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Impact of cluster frontline demonstrations on yield and economics of sesame (*Sesamum indicum* L.)

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Abstract

Indian Council of Agricultural Research (ICAR), New Delhi, initiated national level cluster frontline demonstrations (CFLDs) on oilseeds with the main objective of demonstrating the production potential of improved varieties and technologies in the farmers' fields. The present study evaluates the cluster frontline demonstrations (CFLDs) conducted by ICAR-ATARI, Hyderabad, Zone-10 on Sesame during 2017 to 2021. A total of 3562 CFLDs were conducted in 1425 ha area in 22 districts of Andhra Pradesh, Tamil Nadu and Telangana states for four years. The overall yield advantage of 1.78 q/ha was recorded in demonstration plots compared to the farmers practice with 29.49% increase in yields. Technology gap of 2.11 q/ha and technology index of 21.21% were registered. The net returns of 46557 Rs./ha and benefit cost ration of 3.03 were recorded in demonstration plots compared to 28923 Rs./ha and 2.24 in farmers practices respectively. The technological intervention with improved variety of sesame, technology package and good extension services by the KVKs resulted in enhanced production, productivity and profitability of the farmers.

Keywords: Sesame, cluster front line demonstrations, yield, extension gap, technology index, net returns

Introduction

Sesame (*Sesamum indicum* L.) is an ancient oilseed crop commonly known as gingelly and till. It is grown in both tropical and sub-tropical regions which has a large diversity in cultivars and cultural systems. This probably indicates a great opportunity for a prolonged and higher increase in productivity of sesame. It is globally grown in an area of 11.74 million hectares with a production of 6.01 million tonnes and productivity of 512 kg/ha. India is the largest producer of sesame in the world. It also ranks second in the world in terms of sesame-growing area (12.4%) with about 1.7 million hectares with a total production of 0.74 million tonnes and productivity of 431 kg/ha (FAOSTAT 2020) [1]. Sesame seed is a reservoir of nutritional components with numerous beneficial effects for health promotion in humans (Pathak *et al.*, 2014) [16]. Sesame seeds may be eaten fried, mixed with sugar or in the form of sweat meals and oil is used as a cooking oil in southern India. About 70% of world's sesame seed is used to produce oil and meal. Sesame cake is a rich source of protein, carbohydrates and minerals such as calcium and phosphorus. Worldwide sesame seed consumption was USD 6559 million in 2018 and it will reach USD 7244.9 million by 2024, with a CAGR (Compound annual growth rate) of 1.7% (Myint *et al.*, 2020) [13]. The average productivity of sesame continues to be lower in the range of 144 to 234 kg/ha, mainly due to cultivation of local varieties in marginal lands, poor management practices and non-adoption of improved production technologies. The greatest limitations of increasing in productivity of crop are inadequate supply of nutrients and poor production practices are poor in native fertility (Singh and Khan 2003) [22]. The main challenge for development departments is to bridge the gap between actual and attainable yield by enhancing farmers' access to quality inputs, improved technologies and information (Parthasarathy *et al.*, 2010) [15]. According to Piara *et al.*, (2006) [18] location specific integrated approaches would help to bridge the gap of the predominant crops grown in the target regions. The use of improved varieties and new production technologies are required to improve the soil health and offers a great scope for increasing productivity and profitability. The yield of sesame could be increased by 21 to 53% with adoption of improved technologies such as improved variety, recommended dose of fertilizer, weed management and plant protection (Govardhan Rao and Venkata Ramana 2017) [6].

To achieve the targeted production of oilseeds, the government of India has initiated Cluster Front Line demonstrations on Oilseeds under National Food Security Mission (NFSM). Accordingly, the ICAR-Division of Agricultural Extension, Indian Council of Agricultural Research (ICAR) has been organizing Cluster Front line demonstrations (CFLDs) on oilseeds since Rabi 2015-16 through Krishi Vigyan Kendras in the Country. To enhance sesame production, ICAR-ATARI, Zone-10, Hyderabad organized CFLDs on sesame crop in Andhra Pradesh, Tamil Nadu and Telangana states under National Food Security Mission (NFSM).

Materials and Methods

Cluster frontline demonstration is a unique approach by the Indian Council of Agricultural Research on Oilseed crops to provide a direct interface between scientists and farmers where farmers are guided by the Krishi Vigyan Kendra (KVK) scientists during demonstrations in implementation of improved technologies like seed treatment, IPM, INM, land preparation etc. The CFLDs were found very useful in increasing farmers' knowledge and adoption levels and created greater awareness and motivated the farmers to adopt appropriate oilseed production technologies (Patil *et al.* 2018 & 2019) [17]. The present study evaluates the performance of CFLDs on sesame organized by the KVKs under the supervision of the agricultural scientists of ICAR-ATARI, Zone-10, Hyderabad during 2017 to 2021. A total of 3562 CFLDs were conducted in 1425 ha area in 22 districts of Andhra Pradesh, Tamil Nadu and Telangana states for four years during Rabi and summer seasons. The varieties demonstrated were Sarada (YLM-66), JCS-1020, JCS 96 in Andhra Pradesh, TMV-7 and VRI-3 in Tamil Nadu and JCS-1020, Hima and Swetha Til in Telangana states based on the suitability. Each cluster had a minimum of 10ha area and each front line demonstration was laid out in 0.4 or 0.8 ha and farmers allotted some area for cultivating existing varieties with traditional crop cultivation methods.

Awareness programmers on the importance of improved varieties and new production technologies of sesame were conducted by the KVK staff before the start of the season at all locations. Literature on package of practices was distributed to farmers. Critical inputs like improved high yielding variety seed and bio fertilizers were provided to farmers and recommended package of practices were followed in an integrated crop management approach. KVK scientists visited the demonstration plots at regular intervals to provide need-based agro advisories and timely guidance to the farmers. The data on the growth, performance of the crop, pest and disease incidence, farmer's feedback was recorded from time to time to assess the comparative performance. Sesame crop yields were recorded from the demonstration and control plots at the time of harvest. The gross returns, net returns and B:C Ratio was calculated based on the prevailing prices of inputs and outputs. The technology gap, extension gap and technology index were worked out (Samui *et al.*, 2000) [20] as given below.

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - Farmers yield

Percent increase in yield = [(Demonstration yield - Farmers yield) / Farmers yield] X 100

Technology index = [(Potential yield - Demonstration yield) / Potential yield] X 100 Additional return = Demonstration return - Farmers practice return

Benefit-Cost ratio = Gross Return/Gross Cost

Results and Discussion

Yield Advantage

The data in Table 1 depicts the average yields of sesame obtained in 22 districts of Andhra Pradesh, Tamil Nadu and Telangana states. The overall yield of sesame was higher in demonstration plots (7.83 q/ha) compared with the average yields in farmers practice (6.05 q/ha) recording a yield advantage of 1.78 q/ha with 29.49% increase in yields. The average demonstration yield in Andhra Pradesh ranged from 3.49 q/ha to 11 q/ha whereas the farmer's yield ranged from 2.79 q/ha to 8.83 q/ha. The average demonstration yield in 6 districts of Tami Nadu ranged between 7.2 q/ha to 8.35 q/ha and 7.62 q/ha to 8.78 q/ha in Telangana whereas the farmer's yield ranged between 4.15 q/ha to 6.6 q/ha and 5.4 q/ha to 7.9 q/ha respectively.

The average demonstration yield of sesame was high in Telangana state (8.09 q/ha) compared to Andhra Pradesh (7.8 q/ha) and Tamil Nadu (7.61 q/ha) states. The average yield of sesame was higher in demonstration plots than the farmers practice in all three states which may be due to the adoption of improved varieties in place of local varieties and improved crop cultivation practices in an integrated approach. The difference in yields between the states and districts may be due to different agro-climatic conditions, soil fertility status, irrigation and socioeconomic conditions of the farmers. Meena *et al.* (2018) [11] reported that varietal demonstrations along with integrated cultural practices under CFLD programmer gave positive impact over existing farmers practices in enhancing crop productivity. Amit *et al.* (2020) [2] also reported that the yield of sesame was higher in front line demonstrations with the adoption of high yielding variety as compared to the local check. Kumar *et al.* (2023) [9] depicted that the average yield under demonstrated conditions was higher than the farmer's practices were due to use of recent technological inputs and improved package of practices.

Technology Gap

The technology gap indicates the gap between the demonstrations yield and potential yield. A technology gap of 2.11 q/ha was registered in Zone-10. The lowest technology gap of 1.06 q/ha was registered in Tamil Nadu whereas it was 1.81 q/ha in Telangana and 3.45 q/ha in Andhra Pradesh during the study period (Table 1). The technology gap observed may be attributed to dissimilarity in the soil fertility status, weather conditions, lack of good quality of seed, irrigation facility and location specific crop management practices. Hence the availability of quality inputs and location specific recommendation are necessary to bridge the gap between the potential and demonstration yields. Similar findings were reported by Bamboriya and Singh (2020) [3]. Kumbhare *et al.* (2014) [10] in their study found that the development of location specific package of practices like for soil testing, seed rate, seed treatment, plant population, foliar spray, irrigation schedule and methods, use of bio fertilizers and on-farm testing and demonstrations at farmers' field would be crucial technological interventions to reduce the technology gap.

Extension Gap

The Extension gap refers to the difference between demonstration yield and farmer's yield. The extension gap of 1.78 q/ha was registered during the four years from 2017 to 2021 in Zone-10. The highest extension gap of 1.99 q/ha was registered in Tamil Nadu whereas it was found to be 1.87 q/ha in Andhra Pradesh and 1.49 q/ha in Telangana (Table 1). The extension gap ranged between 0.88 q/ha and 3.02 q/ha in the districts under study (Figure 1) in three states emphasizes the need to educate the farmers regarding improved technologies like improved high yielding varieties and new agricultural practices by the extension personnel to reverse this trend of wide extension gap. Similar findings were reported by Dubey *et al.* (2018) [4], Dubey *et al.* (2022) [5] in pulses, Kumar *et al.* (2022) [8] in rapeseed and mustard and Kumar *et al.* (2023) [9] in pigeon pea. Singh and Gautam (2016) [21] opined that the extension gap in yield of sesame can be minimized by disseminating the technology package and upscaling the adoption percentage to increase production and productivity.

Technology Index

The technology index indicates the feasibility of new technology at field level. It is an important tool for judging the adoption and impact of different technologies (Kumar *et al.*, 2023) [9]. Lower the value of technology index, more is the feasibility of the technological intervention (Jeengar *et al.*, 2006) [7]. The technology index was recorded as 30.71% in Andhra Pradesh, 36.41% in Tamil Nadu and 18.30% in Telangana. The average technology index was 21.21%, which indicates the feasibility of the new technology with improved variety and integrated nutrient management followed in cluster front line demonstrations on sesame crop in the zone. The lower technology index of 2.22% in Guntur district of Andhra Pradesh and 2.71% in Tamil Nadu shows the closeness of demonstration yields to the potential yields and the feasibility of the improved varieties in those regions. The large variation in the technology index between different districts of the three states might be due to soil fertility, weather conditions and adoption level of the technology. Similar results on variation in technology index were reported by Naik *et al.* (2016) [14], Singh and Gautam (2016) [21], Meena *et al.* (2018) [11], Kumar *et al.* (2023) [9] and Meena *et al.* (2023) [12].

Economic Returns

The economic analysis of sesame cultivation was depicted in Table 2. The data related to the economics of CFLDs and control plots was presented as gross cost, gross return and net return. The economic viability of improved demonstrated technology over farmers practice was calculated depending on prevailing cost of inputs and output prices and represented in terms of benefit cost ratio (B:C Ratio). The overall average cost of cultivation of sesame in the zone was 23250 Rs./ha farmers practice and was 22914 Rs./ha in demonstrations. The net returns in the demonstration were registered as 46557 Rs./ha in demonstrations against 28923 Rs./ha in farmer's practice. The B:C ratio in the demonstration was calculated as 3.03 and was 2.24 in farmer's practice. Additional returns over the farmers practice were highest in Cuddalore district (57011 Rs./ha) of Tamil Nadu followed by Guntur district (33330 Rs./ha) of Andhra Pradesh (Figure 2). From the economic analysis it was evident that the net returns and B:C ratio were found to be high in CFLDs compared to control plots. The higher net returns and B:C ratio in the demonstration might be due to increased yields, higher market price because of the better quality of output by the adoption of improved technologies. These findings agree with Raikwar and Srivastva (2013) [19], Govardhan Rao and Venkata Ramana 2017 (2017) [6], Bamboriya and Singh (2020) [3], Amit *et al.* (2020) [2], Kumar *et al.* (2023) [9] and Meena *et al.* (2023) [12], who also reported the higher net returns and B:C ration in demonstrations compared to farmers practice in sesame crop.

Suggestions for reducing the yield gaps and increasing the returns in sesame

1. Availability of improved variety of seed before the commencement of season at reasonable rates.
2. Timely credit availability and remunerative price for the produce.
3. Organizing capacity building programmes and providing extension services to the farmers for creating awareness of improved varieties and latest production technologies.
4. Making latest information on technologies to be accessible to farmers through literature and mass media.

New HYV's by the farmers will subsequently change this alarming trend of galloping extension gap. The new technologies will eventually lead to the farmers to discontinuance of old varieties with the new technology.

Table 1: Yield gaps and varietal performance of sesame

Name of KVK District	Variety	Area (ha)	Demos (No.)	Yield (q/ha)			Yield Increase (%)	Technology Gap (q/ha)	Extension Gap (q/ha)	Technology Index (%)
				Potential	Demo plot	Farmers practice				
Andhra Pradesh										
Chittoor	Sarada (YLM-66)	30	75	11.25	7.27	5.32	36.65	3.98	1.95	35.38
East Godavari	Sarada (YLM-66)	90	225	11.25	7.12	6.10	16.66	4.13	1.02	36.71
Guntur	Sarada (YLM-66)	50	125	11.25	11.00	8.25	33.33	0.25	2.75	2.22
Kadapa	Sarada (YLM-66)	100	250	11.25	10.24	8.83	15.91	1.01	1.41	9.01
Krishna	Sarada (YLM-66)	70	175	11.25	8.05	6.35	26.77	3.20	1.70	28.44
Kurnool	Sarada (YLM-66), JCS-1020	90	225	11.25	9.07	7.10	27.80	2.18	1.97	19.36
Nellore	Sarada (YLM-66)	100	250	11.25	9.30	6.68	39.15	1.96	2.62	17.38
Prakasam	Sarada (YLM-66)	50	125	11.25	6.65	4.44	49.67	4.60	2.21	40.91
Srikakaulam	Sarada (YLM-66)	45	112	11.25	5.88	3.61	62.74	5.38	2.27	47.78
Visakhapatanam	Sarada (YLM-66)	220	550	11.25	5.60	3.94	42.11	5.66	1.66	50.27
Vizianagaram	Sarada (YLM-66), JCS 1020, JCS 96	60	150	11.25	3.49	2.79	25.09	7.76	0.70	68.98
West Godavari	Sarada (YLM-66)	90	225	11.25	9.89	7.69	28.64	1.36	2.20	12.06
Total		995	2487							
Average				11.25	7.80	5.93	31.56	3.45	1.87	30.71
Tamil Nadu										

Cuddalore	TMV-7	40	100	8.5	8.27	5.25	57.52	0.23	3.02	2.71
Karur	TMV-7	40	100	8.5	6.83	5.68	20.40	1.67	1.16	19.62
Perambalur	VRI-3, 2017	20	50	9	7.2	4.15	73.49	1.80	3.05	20.00
Salem	TMV-7	20	50	8.5	7.8	6.2	25.81	0.70	1.60	8.24
Theni	TMV-7	50	125	8.5	7.20	5.83	23.51	1.30	1.37	15.33
Villupuram	VRI-3, 2017	20	50	9	8.35	6.6	26.52	0.65	1.75	7.22
Total		190	475							
Average				8.67	7.61	5.62	35.45	1.06	1.99	36.41
Telangana										
Adilabad	JCS-1020, 2019	20	50	10	7.72	5.4	42.96	2.28	2.32	22.80
Karimnagar	Hima, Swetha til, JCS-1020	160	400	9.6	8.78	7.9	11.18	0.82	0.88	8.51
Nalgonda	JCS-1020	30	75	10	8.23	6.5	26.62	1.77	1.73	17.70
Warangal	Swetha til	30	75	10	7.62	6.6	15.45	2.38	1.02	23.80
Total		240	600							
Average				9.90	8.09	6.60	22.55	1.81	1.49	18.30
Zone Total		1425	3562							
Average				9.94	7.83	6.05	29.49	2.11	1.78	21.21

Table 2: Economic analysis of sesame cultivation under technological interventions and farmers practice

Name of KVK District	Variety	Economics								Additional Returns (Rs.)
		Farmers practice				Demonstration				
		Gross Cost (Rs/ha)	Gross Return (Rs./ha.)	Net Return (Rs./ha.)	B:C Ratio	Gross Cost (Rs/ha)	Gross Return (Rs./ha.)	Net Return (Rs./ha.)	B:C Ratio	
Andhra Pradesh										
Chittoor	Sarada (YLM-66)	24850	45192	20342	1.82	27057	61823	34767	2.28	14425
East Godavari	Sarada (YLM-66)	31250	65025	33775	2.08	28000	76167	48167	2.72	14392
Guntur	Sarada (YLM-66)	34250	61750	27500	1.80	31670	92500	60830	2.92	33330
Kadapa	Sarada (YLM-66)	31550	68732	37182	2.18	29330	77608	48278	2.65	11096
Krishna	Sarada (YLM-66)	13723	41482	27759	3.02	14235	54363	40128	3.82	12369
Kurnool	Sarada (YLM-66), JCS-1020	20758	65681	44923	3.16	23010	83833	60824	3.64	15900
Nellore	Sarada (YLM-66)	24500	72400	47900	2.96	25626	84767	59141	3.31	11241
Prakasam	Sarada (YLM-66)	19567	17583	-1983	0.90	20667	27999	7332	1.35	9315
Srikakaulam	Sarada (YLM-66)	12750	27193	14443	2.13	13000	44278	31278	3.41	16835
Visakhapatanam	Sarada (YLM-66)	16482	39101	22619	2.37	17908	55386	37478	3.09	14859
Vizianagaram	Sarada (YLM-66), JCS 1020, JCS 96	8425	20687	12262	2.46	8455	26032	17577	3.08	5315
West Godavari	Sarada (YLM-66)	17657	62719	45063	3.55	15325	77610	62285	5.06	17223
Total		255760	587544	331783		254282	762365	508083		176299
Average		21313	48962	27649	2.30	21190	63530	42340	3.00	14692
Tamil Nadu										
Cuddalore	TMV-7	27844	51661	23817	1.86	31547	112375	80828	3.56	57011
Karur	TMV-7	37150	64067	26917	1.72	32090	74143	42054	2.31	15137
Perambalur	VRI-3, 2017	19920	37350	17430	1.88	20134	66836	46702	3.32	29272
Salem	TMV-7	25600	63250	37650	2.47	26890	75432	48542	2.81	10892
Theni	TMV-7	20368	43654	23286	2.14	20361	51730	31369	2.54	8083
Villupuram	VRI-3, 2017	25485	62700	37215	2.46	26306	83945	57639	3.19	20424
Total		156367	322681	166315		157328	464462	307134		140819
Average		26061	53780	27719	2.06	26221	77410	51189	2.95	23470
Telangana										
Adilabad	JCS-1020	29862	38340	8478	1.28	28210	54848	26638	1.94	18160
Karimnagar	Hima, Swetha til, JCS-1020	20767	63411	42644	3.05	20939	78360	57421	3.74	14777
Nalgonda	JCS-1020	16500	58500	42000	3.55	15632	74070	58438	4.74	16438
Warangal	Swetha til	22375	54858	32483	2.45	20540	62613	42073	3.05	9590
Total		89504	215109	125605		85321	269891	184570		58965
Average		22376	53777	31401	2.40	21330	67473	46143	3.16	14741
Zone Total		501630	1125334	623704		496931	1496718	999787		376083
Average		23250	52173	28923	2.24	22914	69471	46557	3.03	17634

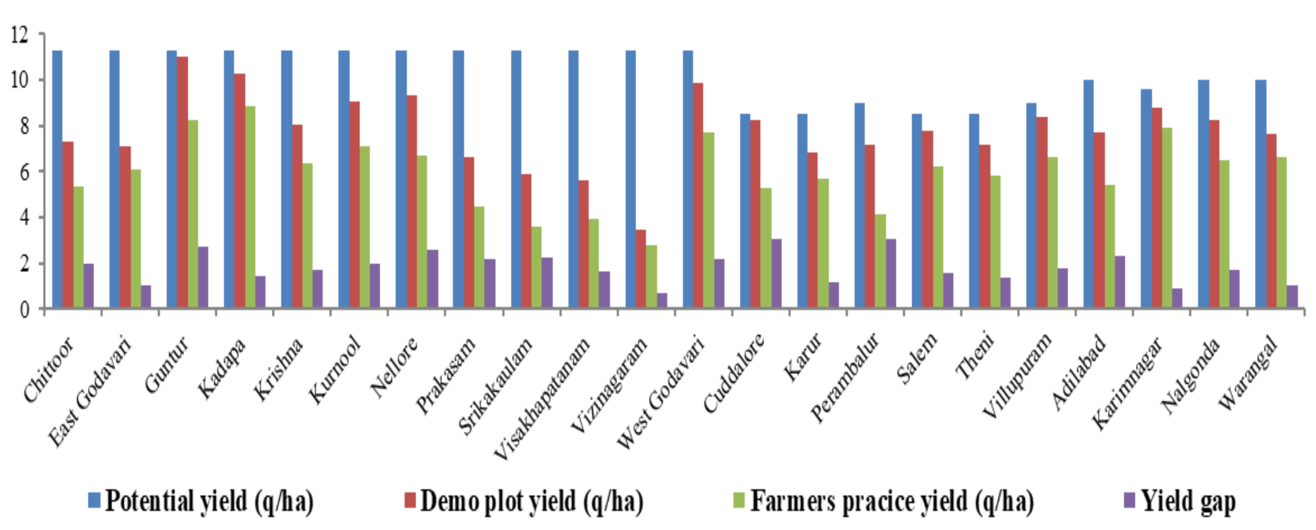

Fig 1: Yield comparison of sesame under farmers practice and demonstration plots

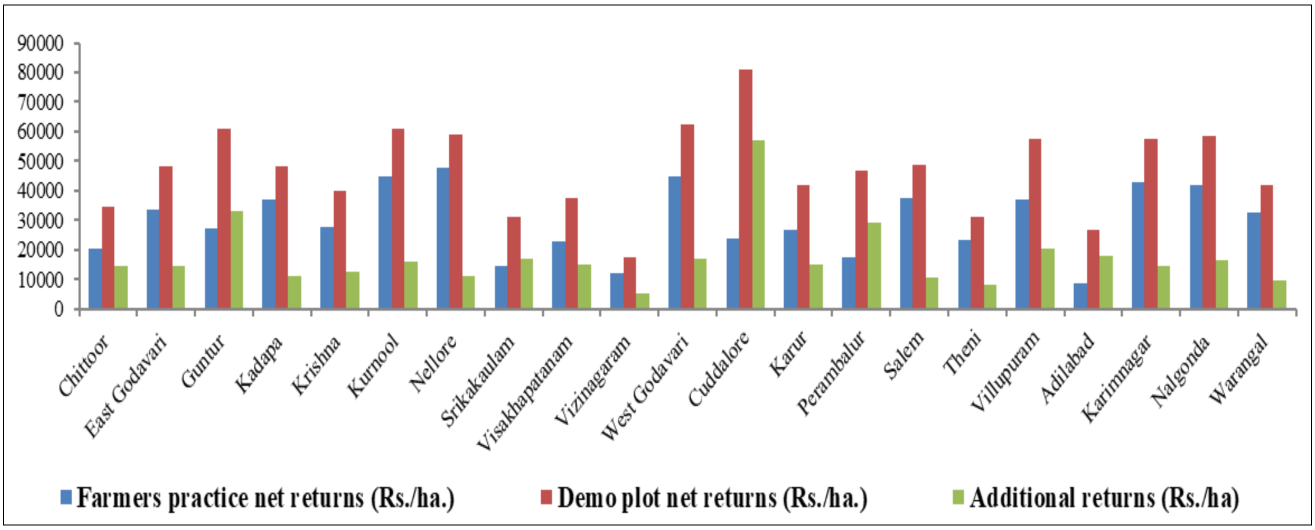

Fig 2: Economics and increase in net returns in demonstration plots in comparison with farmers plot

Conclusion

ICAR-ATARI, Hyderabad, Zone-10 comprising Andhra Pradesh, Tamil Nadu and Telangana states conducted 3562 CFLDs in an area of 1425 ha in sesame crop through the KVKs in 22 districts of Andhra Pradesh, Tamil Nadu and Telangana states. The results of this programmer for the four years from 2017 to 2021 revealed that there was an increase in the yields and net returns due to the use of improved varieties of sesame with recommended technological package in the demonstrations. The extension gap and technology gap can be minimized by educating the farmers and disseminating the technology on improved package of practices. Location specific technology recommendations, upscaling the adoption percentage and availability of quality inputs will increase production and productivity. The technology index (21.21%), increase in yields and net returns indicated the feasibility and economic viability of improved technology and usefulness of cluster front line demonstrations on sesame crop in zone-10. The higher results obtained CFLDs motivated other farmers to adopt recommended farming practices and the new technologies in sesame in the study area.

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