Trends in
Agricultural
Sciences

OPEN ACCESS

Participatory Evaluation and Adaptation Trial Linseed (*Linum usitatissimum* L.) Varieties in Siltie, Hadiya, and Gurage Areas of Central Ethiopia Region

[1]Mukerem Elias, [1]Shimelis Mohammed, [1]Muhammed Sitote and [2]Agdew Bekele

[1]Worabe Agricultural Research Center, Central Ethiopia Agricultural Research Institute, Pulse Crop Breeding Researcher, P.O. Box 21, Worabe, Ethiopia

[2]Southwest Rural Electric Association, Resilient Agriculture for Inclusive and Sustainable Ethiopian Food System South Coordinator, Ethiopia

ABSTRACT

Background and Objective: Using improved linseed variety is crucial for boosting crop production and productivity. Even though several linseed varieties were released, farmers did not utilize improved linseed varieties. This study aimed to assess and suggest the best-performing and high-yielding linseed varieties. **Materials and Methods:** The experiment was carried out for two years (2021-2022) in Silti, Lemo, and Cheha Districts. This experiment included ten linseed varieties: Bekoji-14, Yedeno, Kassa-2, Jeldu, Bakalcha, CI-1525, Kulumsa, Tolle, Chilalo, and local. A randomized complete block design with three replications was used and agronomic and farmer preference data were collected. The data was analyzed using SAS software version 9.0. **Results:** The significant variation for all traits among those linseed varieties. The Chilalo, Bekoji-14, Kassa-2, and Yadeno cultivars had the highest average yield across locations, measuring 1.83, 1.81, 1.71, and 1.69 ton/ha, respectively. Chilalo, Bekoji-14, Kassa-2, and Yadeno types also provided a yield advantage of 38.25 to 50% over the local variety. In the districts of Silti, Lemo, and Cheha, respectively, the Yadeno, Bekoji-14, and Chilalo varieties produced the highest yield than the local variety. The farmers particularly favored the Chilalo and Bekoji-14 varieties. **Conclusion:** Bekoji-14, Yadeno, and Chilalo cultivars produced higher yields and were preferred by farmers in the research area. Pre-extension and demonstration approaches should be used to broaden those varieties for testing in similar agro-ecological zones based on the farmer's selection and yield potential.

KEYWORDS

Linum usitatissimum L., yield advantage, growth performance, linseed varieties, farmer's preferred

INTRODUCTION

Linseed (*Linum usitatissimum* L.), a diploid with 2n = 30 chromosomes, belongs to the Linaceae family. Ethiopia is a secondary center of diversity of linseed. It is an annual, self-pollinated crop[1,2]. Linseed offers a variety of nutritional properties that offer health benefits to both humans and animals. It contains eight important amino acids, including isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. It also has carbs, vitamins, minerals, and crude fiber, and it is the best natural

ISSN: 2957-9449 (Online)
ISSN: 2957-9430 (Print)
https://doi.org/10.17311/tas.2025.60.65

Received: 11 Nov. 2024
Accepted: 17 Mar. 2025
Published: 30 Mar. 2025

source of omega-3 and omega-6 fatty acids[3]. Omega-3 fatty acid (alpha-linolenic acid) acts as a substrate for the production of longer-chain polyunsaturated fatty acids, which alter the biophysical properties of the cell membrane and are essential for appropriate cell function[4]. According to Amare and Abebe[5], the Ethiopian Agricultural Research System has registered more than 19 improved linseed varieties. Farmers do not produce well-performing, high-yielding linseed varieties. A high yield gap existed between the released varieties potential and the national average (1.1 ton/ha) of 0.45 ton/ha[6]. In farmers' practices, linseed is grown on marginal land (because it is not suitable for other crops), proper agronomic practices are not implemented, and linseed is generally regarded as a fill crop. As a result, the dissemination and adoption of released varieties have remained slow[7]. The evaluation released on the released varieties across specific locations involving farmers is important. Farmers' participation in varietal selection gives enough exposure to novel varieties and a high rate of replacement, as well as a strong extension network that provides farmers. Therefore, the objective of this proposal was to evaluate and recommend the best-performing and high-yielding linseed varieties based on farmers' perspectives and to create awareness and get feedback about well-adopted linseed varieties.

MATERIALS AND METHODS

Description of experimental sites: The experiment was carried out in 2022 in the Silti, Lemo, and Cheha Districts of Central Ethiopia. One kebele from each district was randomly selected through communication with woreda and Kebele experts. The description of the experimental site is given in Table 1.

Experimental design: Mother and baby trial fashion in which all materials were designed in Randomized Complete Block Desig (RCBD) with three replications in the Mother Trial and one replication of 10 materials grown on an individual farmer's farm. Bekoji-14, Yedeno, Kassa-2, Jeldu, Bakalcha, CI-1525, Kulumsa, Tolle, Chilalo, and one local cultivar were used. The varieties were obtained from Holleta Agricultural Research Centre. The plot for each material is 1.2 by 3 m with between-row and plant spacing of 20 and 5 cm, respectively. Due to the small seed size, sowing was implemented by drilling the seed in the row, and seedlings were thinned to the spaced between plant spacing.

The yield advantage of improved linseed varieties over the local variety is calculated as divided by the yield of the local variety[8].

$$\text{Yield advantage (\%)} = \text{Yield of improved linseed variety-Yield of local variety} \times 100$$

Thirty farmers (15 male and 15 female) participated in the selection of linseed varieties at those locations. Awareness was created about the importance of linseed production for those farmers. After awareness creation, farmers settled on criteria to select linseed varieties for future production. Growth performance, capsule number, branches, and yield are the criteria for selecting those linseed varieties settled by the farmers. Those farmers were given scores from 1 to 5 on each attribute of the crop, where 1 = Very poor, 2 = Poor, 3 = Good, 4 = Very good, and 5 = Excellent for those linseed variety selections based on the settled criteria. Finally, each value was added and divided by the number of the parameters based on[9].

Statistical analysis: In this study, data were collected from four central rows and one plot as well as the plant based on the following variables: Plant height, number of capsules per plant, number of seeds per capsule, number of branches per plant, biomass, and hectare yield. The agronomics was analyzed using SAS software version 9.0, and means were compared with LSD of 1 and 5% levels of significance.

Table 1: Description of the experimental sites

Region	Districts	Altitude (m.a.s.l)	Latitudes	Longitudes
Central Ethiopia	Silti	2129	0°00'16'N	38°11'29"E
Central Ethiopia	Lemo	2416	7°39'03"N	37°53'23"E
Central Ethiopia	Cheha	2655	8°03'00"N	38°01'01"E

RESULTS AND DISCUSSION

The analysis of variance by location (Table 2) revealed a significant difference in plant height, capsules per plant, and seeds per capsule, as well as a highly significant difference in the number of branches per plant, biomass, and yield. Six improved linseed varieties gave a better yield than the Silti District. Jeldu, CI-1525, and Bakalcha varieties had lower yields than the local varieties in this district (Table 3). This showed that demonstrating any of the varieties for this location would be successful. In the Lemo district, the Bekoji-14 and Kassa-2 varieties produced more than the others (Table 4). In Cheha district, the chilalo variety had the highest yield of the other varieties (Table 5). This finding was consistent with Terfa and Gurmu[10]. Lea and Belay[11] and Paul *et al.*[12] found substantial differences across linseed types in plant height, capsule number per plant, and yield similar to this finding. These varieties differ by location, thus specific recommendations should be provided. Similarly, Gauch and Zobel[13] reported linseed genotype performance varies across locations.

The yield advantage of those varieties in Lemo District over the local variety ranged from 5.34 and 46.56%. Similarly, some varieties had yield advantages ranging from 8.27% (Bakalcha) to 47.37% (Chilalo) in Cheha District. In the Silti woreda, almost all enhanced linseed types yielded more than the indigenous variety. The yield advantages of those types over local variety ranged from 76.47% (CI-1525) to 127.45% (Yadeno), indicating that all tested varieties outperformed local ones (Table 6). Merga *et al.*[14] conducted an experiment on linseed varieties and reported that the yield of linseed varieties ranges from 1.36 to 1.61 ton/ha, the yield advantage of improved varieties ranges from 5.4 to 18.31% over local varieties, and the Yadeno variety yielded the most among the tested varieties, which is consistent with this finding. In contradiction with this study, Sileshi *et al.*[15] reported a higher yield for the kasa-2 variety.

Table 2: Mean square values of linseed agronomic traits over location

Sources of variation	PH	CP	SPC	BR	BM	GY
Location	4026.41**	685.07**	4.66**	22.53**	15.36**	306.54**
Variety	102.48*	57.35**	1.52*	2.99**	0.70**	31.88**
Replication (location)	431.13	157.05	3.19	2.74	1.61	8.42
Location×Variety	75.03*	23.46*	1.43*	1.55**	0.59**	29.97**
Error	40.93	11.43	0.66	0.42	0.08	3.78
CV (%)	6.34	12.15	11.47	11.38	7.94	12.31

**Highly Significant at p≤0.01, *Significant at p≤0.05, PH: Plant height, CP: Capsule per plant, SPC: Seed per capsule, BR: Branch per plant, BM: Biomass and GY: Grain yield

Table 3: Mean performances of yield and yield related traits for linseed varieties at Silti District

Varieties	PH (cm)	CP (No.)	SPC (No.)	BR (No.)	BM (kg)	GY (ton/ha)
Bekoji-14	98.9^{ab}	26.5^{a}	7.5	5.1	4.1^{ac}	1.96^{ab}
Yedeno	93.9^{b}	24.0^{ab}	7.2	6.0	4.4^{ab}	2.32^{a}
Kassa-2	100.5^{a}	19.0^{c}	6.6	6.0	4.5^{a}	2.18^{ab}
Jeldu	98.1^{ab}	19.7^{bc}	7.2	5.6	4.2^{ac}	2.09^{ab}
Bakalcha	94.9^{ab}	24.6^{a}	7.1	5.8	3.9^{bc}	1.83^{b}
CI-1525	95.5^{ab}	19.3^{c}	6.4	5.0	4.2^{ac}	1.80^{b}
Kulumsa	92.9^{b}	26.2^{a}	7.8	5.5	4.6^{a}	1.94^{ab}
Tolle	93.3^{b}	18.4^{c}	6.4	5.5	4.2^{ac}	2.22^{ab}
Chilalo	95.5^{ab}	24.7^{a}	7.0	5.3	4.7^{a}	2.07^{ab}
Local	83.5^{c}	24.1^{ab}	8.0	7.0	3.7^{c}	1.02^{c}
CV (%)	4.0	11.4	17.4	13.7	8.1	13.00
LSD (0.05)	6.5**	4.4**	NS	NS	0.6*	4.3**
GM (ton/ha)	94.7	22.7	7.1	5.7	4.2	1.9

*Significant variation at 0.05%, **Significant variation at 0.01%, small letters level of significant difference within two treatments (similar letter indicates no significant variation among the treatments), PH: Plant height, CP: Capsule/plant, SPC: Seed/capsule, BR: Branch/plant, BM: Biomass and GY: Grain yield

Table 4: Mean performances of linseed varieties for yield and yield related traits at Lemo District

Varieties	PH (cm)	CP (No.)	SPC (No.)	BR (No.)	BM (kg)	GY (ton/ha)
Bekoji-14	115.3	35.7^{a}	7.8^{ab}	6.7^{b-d}	1.8^{d}	1.92^{a}
Yedeno	111.3	30.0^{cd}	6.9^{cd}	5.8^{cd}	3.5^{b}	1.49^{bc}
Kassa-2	109.3	31.7^{a-d}	7.8^{ab}	6.3^{b-d}	2.6^{c}	1.67^{ab}
Jeldu	118.3	27.7^{d}	7.2^{b-d}	5.6^{d}	4.1^{a}	0.88^{de}
Bakalcha	121.7	31.3^{a-d}	6.5^{d}	7.0^{a-c}	2.5^{c}	1.18^{cd}
CI-1525	105.3	34.7^{ab}	8.0^{ab}	7.5^{ab}	2.7^{c}	0.70^{e}
Kulumsa	118.0	30.7^{b-d}	7.5^{bc}	5.8^{cd}	2.9^{c}	1.44^{bc}
Tolle	113.3	30.7^{b-d}	7.4^{b-d}	6.8^{a-c}	2.7^{c}	1.38^{bc}
Chilalo	111.3	33.0^{a-c}	6.7^{cd}	6.0^{cd}	2.6^{c}	1.46^{bc}
Local	111.0	35.3^{a}	8.6^{a}	8.0^{a}	2.7^{c}	1.31^{c}
CV (%)	7.5	8.1	7.1	10.5	11.2	15.70
LSD (0.05)	NS	4.4*	0.9**	1.2**	0.5**	3.6**
GM (ton/ha)	135.5	32.1	7.6	6.6	2.8	1.30

*Significant variation at 0.05%, **Significant variation at 0.01%, small letters level of significant difference within two treatments (similar letter indicates no significant variation among the treatments), PH: Plant height, CP: Capsule/plant, SPC: Seed/capsule, BR: Branch/plant, BM: Biomass, and GY: Grain yield

Table 5: Mean yield and yield related traits performances of linseed varieties at Cheha district

Varieties	PH (cm)	SPC (No.)	CP (No.)	BR (No.)	BM (kg)	GY (ton/ha)
Bekoji-14	89.5^{b-e}	7.7^{a}	33.00^{a}	4.8^{b-d}	3.63^{b}	1.56^{b}
Yedeno	91.4^{a-e}	6.9^{bc}	24.77^{bc}	4.5^{b-e}	3.67^{b}	1.25^{e}
Kassa-2	98.5^{a-c}	5.5^{e}	19.93^{c}	4.2^{ed}	3.73^{b}	1.27^{e}
Jeldu	94.3^{a-d}	5.7^{de}	29.71^{ab}	3.9^{e}	3.23^{c}	1.30^{e}
Bakalcha	101.5^{a}	7.4^{ab}	35.17^{a}	5.1^{bc}	3.37^{c}	1.47^{bc}
CI-1525	99.6^{ab}	5.6^{e}	27.93^{ab}	7.5^{a}	4.17^{a}	1.58^{b}
Kulumsa	92.0^{a-e}	6.3^{cd}	27.67^{a-c}	3.9^{e}	3.37^{c}	1.30^{e}
Tolle	85.9^{de}	7.9^{a}	30.37^{ab}	4.4^{c-e}	2.97^{d}	1.44^{cd}
Chilalo	88.9^{c-e}	6.8^{c}	28.53^{ab}	4.9^{b-d}	3.80^{b}	1.96^{a}
Local	81.9^{e}	6.8^{c}	30.60^{ab}	5.2^{b}	2.87^{d}	1.33^{de}
CV (%)	6.6	5.8	15.59	8.6	3.76	4.60
LSD	10.4*	0.7**	7.84	0.7**	0.22	1.14
GM	92.4	6.7	27.77	4.8	3.48	1.44

*Significant variation at 0.05%, **Significant variation at 0.01%, small letters level of significant difference within two treatments (similar letter indicates no significant variation among the treatments), PH: Plant height, SPC: Seed/capsule, CP: Capsule/plant, BR: Branch/plant, BM: Biomass and GY: Grain yield

Table 6: Yield advantages of improved linseed varieties with over local variety for individual locations

	Lemo		Silti		Cheha	
Varieties	GY (ton/ha)	Yield advantage (%)	GY (ton/ha)	Yield advantage (%)	GY (ton/ha)	Yield advantage (%)
Bekoji-14	1.92	46.56	1.96	92.16	1.56	17.29
Yedeno	1.49	13.74	2.32	127.45	1.25	-6.02
Kassa-2	1.67	27.48	2.18	113.73	1.27	-4.51
Jeldu	0.88	-32.82	2.09	104.90	1.30	-2.26
Bakalcha	1.46	11.45	1.83	79.41	1.47	10.53
CI-1525	0.70	-46.56	1.80	76.47	1.58	18.80
Kulumsa	1.44	9.92	1.94	90.20	1.30	-2.26
Tolle	1.38	5.34	2.22	117.65	1.44	8.27
Chilalo	1.18	-9.92	2.07	102.94	1.96	47.37
Local	1.31	-	1.02	-	1.33	-

GY: Grain yield

On average yield across all tested locations, all improved linseed varieties had given higher yield than the local variety, with the yield advantage ranging from 11.48 to 50.00%. Chilalo and Bekoji-14 varieties had given a higher yield advantage than other varieties across all tested locations (Table 7). Farmer preference data indicated that the Chilalo variety had the highest score of 4.7 (excellent), followed by the Bekoji-14 and Yadeno varieties farmers also selected this Yadeno variety (Table 8). Abebe *et al.*[16] also conducted research on linseed varieties at the West Arsi Zone of Oromiya and reported a 43.5-143.5% yield advantage over local varieties. In the case of Kulumsa-1 and Kuma variety, the contradicting result was reported.

Table 7: Yield advantage of improved linseed varieties with over local variety across all locations

Varieties	Average yield (ton/ha)	Yield advantage (%)
Bekoji-14	1.81	48.63
Yedeno	1.69	38.25
Kassa-2	1.71	39.89
Jeldu	1.42	16.67
Bakalcha	1.49	22.13
CI-1525	1.36	11.48
Kulumsa	1.56	27.87
Tolle	1.68	37.70
Chilalo	1.83	50.00
Local	1.22	-

Table 8: Farmer's preference data on linseed varieties

Varieties	Bakalcha	Bekoji-14	Chilalo	CI-1525	Jeldu	Kassa-2	Kulumsa-1	Local	Tolle	Yedeno
Growth performance	4.2	4.3	4.6	3.8	2.8	2.4	3.9	2.5	3.7	4.4
Capsule per plant	4.3	4.5	4.6	3.3	3.2	2.4	3.5	2	4.2	4.3
Branch per plant	3.7	4.1	4.7	3.7	2	2.9	3	4.2	3.8	3.6
Yield	3.3	4.3	4.9	3.5	2	2.6	3.3	2.2	3.5	4.2
Average	3.9	4.3	4.7	3.6	2.5	2.6	3.4	2.7	3.8	4.1
Rank	5	2	1	6	9	10	7	8	4	3

Linseed productivity was one of the most significant gaps in the Central Ethiopia Region. One method for increasing crop production and productivity is to use better varieties. The result implies that some of the improved linseed types were well adapted to the location, preferred by farmers, and gave higher yields than the indigenous variety. The farmer selected the Bekoji-14, Chilalo, and Yadeno varieties due to their yield. The demonstration of those varieties with different farmers with large plot areas is critical for further enhancing production and productivity. Therefore, pre-extension and demonstration approaches should be used to broaden those varieties for testing in similar agroecological zones based on the farmer's selection and yield potential. Since the study was focused on the production component, further research on the consumption of linseed in the area is needed.

CONCLUSION AND RECOMMENDATION

Linseed varieties had significant variation for different traits across locations. Bekoji-14 and Kassa-2 at Lemo woreda, Chilalo at Cheha woreda, and Yadeno at Silti woreda gave higher yield and yield advantage over local variety. Farmers selected Chilalo, Bekoji-14, and Yadeno varieties based on settled criteria. Therefore, based on the analyzed result and farmers preferences, Chilalo, Bekoji-14, and Yadeno varieties will be demonstrated in the future for all tested and similar agro-ecological areas through pre-extension and demonstration.

SIGNIFICANCE STATEMENT

Limited production and productivity of linseed is the major problem in the Central Ethiopia Region. Improved linseed varieties, such as Bekoji-14, Yadeno, and Chilalo, have high yields and are preferred by farmers in the Central Ethiopia Region. Despite this, farmers in the study area continue to produce local varieties, which are low-yielders compared to improved linseed varieties. Demonstrating these varieties in tested and similar agro-ecologies will increase production and productivity.

ACKNOWLEDGMENTS

The author acknowledges Central Ethiopia Agricultural institution and Worabe Agricultural Research Center (WARC) for facilitating the activity, Holleta Agricultural Research Center (WARC) for providing those linseed varieties. I also thanks to all researchers and technical assistants for their contributions.

REFERENCES

1. Hall, L.M., H. Booker, R.M.P. Siloto, A.J. Jhala and R.J. Weselake, 2016. Flax (*Linum usitatissimum* L.). In: Industrial Oil Crops, McKeon, T.A., D.G. Hayes, D.F. Hildebrand and R.J. Weselake (Eds.), Elsevier, Amsterdam, Netherlands, ISBN: 978-1-893997-98-1 pp: 157-194.
2. Tadesse, T., A. Parven, H. Singh and B. Weyessa, 2010. Estimates of variability and heritability in linseed germplasm. Int. J. Sustainable Crop Prod., 5: 8-16.
3. Chetana, M.L. Sudha, K. Begum and P.R. Ramasarma, 2010. Nutritional characteristics of linseed/flaxseed (*Linum usitatissimum*) and its application in muffin making. J. Texture Stud., 41: 563-578.
4. Zuk, M., D. Richter, J. Matuła and J. Szopa, 2015. Linseed, the multipurpose plant. Ind. Crops Prod., 75: 165-177.
5. Amare, K. and G. Abebe, 2022. Variability and performance evaluation of released linseed varieties for yield and related traits in South Gondar Zone, Ethiopia. Int. J. Agron., Vol. 2022. 10.1155/2022/4805942.
6. Hailu, D. and R. Gidey, 2022. Potential for oil seed crops production increase in Ethiopia through closure of existing yield gaps. Int. J. Agric. Econ., 7: 227-231.
7. Ayenew, A., D. Bikis, S. Sharie, Y. Taye and Z. Addisu, 2023. Participatory variety selection of Fababean (*Vicia faba* L.) for yield and yield components in Gunabegemidir District, North Western Ethiopia. Sci. Dev., 4: 63-70.
8. Aslam, M., M.A. Akhtar, M. Yaseen, M.A. Maqbool, W. Akbar and J. Ramzan, 2022. Bio-stimulation and yield responsiveness in maize. Pak. J. Bot., 54: 553-561.
9. Joshi, A., S. Kale, S. Chandel and D.K. Pal, 2015. Likert scale: Explored and explained. Br. J. Appl. Technol., 7: 396-403.
10. Terfa, G.N. and G.N. Gurmu, 2020. Genetic variability, heritability and genetic advance in linseed (*Linum usitatissimum* L.) genotypes for seed yield and other agronomic traits. Oil Crop Sci., 5: 156-160.
11. Lea, D. and T. Belay, 2021. Adaptation of improved linseed (*Linum usitatissimum* L.) varieties for seed yield in Kafa and Benchmaji Zones of South Western Ethiopia. Asian J. Plant Sci. Res., 11: 30-32.
12. Paul, S., P. Satasiya and A. Kumar, 2020. Genetic variability, correlation and path coefficient analysis of introduced genotypes of linseed (*Linum usitatissimum* L.) in mid-hills of North-West Himalayas. J. Pharmacogn. Phytochem., 9: 1189-1192.
13. Gauch, H.G. and R.W. Zobel, 1997. Identifying mega environments and targeting genotypes. Crop Sci., 37: 311-326.
14. Merga, M., W. Mekasa and K. Mammo, 2023. Evaluation of linseed (flax seed) varieties. J. Innovative Agric., 10: 9-15.
15. Sileshi, Y., M. Hailemariam, B. Atero and A. Tesfaye, 2020. Linseed (*Linum usitatissimum* L.) variety adaptation at South Western Ethiopia. Int. J. For. Hortic., 5: 41-45.
16. Abebe, S., M. Gichamo, A. Doda and B. Sime, 2022. Participatory evaluation of Linseed (*Linum usitatissimum* L.) varieties under farmers training center at Dodola District of West Arsi Zone, Oromia Regional State, Ethiopia. Open J. Plant Sci., 7: 014-019.