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Revitalizing Linseed in Paddy Fallow Area of Eastern Vidarbha for Sustainable Growth: The Impact of Cluster Demonstrations and Value-Added Chain Development

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ABSTRACT

An 8 lakh hectare paddy area remains fallow in Rabi sesason in eastern Vidarbha due to cultivation of long duration paddy varieties, poor fertility status of soil, water logging, excessive moisture in lowland area and lack of irrigation. The residual moisture left in soil after harvest of paddy is often sufficient to raise linseed. Linseed is a traditional oilseed crop that plays a major role in increasing the income of small and marginal farmers in the paddy fallow area of the eastern Vidarbha region of Maharashtra during the Rabi season. All India Coordinated Research Project on Linseed, College of Agriculture, Nagpur organized training programs, cluster demonstrations under irrigated and rainfed situations in paddy fallow area and field days for 234 and 295 linseed growers during 2022-23 and 2023-24. The cluster demonstration of linseed with a varietal introduction along with the whole package of an improved package of practices like the adoption of high-yielding variety PKV NL-260, line sowing or sowing with zero till seed drill, improved seed rate @ 15 kg/ha, seed treatment with bio-mix consortium, irrigation at critical growth stages @ 40-45 DAS and 65-70 DAS, integrated nutrient and weed management practices, plant protection practices after undergoing the training. The farmers under medium and higher level of knowledge groups increased from 25 to 52% and from 15 to 33%, respectively. The adoption level in medium level and high level were increased from 16 to 60% and 10 to 18%, respectively. Further, farmers with low levels of adoption declined from 74 to 22%. The two-year data revealed the yield of linseed increased to 34.40% over the yield obtained under farmer's practices. The results also showed that due to enhanced knowledge and adoption of an improved package of practices, the yield of linseed variety increased by 6% during the second year (2023-24) as compared first year (2022-23) over the yield obtained under farmers' practices. The linseed seed yields 31.10% and 37.57% higher yield over the local variety and improper management practices used by farmers during 2022-23 and 2023-24. The average extension gap (162 kg/ha), technology gap (263 kg/ha) and technology index (29.24%). The reduction technology gap and index were 92 kg/ha and 10.27% showing that the feasibility to the adoption of a demonstrated improved package of practices for linseed cultivation in paddy fallow area was found productive and economically viable as compared to existing farmer practices. The results clearly indicate that the intervention of an improved package of practices of linseed cultivation through cluster demonstration in the paddy area of eastern Vidarbha had a significant positive impact on the adoption of improved practices enhanced yield potential of linseed to greater extent and development of value addition chain helpful for the income level of the farming community which helps in uplifting the socio-economic level of farmers. This study suggests the need of conducting of cluster demonstrations, intensive trainings and intervention of improved technology to educate the linseed growers for achieving higher production of linseed and development of value additional chain in the approximately 8 lakh hectare paddy fallow area in eastern region of Vidarha during rabi season.

Keywords: *Adoption, Knowledge, Impact, Linseed, Seed yield, Paddy fallow area, Vidarbha, Extension gap, Technology Gap and Technology index.*

INTRODUCTION

Linseed was the traditional oilseed crop of Vidarbha but in the intervening period, the crop became near to extinct due to changing cropping systems. Before three decades it was grown in eastern, central and western Vidarbha. At that time Maharashtra ranked second in India with respect to area measuring 70,000 hectares which has gone down to 6000 hectares at present. The reasons behind this decreasing area are market rate, other competitive *rabi* crops and less awareness of this crop to young farmers, the occurrence of Wilt, Bud fly infestation and quality seed production. To overcome these reasons and to increase the area of linseed, the use of improved varieties with an improved package of practices are needed, breeding for resistance to wilt and bud fly infestation, increasing awareness among young farmers by conducting large number of demonstrations, creating awareness among farmers regarding the importance of crop, and development of value chain from seed to processing and thus making the cultivation of crop more remunerative and thereby moving a step forward to increase the self-sufficiency of vegetable oils in the country.

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Cluster demonstrations are an appropriate tool to demonstrate the technologies developed by NARS among the farmers. These technologies are demonstrated in the farmer's field under the guidance and supervision of a team of scientists who have developed them. ICAR-Indian Institute of Oilseeds Research, Hyderabad has been allocating demonstrations under Schedule cast Sub Plan (SCSP), Tribal Sub Plan (TSP) and Front line demonstrations to AICRP on Linseed, College of Agriculture, Nagpur. AICRP on Linseed has started the resurgence of linseed in the Vidarbha region through using high-yielding variety PKV NL-260 and improved package of practices in Cluster Demonstrations on the Farmer's field of the entire 11 districts of Vidarbha region, focusing mainly in Paddy fallow area of eastern Vidarbha where linseed can very well fit into their cropping system. A crop demonstration campaign was done to revive this crop in which the number of linseed crop demonstrations has been increased from 20 to 335 under tribal sub-scheme, scheduled caste scheme as well as front-line demonstrations on farmers' fields. Emphasis was given to farmers of Chimur, Nagbhid and Sindewahi Tahsil of Chandrapur District and Ramtek, Umred Tahsil of Nagpur District where linseed was a predominant crop earlier and now paddy is the predominant *kharif* crop and the area in *rabi* remains fallow mainly because they don't have irrigation facilities for the *rabi* crop and linseed can be an alternative crop in the paddy fallow area. The productivity level of Linseed in Vidarbha was very low (264.5Kg/ha) during *rabi* 20021-22 (3). The major reason for this can be attributed to the method sowing i.e broadcasting & timely sowing. Other reasons include use of high seed rate, growing the crop under rainfed conditions, improper crop production and protection technologies. Realizing the importance of frontline demonstrations and the technology gap in the production and protection technology of linseed along with the objectives of revival of the crop in its traditional area, AICRP on Linseed, College of Agriculture, Nagpur has conducted Cluster demonstrations at Chimur, Nagbhid and Sindewahi Tahsil of Chandrapur District and Ramtek, Umred Tahsil of Nagpur District.

MATERIALS AND METHODS

The cluster demonstrations on linseed were conducted at farmer's fields in different villages of Chimur, Nagbhid and Sindewahi Tahsil of Chandrapur District and Ramtek, Umred Tahsil of Nagpur District of Eastern Vidarbha region of Maharashtra during *Rabi* season of 2021-22 to 2023-24 in paddy fallow area under rainfed and irrigated conditions. The soils of the area under study were sandy loam to loam, poor in fertility status and water- holding capacity. During 2021-22, one days training program entitled "Improved package of practices for linseed in Eastern Vidarbha" was conducted at Pardi (T), Nagbhid Tahsil of Chandrapur in which 100 farmers participated. The training schedule was arranged for 2 to 3 hour/day by 3 to 4 experts of different fields. During *rabi* 2022-23, a total 50 demonstrations were conducted out it 20 demonstrations each conducted in Pardi (T) village of Nagbhid and Girgav village of Sindewahi Tahsil and 10 demonstrations where undertaken at Doma village, Shankarpur Mandal, Tahsil Chimur, District Chandrapur. A field day in this regard was conducted on 10th February 2023 at Doma village. Approximately 100 farmers had attended the program. An oil mill was installed by a farmer Shri. Tilakji Karkade at village Shankarpur, Tahsil Chimur, District Chandrapur. He had purchased the seeds of most of the farmers for oil extraction. Some of the farmers had extracted oil for their own consumption. Since oil is consumed by the farmers in Chandrapur, more so after corona, the crop is gathering popularity. During 2023-24, under “one village one variety concept” 130 demonstrations were distributed to the farmers in the Shankarpur Mandal, Tahsil Chimur and 50 demonstrations were distributed in Sindewahi Tahsil of District Chandrapur, by AICRP on Linseed, College of Agriculture Nagpur under SCSP, TSP and FLD schemes with the help of officials of the State Agriculture Department, Shankarpur block, Tahsil Chimur, District Chandrapur. Looking into the impact of the previous year, the Agriculture Department also distributed 50 demonstrations at Amboli, Kaparla (B) and Shankarpur. An approximate area of 240 ha of Linseed, variety PKV NL 260 was being grown in the Shankarpur Mandal of Tahsil Chimur District Chandrapur. Cluster demonstrations were conducted on linseed during 2022-23 & 2023-24 to disseminate the technologies developed and to establish production potentials on the farmer's field.

The respondents for the study were selected through an equal allocation from each tahsil using a purposive sampling technique for representing the whole area. Surveys were conducted and trainings were imparted to 20 linseed growers from each tahsil with a total sample of 100 elected farmers. This is done through a cluster approach where a group of farmers are selected. Critical inputs were also provided to the farmers are presented in Table 1 and technical guidance are provided to these farmers. Training are conducted at the actual site of sowing in the farmer's field and monitoring of the demonstrations is done on a regular basis and the queries faced by farmers are solved from time to time. When the crop is in an appropriate stage, a field day is conducted at the farmer's field wherein other interested farmers are invited to see the crop. The farmers are driven by the perception of seeing is believing and learning by doing. Thus the newly released crop production and protection technologies and management practices are demonstrated to the farmers. This included line sowing instead of broadcasting, using optimum seed rate, application of a recommended dose of fertilizers, management of weeds and bud fly management. As the farmers in Chimur, Nagbhid and Sindewahi tahsil of Chandrapur District and Ramtek, Umred Tahsil of Nagpur District grow early, mid-late or late paddy, and after harvesting of paddy, the linseed was broadcasted.

Cluster demonstrations were conducted to study the gaps between the potential yield and demonstration yield, extension gap and technology index. Five hundred fourteen demonstrations covering an area of 529 acres (212 ha) were laid out in different blocks of Nagpur and Chandrapur Districts with selected linseed growers during both year 2022-23 and 203-2024. In the present study, the data on seed yield were collected from demonstration plots. Besides, data on commonly adopted practices by the linseed farmers were also collected.

For demonstration plots of linseed, critical inputs in the form of seed of an improved variety of linseed, balanced fertilizers, agrochemicals like weedicides, insecticides and fungicides *etc*. were provided and non-monetary inputs like timely sowing, line sowing and timely weeding were also performed. Whereas, traditional practices were adopted in case of local checks. The demonstration was conducted under the guidance and supervision of scientists of the linseed research project in performing field operations during the course of training and visits. The technologies demonstrated and local practices are mentioned in Table 1.

Proper monitoring and supervision of the demonstrated plots were conducted from sowing to harvesting by frequent visits and suitable suggestions were given whenever required. Six field days were organized at the pre-harvest stage of linseed crop for yield maximization by improved agro-techniques among linseed growers (Table 1). The materials of the present study with respect to demonstrated practices and farmers' practices are presented in Table 2. Yield data was collected from demonstration plots and farmers's practices and cost of cultivation, net income and benefit-cost ratio was computed.

Table 1. Details of the trainings, field days and cluster demonstrations on improved package practices for linseed during 2022-23 and 2023-24

Area/ Tahsil of FLDs	Extension Activity	Number of participant farmers		
		Men	Women	Total
Nagbhid	Training on improved production technologies	90	30	120
	Cluster Demonstrations	85	13	98
	Field Day	130	45	185
Sindewahi	Training on improved production technologies	95	15	110
	Cluster Demonstrations	90	12	102
	Field Day	210	47	257
Chimur	Training on improved production technologies	168	25	193
	Cluster Demonstrations	120	20	140
	Field Day	270	45	315
Ramtek	Training on improved production technologies	75	13	88
	Cluster Demonstrations	80	10	90
	Field Day	150	27	227
Umred	Training on improved production technologies	105	13	78
	Cluster Demonstrations	90	09	99
	Field Day	120	60	180

A survey questionnaire was designed to capture most of the variables that would show efficiency in various levels of production technology development and transfer. This approach successfully mitigated key analytical issues associated with the differences between technology and knowledge (32). One hundred linseed grower respondents of the selected five blocks were interviewed in the year 2022-23. After the collection of data, a tally sheet was prepared which facilitated the enumeration of answers of each question.

Table 2. Details of linseed cultivation practices under Cluster Demonstration and Farmer practices

Sr. No.	Package of practices	Cluster demonstration (Demonstrated package)	Farmers practices
1	Selection of variety	PKV NL-260	Local variety
2	Seed treatment	Bio Mix Consorstium	None
3	Time of Sowing	1 to 15 November	Upto15 December
4	Method of sowing	Line sowing at by tractor operated seed drill/ Zerotill seed drill	Broadcasting
5	Spacing	30 cm	None
6	Seed rate	15 kg/ha	25 kg/ha
7	Application of recommended dose of fertilizer	60:30:00 kg NPK/ha	Imbalance use of fertilizers
8	Irrigation	Two irrigation at critical growth stages i.e pre flowering stage (40-45DAS) and Capsule formation stages (65-70 DAS)	Only one irrigation as per their convenience
9	Weed Management	Application of post emergence herbicide Clodinofop + Metsulfuron Methyl	No weed management done
10	Plant protection measures for control of insect pest and diseases	With the appearance of bud fly and foliar spray of insecticides	Generally, not practiced
11	Harvesting and Threshing	Harvesting done by Manually and threshing through thresher	Manual
12	Value addition	Oil mills given to farmers group at Ramtek tahsil of Nagpur District and in Chimur and Nagbhid tahsil of Chandrapur District, 2 farmers established oil mill unit after intervention of PKV NL-260 having high oil content upto 32 to 35%.	Rarely developed

The data were analysed by calculating simple mean and percentages. The extension gap, technology gap and the technology index, estimated by using the following formula (29).

Extension Gap =Demonstration yield – Farmers yield

Technology gap = Potential yield - Demonstration yield

$$\textbf{Technology index} = \frac{\text{(Potential yield - Demonstration yield)}}{\text{Potential yield}} \times 100$$

RESULTS AND DISCUSSION

Effect on knowledge and adoption level of technologies

To assess the impact of training programs on the knowledge level of farmers regarding linseed package practices for cultivation, the data were collected pre- and post- training programmes (Table 3). It observed that initially 60% of farmers possessed low, 25% medium and 15% high level of knowledge whereas after acquiring training, the values were 17% for low, 52% for medium and 33% for high level of knowledge. Thus, results indicated that there was a considerable increase in the knowledge level of linseed farmers who attended the on/off-campus training as well as field days. Similar findings were observed by (19), (17) and (7).

Table No. 3. Change in knowledge level of farmers before and after training

Knowledge level	Pre-training	Post-training	Increase (%)
Low	60	15	-75
Medium	25	52	108
High	15	33	120

Demonstration of improved production technologies in linseed resulted in an increased level of adoption, thus confirming the notion that "Seeing is believing and learning by doing" (Table 4). The data showed that 60% of the farmers had low level of adoption before the demonstration and that got reduced to 15% after the training, demonstration and field days. The overall knowledge level and adoption level of the farmers about the improved package of practices of linseed had increased by 75% in low-level adoption category, 108% in medium-level adoption and 120% in high-level adoption after acquiring training and conducting of demonstrations on linseed. The farmers took keen interest in observing the performance of new and improved varieties and package of practices to be aware about seed treatment, method of sowing, seed rate, time of sowing, weeding, harvesting and value addition practices (Table 5). The knowledge was quite low with regard to the method of sowing, time of sowing, seed rate, weed management aspect of crop management and value addition and marketing after harvesting of crop. These results being reported by with (20), (14), (1) and (37).

The knowledge level of farmers regarding improved package practices for linseed cultivation and value addition increased significantly from low to high category (Table 5). Large number of farmers have sufficient knowledge about all improved packages of practices of linseed viz., use of high-yielding varieties (70%), seed treatment (82%), time of sowing (76%), method of sowing and spacing (87%), seed rate (82%), application of a recommended dose of fertilizers (70%), application of micro-nutrient (45%), irrigation (72%), weed management (77%), plant protection measures (74%), harvesting and threshing (60%), value addition (79%). The knowledge levels increased for weeding, fertilizer application, plant protection measures and harvesting practices in agronomical crops after attending the training programmes. Similar findings were corroborated with the findings of (19), (17), (8) and (9).

Table 4. Change in adoption level of recommended cultivation technology of linseed

Category	Pre-training	Post-training	Increase (%)
Low level	74	22	-70
Medium level	16	60	275
High level	10	18	80

Table 5 Knowledge level of farmers after intervention package of practices of linseed

Particulars	Knowledge level		
	Low	Medium	High
Selection of high yielding improved variety	10	19	70
Seed treatment	08	10	82
Time of Sowing	11	13	76
Method of sowing and spacing	05	08	87
Seed rate	08	10	82
Application of recommended dose of fertilizer	10	20	70
Irrigation	18	10	72
Weed Management	10	13	77
Plant protection measures for control of insect pest and diseases	12	14	74
Harvesting and Threshing	18	22	60
Value addition	06	15	79

Data reveal that the gain in the knowledge level of farmers about the improved package of practices of linseed after intervention increased appreciably (Table 6) viz., use of high-yielding varieties (76%), seed treatment (69%), time of sowing (40%), method of sowing and spacing (50%), seed rate (62%), application of a recommended dose of fertilizers (56%), irrigation (52%), weed management (61%), plant protection measures (58%), harvesting and threshing (41%), value addition (26%). The knowledge acquired by the beneficiary farmers was high but its adoption was less for the improved technologies. This insinuates that still more awareness on this technology has to be disseminated to the farmers. This similar finding was recorded in different crops by (19), (20), (1), (33) and (21). The new production technologies are often correlated with risks and uncertainties about proper utilization or application, scale appropriateness and suitability with the prevailing environment, and importantly with farmers' perceptions and expectations reported by (21). Agricultural production carries inherent risks, as farmers face various challenges. Implementing enhanced agricultural practices may serve as a crucial strategy for maintaining production in this uncertain environment noted by (26). With numerous technologies being developed and shared in this context, it is essential to investigate the factors that affect farmers' adoption of these practices and their subsequent influence on productivity. These factors may be responsible for low adoption by farmers' inspite of high knowledge.

Table 6. Knowledge level of farmers after intervention package of practices of linseed

Particulars	Knowledge level (%)		
	Before intervention	After intervention	Gain in Knowledge
Selection of high yielding improved variety	12	88	76
Seed treatment	15	84	69
Time of Sowing	28	68	40
Method of sowing and spacing	16	66	50
Seed rate	18	80	62
Application of recommended dose of fertilizer	19	75	56
Irrigation	24	76	52
Weed Management	19	80	61
Plant protection measures for control of insect pest and diseases	12	70	58
Harvesting and Threshing	30	71	41
Value addition	11	37	26

Yield performance

Pooled results of demonstrations (Table 9 and Fig. 1 and 2) revealed that the yield performance of variety PKV NL-260 grown in Nagbhid, Chimur, Sindewahi, Ramtek and Umred tahsil of eastern Vidarbha region of Maharashtra was 611kg/ha which was 34.40% higher over farmer's practices (476 kg/ha) was due to the proper adoption of improved package of practices for linseed cultivation suggested by scientists. The linseed variety PKV NL-260 grown in nagbhid, chimur, sindewahi and umred tahsil of eastern Vidarbha region of Maharashtra showed 31.10% and 37.57% higher yield over the local variety used by farmers during 2022-23 and 2023-24. The results also showed that due to enhanced knowledge and adoption of an improved package of practices, the yield of linseed variety increased by 6% during the second year (2023-24) as compared first year (2022-23) over the yield obtained under farmers' practices. An increase in linseed yield due to improved demonstrations had very good impact on the farming community of Nagbhid, Chimur, Sindewahi, Ramtek and Umred tahsil of eastern vidarbha as they were motivated towards adoption of new

agricultural technologies applied in the linseed demonstration plots (Table 7 and 8). The area and productivity of linseed increased by 22% and 15.72% in 2023-24 as compared 2021-22 in vidarbha (Anonymous 22 and 2024) supported the present results. Yield fluctuation may be due to variations in prevailing social, economic and prevailing micro agro-climatic conditions of that particular village. Use improved package of practices for linseed cultivation include use of improved variety of linseed PKV NL-260 having high oil content upto 35% to 38% and 58% omega-3, optimum sowing time, proper seed treatment, line sowing and sowing with zero till seed drill, recommended dose of fertilizers, integrated weed and plant protection management practices followed under cluster demonstration of linseed enhanced the yield of linseed compared to farmer's practices. This results are in accordance with the similar findings of (16), (34), (5), (38), (10), (35), (20) and (23).

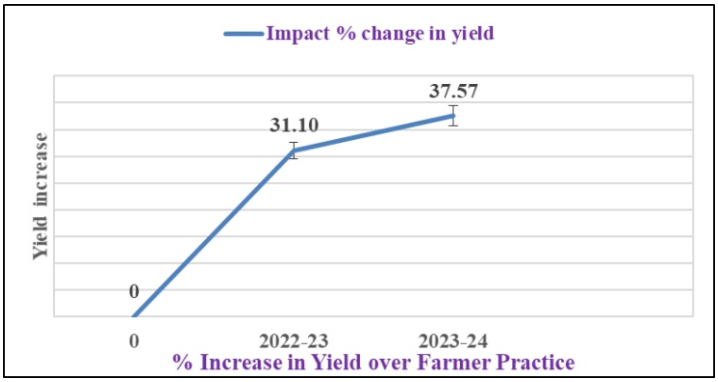

Fig. 1. Impact analysis of percent change in yield

Economic analysis

Economic analysis of the yield performance revealed that crop in demonstrations grown with an improved package of practices recorded higher mean gross monetary return (Rs.34,969/ha) and additional net monetary return (Rs.7,180/ha). The results indicated that the B:C ratio of linseed cultivation enhanced up to 2.87 during pooled study in comparison to 2.54 in farmer practices at Nagbhid, Chimur, Sindewahi, Ramtek and Umred tahsil of eastern Vidarbha. The B:C ratio of linseed cultivation under enhanced in Umred, Nagbhid and Chimur tahsil during 2023-24 year as compared to 2022-23, respectively. This is might be due to yield maximization by adopting an improved package of practices of linseed cultivation. (35), (30), (35), (31), (23), (7), (24) and (22) have also found similar findings.

Gap analysis

Moreover, some Farmer Groups and Farmer's Producer Company (FPC) co-operated enthusiastically in carrying out of linseed demonstrations which led to encouraging results. Results revealed an extension gap of 162 kg/ha was recorded in two year pooled data. During 2022-23 to 2023-24, an extension gap 140 kg/ha to 185 kg/ha, highest extension gap 185 kg/ha was recorded in 2023-24 which emphasized the need to minimize the extension gap by educating the farmers through various extension approaches like training programs, field visits, exposer visit, field day for the adoption of improved high yielding varieties of linseed and newly improved package of practices for linseed cultivation to reverse this trend of wide extension gap. These extension programs have wide potential to encourage the farmers adopt new and improved production technologies with high-yielding varieties of linseed will resulting in a reduction in high extension gap.

The technological gap is a metric to measure the difference between the demonstration yield and the potential yield. The technology gap was higher (309 kg/ha) in 2022-23 as compared to 206 kg/ha in 2023-24. The reduction in the technology gap indicate that the feasibility of the improved variety and technology at farmer's field. The lower value of the technology gap indicates more will be the feasibility of technology distributed. Under two-year cluster demonstration investigation, the average technology gap was 263 kg/ha as shown in table 12 and fig no.3. It shows that still there is a gap in technology disseminated or transferred through demonstration as a result of which the potential yield of improved practices could not be achieved by the adopting farmers. This might be due to the localized performance of a high-yielding improved variety, differences in soil fertility, soil moisture, microclimatic condition, rainfed situations, an improved package of practices or availability of inputs at critical growth of crop, the incidence of disease and insect-pest, and overall crop management practices followed by the farmer different places. Hence, need to develop location location-specific improved package of practices to minimize the technology gap for linseed yield in different farming situations. These results similar with the finding observed by (34), (28), (8), (36), (27), (38), (20), (18), (7), (12) and (25) in different crops.

The value of the technology index depicted in Table 10, 11 and 12, revealed that the technology index measures the percentage ratio of the technological gap to potential yield. It also demonstrates the feasibility of demonstrated technologies in farmers' fields. The average value of the technology index was 29.24%. According to the results (Fig.3), the highest technology index value of 34.38% was recorded in 2022-23, while the lowest technology index value of 24.11% was recorded 2023-24. The findings of (34), (5), (36), (38) (14), (13) and (25) supported the present study.

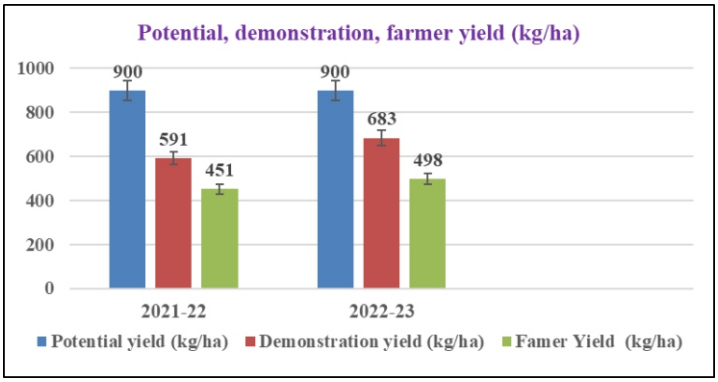

Fig. 2. Impact analysis of yield of linseed crop

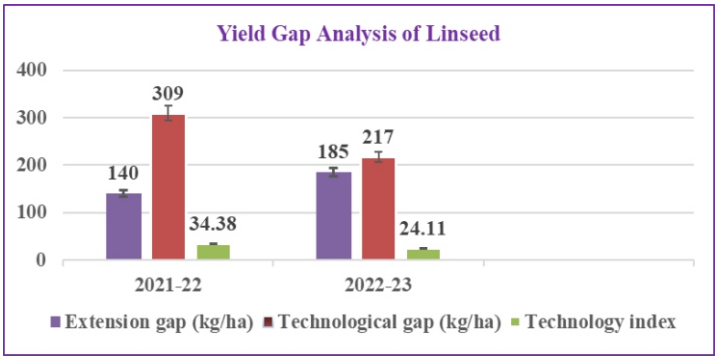

Fig. 3. Impact analysis of technological gap

Development of value addition chain in linseed

All India Coordinated Research Project on Linseed, College of Agriculture, Nagpur emphasized educating the farmers through various means like a training program, field day, adoption of an improved package of practices for linseed cultivation, exposure visit of linseed grower for adopting new technologies to reduce the wide extension gap. When large number of farmers adopt the improved technology on the larger area under linseed cultivation, it will subsequently change trend of extension and technological gap and will minimize technology index. Training program to linseed growers for processing and value addition of linseed at farmers' level increased market rate of produce which help to minimize the technology gap and extension gap in linseed. The impact of training program come into reality linseed growers of Chimur, Nagbhid tahsil of Chandrapur district established oil expeller unit and developed value addition chain at village or block level. All India Coordinated Research Project on Linseed, College of Agriculture, Nagpur under SCSP on linseed scheme with the financial support of Indian Institute of Oilseeds Research, Hyderabad provided the oil expeller to linseed growers of Ramtek tahsil of Nagpur District. Development of value addition chain in linseed reflecting on increasing profit margin, oil availability for consumption and providing employment to youth.

The economic study of linseed value addition (Table No. 13) reflects on linseed farmer's gets additional net monetary returns Rs. 3650 or 52% additional profit per quintal after selling of linseed oil as processed product as compared to selling of raw linseed. This assertion stating that value addition is very helpful for the horizontal expansion of linseed when analysing the potential of traditional oilseed crop like linseed for profit maximization. Value added linseed products like linseed oil beneficial because they increase income, open up new markets, lengthen the marketing season for producer to sell and enable them to develop a new brand for their product. This might be due to value-addition in agricultural commodity transforming raw farm produce into a new product(s) *via* oil extraction or oil expeller. The essence of value addition chain is to increase the product's consumer base, boost sales revenue from the derived product or products, process, or actualized physical isolation of the product or commodity *via* producer. Similar result asserted by (2), (22) and (7).

Table 13. Economics of linseed value addition

Oilseed crop	Oil recovery (kg)	Oil Cake (kg)	Selling Price (Rs./kg)		Value (Rs.)			Price of oil seed crop (B)	Cost milling Rs. per Quintal (C)	Additional Net Monetary Returns (Rs./Quintal) (A-B-C)
			Oil	Oil cake	Oil	Oil cake	Total (Rs.) (A)			
Linseed	35	65	230	40	8050	2600	10650	5500	1500	**3650**

Conclusion

It can be concluded that the knowledge and adoption level of the farmers was enhanced after imparting training and conducting cluster demonstrations in paddy fallow area. Training program, visit to a demonstration at the critical growth stage of crop and field day leads to awareness and adoption of recommended package of practices for linseed cultivation. The productivity gain under demonstrations over farmer's practices created awareness and motivated other farmers to adopt an mproved package of practices in crop management and high-yielding variety of linseed in paddy fallow area of Nagpur and Chandrapur Districts of eastern vidarbha. The well planned and implementation of cluster demonstration of linseed and development of value addition chain in linseed conducted under the close supervision of scientists are the most important tools to demonstrate an improved package of practices in linseed crop production and protection technologies and its management practices in the farmers' field in different districts of eastern Vidarbha. The conduction of cluster demonstration and development of value addition chain in linseed crop in paddy fallow area of eastern Vidarbha reflecting the fruitful results not only on increasing area and productivity of linseed but also increasing additional net monetary return, employment and stability in market price.

As per the state agriculture department report for the year 2023-24, area and productivity of linseed increased by 22% and 15.72% as compared 2021-22 in vidarbha. This is possible due to consistency and continuous efforts through the intervention of improved technology and development of value addition chain.

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Future Scope of the study: The conduction of cluster demonstration, intensive training and intervention of improved technology to educate the linseed growers for achieving higher production of linseed and development of value addition chain in the paddy fallow area of the eastern region of Vidarbha. For increasing area and productivity of linseed but also increasing additional net monetary return, employment.

Table 7. Yield performance and economic analysis of linseed grown under farmer practices and improved practices during 2022-2023 (N=100, 20 from each block)

Area/Block/tehsil	Variety used in IP	Variety used in FP	Yield (kg/ha)		Productivity of linseed in Maharashtra (kg/ha)	% YIOFP	Cost of Cultivation (Rs/ha)		Additional Cost of Cultivation	GMR (Rs/ha)		NMR (Rs/ha)		ANMR (Rs/ha)	B:C Ratio		ICBR
			IP	FP			IP	FP		IP	FP	IP	FP		IP	FP	
Nagbhid	PKV-NL-260	Local	548	438	246	25.11	11790	9910	1880	30140	24090	18350	14180	4170	2.56	2.43	2.22
Chimur	PKV-NL-261	Local	620	480	246	29.17	12340	10240	2100	34100	26400	30655	26243	4412	2.76	2.58	2.10
Sindewahi	PKV-NL-262	Local	585	425	246	37.65	10730	8700	2030	32175	23375	27061	20368	6693	3.00	2.69	3.30
Rametk	PKV-NL-263	Local	560	430	246	30.23	11640	9600	2040	30800	23650	28405	20593	7812	2.65	2.46	3.83
Umred	PKV-NL-264	Local	640	480	246	33.33	12600	10540	2060	35200	26400	20959	13416	7543	2.79	2.50	3.66
Mean	-	-	**591**	**451**	**246**	**31.10**	**11820**	**9798**	**2022**	**32483**	**24783**	**25086**	**18960**	**6126**	**2.75**	**2.53**	**3.02**

Table 8. Yield performance and economic analysis of linseed grown under farmer practices and improved practices during 2023-2024 (N=100, 20 from each block)

Area/Block/tehsil	Variety used in IP	Variety used in FP	Yield (kg/ha)		State productivity (kg/ha)	% YIOFP	Cost of Cultivation (Rs/ha)		Additional Cost of Cultivation	GMR (Rs/ha)		NMR (Rs/ha)		ANMR (Rs/ha)	B:C Ratio		ICBR
			IP	FP			IP	FP		IP	FP	IP	FP		IP	FP	
Nagbhid	PKV-NL-260	Local	750	590	246	27.12	13460	11670	1790	41250	32450	27790	20780	7010	3.06	2.78	3.92
Chimur	PKV-NL-261	Local	690	510	246	35.29	12600	10800	1800	37950	28050	25350	17250	8100	3.01	2.60	4.50
Sindewahi	PKV-NL-262	Local	620	450	246	37.78	11500	9540	1960	34100	24750	22600	15210	7390	2.97	2.59	3.77
Rametk	PKV-NL-263	Local	625	460	246	35.87	12500	10750	1750	34375	25300	21875	14550	7325	2.75	2.35	4.19
Umred	PKV-NL-264	Local	730	481	246	51.77	12700	10900	1800	40150	26455	27450	15555	11895	3.16	2.43	6.61
Mean	-	-	**683**	**498**	**246**	**37.57**	**12552**	**10732**	**1820**	**37565**	**27401**	**25013**	**16669**	**8344**	**2.99**	**2.55**	**4.60**

Table 9. Yield performance and economic analysis of linseed grown under farmer practices and improved practices during 2022-23 and 2023-24 and pooled

Year	Variety used in IP	Variety used in FP	Yield (kg/ha)		State productivity (kg/ha)	% YIOFP	Cost of Cultivation (Rs/ha)		Additional Cost of Cultivation	GMR (Rs/ha)		NMR (Rs/ha)		ANMR (Rs/ha)	B:C Ratio		ICBR
			IP	FP			IP	FP		IP	FP	IP	FP		IP	FP	
2022-23	PKV-NL-264	Local	591	451	246	31.10	11820	9798	2022	32483	24783	25086	18960	6126	2.75	2.53	3.02
2023-24	PKV-NL-264	Local	683	498	246	37.57	12552	10732	1820	37565	27401	25013	16669	8344	2.99	2.55	4.60
Pooled	PKV-NL-264	Local	637	474	246	34.40	12186	10265	1921	35024	26092	25050	17815	7235	2.87	2.54	3.81

Abbreviations used YIOFP: Yield increase over farmer's practice; GMR: Gross monetary return; ANMR: Additional Net Monetary Return; IP: Improved practices; FP: Farmers' Practices; B:C : Benefit : Cost, ICBR: Incremental cost benefit ratio.

Table 10. Exploitable productivity, technology gaps, technology index, extension gaps and cost benefit ratio of linseed as grown under cluster demonstrations and existing package of practices during 2022-23. (N=100, 20 from each block)

Area	No. of Demonstrations	Demonstration yield (kg/ha)	Farmers yield (kg/ha)	Potential Yield (kg/ha)	Extension gap (kg/ha)	Technological gap (kg/ha)	Technology index
Nagbhid	50	548	438	900	110	352	39.11
Chimur	20	620	480	900	140	280	31.11
Sindewahi	20	585	425	900	160	315	35.00
Rametk	20	560	430	900	130	340	37.78
Umred	20	640	480	900	160	260	28.89
	100	**591**	**451**	**900**	**140**	**309**	**34.38**

Table 11. Exploitable productivity, technology gaps, technology index, extension gaps and cost benefit ratio of linseed as grown under cluster demonstrations and existing package of practices during 2023-2024. (N=100, 20 from each block)

Area	No. of Demonstrations	Demonstration yield (kg/ha)	Farmers yield (kg/ha)	Potential Yield (kg/ha)	Extension gap (kg/ha)	Technological gap (kg/ha)	Technology index
Nagbhid	20	750	590	900	160	150	16.67
Chimur	20	690	510	900	180	210	23.33
Sindewahi	20	620	450	900	170	280	31.11
Rametk	20	625	460	900	165	275	30.56
Umred	20	730	481	900	249	170	18.89
	100	**683**	**498**	**900**	**185**	**217**	**24.11**

Table 12. Exploitable productivity, technology gaps, technology index, extension gaps and cost benefit ratio of linseed as grown under cluster demonstrations and existing package of practices during 2022-2023, 2023-2024 and pooled

Year	No. of Demonstrations	Demonstration yield (kg/ha)	Farmers yield (kg/ha)	Potential Yield (kg/ha)	Extension gap (kg/ha)	Technological gap (kg/ha)	Technology index
2022-2023	100	591	451	900	140	309	34.38
2023-2024	100	683	498	900	185	217	24.11
Pooled	**100**	**637**	**474**	**900**	**162**	**263**	**29.24**

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