International Journal of Agricultural and Applied Sciences, December 2025, 6(2): 1-4
https://www.agetds.com/ijaas
ISSN: 2582-8053
https://doi.org/10.52804/ijaas2025.621

Research Article

OPEN ACCESS

Adaptation of Common bean (*Pharsalus vulgaris* L.) Varieties in Kafa Zone of South Western Ethiopia

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(Received: 10/06/2025; Revised: 30/08/2025; Accepted: 20/09/2025; Published: 20/12/2025)

ABSTRACT
Common bean (*Phaseolus vulagris* L) is the second most important source of human dietary proteins and the third most important source of calories. Common bean seeds contain 20-25% proteins, much of which is made up of the storage Protein phaseolin. A field experiment was conducted on farmer's field of Gimbo district Kafa zones in the Southwest Ethiopia region (SWER). The objective of the study was to select the best-performing common bean varieties to increase productivity and production of common beans in the target areas. The treatments involved were nine improved varieties of common bean: Ibadu, Gegeba, Tatu, Omo-95, Remeda, Nasir, Tafache, SER-119, SER-125, and Local. The experiment was carried out using a randomized complete block design (RCBD) with three replications at Gimbo district in 2021 and 2022 under rain fed condition. ANOVA revealed significant differences among the varieties (P< 0.001) for days to flowering, days to maturity, plant height, the number of pods per plant, the number of seed per pod and grain yield. However, the variety x year's interaction was no significant for all traits which implies the durability of varieties in each year. Among the tasted varieties Gegeba (77.66 days) was early maturing type. Variety, Tatu was observed as dwarf type (37.46 cm tall) which used for logging sensitive areas. The highest grain yield quintal per hectare was harvested from variety SER-119 (32.25qtl/ha), followed by varieties, Ibado (30.69 qtl/ha), Nasir (30.59 qtl/ha) and SER-125 (30.09 qtl/ha). Therefore, varieties SER-119, Ibado, Nasir and SER-125 was recommend as promising varieties for the study areas and areas with similar agro ecologies.
Keywords: *Adaptation, Common bean, Phaseolus vulgaris, Varieties*

INTRODUCTION
Common bean (*Phaseolus vulagris* L) is the second most important source of human dietary proteins and the third most important source of calories Bennink (2005). It is a very important legume crop grown worldwide and it is one of the most important and widely cultivated species of Phaseolus in Ethiopia (Habtamu Alemu Keba, 2018). Common bean seeds contain 20-25% proteins, much of which is made up of the storage Protein phaseolin (Ma and Y, Bliss 1978). It is grown predominantly by smallholder producers as an important food crop and source of cash. It is cultivated primarily for dry seeds, green pods (as snap beans) and green-shelled seed. It is the second most important source of human dietary proteins and the third most important source of calories (Sarikamis et al., 2009). According to Miklas et al. (2006), this crop has a high nutritional value with important protein contents (22%), minerals (calcium, copper, iron, magnesium, manganese, zinc), and vitamins necessary to warrant the food security of people in the developing countries. High in nutrients and commercial potential, the common bean holds great promise for combating hunger, increasing income and improving soil fertility. P.*vulgaris* is the most widely distributed *Phaseolus* species as it is grown across all the continents with a broad range of adaptation to various environmental conditions (Wondimu et al., 2022). There are wide range of common bean types grown in Ethiopia, including mottled, red, white and black varieties (Ali K, et al., 2003). The most commercial varieties are pure red and pure white color beans and these are the most commonly grown types with increasing market demand (Ferris S, et al., 2008). Common bean production is heterogeneous in terms of ecology, cropping system and yield (Simane B, et al., 1998). It grows in most of the agro-ecology zones of low and mid-altitude areas of the country. Common bean is very favored by Ethiopian farmers because of its fast-maturing uniqueness that enables households to get cash returns essential to pay for food and other household needs when other crops have not yet matured (Legesse et al., 2006).

The land area for common bean production in Ethiopia by 2014 was 323,318 ha, and it was reduced to 311,583 ha by 2020. Even though the area coverage is reduced by 4%, the total crop production increased from 51,373 ton to 55,256 ton (CSA, 2021). Improvement of common bean in the country is influenced by both abiotic and biotic factors (Demelash, 2018). In case of SNNPR, the production is 1,615,813.99 quintals in 102836.43 hectare of land with an average yield 15.71 qtl/ha which is low compared to national yield (CSA, 2018). This increase was attributed to the productivity level of common bean grain yield, which was improved relative to the actual land area harvested to 1.8 t/ha (CSA, 2021). However, the grain yield obtained under farmers' field is far below the corresponding grain yield (3/ t ha) recorded at the research stations (Ministry of Agriculture and Natural Resource, 2016). This indicates, that the yield difference between the farmers' and the research-based practices is about 1.2 t /ha against the potential grain yield of 3.5 t /ha reported by different investigators in Ethiopia (Mohammed and Feleke, 2022).

Agroecologies of Kafa zone Gimbo district, is suitable for growing of common bean at south-western Ethiopia. However, the lack of improved varieties of common bean is the major constraint that plays a great role for low yield of the common bean in the study area. Therefore, there is need to introduce improved common bean varieties to the target area is paramount to come up with improved productivity and production of common bean in the study area. So, this research was initiated to select the best-performing common bean varieties in the study area. Therefore, to boost and improve the production of common bean in study area, nationally released varieties were evaluated for grain yield and for their adaptability.

MATERIALS AND METHODS

Description of the experimental area

The study was carried out in two seasons in Gimbo (Kichib kebele) on the farm. Gimbo district is located 400 km south of Addis Ababa, the site situated at 7° 20′ 52''N latitudes and 36° 10′ 38″ longitudes with altitude of 1450 M.A.S.L.The district receives a maximum and minimum temperature of 25^{0}c and 14^{0}c respectively whereas the annual rainfall ranged 1735-2545^{0}c.

Experimental materials and design

Nine improved common bean varieties (Tatu, Omo-95, Gegeba, Ibadu, Nasir, SER-119, Tafache, Remeda and SER-125) and one local check were used in this study. The design of the experiment was randomized complete block design (RCBD) with three replications second week of July in 2021 and 2022 cropping seasons on the farm of the district, which is the main cropping season. The plot size was 2 x 2.4 m (having 6 rows with harvestable plot size of 1.6 x 2 m and a spacing of 0.40 m between rows and 0.10 m between plants were maintained. 1.50 m between replications, 1 m between blocks and leave 0.50m between plots within each block. 100 kg of NPS fertilizers was applied at sowing time. Management practices were done uniformly for all plots as per of national recommendations.

Data collection

Phonological parameters such as days to flowering and days to maturity were recorded. Days to flowering was recorded by counting the number of days after emergence when 50% of the plants per plot had the first open flower. Days to maturity was recorded when 90% of pods matured per plot. Five plants were randomly selected from the four central rows to determine plant height and yield components like pods per plant and seed per pod the first and sixth rows excluded from the data for the border effect. Four central rows were harvested for the determination of grain yield and adjusted to 12% moisture content.

Data Analysis

All the collected agronomic data were subjected to the analysis of variance (ANOVA) using the statistical Software program of R, version 3.3.4. Mean separation was carried out to determine significant differences Among varieties using Fisher's Least Significant Difference (LSD) test at 5% probability level, and Coefficient of Variance (C.V) was calculated to reveal the relative measure of variation that exists within the data.

RESULTS AND DISCUSSION

Combined ANOVA showed the mean square value was highly significant to very highly significant (0.01 to 0.001) for all of the traits under the study which implies the presence of differences among the varieties. Days to 95% physiological maturity, number of pods per plant and seed yield showed significant, highly significant and very highly significant differences in year, which implies the presence of seasonal variation among successive years at the same location (Table 1).

The maximum numbers for days to 50% flowering was recorded from varieties Nasir (48.16), local (47.66), (SER-119 (47), SER-125 (47) and followed by varieties, Omo-95 (44.16), local (66.66), Remeda (44), Ibado (43.66), Tafach (43.16), Gegeba (42.66) and Tatu (41.83). statistically no difference among them. Which is to mean that tested varieties were grouped in to two based flowering days i.e., late flowering and early flowering types were observed in this study.

Varieties Omo-95 (85.33) and SER-119 (85.16) took maximum days for maturity, followed by varieties, SER-125 (82.83), Nasir (82.83b), Tatu (82.5), Remeda (82.50) and Ibado (80.83). On the other hand, varieties Gegeba (77.66) and Tafache (78.5) took the minimum days for 95% physiological maturity.

Examined varieties were significantly different with plant height (Table 2). The maximum plant height was obtained from varieties SER-119 (58.33 cm), Omo-95 (57.46 cm), Remeda (57.16 cm) and SER-125 (54.33 cm) followed by Nasir (50.43 cm) and local (49.66 cm). Whereas, the minimum plant height was obtained from Tatu (37.46 cm) variety. This mean that, Tatu variety was the only dwarf type included in this experiment.

There was significant different among studied common bean varieties besides number of pods per plant. In current investigation, the number of pods per plant ranged from 9.53 (Tafache) to 20.56 (SER-119). More numbers of pods per plant was counted from variety SER-119 (20.56) and followed by varieties local (19.40), Nasir (18) and SER-119 (17.80). On other side, minimum number of pods per plant was counted from variety, Tafache (9.53).

The highest number of seeds pod was counted from varieties local (4.91), SER-119 (4.83), Omo-95 (4.75), Nasir (4.73) and SER-125 (4.60) followed by Remeda, (4.20) variety. The list number of seeds per pod was recorded from variety Ibado (3.58). The maximum grain yield quintal per hectare was harvested from varieties, SER-119 (32.25 qtl/ha) or yield advantage (21%) over the check, Ibado (30.69 qtl/ha), (15.55%) yield advantage over the local check. Nasir (30.59 qtl/ha), (16.27%) yield advantage over the local check and SER-125 (30.09 qtl/ha), (15%) yield advantage over the local check followed by Remeda (28.74 qtl/ha), Gegeba (26.84 qtl/ha), Tatu (26.70 qtl/ha) varieties. The list yield was harvested from Tafache (21.60 qtl/ha) and local (25.61 qtl/ha) varieties (table 2). Firdisa, G. et al., (2024) conducted experiment on different common bean varieties and reported the highest yield from SER 119.

Table 1. Mean square values of combined ANOVA for grain yield and related traits of common bean varieties from 2021 and 2022 cropping season at Gimbo.

SOV	DTF	DTM	PH	NPPP	NSPP	SYLD
Year	17.06	138.01*	22.08	310.08**	0.77	227.68***
Rep	18.21	7.66	91.53	28.04	0.25	12.176
Variety	31.60**	38.03***	344.55**	92.73***	1.40**	72.92***
Var*year	7.88	3.38	7.55	2.963	0.13	9.553
Error	5.12	3.51	18.80	9.68	0.15	12.23

Where, SOV=source of variation, DTF=days to flowering, DTM= days to maturity, PH= plant height, NPPP= number of pod per plant, NSPP= number of seed per pod, YLD (kg/ha-1 = yield in kilogram per hectare, NS= Non-significant, *= Significant at the 0.05 level, **=significant at 0.01 level, *** =significant at 0.001 level.

Table 2. Mean performance of 10 common bean varieties for yield and yield attributing traits tested at Gimbo in the 2021 and 2022 cropping seasons

Variety	*DTF*	*DTM*	*PH*	*NPPP*	*NSPP*	*YLD(qtha-1)*
SER-125	47.00a	82.83b	54.33ab	17.80ab	4.60ab	30.09ab
SER-119	47.00a	85.16a	58.33a	20.56a	4.83a	32.25a
Gegeba	42.66b	77.66d	42.93c	10.73d	3.90cd	26.84bcd
Tatu	41.83b	82.50b	37.46d	10.83d	3.80cd	26.70bcd
Ibado	43.66b	80.83b	42.73c	12.76cd	3.58d	30.69ab
Omo-95	44.16b	85.33a	57.46a	16.00bc	4.75a	23.08de
Remeda	44.00b	82.50b	57.16a	15.83bc	4.20bc	28.74abc
Tafache	43.16b	78.50cd	41.80cd	9.53d	4.08c	21.60e
Nasir	48.16a	82.83b	50.43b	18.00ab	4.73a	30.59ab
Local	47.66a	80.66bc	49.66b	19.40ab	4.91a	25.61cde
Means	44.93	81.88	49.23	15.14	4.34	27.62
LSD (P≤ 0.05)	5.03	2.29	8.80	20.54	8.95	12.66

DTF=days to flowering, DTM= days to maturity, PH= plant height, NPPP= number of pod per plant, NSPP= number of seed per pod, YLD (qtl/ha) = yield in quintal per hectare,

CONCLUSION

The adaptability potential of nine improved varieties and one local check was evaluated for yield and yield-related traits. The ANOVA result of the vegetative, yield and yield-related data revealed that significant differences were observed for all studied traits. However, the variety x year's interaction was not significant for all traits which implies the durability of varieties in each year. Among the tasted varieties, Gegeba (77.66) was early early-maturing type. Variety, Tatu was observed as a dwarf type (37.46), which is used for logging-prone areas.

The highest grain yield quintal per hectare was harvested from variety SER-119 (32.25qtl/ha), followed by varieties, Ibado (30.69 qtl/ha), Nasir (30.59 qtl/ha) and SER-125 (30.09 qtl/ha). Therefore, varieties SER-119, Ibado, Nasir and SER-125 were recommended as a promising variety for the study areas and areas with similar agroecologies.

CONFLICT OF INTEREST

The author here declares there is no conflict of interest in the publication of this article.

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Citation: Tesfaye Tarekegne, Tesfaye Belay and Awol Beshir *2025.* Adaptation of Common bean (*Pharsalus vulgaris* L.) Varieties in Kafa Zone of South Western Ethiopia. *International Journal of Agricultural and Applied Sciences, 6*(2): 1-4. https://doi.org/10.52804/ijaas2025.621