

Transforming mustard cultivation in Rajasthan

Field level experiences of cluster FLDs

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Indian mustard (Brassica juncea) is grown in India's diverse agro-climatic conditions under irrigated/rainfed, timely/late sown, saline soils, and mixed cropping conditions. It is a major player in the oilseed sector, and faces challenges in meeting the rising domestic demand for vegetable oils. In order to boost the oilseed production, one of the innovations in frontline extension approach implemented since 2015-16. Frontline demonstration in cluster mode was initiated by the Indian Council of Agricultural Research under National Food Security Mission to bridge the yield gap by demonstrating improved agricultural practices at farmers' fields under the supervision of the agricultural scientists. During rabi 2022-23, total 3,151 Cluster Frontline Demonstrations (CFLDs) were undertaken to demonstrate the full packages of practices, including improved varieties, integrated nutrient management, and pest control. The CFLDs resulted in a significant yield increase of 22.36% over farmers practices, with an average yield of 17.61 q/ha and a net return of ₹68,816.81/ha. During 2022-23, KVKs could add ₹9.22 crores to the state's economy through these CFLDs. Results also indicate significant inter and intra-variety variations in the yield as well as yield gaps in mustard across the districts. RH-749 variety followed by RH-725 and DRMR 2017-15 (Radhika) were exceptionally effective varieties in Rajasthan. Hence, these varieties should be promoted through widespread extension programmes in the state. The success of CFLDs highlights their potential as a scalable and effective extension approach to boost the oilseed production and reduce India's dependency on imports.

Keywords: Cluster frontline demonstrations, Income enhancement, Mustard, Yield gap

India holds fourth position in the global production and consumption of oilseeds. It shares about 10% of the total oilseed production globally and consumes around 24-25 million tonnes of edible oil annually. While edible oils are essential in human diets, providing necessary calories and nutrients, the oilseed sector is also a major economic driver, employing over 10 million people worldwide. Its by products like oil cake are integral to cattle feed and organic fertilizers. In India, nine annual oilseed crops including seven edible oilseeds (groundnut, rapeseed & mustard, soybean, sunflower, sesame, safflower, and niger) and two non-edible oilseeds (castor and linseed) are grown in diverse

agroecological conditions. The consumption of mustard oil is about 40% of all other edible oils (Ministry

of Agriculture and Farmers' Welfare (MA&FW), 2023). The total acreage under mustard during 2022-23 was



Scientist-Farmer interaction at farmer's field (KVK, Bharatpur)

88.5 lakh ha with a total harvest of 126.4 lakh tonnes at 1,428 kg/ha productivity. India is the fourth largest producer of mustard after Canada, Germany, and China. This crop is predominantly grown in Rajasthan, Madhya Pradesh, Uttar Pradesh, and Haryana. Rajasthan is India's mustard state having a share of 46.1% of the total production (Directorate of Oilseed Development, Hyderabad, 2022-23).

Demand and supply of oilseeds

India's oilseed sector has grown dynamically over the past three decades, with a 4.1% annual growth rate. Domestic production, increasing at 3.89% annually, has not kept pace with rising demand driven by a 6% yearly growth in per capita edible oil consumption. As a result, India imports about 60% of its edible oil needs. Mustard oil leads the market with a 40% share, followed by refined oil at 38% and groundnut oil at 7%. The NITI Aayog report (2024), titled *"Pathways and Strategies for Accelerating Growth in Edible Oils Towards the Goal of Atmanirbharta,"* highlights a sharp rise in India's per capita edible oil consumption, now at 19.7 kg/year. In 2022-23, India imported 16.5 million tonnes (MT) of edible oils, with domestic production meeting only 40-45% of the demand. This poses a significant challenge to achieving self-sufficiency in edible oils. Under a Business-As-Usual (BAU) scenario, the national supply is projected to reach 16 MT by 2030 and 26.7 MT by 2047. The NITI Aayog report (2024), titled *"Crop Husbandry, Agriculture Inputs, Demand & Supply,"* projected that edible oil demand in 2019-20 was 22.5 MT, while production stood at 11.6 MT. Under the Business-As-Usual (BAU) scenario, production is expected to double to 24 MT by 2047-48, assuming a 24% average recovery from oilseed crops. Edible oil from secondary sources is projected to grow at 3.76% annually, consistent with the growth rate from 2011-12 to 2019-20. In a High-Yield Growth (HYG) scenario, higher growth rates in oilseed yield (2.87%) and secondary sources (4.51%) could increase production to 33 MT by



Performance of DRMR 2017-15 (Radhika) variety at farmer's fields in Jaipur-I

2047-48. Total demand is expected to reach 27 MT by 2030-31 and 31 MT by 2047-48 in the BAU scenario, with slightly higher demand under high economic growth.

India's reliance on rainfed oilseed cultivation and lower productivity compared to global standards presents challenges. However, with growing domestic demand, the potential rewards are significant. Notably, imported oils, except palm oil, are included in demand estimates, though some are used for industrial purposes. Increased funding for oilseed programmes is essential to boost domestic production, meet rising demand, and reduce imports.

Cluster FLDs in participatory mode

A special programme for the demonstration of new varieties through Krishi Vigyan Kendra (KVKs) to promote the adoption of new varieties of mustard was initiated under the National Food Security Mission (NFSM) through a collaborative project of ICAR-DAFW in 2015-16. CFLDs is a novel approach over individual and isolated FLDs and technology application research for popularization of the latest notified/released varieties along with the full package of practices on a cluster of farmers' fields of a village or more villages. This enables to demonstrate the potentiality of technologies with scale to participating farmers

as well as the farmers of adjacent villages and other agencies. The robustness of precision in outcomes of technology dissemination is enhanced due to economy of scale, and so is the opportunities for performance analysis and the feedback of practitioners. The frontline extension agencies in Rajasthan under ICAR-Agricultural Technology Application Research Institute, Zone-II, Jodhpur have been implementing CFLDs on mustard. During *rabi* 2022-23, CFLDs on 1,340 ha area with involvement of 3,151 farmers covering Rajasthan were conducted. Full packages of practices of mustard including newly developed varieties, sowing methods, seed treatment, integrated nutrient management (INM), use of micronutrients, bio-fertilizers, integrated pest, and disease management and intercropping, etc. were implemented.

Yield and yield gaps

To demonstrate the potential yields of nine leading varieties of mustard, FLDs were organized in cluster mode at farmers' fields (Table 1 and Table 2). In CFLDs, the average yield using improved varieties and practices was 1,761 kg/ha, resulting in a net return of ₹68,816.81/ha. In comparison, farmers' practices yielded 1,441 kg/ha and generated a net return of ₹51,888.55/ha. This results in a yield gap of 320 kg/ha (22.36%).

Table1. Performance of Mustard varieties during 2022-2023 in Rajasthan (n=3151)

Variety	KVK	Average yield- FPs (q/ha)	Average yield- CFLDs (q/ha)	Yield gap (%)
RH-725	Jodhpur-I	18.09	21.18	17.08
	Hanumangarh-I	15.34	17.55	14.41
	Hanumangarh-II	15.20	18.40	21.05
	Sriganganagar	15.34	19.70	28.42
	Bikaner-II	16.71	21.35	27.81
	Jaisalmer-II	12.65	16.30	28.85
	Sikar	16.25	18.61	14.52
	Sikar-II	13.50	17.86	32.30
	Nagaur-I	16.24	20.11	23.83
	Pali	12.50	20.51	64.08
	Sirohi	12.91	15.00	16.19
	Karauli	21.80	24.90	14.22
	Bhilwara-I	13.60	16.50	21.32
	Bhilwara-II	13.85	16.60	19.86
	Rajsamand	13.20	16.30	23.48
	Sawai Madhopur	15.54	18.79	20.91
Average		15.17	18.73	24.27
RH-761	Jaisalmer-I	12.30	15.27	24.17
	Chittorgarh	15.10	18.30	21.19
	Pratapgarh	15.60	18.80	20.51
Average		14.33	17.46	21.96
DRMRIJ-31	Jalore-I	13.85	19.25	38.99
	Baran	15.40	18.10	17.53
	Barmer-I	10.54	12.92	22.58
	Churu-II	14.70	17.50	19.05
	Dausa	17.00	20.52	20.71
	Alwar-I	16.60	19.30	16.27
Average		14.68	17.93	22.52
DRMR-1165-40	Bikaner-I	13.33	16.02	20.18
	Nagaur-II	13.05	15.10	15.71
	Jalore-I	13.39	17.25	28.80
	Alwar-II	14.40	16.13	12.04
	Udaipur-I	10.30	15.55	50.97
	Udaipur-II	13.50	15.30	13.33
	Jhalawar	11.73	15.62	33.16
	Bharatpur	17.42	20.22	16.05
	Dholpur	18.27	21.70	18.80
	Pali-II	18.41	22.35	21.40
	Tonk	17.40	20.80	19.54
Average		14.65	17.82	22.73
DRMR 2017-15	Jaipur-I	18.63	22.46	20.56
	Jaipur-II	18.35	20.45	11.44
	Ajmer	13.97	18.74	34.14
	Dungarpur	10.08	12.29	21.92
	Kota	14.59	16.93	16.04
Average		15.12	18.17	20.82
PM-30	Barmer-II	13.20	16.30	23.48
	Jhunjhunu	15.01	16.42	9.40
Average		14.10	16.36	16.02
PM-32	Bundi	12.82	15.25	18.95
CS-60	Churu-I	13.23	15.96	20.63
RH-749	Jodhpur-II	15.63	20.85	33.37
Overall Average		14.41	17.61	22.36

Yield variability in districts/varieties

Substantial intra-district and intra-variety as well as intra-district and inter-variety variations were observed in the performance of mustard under FP as well as CFLDs. A much wider intra-variety variation of 0.92 to 31.07% in productivity was recorded under FP against the variation of 0.61 to 8.95% under CFLDs. The intra-district and intra-variety variations for CFLDs in Hanumangarh, Bhilwara, and Sikar were 4.62%, 0.61% and 4.20% for the mustard variety RH-725, respectively. The highest intra-district and intra-variety variation was shown by mustard variety DRMR 2017-15 (8.95%) and the lowest variation was recorded for mustard variety RH-725 (0.61%). These, intra-variety variations highlight the influence of local environmental conditions, management practices, and other factors on the performance of variety. While, some varieties show relatively stable performance across different locations (e.g. PM-30), others like RH-725 and DRMR-1165-40 exhibit more variability, suggesting a higher sensitivity to local conditions. These values indicate that yields in farmers' practice (FP) and the improvements from CFLDs vary significantly across districts and varieties. Similarly, highest intra-district and inter-variety variation under CFLDs was shown in Barmer district (26.16%) with two varieties DRMRIJ-31 and PM-30, and the lowest variation under CFLDs was shown in the Jodhpur district (1.56%) with two varieties namely RH-725 and RH-749. Varieties such as RH-749 and DRMR 2017-15 may offer higher yields with lesser variability. The magnitude of yield increase varied depending upon the districts and varieties. The management of natural resources and other yield-maximizing options shall have to be put in place in the production cycle for realizing the potential harvests from the HYVs. Mustard variety RH-749 proved the best performing which should be promoted by state department of agriculture.

Table 2. Economics of FPs and CFLDs on mustard in Rajasthan during 2022-23 (n=3151)

KVK	Economics of FP (₹/ha)				Economics of CFLDs (₹/ha)			
	Cost of cultivation	Gross return	Net return	B:C ratio	Cost of cultivation	Gross return	Net return	B:C ratio
Jodhpur-I	32,580.00	90,300.00	57,720.00	2.77	36,260.00	105,900.00	69,640.00	2.92
Hanumangarh-I	33,171.00	81,700.00	48,529.00	2.46	32,172.00	93,366.00	61,194.00	2.90
Hanumangarh-II	29,000.00	85,880.00	56,880.00	2.96	30,000.00	103,960.00	73,960.00	3.47
Sriganganagar	27,300.00	86,671.00	59,371.00	3.17	28,500.00	111,305.00	82,805.00	3.91
Bikaner-II	28,160.00	94,391.91	66,231.91	3.35	29,240.00	120,642.57	91,402.57	4.13
Jaisalmer-II	28,650.00	71,472.50	42,822.50	2.49	30,860.00	92,095.00	61,235.00	2.98
Sikar	28,375.00	89,375.00	61,000.00	3.15	28,925.00	102,355.00	73,430.00	3.54
Sikar-II	32,500.00	76,275.00	43,775.00	2.35	33,750.00	100,909.00	67,159.00	2.99
Nagaur-I	34,550.00	97,914.60	63,364.60	2.83	35,750.00	120,973.98	85,223.98	3.38
Pali	28,500.00	70,625.00	42,125.00	2.48	31,200.00	115,853.25	84,653.25	3.71
Sirohi	22,267.00	72,941.50	50,674.50	3.28	24,800.00	84,829.10	60,029.10	3.42
Karauli	32,300.00	123,170.00	90,870.00	3.81	34,900.00	140,685.00	105,785.00	4.03
Bhilwara-I	21,300.00	76,160.00	54,860.00	3.58	22,900.00	92,389.00	69,489.00	4.03
Bhilwara-II	20,643.00	77,549.00	56,906.00	3.76	22,434.00	92,948.00	70,514.00	4.14
Rajsamand	17,500.00	63,360.00	45,860.00	3.62	19,500.00	78,240.00	58,740.00	4.01
Sawai Madhopur	21,537.00	78,477.00	56,940.00	3.64	23,987.00	94,919.00	70,932.00	3.96
Jaisalmer-I	22,969.61	69,495.00	46,525.39	3.03	25,269.61	86,289.90	61,020.29	3.41
Chittorgarh	26,560.00	85,315.00	58,755.00	3.21	27,790.00	103,395.00	75,605.00	3.72
Pratapgarh	22,450.00	77,880.00	55,430.00	3.47	23,650.00	94,160.00	70,510.00	3.98
Jalore-I	41,302.00	72,526.00	31,224.00	1.76	41,632.00	101,494.00	59,862.00	2.44
Baran	24,800.00	87,010.00	62,210.00	3.51	23,838.00	102,265.00	78,427.00	4.29
Barmer-I	25,800.00	47,430.00	21,630.00	1.84	28,300.00	58,140.00	29,840.00	2.05
Churu-II	26,850.00	70,171.00	43,321.00	2.61	27,549.00	83,693.00	56,144.00	3.04
Dausa	52,330.00	87,350.00	35,020.00	1.67	50,032.00	105,100.00	55,068.00	2.10
Alwar-I	22,250.00	84,660.00	62,410.00	3.80	23,150.00	98,430.00	75,280.00	4.25
Bikaner-I	30,000.00	75,314.50	45,314.50	2.51	29,240.00	90,513.00	61,273.00	3.10
Nagaur-II	24,700.00	81,557.50	56,857.50	3.30	25,900.00	95,052.50	69,152.50	3.67
Jalore-II	28,945.33	75,672.33	46,727.00	2.61	29,673.33	97,462.50	67,789.17	3.28
Alwar-II	30,830.00	78,880.00	48,050.00	2.56	32,200.00	83,893.33	51,693.33	2.61
Udaipur-I	24,150.00	56,650.00	32,500.00	2.35	28,250.00	85,800.00	57,550.00	3.04
Udaipur-II	48,000.00	81,200.00	33,200.00	1.69	48,000.00	87,275.10	39,275.10	1.82
Jhalawar	23,100.00	63,315.00	40,215.00	2.74	24,650.00	86,667.00	62,017.00	3.52
Dholpur	42,525.00	102,830.00	60,305.00	2.42	41,680.00	122,605.00	80,925.00	2.94
Pali-II	25,273.06	100,769.39	75,496.33	3.99	26,079.80	121,790.82	95,711.02	4.67
Tonk	28,500.00	98,310.00	69,810.00	3.45	29,800.00	117,520.00	87,720.00	3.94
Bharatpur	43,790.63	104,694.19	60,903.56	2.39	40,203.00	120,493.00	80,290.00	3.00
Jaipur-I	25,700.00	105,260.00	79,560.00	4.10	27,950.00	126,899.00	98,949.00	4.54
Jaipur-II	27,810.00	90,833.00	63,023.00	3.27	28,540.00	101,228.00	72,688.00	3.55
Ajmer	27,800.00	66,960.00	39,160.00	2.41	28,450.00	89,952.00	61,502.00	3.16
Dungarpur	24,400.00	56,448.00	32,048.00	2.31	27,300.00	68,825.00	41,525.00	2.52
Kota	28,100.00	82,433.00	54,333.00	2.93	28,850.00	95,654.50	66,804.50	3.32
Barmer-II	25,400.00	71,940.00	46,540.00	2.83	29,300.00	88,835.00	59,535.00	3.03
Jhunjhunu	37,740.93	80,959.23	43,218.29	2.15	33,250.00	92,776.01	59,526.01	2.79
Bundi	27,000.00	72,700.00	45,700.00	2.69	28,500.00	86,000.00	57,500.00	3.02
Churu-I	33,842.00	72,102.00	38,260.00	2.13	35,978.00	96,558.00	60,580.00	2.68
Jodhpur-II	27,112.50	88,309.50	61,197.00	3.26	32,155.00	117,774.25	85,619.25	3.66
Average	29,094.87	80,983.42	51,888.55	2.88	30,268.21	99,085.02	68,816.81	3.36



Crop cutting experiment at farmer's field in Kota district

Income enrichment

The CFLDs with the recommended PoPs resulted in higher net return and benefit:cost ratio (₹68,817/ha and 3.36) than FPs (₹51,889/ha and 2.88). On an average, a yield advantage of 320 kg/ha was achieved by CFLDs adding to farmers' income by ₹16,928/ha. Improved varieties of mustard under CFLDs fetched distinct monetary advantages over farmers' saved seed/variety. Improved varieties proved advantageous in monetary returns by 7.58% with DRMR-1165-40 in Alwar-II conditions to 100.96% with RH-765 in Pali-I conditions. The implementation of 3,151 CFLDs over an area of 1,340 ha successfully reduced yield gaps by 320 kg/ha. This achievement significantly contributed to the state's economy

and generated an additional revenue of ₹9.22 crores.

Future prospects

Oilseed yields in India are notably lower than in other major producing countries, especially for minor crops. Many high-acreage states and districts also have low yields. Farmers often lack knowledge about efficient input use and technology, and face constraints such as limited education, resources, and access to quality inputs. Ensuring the supply of high-quality seeds, promoting efficient water use, and enhancing mechanized farming practices are essential steps to boost the yields and sustain natural resources. However, some of the policy issues to be addressed for are enhancing the mustard production.

- Targeting to increase oilseed yield in the states with higher oilseed area with low yield and higher yield gaps.
- Ensuring the timely supply of inputs (seed, fertilisers, etc), expanding seasonal irrigation coverage, and promoting pest-resistant, and high-yielding varieties.
- Prioritizing and understanding of region-specific factors to enhance the yield by investing in low-cost technologies, and providing targeted promotion, training, and cluster demonstrations for farmers/farm women.

SUMMARY

The cluster FLD approach is a highly effective tool for boosting crop production and productivity while encouraging farmers to adopt improved technologies and practices. It enhances farmers' knowledge, attitudes, and skills. Demonstration plots showed higher yields compared to farmers practices, and foster the strong relationships and confidence between farmers and scientists. Partner farmers served as valuable sources of information, produced the high-quality seeds, and facilitated farmer to farmer extension of high-yielding varieties. Mustard variety RH-749 followed by RH-725 and DRMR 2017-15 (Radhika) proved to be the best performing varieties in Rajasthan. These varieties should be promoted through widespread extension programmes. There is also need to increase the seed production of these farmers preferred varieties on both the extension farms and farmers' fields through a participatory approach. Efforts should also be intensified to develop high-yielding and climate-resilient varieties to support the diversification of oilseed production.



Cluster frontline demonstration of DRMR 1165-40

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