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Enhancement of Productivity and Profitability of Sesame (*Sesamum indicum* L.) through Involvement of Scientific Recommended Cultivation Practices under Front Line Demonstrations (FLDs) in Sidhi District of Madhya Pradesh

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ABSTRACT: Farm Science Centre also known as Krishi Vigyan Kendra, which conducted Front Line Demonstrations in the program of AICRP on Sesame & Niger in the year 2019 to 2021 incorporating newly released improved variety "TKG 306" and applying scientific cultivation practices in their crop production. Sesame productivity and economic returns in enhanced technology were calculated and compared to the practices of the corresponding farmers (local check). Among recommended crop production techniques of sesame ICM gave the highest yield of 645 kg/ha followed by 579 kg/ha (Plant Protection), 481 kg/ha (Sowing method) and 469 kg/ha (Improved variety TKG 306) as compare to farmers practice and overall average of all the recommended practices (544 kg/ha) gave higher yield over farmers practice (304 kg/ha). Same trends were observed in with respect to growth and yield attributes. The maximum production was 6.45 q/ha in the Front Line Demonstrations plot, and 2.98 q/ha in farmers' practice. Despite a rise in sesame yield, there was a technology gap, an extension gap, and a technology index. The highest net return from recommended practice were observed of Rs 32076/- in ICM followed by Rs. 27951/- (Plant protection), Rs. 23857/- (Sowing method) and Rs. 22148/- (Improved variety) comparison to farmer practice i.e. Rs 12114/, (ICM) followed by Rs. 11867/- (sowing method), Rs. 11514/- improved variety (TKG 306) and Rs. 11175/- plant protection respectively. The difference in percent increase in yield was discovered to be linked to a lack of information and a bad socioeconomic situation. With this study, it was found that the FLDs programmes were effective in changing attitudes, skill, and knowledge of enhanced package and practices of HYV of sesame adoption under sustainable agriculture practices.

Keywords: Frontline Demonstration, Technology gap, Extension gap, Sesame.

INTRODUCTION

Sesame is one of the oldest crops known to humans. There are archeological remnants of sesame dating to 5,500 BC in the Harappa Valley in the Indian subcontinent (Bedigian and Harlan, 1986). Sesame (*Sesamum indicum* L.), which is variously known as sesamum, til, simsim, benised, gingelly, gergelim etc. and one of the most important oilseeds crops, extensively grown in India. Sesame plays an important role in agricultural and industrial economics of our country. Sesame stand next to groundnut so far as the production of edible oil is concerned. Sesame was cultivated on an area of 17.78 lakh ha with production of 8.11 lakh tonnes and productivity of 456 kg/ ha during 2014-15 (Anonymous, 2016). Sesame is "the queen of the oilseed crops" by virtue of the excellent quality of the oil, flavor, taste and softness. Its oil content generally varies from 46 to 52%. Nutrient management is an old concept in traditional agriculture because of low nutrient turn over in soil plant system (Meelu and Singh 1991). Sesame plant is highly susceptible to water logging and can therefore only thrive during moderate rainfall or when irrigation is carefully controlled in drier regions. The plant is highly resistant to drought for having tap roots, and can provide good harvests even under stored soil water (Jahan and Abdullah-Al-Mamun, 2021). Among the important oilseed crops widely grown in the world such as rapeseed, peanut, soybean, sunflower, sesame (*Sesamum indicum* L.) provides one of the highest and richest edible oils (Pathak *et al.,* 2014).

The Technology Mission on Oilseeds was established in 1986 with the goal of creating/managing conditions that would allow the best of production, processing, and storage technologies to be used to achieve edible oil self-sufficiency. The Mission was able to make significant progress within a decade, and this shift was dubbed the "Yellow Revolution." India's oilseed output is presently anticipated to reach 25.5 million tonnes. India is one of the top five producers of oilseeds in the world. In India, nine edible oilseeds are grown, with sesame coming in fifth (about 0.8 million tonnes), behind groundnut, rape seed, soybean, and sunflower. Sesame seeds were one of the first crops processed for oil as well as one of the earliest condiments (de Carvalho *et al.,* 2001). Seed color can vary, though they are usually beige or creamy white when husked. Sesame oil, other than its use as cooking medium, has certain industrial applications as it is used to make hair oil, hydrogenated oil and certain medicines (Salunkhe *et al.,* 1991; Suja *et al*., 2004; Quasem *et al.,* 2009). Cultivating domestic demand for edible oil, along with the rise of sesame as a possible export commodity, presents farmers with an excellent opportunity to start growing this crop and be assured of a fair market value. However, there is a significant difference between the potential possible yield and the average sesame yield.

Nearly 72 percent of the area under oilseeds is rainfed, and input utilisation is low. Oilseed production is carried out across the country in about 26 million ha on marginal soils, reliant on monsoon rains. Sesame productivity is low due to the usage of low yielding cultivars (local), poor soil fertility, and nutritional imbalances (Engoru and Bashaasha, 2001). Agriculture extension services tailored to individual locations and needs are critical for small and marginal farmers, especially when the agricultural sector shifts from supply to market demand. The more advanced technology packages were also determined to be cost-effective. However, adoption rates for numerous aspects of the upgraded technology were low, highlighting the need for more widespread distribution (Kiresur *et al.,* 2001). Several biotic, abiotic, and socioeconomic restrictions prevent the yield potential from being realised, and these must be addressed.

Although the productivity of sesame in the Sidhi district is lower than the national average (285 kg/ha), it can be improved by using appropriate agronomic practices, such as high yielding varieties, integrated nutrient management, integrated pest management, and proper irrigation management, among other things. Farmers are using old and degraded seeds, local varieties with higher seed rates (i.e. 15-20 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.

There are several constraints, which need immediate attention of the planners and research managers. Major bottleneck of low productivity is that sesame is mainly grown in the kharif season under vagaries of monsoon, which is further aggravated by several pests and diseases (Sutaliya and Jakhar, 2020). Cultivated sesame still has some wild characters including seed shattering, indeterminate growth habit and asynchronous capsule ripening leading to a very weak seed yield (300–400 Kg/ha) (Islam *et al.,* 2016).

With this in mind, the current study was conducted to determine farmer awareness of sesame cultivation, the extent of adoption of better methods, and the yield gap in linseed production technology. Krishi Vigyan Kendra is a grass-roots organization dedicated to the use of technology by assessing, refining, and disseminating proven technologies in various micro-farming situations throughout the district (Das, 2007). Frontline demonstration has been proven to be a successful method in increasing linseed crop production and productivity by changing farmers' knowledge, attitude, and skill (Singh *et al.,* 2018). To propagate the technology in the district, cluster frontline demonstrations on sesame were held from kharif 2019 to 2021.

MATERIALS AND METHODS

With the launch of the technological mission on oilseeds and pulses, ICAR developed a new concept of field demonstration called Frontline Demonstration. Frontline demonstrations' major goal is to show freshly released crop production technologies and management approaches in the farmer's field. The present investigation was carried out during the kharif season in the adopted farmers' field on different modules during 2019, 2020 and 2021 by Krishi Vigyan Kendra of Sidhi district. In total 20 FLDs were conducted in 8.0 ha area during the years. During these study comprised four components of scientific production technologies viz. ICM, Improved variety TKG-306, Plant protection and method of sowing. No proper management of crops, locally cultivated varieties, no plant protection and broadcasting method of sowing were used as local check. The FLDs were conducted to study the gap between the potential yield and demonstration yield, extension gap and the technology index. In the present evaluation study the data on output of sesame cultivation were collected from FLDs plots, besides the data on local practices commonly adopted by the farmers of this region were also collected. Another issue in the district is the red, black soil with shallow depth and stony character present in undulated terrain. Choose tillage procedures that will keep the soil in the optimum physical condition for a beneficial crop's growth and development throughout land preparation. Plow and harrow the soil to a depth that will physically sustain the plant while also allowing it to use enough moisture and nutrients. It must also be deep enough to manage weeds and leave the soil surface level. A flat field enhances water efficiency, aids in crop weed management, and allows for rapid water disposal. Treatments for FLDs in the soil During the crop time, demonstration fields were taken utilizing trichoderma @ 5 kg/ha and plant protection measures. Sesame seeds were sown in rows and fertilizers were administered at a rate of 60:40:40:25 kg/ha of N: P: K: S. At sowing time, a 1/2 dose of nitrogen, a full dose of phosphorus, potash, and sulphur were administered. 2 to 3 days before sowing, seeds were treated with carbendazim at a rate of 2 g/kg seed. Weeds are easier to control during their early stages of growth. After two or three days after sowing, spray with pendamathlin at a rate of 3.5 l/ha. Each frontline demonstration occupied 0.4 ha of land, with the next 0.4 ha serving as a control (farmer's practice). By using a random crop cutting procedure, the primary data were acquired from the selected FLDs Farmers. Before harvesting, the plant's final height (cm) and other yield-related characteristics were measured. The crop was collected when it was fully mature. Extension gap, technology gap, and technology index were determined using the following formula presented by Samui *et al*., (2000); Dayanand *et al*., (2012):

% increase in yield = [{Demo yield – Farmers practices}/farmers practices] × 100

Technology gap = Potential yield – Demo yield

Extension gap = Demonstration yield – Farmers yield

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

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

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

Table 1: Analysis of existing and recommended practices under FLDs.

Sr. No.	Recommendation	Existing	Gap (%)
1	Improved variety TKG 306	Old variety and degenerated seed	Full gap
2	The importance of properly preparing the land in order to achieve a good tilth. It requires two to three ploughings.	Ploughing is limited to one or two passes, which prevents the soil from breaking down into small particles.	Partial gap
3	Based on the inadequacies identified, soil testing and application of basal fertilisers, farm yard manure (FYM), Azospirillum, Phosphobacteria, and micronutrients such as Zinc sulphate and Manganese sulphate. kg/ha 60:40:40:25	There is no soil testing. Normally, because it is cultivated as a residual crop, farmers do not apply fertiliser. If fertiliser is used, it is normally DAP at a rate of 10 kg per acre.	Full gap
4	Treating the seeds with Trichoderma, Azospirillum and Carbendazin/Thiram	Mostly farmers use their own farm produce and the seeds are not treated.	100
5	Using a seed drill, combine 2 kg of seeds with 4 kg of fine sand for seed disseminating or line planting.	Farmers use higher quantity of seeds	Partial gap
6	To maintain the desired population, weeding and thinning procedures are carried out. Weeding should be done twice, once during 15 DAS and once during 30 DAS.	No weeding	Full gap
7	Fertilizers are used as a top dressing and growth regulator. During the 35 DAS, urea is advised as a top dressing since it supplies enough nitrogen to aid in the plant's vegetative growth.	This is not practiced by farmers	Full gap
8	Correct detection of pests and diseases, as well as applying the appropriate management measures and removing diseased and afflicted plants, as well as determining the best time to harvest crops and pest protection post-harvest	No preventive measure is followed	Full gap

RESULTS AND DISCUSSION

A. Growth and yield attributing characters

During the three-year study period from kharif 2019 to kharif 2021, it was discovered that the use of better production methods in demonstration trials increased yields over farmers' practices. On an 8-hectare parcel of land with 20 demonstration plots, frontline demonstrations were held. With improved manufacturing technology, the growth and yield contributing metrics were boosted. On an average of three years study and four production technologies, the plant height, Number of capsules per plant and Number of seeds/capsules and test weight increase were observed 131.5 cm, 88.7, 76.9 and 2.93 g, respectively as compare to farmers practice (116.8 cm, 62.4, 62.5 and 2.09 g, respectively) depicted in Table 2. Among all four scientific production technologies ICM recorded highest plant height (133 cm), number of capsules per plant (91.4), number of seeds per capsule (80.3) and test weight (2.96 g) over other production technologies like improved variety, plant protection and sowing method (Singh *et al*., 2016).

B. Yield

Frontline demonstrations were conducted on 20 acre of land with 20 demonstration plots during kharif-2019 to kharif-2021 on sesame. The results indicates that the average yields of three years experiments, ICM gave the highest yield of 645 kg/ha followed by 579 kg/ha (Plant Protection), 481 kg/ha (Sowing method) and 469 kg/ha (Improved variety TKG 306). All the four component of production technologies gave higher yield over farmers practice (304 kg/ha). Same trend in yield were observed during the three years of study period. ICM (106.1%) had the highest percent improvement in production over farmers' practise, followed by plant protection (92.4), sowing method (57.7%), and improved variety TKG 306 (42.9) Table 3. The results show that the Frontline demonstration had a positive influence on the Sidhi area farming community, as they were inspired by the novel agro technologies used in the FLD plots. Yield of sesame was varied with different scientific technologies, which might have been due to improved variety, change in sowing method, proper insect and pest management. The highest yield observed in ICM this may be due to adoption of proper and complete agronomic management practices. These results are in conformity with the findings of Meena *et al.*, (2018); Patel *et al.*, (2014); Singh *et al.*, (2016).

Table 2: Growth and yield attributing character as influenced by different scientific crop production technologies under FLDs.

Technology	No. of Demo./ Year	Area/ Year (ha)	Average of three years (Kharif-2019 to Kharif-2021)							
			Plant height (cm)		Capsules/plant		Seeds/capsule		Test weight (g)	
			Demo	Check	Demo	Check	Demo	Check	Demo	Check
ICM	05	2.0	133	119	91.4	64.2	80.3	65.6	2.96	2.16
Improved Variety (TKG 306)	05	2.0	130	115	87.3	61.6	75.5	61.6	2.91	2.02
Plant Protection	05	2.0	131	116	89.2	62.4	76.4	62.4	2.94	2.10
Sowing Method	05	2.0	132	117	86.8	61.3	75.3	60.2	2.91	2.08
Total/ Average	**20/05**	**8.0/ 2.0**	**131.5**	**116.8**	**88.7**	**62.4**	**76.9**	**62.5**	**2.93**	**2.09**

Table 3: Yield influenced by different scientific crop production technologies under FLDs.

Technology	No. of Demo . / Year	Area/ Year (ha)	Kharif-2019		% Increase Over check	Kharif-2020		% Increase Over check	Kharif-2021		% Increase Over check	Average		% Increase Over check
			Yield (q/ha)			Yield (q/ha)			Yield (q/ha)			Yield (q/ha)		
			Demo	Check		Demo	Check		Demo	Check		Demo	Check	
ICM	05	2.0	6.32	3.10	50.95	6.69	3.10	53.66	6.34	3.19	98.74	6.45	3.13	106.1
Improved Variety (TKG 306)	05	2.0	4.70	2.98	36.59	-	-	-	4.69	2.99	57.72	4.69	2.98	42.9
Plant Protection	05	2.0	5.73	2.98	47.99	5.86	2.98	49.18	5.78	3.07	88.27	5.79	3.01	92.4
Sowing Method	05	2.0	4.80	3.00	37.50	-	-	-	4.82	3.10	55.48	4.81	3.05	57.7
Total/ Average	**20/05**	**8.0/ 2.0**	**5.39**	**3.02**	**43.26**	**6.28**	**3.04**	**51.42**	**5.41**	**3.09**	**75.05**	**5.44**	**3.04**	**74.8**

C. Economic Parameters

Table 4 shows the economic indicators of front line demonstrations, such as gross spending, gross returns, net returns, and BC ratio. The data clearly showed that the net returns from suggested practices were significantly higher than the check plot, i.e. farmers practiced in all demonstrations from kharif-2019 to kharif-2021. Plant protection (27951), sowing technique (23897), and enhanced variety (TKG 306) (22148) had the highest net return from recommended practice in ICM, followed by plant protection (27951), sowing method (23897), and improved variety (TKG 306) (22148) over check (farmers practice). Throughout the years of research, the same pattern emerged. The technological interventions provided in demonstration plots, such as balanced nutrition, sowing method, enhanced variety, and timely management of insect and diseases, are ascribed to additional revenue in ICM over all the prescribed practices and control checks. A cost-benefit study of the yield performance found that demonstration plots had a much greater cost-benefit ratio than control plots. The cost-benefit ratios for the exhibited and control plots were 3.79, 3.16, 3.49, and 3.23, respectively, and 2.30, 2.24, 2.21, and 2.29. As a result, favorable cost-benefit ratios demonstrated the economic sustainability of the demonstration intervention and persuaded farmers of its utility. The results clearly showed that ICM had the highest yield increase and the highest cost-benefit ratio of 3.79. The differences in cost-benefit ratios between scientific agricultural production technologies may be mostly due to yield performance and input-output costs (Patel *et al.*, 2014; Singh *et al.*, 2016).

Table 4: Economic Indicators as influenced by different scientific crop production technologies under FLDs.

Technology	Kharif-2019								Kharif-2020							
	Gross Cost (Rs.)		Gross Return (Rs.)		Net Return (Rs.)		BCR		Gross Cost (Rs.)		Gross Return (Rs.)		Net Return (Rs.)		BCR	
	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check
ICM	11475	9200	40972	20117	29497	11117	3.57	2.19	11475	9200	43385	20117	31910	11117	3.78	2.19
Improved Variety (TKG 306)	10277	9200	30492	19338	20215	10138	2.96	2.10	-	-	-	-	-	-	-	-
Plant Protection	11185	9200	37159	19338	25974	10138	3.32	2.10	11185	9200	38015	19338	26830	10138	3.39	2.10
Sowing Method	10277	9200	31128	19468	20851	10268	3.03	2.12	-	-	-	-	-	-	-	-
Technology	Kharif-2021								Average of three years							
	Gross Cost (Rs.)		Gross Return (Rs.)		Net Return (Rs.)		BCR		Gross Cost (Rs.)		Gross Return (Rs.)		Net Return (Rs.)		BCR	
	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check
ICM	11535	9200	46356	23309	34821	14109	4.02	2.53	11495	9200	43571	21181	32076	12114	3.79	2.30
Improved Variety (TKG 306)	10277	9200	34358	21790	24081	12890	3.36	2.37	10277	9200	32425	20564	22148	11514	3.16	2.24
Plant Protection	11185	9200	42235	22447	31050	13248	3.78	2.44	1118	9200	39136	20374	27951	11175	3.49	2.21
Sowing Method	10277	9200	35220	22666	26943	13466	3.43	2.46	10277	9200	33174	21067	23897	11867	3.23	2.29

D. Technology gap, Extension gap and Technology Index

During the study period as well as the average of the study periods, the technological gap, which correlates to the gap in the demonstration yield over potential yield, was 55 kg/ha for ICM, 231 kg/ha for better variety (TKG 306), 121 kg/ha for plant protection, and 219 kg/ha for sowing method. The disparity in technology exhibited in various scientific agricultural production technologies could be due to differences in soil fertility level and weather circumstances. As a result, it appears that location-specific recommendations are required to close the gap (Patel *et al*., 2014; Singh *et al*., 2016; Singh *et al*., 2021).

Table 5: Technology and Extension gap of the different scientific crop production technologies under FLDs

Technology	Potential Yield (q/ha)	Technology gap (q/ha)				Extension gap (q/ha)				Technology Index			
		Kharif-2019	Kharif-2020	Kharif-2021	Average	Kharif-2019	Kharif-2020	Kharif-2021	Average	Kharif-2019	Kharif-2020	Kharif-2021	Average
ICM	7	0.68	0.31	0.66	0.55	3.22	3.59	3.15	3.32	9.71	4.42	9.43	7.85
Improved Variety (TKG 306)	7	2.30	-	2.31	2.31	1.72	-	1.70	1.71	32.85	-	33.00	32.93
Plant Protection	7	1.27	1.14	1.22	1.21	2.75	2.88	2.71	2.78	18.14	16.29	17.43	17.29
Sowing Method	7	2.20	-	2.18	2.19	1.80	-	1.75	1.78	31.43	-	31.14	31.29

ICM had the highest extension gap of 332 kg/ha, followed by plant protection (271 kg/ha), sowing method (178 kg/ha), and improved variety TKG 306 (171 kg/ha), highlighting the importance of educating farmers through various means to encourage the adoption of improved high yielding varieties and improved agro technologies in order to reverse the trend of wide extension gaps (Patel *et al*., 2014; Singh *et al*., 2016; Singh *et al*., 2021)

The technology index demonstrates the viability of advanced technology on the farm. The lower the technology index value, the more feasible the technology is. The ICM has the lowest technology index (7.85), followed by plant protection (17.29), sowing method (31.29), and enhanced variety TKG 306 has the highest technology index (31.29). (32.93). During all years of the study period, as well as the average of the study periods, the same pattern was found. The greatest ICM technology rating implies that we can boost sesame productivity in this location if we use all scientific technology for crop development (Patel *et al*., 2014; Singh *et al*., 2016).

E. Constraints

Farmers identified access to credit as a restriction, as well as a lack of understanding in the application and practice of suggested agronomic practices. The constraints that were identified were as follows:

- Lack of quality seed materials for sowing;
- Low yield;
- Pests and diseases;
- Labor availability;
- Lack of knowledge of appropriate management procedures to achieve good yields
- High yield fluctuation within the field
- Natural occurrences
- Low sales returns

Seed treatment, seed drill use, thinning, insect control techniques, organic agricultural practices, and micronutrient application were among the knowledge gaps identified. Technical assistance and ongoing communication with farmers aid in the development of their confidence and the clarification of their concerns. Other external considerations, such as the vagaries of nature and labour availability, loans, locally available materials, and market volatility, are the key restraints that farmers confront. Farm mechanization might alleviate the strain, but farmers would have a tough time raising the necessary funds.

CONCLUSION

It is concluded from the study that through FLD of recommended technologies, yield of sesame can be increased to its potential yield in Sidhi district. This will substantially increase the income as well as livelihood of the farming communities. Major attention is to be made on development of area specific technology module for enhancing the productivity of oilseeds in various agro ecosystem of Madhya Pradesh.

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