Original Research Article

~~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

ABSTRACT

Linseed is one of the most important oilseeds crops next to mustard in India, which plays a major role in supplementing the income for small and marginal farmers of the Sidhi district of Madhya Pradesh. The development of ~~the~~ Agriculture ~~is primarily depending~~primarily depends on ~~the application of~~applying ~~the~~ scientific technologies by making the best use of available resources. To increase ~~the production, productivity, profitability and quality of agricultural produce, Cluster Front Line Demonstrations were conducted at various farmers field~~agricultural production, productivity, profitability, and quality, Cluster Front Line Demonstrations were conducted at various farmers' fields during rabi seasons of three selected blocks of Sidhi district of Madhya Pradesh. Krishi Vigyan Kendra, Sidhi conducted 150 cluster frontline demonstrations of Linseed during two consecutive years from 2016–17 and 2018–19. The critical inputs were identified in existing production technology through meetings and discussions with farmers. Prevailing ~~farmer's~~ farmer's practices were treated as control for comparison with recommended practices. The average yield of recommended practices registered 94 percent higher ~~over~~ than the farmers' practice. The average ~~of~~ technology gap, extension gap, and technology index were observed at 10.59 q /ha, 3.59 q/ha, and 58.84 percent, respectively. The highest grain yield (7.67 q/ha) was recorded in ~~the year~~ 2018-19, and it was 101.3 per-cent more ~~over~~ than the farmers' practice (3.81 q/ha). Average net profitability of worth Rs. 9037 /ha ~~as compared with farmers practices (Rs. 1785/ha) were obtained and average benefit cost ratio i.e. 1.68 and 1.19 were recorded in demonstrated plot and farmers practice~~compared with farmers' practices (Rs. 1785/ha) were obtained, and the average benefit cost ratio, i.e. 1.68 and 1.19 were recorded in the plotted and farmers' practice, respectively. The higher ~~additional~~ other returns (Rs. 7252/ha) and effective gain (Rs. 3659/ha) obtained under demonstrations could be ~~due to~~ improved ~~technology~~technology, timely ~~operations of crop cultivation~~crop cultivation operations, and scientific monitoring.

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

Introduction

Linseed or flax (*Linum usitatissimum* L., 2n= 30, X = 15) belongs ~~to the family~~ Linaceae. It is the second most important *rabi* oilseed crop and stands next to rapeseed-mustard in ~~area of cultivation and seed production in India~~India's area of cultivation and seed production. The genus Linum is composed of approximately 230 species, but cultivated linseed ~~/~~ /flax is the only species of economic importance ~~in the genus~~ (Tadesse *et al.*, 2010) and is one of the oldest crops cultivated for fiber and oil. The word ~~'~~'flax~~'~~' is used when it is grown for fiber, ~~'~~'linseed~~'~~' is used when it is grown for oil purposes, and ~~'~~'dual purpose ~~flax'~~ flax' when grown for both oil and fiber. Linseed is popularly known as *Alsi* in Madhya Pradesh. Linseed is an amazing source of essential fatty acids, and it can be seen as an alternate source of omega-3 fatty acids for vegetarians. Linseed oil has been used for centuries as a drying oil whose oil content varies from 33-45% (Gill, 1987). ~~About 20% of the total linseed oil produced in India is used by farmers~~Farmers use about 20% of the total linseed oil produced in India. ~~and rest about 80% goes to industries for the manufacture of paints, varnish, oilcloth, linoleum and printing ink~~The rest, about 80% goes to industries to manufacture paints, varnish, oilcloth, linoleum and printing ink, etc. The oil cake is the most valuable feeding cake for animals, it contains 36% protein, and 85 % of it is digestible fiber. The oil cake is also used as manure; it contains 5 % nitrogen (N), 1.4 % phosphorus (P_2O_5), and 1.8 % potassium (K_2O). Fibers obtained from the stem are known for their length and strength and are two to three times as strong as ~~those of~~ cotton (Taylor, 2012). Linseed has an important position in the Indian economy due to its wide industrial utility. But the national average productivity of linseed seed is quite low ~~as~~ compared to other countries. In India, ~~linseed~~ Linseed is grown mostly under rainfed (63%), utera (25%), irrigated (17%), and in input starved conditions in major ~~linseed~~ Linseed producing states i.e. Madhya Pradesh, Chhattisgarh, Maharashtra, Jharkhand, Uttar Pradesh, and Odisha (Srivastava, 2009). Linseed oil is rich in alpha-linolenic acid (ALA) and contains about 55% ALA. It also contains high levels of dietary fiber as well as lignin. ~~Abundance~~ The abundance of micronutrients and omega-3 fatty acids is also present. It has a good taste and contains 36% protein, out of which~~,~~ 85% is digestible. It serves as a good source of minerals especially, phosphorous (650 mg/100g), magnesium (350 - 431 mg/100g), calcium (236 - 250 mg/100g), and has a very low amount of sodium (27 mg/100g) (Ganvit, 2019).

The productivity of ~~linseed~~ Linseed in the Sidhi district is very poor (305 kg/ha) than the national productivity~~, ~~; it can be increased by following the appropriate agronomic practices along with high yielding varieties, integrated nutrient management, integrated pest management, proper irrigation management, etc. Farmers are using old and degenerated seeds local varieties with higher seed rate i.e. 30-35 kg/ha, growing in marginal lands, rainfed conditions, no insect management and insufficient plant nutrients~~;~~. ~~especially f~~Farmers are not applying Sulphur, although most of the linseed area of the district is Sulphur deficient.

Keeping this in view, the present investigation was carried out to study ~~the awareness level of farmer's regarding linseed cultivation,~~farmers' awareness level regarding linseed cultivation and the extent of adoption of improved practices~~,~~ to find out the yield gap in linseed production technology. Krishi Vigyan Kendra are ~~grass-~~grass-root level organization meant ~~for application of technology through assessment, refinements and dissemination of proven technologies under different micro farming situation~~to apply technology through assessment, refinements, and dissemination of proven technologies under different micro farming situations in the district (Das, 2007). Frontline Demonstration has been proved a successful tool in enhancing the production and productivity of linseed crops ~~through changing the knowledge, attitude and skill of farmers~~by changing farmers' knowledge, attitude, and skill (Singh *et al.*, 2018). Cluster frontline demonstrations were conducted on ~~linseed~~ Linseed during 2016-17 and 2018-19 to disseminate the ~~technology~~ technology in the district.

Materials and Methods

The present study was carried out in the Sidhi district of Madhya Pradesh, which is located ~~on~~ in the North-East part of Madhya Pradesh state and lies at 24.395603 latitude and 81.882530 longitudes with an altitude of 272 m above the mean sea level. Cluster frontline demonstrations were conducted during 2016-17 and 2018-19 ~~with evaluation the performance of JLS-27,~~to evaluate the performance of JLS-27, a variety of ~~linseed~~ Linseed in Sidhi, Majhauli, and Sihawal blocks of the district. In this study, 75 farmers were selected from ~~aforesaid blocks~~blocks above during the study period under cluster frontline demonstration of ~~linseed~~Linseed. Total 150 front line demonstrations under real farming situations were conducted during *rabi* seasons of 2016-17 and 2018-19 in three blocks under ~~krishi~~ Krishi vigyan Kendra operational area. The area under each demonstration was 0.4 ha. The soil was sandy clay-loam in texture with moderate water holding capacity, low to medium in organic carbon (0.034-0.055%), low in available nitrogen (118-212 kg/ha), medium in available phosphorus (10-14 kg/ha), low to medium in available potassium (206-303 kg/ha) and soil pH was slightly acidic to neutral in reaction (6.5-7.1). The treatment comprised of recommended practice (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. v/s farmers practice. ~~Crop~~ The crop was sown between 20 October to 15 November with a spacing of 30 cm x10 cm, and the seed rate was 20 kg/ha. An entire dose of P through Diammonium Phosphate (DAP), K through Muriate of Potash and Sulphur through bentonite sulphur was applied as basal during sowing. The seeds were treated with *Trichoderma viridae* @ 5 g/kg seeds, then seeds were inoculated by *Azotobacter* and phospho-solubilizing bacteria biofertilizers, each 5g/kg of seeds. Hand weeding was done once at 30 days after sowing. One spray~~s~~ of Profenophos @ 750 ml/ha + ready mix combination of Carbendazim+ Mancozeb @ 2.5g/lit water was applied at 30 DAS. Fields were irrigated prior to sowing and pre-flowering (35 DAS). The crop was harvested 10th March to 20th of March during years of cluster front line demonstrations. ~~Farmer's~~ Farmer's practice constituted local variety with degenerated seed was used, crop was sown between 10 to 20 October, broadcasting method of sowing, higher seed rate (35 kg/ha), imbalance dose of fertilizers applied (10 kg DAP/ha), no seed treatment, no biofertilizers, no hand weeding, no irrigation and no plant protection measures were adopted. ~~Crop~~ The crop was harvested ~~on~~ at the same time ~~of~~ as harvesting of cluster front line demonstration plots. Harvesting and threshing operations were done manually; 5m x 3m plot harvested in 3 locations in each demonstration~~s~~ and average grain weight taken at 12% moisture level. ~~Similar~~ The similar procedure adopted on Farmers Practices plot under each demonstration then grain weight was converted into quintal per hectare (q/ha).

Before conducting the demonstrations, training~~s~~ to farmers of respective villages w~~ere conducted with respect to~~as conducted regarding technological interventions. All other steps like site selection, farmers selection, the layout of demonstration, farmers participation~~ etc. were followed as~~, etc., were suggested by Choudhary,1999. Visits of farmers and extension functionaries were organized at demonstration plots to disseminate the ~~technology~~ technology at a large scale. The data output ~~were~~ was collected from both CFLD plots as well as ~~farmer’s~~ farmer's practices plot. Finally,~~ and finally~~ the extension gap, technology gap, technology index along with the ~~benefit~~ benefit-cost ratio were worked out (Samui *et al.*, 2000) as given below:

$$\text{Harvest index (\%)} = \text{Grain yield} / \text{Biological yield} \times 100$$

$$\text{\% increase in yield} = [\{\text{Demo yield} - \text{Farmers practices}\} / \text{farmers practices}\} \times 100$$

$$\text{Technology gap} = \text{Potential yield} - \text{Demonstration yield}$$

$$\text{Extension gap} = \text{Demonstration yield} - \text{Farmers yield}$$

$$\text{Technology index} = [(\text{Potential yield} - \text{Demonstration yield}) / \text{Potential yield}] \times 100$$

$$\text{Additional cost in improved technology (Rs./ha)} = \text{Cost of improved technology (Rs/ha)} - \text{Cost of farmers practice (Rs./ha)}$$

$$\text{Additional returns (Rs/ha)} = \text{Net returns of improved technology (Rs./ha)} - \text{Net returns of farmers practice (Rs./ha)}$$

$$\text{Effective gain (Rs./ha)} = \text{Additional returns} - \text{Additional cost of improved technology}$$

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

The techniques which were part of the package of practices were emphasized. However, it was left to the farmers to adopt and practice them depending on the~~ individual farmer’s resource availability and preference as to~~ir resource availability and preference for inputs (fertilizers and pesticides). Table 1 ~~gives a comparison between~~compares the existing practice and those that were recommended.

Results and Discussion

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. ~~Full~~ The total gap was observed in the case of use of HYVs, seed treatment & fertilizer application, sowing method, weed control, irrigation and plant protection measures~~, while~~. In contrast, a partial gap was observed in seed rate and field preparation, which definitely may be the reason ~~of~~ for not achieving potential yield and demonstrated yield by farmers' practices. Farmers were not aware ~~about~~ of recommended technologies. Farmers~~ in general~~, in general, used degenerated seeds of local or old-age varieties instead of the recommended ~~high~~ high-yielding resistant varieties. Unavailability of seed in time & at the local level and lack of awareness were the main reasons ~~of~~ for this gap in ~~farmer's~~ farmer's practices. Farmers applied ~~higher seed rate than the recommended and they were not using seed treatment technique for the management of seed born diseases and also not aware the application of micronutrient i.e. sulphur and zinc for enhancement of yield and quality of~~a higher seed rate than the recommended. They were not using seed treatment technique to manage seed-born diseases. They were also not aware of the application of micronutrients, i.e. sulphur and zinc, to enhance yield and quality ~~linseed~~ Linseed because of lack of knowledge and interest. Sharma *et al*., 2011 and Balai *et al*., 2012 also reported ~~that there is~~ a technological gap between improved practices and existing practices.

Yield attributing characteristics

The yields attributing parameters like the number of capsule/plant and harvest index (%) of ~~linseed~~ Linseed obtained over the years under recommended practice a~~s well as~~nd farmers practice are depicted in Table 2. The Number of capsules/plant ~~of linseed~~ ranged from 56 to 62 with a mean of 59 under recommended practice on farmers' fields ~~as compare~~compared to ~~range from~~ 30 to 32 with a mean of 31 recorded under farmers practice. The higher ~~values of number of capsules/plant~~number of capsules/plant values ~~in~~ is recommended practice ~~as compare to farmers practice was may be due to the use of high yielding varieties, integrated nutrient management and integrated pest management~~compared to farmers' practice may be due to the use of high yielding varieties, integrated nutrient management, integrated pest management, etc. (Singh *et al*., 2021).

Seed yield

The yield performance of recommended practices and farmers' practices are depicted in Table2. The data revealed that ~~under demonstration plot, the performance of linseed yield~~the performance of linseed yield under demonstration plot was found higher than that under farmers' practice during both consecutive years of demonstrations (2016-17 and 2018-19). The yield of linseed under demonstration was recorded 7.15 & 7.67 q/ha during 2016-17 & 2018- 19, respectively over farmers practice 3.83 & 3.81 q/ha. The yield enhancement due to technological intervention was observed at 86.7 % & 101.3 % over farmers' practice. The cumulative effect of the technological intervention of both the years~~,~~ revealed ~~on~~ an average yield of 7.41 q/ha, 94 % higher ~~over~~ than farmers' practice (3.82 q/ha). The year ~~to~~ -to-year variations in yield can be explained ~~on the basis of~~based on variations in prevailing social, economic, and climatic condition of the particular villages (Singh et al., 2021 and Singh *et al*., 2022).

Economic Parameter

Economic performances of ~~linseed~~ Linseed under cluster front line demonstrations were depicted in table 3. The inputs and outputs prices of commodities prevailed during both the years of demonstrations were taken for calculating cost of cultivation, net returns, and ~~benefit~~ benefit-cost ratio. The investment ~~on~~ in production by adopting recommended practices ranged from Rs.1113 to 13425/ha with a mean value of Rs.13269/ha over the farmers practice Rs. 9870/ha and Rs.9480/ ha during the demonstrations period. Cultivation of ~~linseed~~ Linseed under recommended practices gave a higher net return of Rs.8337- Rs. 9737 compared to Rs.1620- Rs. 1950/ha under farmers practice during 2016-17 & 2018-19, respectively. The average ~~benefit~~ benefit-cost ratio of recommended practices was 1.68, varying from 1.63 to 1.73 during the study period, and in farmers' practice was 1.19, ~~varying~~ ranging from 1.16 & 1.21. This may be due to higher yields obtained under recommended practices ~~compared to farmers~~than farmers' practice. Similar results have been reported earlier by Tomar, 2010~~,~~ ; Patel *et al*., 2014 and Singh *et al.*, 2016.

Technology gap, Extension gap, and Technology Index

Technology Gap

The technology gap shows the gap in the demonstration yield over potential yield and the average technology gap was 10.59 qt/ha during the study period (Table 2). The trend of technology gap ranging between 10.85 and 10.33 qt/ha in 2016-2017 and 2018-2019, respectively, and it reflects the farmers' cooperation in carrying out such demonstrations with encouraging results in subsequent years. The frontline demonstrations were laid down under the supervision of KVK Scientists at the farmer's field. The technology gap observed might be ~~attributing~~ attributed to the dissimilarity in soil fertility status, local climatic situations, varietal suitability, and adoption of technological practices. The technology gap impl~~y researchable issues for realization of potential yield, while the extension gap imply~~ies researchable issues for potential yield realization, while the extension gap implies what can be achieved by the transfer of existing technologies. Mukharjee (2003) ~~have~~ has also opined that depending on the identification and use of the farming situation, specific interventions may have ~~greater~~ more significant implications in enhancing system productivity. Similar findings were also recorded by Katare *et al*. (2011) and Singh *et al.*, 2022.

Extension Gap

Extension gap is a parameter to know the yield differences between the demonstrated ~~technology~~ technology and farmer's practice, and observed data was depicted in table 2. The extension gap ranging 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~~emphasized the need to educate the farmers through various means to adopt 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 to the farmers to disenchantment~~disenchant the farmers, discontinu~~ance of~~ing old varieties with the new ~~technology~~technology. The results a~~re in agreement with research worker Patel *et al*., (2013), who stated that, location based problem identification and thereby specific interventions may have great implications in the enhancement of~~gree with research worker Patel et al., (2013), who stated that location-based problem identification and, thereby, specific interventions may have great implications in enhancing crop productivity.

Technology Index

The technology index showed the ~~feasibility of the evolved technology~~ evolved technology feasibility at the farmer's fields. ~~Higher~~ The higher technology index reflected the insufficient extension services for technology transfer~~transfer of technology~~. The lower value of technology index shows the efficacy of the ~~good~~ excellent performance of technological interventions. The average technology index was ~~observed~~ 58.84 per-cent under cluster front line demonstration (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 t~~echnology index shows that the farmer's interest in adopting technology is increasing~~he technology index shows that the farmer's interest in adopting technology increases. This variation indicates that results differ according soil fertility status, weather condition, non-availability of irrigation water, and insect-pests attack in the crop. The ~~results of the present study~~present study results a~~re in consonance~~lign with the findings of (Patel *et al*. 2014, Singh *et al*. 2021 & Singh *et al*. 2022).

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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 at 30 days after sowing.	No weeding	Full gap
8	Irrigation	Fields were irrigated prior 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 sprays 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

Table 2: Growth and yield parameters, Technology gap, Extension gap, and Technology index of ~~linseed~~ Linseed as affected by recommended practices as well as ~~farmer’s~~ 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**