released common bean technologies, calculate the profitability of released common bean technologies under farmer conditions, and gather feedback from farmers to advance common bean production in the Guji zone midland areas.

MATERIALS AND METHODS

Description of the study area

Ethiopia's capital, Addis Ababa, is 468 kilometers away from the Adola Rede district, which is situated in the southern Oromia region. The district lies between 5°44'10"- 6°12'38" latitudes and 38°45'10"-39°12'37" longitudes. Three agro climatic zones; humid, sub-humid, and dry arid define the district. Regarding the agricultural calendar, the district's rainfall pattern is mono-modal in the highlands and bimodal in the lowlands and midlands. It is said that whereas the humid agro-climatic zones see very high rainfall, the dry desert agro-climatic zones receive relatively little rainfall. In this area, a lot of agricultural households engage in rain-fed agriculture. This district's farmers harvest in both autumn and the spring. The main crops grown by the farmers in the study's areas are tef, maize, and common beans. As a means of subsistence, they also produced coffee [26,27]. Common beans, often

known as haricot beans, are grown in both the *meher* and *belg* seasons. Common beans are an intriguing pulse crop in the Adola Rede area because of their double-cropping qualities.

Sites and farmers' choices

Adola Rede district has been chosen to showcase common bean technologies. Based on their ability to produce common beans, Derartu and Kiltu Sorsa sites were chosen from the district. Five farmers were chosen per site, depending on their desire to grow common beans on their farm. With support from development agents and the Adola Rede District Agricultural Office, farmers were selected.

Research Design

For this activity food type common bean varieties released by Bore Agricultural Research Center in 2022 were used for demonstration. Hegere, and Duromsa varieties were demonstrated with local varieties in 2023 main production year. The varieties were demonstrated with the recommended technologies of seed rate, fertilizer rate, spacing, and management practices. During the demonstration, the recommended packages of 40cm between rows, 10cm between plants, and 121 kg/ha of NPS fertilizer were applied for the experiment. A 90kg/ha seed rate was sown on the 100m² area for each variety. The treatments were laid out in simple plots of ten (10) farmers as replication. Hand weeding was conducted to control weeds.

Technology demonstration and evaluation approach

Training was given to participating farmers, Development Agents, and experts. Mini-field day was organized to enhance demand and further promotion of new common bean varieties in the midlands of Guji Zone. Farmers' preference was conducted at the maturity stage. All experimental farmers were participated in varieties and trait preferences.

Techniques for gathering and analyzing data

To gather information on the yield, cost, and preferences of farmers, field observation and interviews were conducted. Five common bean plants from each type were randomly selected for the number of pods per plant and the number of seeds per pod. The productivity and profitability of common bean production in the Guji zone's midlands were examined using descriptive statistics and net income. Following is the computation of net income:

$$TR = Y * P \dots\dots\dots 1$$

Y= yield obtained (qt/ha) and P farm gate price in birr

Net income (NI) will be collected as:

$$NI = TR - TVC - FC \dots\dots\dots 2$$

Where TR= Total Revenue, TVC= total variable cost and FC= fixed cost

A five-level Likert scale was used to examine farmers' preferences about the production of common bean varieties (1 being very poor, 2 being poor, 3 being average, 4 being good, and 5 being very good).

RESULTS AND DISCUSSIONS

Farmers' know-how implementation during demonstration of common bean technologies

Building capacity for the know-how application of agricultural technologies, varieties, practices, methodologies, and other recommendations is necessary. Farmers and technology users must be proficient in both producing and utilizing the technologies. To improve farmers' knowledge of the production and use of common bean technologies (varieties and agronomic recommendations/seed rate,

fertilizer rate, sowing, managements), this demonstration, training, and mini-field day were utilized. This study considered the usefulness of mini-field days and training programs in disseminating improved crop varieties and accelerating their integration into existing agricultural practices [25,26,28]. To bridge the knowledge gap on newly released common bean varieties, a training program equipped 43 farmers (30 male, 13 female), along with development agents and subject matter experts (6 each), for successful field implementation. At maturity stage on farm performance of the demonstrated varieties were visited by farmers and others through mini-field day (Table 1). This mini-field day was used to enhance the promotion of the varieties in study areas. Based on performance at the demonstration the participants desired to produce Hegere and Duromsa varieties over the local variety.

Performance of common bean varieties on farmers' land

The new varieties of Hegere and Duromsa as well as local variety were evaluated on their pod per plant, seed per pod, and yield. Number of pod per plant is an important trait of common bean. The current demonstration of common bean showed that more number of pods per plant was obtained from the Duromsa variety followed by the Hegere variety while the least was obtained from the local variety. This showed that the new varieties inherited their good characteristic of pod per plant which is used for increment of crop yield. Local and Hegere varieties are less prolific than the Duromsa variety in terms of seeds per pod. On average, 5.31, 5.05, and 3.87 seeds per pod were obtained from Duromsa, Hegere and local variety, respectively (Table 2). Producers of common beans focus primarily on the number of seeds per pod and pods per plant [9]. The usage and production of variety in agricultural production may be determined by the yield performance of a new variety. The demonstration's outcome showed that at the midland of Guji zone 33.85 qt/ha, and 29.55 qt/ha yield of common bean was harvested from the new variety of Duromsa and Hegere variety, respectively (Table 2). In the study area, the yield results of the new varieties outperformed those of the common bean variety found locally (20.60 qt/ha). The new varieties shown in this activity were more significant in increasing farmers' yields than the earlier demonstrations in the midlands of the Guji zone, where they attained 20.5-23 qt/ha of improved varieties [23,29]. Furthermore, Hegere and Duromsa have higher yield advantages over the country, Oromia region, and Guji zone, with respective common bean yields of 17.96, 18.92, and 18.09 qt/ha [30]. Furthermore, the yield performance of Hegere and Duromsa outperformed the yields of 17.58–27.15 qt/ha from improved common bean varieties in the same locations [10,31]. This demonstrated that new varieties yield more than improved varieties that farmers may use to produce large quantities for household consumption and marketing.

One way ANOVA analysis showed that there is a significant yield difference in demonstrated common bean varieties at 1% level of significant (F-value is 25.144 and P=0.001) (Table 3). This suggests that each demonstrated variety showed its potential yield on farmers land during demonstration.

Cost-benefit analysis of common bean production

Total Variable Costs (TVC) gathered during the common bean demonstration was the costs of seed, fertilizer, land preparation, planting,

harvesting, and threshing. The local variety's TVC cost was 18850 birr/ha, whereas the Duromsa and Hegere varieties' TVC costs were 20850 birr/ha in total. There are two growing seasons for common beans in a year: the *meher* and *belg*. Fixed cost of land also collected. The profitability analysis in this study solely took into account the production throughout the *meher* season. Thus, for one-time harvesting, Total Fixed Cost (TFC) was taken into consideration. The fixed cost (FC) of land for the common bean demonstration was 6200 birr/ha for a single crop of common beans. According to farmers' feedback during the demonstration, the price of Hegere, Duromsa, and local varieties was estimated at 3,000, 2,500, and 2000 birr/ha, respectively. Even though the Duromsa variety yielded more than the Hegere variety, it cost less to meet market demand. Thus, the total revenue (TR) for Hegere was 88,650 birr/ha, followed by Duromsa's 67,700 birr/ha and the local variety's 51,500 birr/ha. For the new varieties and local, the total cost (sum of TVC and FC) was 27,050 and 25,050 birr/ha, respectively. The demonstrated Hegere, Duromsa, and local varieties yielded net benefits of 61,600, 40,650, and 26,450 birr/ha, respectively (Table 4). This suggests that producing Hegere and Duromsa might yield revenue that is two to three times higher than that of the local variety.

Farmers' preference on common bean traits and varieties

Based on their preference farmers want to produce a certain variety more than the others. The common bean varieties that farmers preferred were evaluated in this demonstration. The five most often detected traits from common bean varieties in the study area at the time of the demonstration are yield, sweetness, early maturity, disease tolerance, and market demand. When it came to adopting new varieties, farmers preferred the new variety's yield advantage over the local variety. Farmers choose the Duromsa variety as the first in this demonstration because of its greater output, followed by the Hegere and local varieties in second and third place, respectively (Table 5). Furthermore, the Duromsa variety (small size and cream color) was chosen ahead of the other varieties due to its disease resistance; yet, it was less sweet and had a lower market demand than the Hegere variety (small size and red color) and the local varieties (big size and red color). When it came to domestic food consumption, farmers preferred the Hegere type in the forms of powder and boiling. Both variety size and color influence market demand for common beans in the study area. In the market, red and large sizes are the most popular. Hegere is smaller than the local variety, which is also red in color and larger in size, even if it has a higher market demand because of its red.

Early mature crop variety is needed in the midlands of Guji zone due to moisture stress and double cropping patterns of the areas. Hegere, Duromsa, and local varieties were considered the early maturing varieties required for the moisture-stressed midlands of the Guji zone. Hegere, Duromsa, and the local variety were ranked first, second, and third, respectively, based on market demand, yield, disease tolerance, sweetness, and early maturity (Table 4). This proved that farmers choose the newly demonstrated varieties to replace the local variety for the production of common beans. The outcome was comparable to that of Cholo *et al.* [20], where farmers ranked yield and market demand as their primary assessment criteria for the production of improved common bean varieties. Furthermore, as noted by Abebe *et al.* [17] and Miruts [32], farmers preferred the common bean variety over the others due to their yield and market demand.

Table 1: Capacity building on common bean technologies

Capacity building methods	DAs			SMSs			Farmers		
	M	F	T	M	F	T	M	F	T
Training	6	-	6	6	-	6	30	13	43
Mini-field day	6	-	6	6	-	6	28	13	41

DAs, Development Agents; SMSs, Subject Matter Specialists; M, Male; F, Female; T, Total

Table 2: Performance demonstrated common bean varieties

Varieties	Performances	N	Minimum	Maximum	Mean	Std. Deviation
Hegere	Pods per plant (number)	10	17.00	24.60	20.78	2.35
	Seeds per pod (number)	10	4.00	6.00	5.04	0.60
	Yield (qt/ha)	10	22.50	36.00	29.55	4.57
Duromsa	Pods per plant (number)	10	19.00	25.20	22.18	1.72
	Seeds per pod (number)	10	4.40	6.00	5.31	0.42
	Yield (qt/ha)	10	24.50	42.00	33.85	5.34
Local	Pods per plant (number)	10	16.00	20.00	17.92	1.44
	Seeds per pod (number)	10	3.00	4.70	3.87	0.54
	Yield (qt/ha)	10	17.00	25.00	20.60	2.27

Table 3: ANOVA Result of yield (qt/ha) of demonstrated varieties

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	913.850	2	456.925	25.144	.001
Within Groups	490.650	27	18.172		
Total	1404.500	29			

Table 4: Profitability analysis of demonstrated common bean varieties

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
TR Hegere (birr/ha)	10	67500.00	108000.00	88650.0000	13701.27731
TR of Duromsa (birr/ha)	10	49000.00	84000.00	67700.0000	10677.59856
TR of local (birr/ha)	10	42500.00	62500.00	51500.0000	5676.46212
TVC for improved seed (birr/ha)	10	19040.00	23640.00	20850.0000	1499.59254
TVC for local seed (birr/ha)	10	17040.00	21640.00	18850.0000	1499.59254
TFC (birr/ha)	10	6000.00	7000.00	6200.0000	421.63702
TC improved seed (birr/ha)	10	25040.00	29640.00	27050.0000	1441.41135
TC for local variety (birr/ha)	10	23040.00	27640.00	25050.0000	1441.41135
NI of Hegere (birr/ha)	10	40410.00	81610.00	61600.0000	14265.55292
NI of Duromsa (birr/ha)	10	21910.00	54360.00	40650.0000	10612.04243
NI of local (birr/ha)	10	18760.00	34860.00	26450.0000	4482.98016

Table 5: Farmers' trait preference and rank (N=10)

Varieties	Traits							Rank
	Yield	Disease tolerance	Sweetness	Early maturity	Market demand	Total	Average	
Hegere	42	43	48	47	46	226	45.2	1
Duromsa	46	45	35	45	30	201	40.2	2
Local	28	29	35	40	35	167	33.4	3

CONCLUSION AND RECOMMENDATION

The role of new variety in crop production is highly recognized. To increase crop production different varieties were released by agricultural research center. In line with the release of varieties the demonstration of released variety on farmers' land is important. The new Hegere and Duromsa common bean varieties were demonstrated with local variety on farmers' lands. Hegere and Duromsa varieties gave better yields compared to the local variety. At the midlands of the Guji zone, the production of Hegere and Duromsa was profitable. The three most desired characteristics of the common bean variety, according to farmers

during the demonstration, were productivity, disease resistance, and market demand. Accordingly, farmers preferred the Hegere variety due to its red color despite lower yield than the Duromsa variety. Common beans of a large size and red color are in great demand on the market. Therefore, farmers should grow the Duromsa variety for domestic use and the Hegere variety for the local market. Hegere and Duromsa should be scaled out to large areas in the midlands of Guji zone.

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Conflict of interest

There is no conflict of interest.

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