



Cluster Frontline Demonstration: An Effective Technique to Transfer the Technology for Enhancing Productivity and Profitability of Linseed (*Linum usitatissimum*) in Sidhi District of Madhya Pradesh

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Authors' contributions

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

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ABSTRACT

Linseed, along with mustard, is one of India's most important oilseed crops, and it helps small and marginal farmers in the Sidhi district of Madhya Pradesh supplement their income. Agriculture's development is mostly dependent on the use of scientific technology while making the most efficient use of available resources. Cluster Front Line Demonstrations were held at various farmers' fields during the rabi seasons of three selected blocks in Madhya Pradesh's Sidhi district to boost agricultural produce production, productivity, profitability, and quality. During the years 2016-17 and 2018-19, Krishi Vigyan Kendra, Sidhi, conducted 150 cluster frontline Linseed demonstrations. Through meetings and talks with farmers, the important inputs in existing production technology were discovered. Farmers' methods that were in use at the time were used as a control for comparing to the recommended procedures. The average yield of recommended practices registered 94 percent higher than the farmer's practice. The average technology gap, extension gap and technology index were observed 10.59 q/ha, 3.59 q/ha and 58.84 percent respectively. The

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highest grain yield (7.67 q/ha) was recorded in the year 2018-19, it was 101.3 per cent more than the farmer's practice (3.81 q/ha). Average net profitability of worth Rs. 9037 /ha as compared with farmers practices (Rs. 1785/ha) were obtained an average benefit-cost ratio i.e. 1.68 and 1.19 were recorded in demonstrated plot and farmers practice respectively. The higher additional returns (Rs. 7252/ha) and effective gain (Rs. 3659/ha) obtained under demonstrations could be due to improved technology, timely of crop cultivation operations and scientific monitoring.

Keywords: CFLD; Linseed; JLS-27; Yield; technology gap; technology index; net returns; effective gain and BC ratio.

1. INTRODUCTION

Linseed or flax (*Linum usitatissimum* L., 2n=30, X=15) is a member of the Linaceae family. In terms of cultivation and seed output in India, it is the second most significant rabi oilseed crop, trailing only rapeseed-mustard. Although the genus *Linum* has roughly 230 species, cultivated Linseed/flax is the only economically important species in the genus [1] and is one of the oldest crops farmed for fibre and oil. When it's grown for fibre, it's called flax; when it's grown for oil, it's called linseed; and when it's cultivated for both oil and fibre, it's called 'dual-purpose flax'. In Madhya Pradesh, linseed is referred to as *Alsii*. Linseed is a fantastic source of vital fatty acids and can be used as an omega-3 fatty acid substitute for vegetarians. Linseed oil, with an oil content ranging from 33 to 45 percent, has been used as a drying oil for millennia [2]. Farmers use roughly 20% of the total linseed oil produced in India, while the remaining 80% is used by industry to make paints, varnish, oilcloth, linoleum printing ink, and other products. The oil cake is the most beneficial animal feed cake because it includes 36 percent protein and 85 percent digestible fibre. The oil cake, which includes 5% nitrogen (N), 1.4 percent phosphorus (P₂O₅), and 1.8 percent potassium, is also utilised as manure (K₂O). The stem fibres are recognised for their length and strength, and are two to three times stronger than cotton fibres [3]. Linseed plays a significant role in the Indian economy due to its numerous industrial applications. However, as compared to other countries, the national average productivity of linseed seed is rather low. Linseed is predominantly grown in India's key linseed producing states, such as Madhya Pradesh, Chhattisgarh, Maharashtra, Jharkhand, Uttar Pradesh, and Odisha, under rainfed (63 percent), utera (25 percent), irrigated (17 percent), and input-starved conditions [4]. Linseed oil is high in alpha-linolenic acid (ALA), which accounts for around 55 percent of the oil's content. It also has a high content of dietary fibre and lignin. There

are also plenty of vitamins and omega-3 fatty acids. It has a pleasant flavour and contains 36% protein, of which 85 percent is digestible. It's high in minerals, particularly phosphorus (650 mg/100g), magnesium (350 - 431 mg/100g), and calcium (236 - 250 mg/100g), while it's low in sodium (27 mg/100g) [5].

Linseed production in the Sidhi district is quite low (305 kg/ha), but it can be improved by using appropriate agronomic methods, high yielding varieties, integrated nutrient management, integrated pest management, and correct irrigation management, among other things. Farmers are using old and degraded seeds, local varieties with higher seed rates, i.e. 30-35 kg/ha, growing in marginal lands, rainfed conditions, no insect management, and insufficient plant nutrients; farmers, in particular, are not applying Sulphur, despite the fact that the district's linseed area is Sulphur deficient.

With this in mind, the current research was conducted to determine farmer awareness of linseed cultivation, the extent of adoption of improved techniques, and the yield gap in Linseed production technology. Krishi Vigyan Kendra is a grass-roots organisation dedicated to the use of technology by assessing, refining, and disseminating proven technologies in the district's various micro-farming situations [6]. By altering farmers' knowledge and expertise, Frontline Demonstration has proven to be a beneficial instrument in increasing the production and productivity of Linseed crops [7]. Linseed was the subject of cluster frontline demonstrations in 2016-17 and 2018-19 in order to propagate the technology throughout the district.

2. MATERIALS AND METHODS

The current study was conducted in Madhya Pradesh's Sidhi district, which is located in the state's north-east corner and lies at 24.395603 latitude and 81.882530 longitudes, with an

elevation of 272 metres above mean sea level. During the years 2016-17 and 2018-19, cluster frontline demonstrations were held in the district's Sidhi, Majhauili, and Sihawal blocks to assess the performance of the JLS-27 Linseed variety. During the study period, 75 farmers were chosen from the aforementioned blocks to participate in the cluster frontline demonstration of Linseed. During the rabi seasons of 2016-17 and 2018-19, 150 front-line demonstrations in real-life farming conditions were held in three blocks within the Krishi Vigyan Kendra operational region.

Each demonstration occupied 0.4 hectares. The soil texture was sandy clay-loam with moderate water holding capacity, low to medium organic carbon (0.034-0.055%), low to medium available nitrogen (118-212 kg/ha), medium available phosphorus (10-14 kg/ha), low to medium available potassium (206-303 kg/ha), and soil pH was slightly acidic to neutral in reaction (6.5-7.1). Recommended approach (Improved variety JLS-27, integrated nutrient management-@ 60:40:20:25 kg NPKS/ha + Azotobacter + PSB @ 5 g/kg seed, integrated pest management + seed treatment with *Trichoderma viridae* @ 5 g/kg seed + Profenophos @ 750 ml/ha, etc.) vs farmer's practice

The crop was planted between October 20 and November 15, using a 30 cm x 10 cm spacing and a seed rate of 20 kg/ha. During sowing, a whole dose of P was applied by Diammonium Phosphate (DAP), K via Muriate of Potash, and Sulphur via bentonite sulphur. The seeds were inoculated with *Azotobacter* and phospho-solubilizing bacteria biofertilizers at a rate of 5 g/kg seeds after being treated with *Trichoderma viridae* at a rate of 5 g/kg seeds. 30 days following seeding, hand weeding was done once. At 30 DAS, one spray of Profenophos @ 750 ml/ha was sprayed, along with a ready mix of Carbendazim+ Mancozeb @ 2.5 g/lit water. Before sowing and pre-flowering, the fields were watered (35 DAS).

During years of cluster front line demonstrations, the crop was harvested from March 10 to March 20. Local variety with degenerated seed was used, the crop was sown between 10 and 20 October, broadcasting method of sowing, higher seed rate (35 kg/ha), imbalance dose of fertilisers applied (10 kg DAP/ha), no seed treatment, no biofertilizers, no hand weeding, no irrigation, and no plant protection measures were used, and no seed treatment, no

biofertilizers, no hand weeding, no irrigation, and no plant protection measures were used. The crop was harvested at the same time as the demonstration plots in the cluster front line. Harvesting and threshing were done by hand in each demonstration, with a 5m x 3m plot harvested in three places and an average grain weight recorded at a moisture level of 12 percent. Under each of the Farmers Practices plots, a similar technique was used.

Prior to the rallies, farmers in the individual areas were given training on technical interventions. All other phases, such as site selection, farmer selection, demonstration layout, farmer participation, and so on were followed as suggested by Choudhary, 1999. Farmers and extension personnel were invited to visit demonstration plots in order to promote the technique on a large scale. The data was obtained from both CFLD plots and farmer's practices plots, and the extension gap, technology gap, technology index, and benefit-cost ratio were calculated as follows [8]:

Harvest index (%) = Grain yield / Biological yield x 100

% increase in yield = [(Demo yield - Farmers practices) / farmers practices] x 100

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - Farmers yield

Technology index = [(Potential yield - Demonstration yield) / Potential yield] x 100

Additional cost in improved technology (Rs./ha) = Cost of improved technology (Rs/ha) - Cost of farmers practice (Rs./ha)

Additional returns (Rs/ha) = Net returns of improved technology (Rs./ha) - Net returns of farmers practice (Rs./ha)

Effective gain (Rs./ha) = Additional returns - Additional cost of improved technology

Benefit cost ratio (BCR) = $\frac{\text{Gross returns (Rs./ha)}}{\text{Cost of cultivation (Rs./ha)}}$

The techniques that were included of the practise package were highlighted. However, it was up to the farmers to adopt and put them into practise, based on their resource availability and input preferences (fertilizers and pesticides). Table 1 shows a comparison between current practise and those that were suggested.

Table 1. Comparison between technological interventions and existing farmers practice under cluster front line demonstration programme

S No	Particular	Recommendation	Existing	Gap (%)
1	Variety	Improved variety JLS 27	Old variety and degenerated seed	Full gap
2	Seed rate	20 kg/ha	30-35 kg/ha	Partial gap
3	Field Preparation	Importance of preparing the land to get fine tilth. It needs 2 to 3 ploughing	Ploughing is restricted to one or two, which does not break the soil into fine particles	Partial gap
4	Seed treatment and Fertilizer	Azotobacter + PSB @ 5 g/kg seed, Trichoderma viridae @ 5 g/kg seed and application of micronutrients such as Zinc sulphate. 60:40:20:25 NPKS kg/ ha.	Soil testing is not done. Normally farmers do not apply fertilizer as it is raised as a residual crop. Farmers apply usually DAP at 10 kg per acre.	Full gap
5	Sowing Time	25 October to 10 November	October to November	No gap
6	Sowing method	Line sowing	Broadcasting	Full gap
7	Weed control	Hand weeding was done once 30 days after sowing.	No weeding	Full gap
8	Irrigation	Fields were irrigated before to sowing and at pre-flowering (35 DAS)& seed setting stage (70 DAS)	This is not practiced by farmers	Full gap
9	Plant Protection	One spray of Profenophos @ 750 ml/ha + ready mix combination of Carbendazim+ Mancozeb @ 2.5g/lit water was applied at 30 DAS.	No preventive measure is followed	Full gap

3. RESULTS AND DISCUSSION

3.1 Gap analysis of Recommended and Existing practices

The gap among the existing and recommended technologies of Linseed crop in district Sidhi has been depicted in Table-1. The full gap was observed in the case of use of HYVs, seed treatment & fertilizer application, sowing method, weed control, irrigation and plant protection measures, while a partial gap was observed in seed rate and field preparation, which definitely may be the reason of not achieving potential yield and demonstrated yield by farmers practices. Farmers were not aware of recommended technologies. Farmers, in general, used degenerated seeds of local or old-age varieties instead of the recommended high yielding resistant varieties. Unavailability of seed in time & at the local level and lack of awareness were the main reasons for this gap in farmer's practices. Farmers applied higher a seed rate than the recommended and they were not using seed treatment techniques for the management of seed born diseases and also not aware of the application of micronutrients i. e., sulphur and zinc for enhancement of yield and quality of linseed because of lack of knowledge and interest [9,10] also reported that there is a technological gap between improved practices and existing practices.

3.2 Yield Attributing Characteristics

Table 2 shows the yields attributing factors such as the number of capsules per plant and the harvest index (percent) of Linseed achieved over the years under suggested practise and farmers practise. Under suggested practise in farmer's fields, the number of capsules/plants of linseed ranged from 56 to 62, with a mean of 59, compared to a range of 30 to 32, with a mean of 31 found under farmers' practise. The utilisation of high yielding cultivars, integrated nutrition management, integrated pest control, and other factors may have contributed to the higher values of capsules/plant in recommended practise compared to farmers' practice [11].

3.3 Seed Yield

Table 2 shows the yield performance of suggested techniques and farmer practises. During both consecutive years of demonstrations, the performance of the demonstration plot's Linseed yield was

determined to be higher than that of the farmers' practise (2016-17 and 2018-19). During 2016-17 and 2018-19, the yield of Linseed under demonstration was 7.15 and 7.67 q/ha, respectively, compared to farmers' practise of 3.83 and 3.81 q/ha. The yield increase owing to technology intervention was 86.7 percent and 101.3 percent, respectively, over the farmer's practise. The combined effect of the technological intervention in both years resulted in an average production of 7.41 q/ha, which is 94 percent greater than the average yield of farmers (3.82 q/ha). Variations in yield from year to year can be explained by changes in the social, economic, and climatic conditions [11,12].

3.4 Economic Parameter

Table 3 shows the economic success of Linseed in cluster front line demonstrations. The cost of cultivation, net returns, and benefit-cost ratio were calculated using the input and output prices of commodities that prevailed during both years of the demonstrations. During the demonstration period, the investment in production by following recommended techniques varied from Rs. 1113 to 13425/ha, with a mean value of Rs.13269/ha, compared to the farmers' practise of Rs. 9870/ha and Rs.9480/ha. Linseed cultivation with suggested procedures yielded a greater net return of Rs.8337- Rs. 9737 per hectare in 2016-17 and Rs.1620- Rs. 1950 per hectare in 2018-19, respectively. During the study period, the average benefit-cost ratio of suggested procedures was 1.68, ranging from 1.63 to 1.73, while the farmers' practise was 1.19, ranging from 1.16 to 1.21. This could be because recommended techniques produce larger yields than farmer practises. Similar results have been reported earlier by Tomar [13-15].

3.5 Technology Gap, Extension gap and Technology Index

3.5.1 Technology Gap

During the study period, the average technological gap was 10.59 qt/ha, indicating a difference between the demonstration yield and prospective output (Table 2). The trend of the technological gap in 2016-2017 and 2018-2019 was 10.85 and 10.33 qt/ha, respectively, and it demonstrates the farmers' collaboration in carrying out such demonstrations with good outcomes in succeeding years. At the farmer's field, frontline demonstrations were set up under the supervision of KVK scientists. The found

Table 2. Growth and yield parameters, Technology gap, Extension gap and Technology index of linseed as affected by recommended practices as well as farmer's practices

Year	Area (ha)	No. of farmers	No. of capsules /plant		Grain yield (q/ha)			% Increase over FP	Straw yield (q/ha)		Harvest index (%)		Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
			RP	FP	Potential	RP	FP		RP	FP	RP	FP			
2016-17	30	75	56	32	18	7.15	3.83	86.7	28.4	21.3	20.11	15.24	10.85	3.32	60.28
2018-19	30	75	62	30	18	7.67	3.81	101.3	30.2	21.6	20.25	14.99	10.33	3.86	57.39
Total/ Average	60	150	59	31	18	7.41	3.82	94.0	29.3	21.45	20.18	15.12	10.59	3.59	58.84

Table 3. Effect of cluster frontline demonstrations on economic parameters

Year	Gross expenditure (Rs./ha)		Additional cost (Rs./ha)	Gross return (Rs./ha)		Net return (Rs./ha)		Additional returns (Rs./ha)	Effective gain (Rs./ha)	B:C Ratio	
	RP	FP		RP	FP	RP	FP			RP	FP
2016-17	13113	9870	3242	21450	11490	8337	1620	6717	3475	1.63	1.16
2018-19	13425	9480	3945	23162	11430	9737	1950	7787	3842	1.73	1.21
Total/ Average	13269	9675	3594	22306	11460	9037	1785	7252	3659	1.68	1.19

technology gap could be due to differences in soil fertility level, local meteorological conditions, varietal appropriateness, and technological adoption. The technological gap refers to topics that can be researched in order to realise potential yield, whereas the extension gap refers to what can be accomplished through the transfer of existing technologies. According to Mukharjee [16] various interventions may have larger consequences in boosting system productivity depending on how the farming condition is identified and used. Similar findings were also recorded by Katare *et al.* [17] and Singh *et al.* [12].

3.5.2 Extension Gap

The extension gap is a parameter to know the yield differences between the demonstrated technology and farmer's practice and observed data was depicted in Table 2. The extension gap ranged between 3.32 – 3.86 q/ha during the study period with an average of 3.59 q/ha which emphasized the need to educate the farmers through various means for the adoption of improved high yielding variety and improved agro technologies to reverse this trend of wide extension gap. More and more use of new HYV's by the farmers will subsequently change this alarming trend of developing extension gap. The new technologies will eventually lead the farmers to disenchantment discontinuance of old varieties with the new technology. The findings support the findings of Patel *et al.* [18] who said that location-based problem identification and, as a result, particular treatments could have a significant impact on crop output.

3.5.3 Technology Index

The technology index demonstrated the viability of advanced technology on the farm. The higher technology score suggested a lack of extension services for technology transfer. The lower value of the technology index demonstrates the efficacy of technological solutions that function well. Under cluster front line demonstration, the average technology index was found to be 58.84 percent (Table 2). The technology index was observed 60.28 and 57.39 per cent respectively in the year 2016-2017 and 2018-2019. The decreasing trend in the technology index shows that the farmer's interest in adopting technology is increasing. This variation indicates that results differ according to soil fertility status, weather condition, non-availability of irrigation water and insect-pests attack in the crop. The results

present study results agree with the findings of [14,11,12,19].

4. CONCLUSION

According to the findings of the study, the production of Linseed in Sidhi district can be enhanced to its potential yield by using FLDs of suggested technologies. The income and livelihood of farming communities will significantly improve as a result of this. The development of area-specific technological modules for increasing oilseed yield in Madhya Pradesh's varied agro-ecosystems would receive special emphasis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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