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Unveiling the Mustard Crop's Yield Potential Through Rashtriya Krishi Vikas Yojana Front Line Demonstration and Yield Gap Analysis in Eastern Vidarbha, Maharashtra

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ABSTRACT

Front-line demonstration constitutes one of the best methods accessible when it comes to technology assignment. The current study aims to identify the mustard [Brassica juncea (L.) Czern.] yield gap caused by FLDs. Four district demonstrations of the AICRP on Mustard were held during 2021–2022, 2022–2023 and 2023-2024 and were implemented in a number of villages in the eastern Vidarbha district for 800 farmers. The methods used by the majority of farmers were used as a control to compare them with advised methods. According to the average Three years data, the average yield of the exhibited plot was (617 kg/ha), which was higher than the control's yield of (347 kg/ha). Additionally, there was an additional yield of (269.31 kg/ha) and (78.38%) increase in average mustard productivity. The average index and technology gap were determined to be (48.60%) and (583.25 kg/ha), respectively. The range of the expansion gap was (163 kg/ha) to (437.92 kg/ha). Challenges such as variability in agro-climatic conditions, farmer compliance, and timely resource availability were encountered during implementation. Despite this, the study significantly contributed to validating the effectiveness of FLDs in enhancing mustard productivity, building farmer awareness, and identifying key technological bottlenecks that need refinement for broader adoption.

Keywords: *Oilseed, Technology gap, Extension gap, Farming methods, Technology gap, Extension gap, Technology index.*

I. INTRODUCTION

Oilseeds are the second-largest agricultural contributor in India after grains, occupying 14% of the country's cultivated land and accounting for 10% of the total agricultural value and 3% of the GDP. Among these, mustard and rapeseed are significant, with Indian mustard covering over 70% of the land dedicated to rapeseed-mustard cultivation. Other important varieties include toria, yellow sarson, and brown sarson. Globally, soy, oil palm, and rapeseed-mustard are the most crucial edible oilseeds. Due to a mismatch between domestic production and consumption, India relies on edible oil imports. Rapeseed and mustard are vital for small, rain-fed farmers, requiring minimal water (80-240 mm). These crops cover 6.8 million acres, mainly in northern and eastern India, with 30.7% grown under rain-fed conditions.

Despite its adaptability to various agro-climatic conditions, rapeseed-mustard cultivation in India faces challenges like fluctuating yields due to biotic and abiotic factors, and the domestic price support program. However, improved irrigation and soil quality, especially in areas like Eastern Vidarbha, make mustard cultivation viable.

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The region receives significant rainfall during the monsoon and has mild winter temperatures, making it conducive for mustard. Traditionally, farmers here grow mustard for personal consumption, using local varieties with low yields (1-2 Q./Acre). The decline in mustard cultivation over the past few decades is due to low productivity and unstable prices.

A project under the Rashtriya Krishi Vikas Yojana aimed to boost mustard production by introducing high-yielding, disease-resistant varieties and low-cost technologies. Implemented across four districts of Nagpur Division, the project doubled mustard cultivation from 1,511 hectares in 2021-22, 2,925 hectares in 2022-23 and 3,654 hectares in 2023-24.

II. MATERIAL AND METHODS

The Project was conducted by the All India coordinated research project on mustard, College of Agriculture, Nagpur, Maharashtra at 800 Farmers farm during the *Rabi* season of 2021-22, 2022-23 and 2023-24. Twenty-five farmers of one or two villages of each block were selected. The project were run in Koregaon, Chop, Kasavi, Sawalkheda, Wasa, Sawargaon, Shegoan, Mangali, Bembal, Mhatardevi, Khurshipar, Bidshitepar, Yetewai, Kesalwada, Jevnala, Jaitpur, Hardoli, Lohara, Lodhitola, Hiratola, Navegoan, Davva, Bori, Kunghada, Bollepalli, Murpar, Pendhari, Sawargaon, Sawalgaon, Torgaon, Bainwai, Bikali, Usagaon, Umari, Lendezari, Katurli, Navargaon, Bondgaov, Kahali, Usagaon, Khamari of villages of 40 blocks of Four districts (Bhandara, Gondia, Chandrapur and Gadchiroli) from Eastern Vidarbha. For the experiment, the mustard cultivar TAM-108-1, which is suited for timely sown irrigated conditions, was used.

A list of appropriate places at the respective villages was prepared before the On Farm Trail (OFT) by holding group meetings and site visits. An area of 0.40 ha was determined for each farmer, totalling 10 ha from block. Both the local check and the technology that was exhibited were conducted according to custom. The output data were gathered from the demonstrated and control plots and then the extension gap, technology gap, and technology index were calculated, along with the benefit-cost ratio. The following formulas were used to determine the percent increase in yield, technology gap, extension gap, and technology index.

The enlisted farmers were compiled from group meetings prior to conducting FLDs, and the farmers who were chosen received specialized training regarding a package of mustard practices. For improved crop cultivars the variation between the demonstration package and current farmer practices is listed (Table 1).

Improved technology includes the selection of new, high-yielding cultivars, line sowing, timely sowing, seed treatment, keeping an appropriate plant population, and providing advice on plant protection and plant protection measures [8]. The latter weeks of October and the first two weeks of November were dedicated to the sowing process. 45 X 10 cm was the spacing, and the seed rate was 4-5 kg/ha. The mean recommended dosage of fertiliser. On the other hand, 50 kg N and 40 kg P_2O_5 per hectare was the average recommended amount of fertiliser applied in the demonstration plots. In accordance with the findings of soil tests, fertilisers were applied. Fertilisers were applied for nitrogen, phosphorus, potash, and sulphur, using urea, DAP, MOP, and elemental S, in that order. A full dose of P_2O_5 elemental S and half of a dose of N were applied when the seeds were sowed, with the remaining N being applied during the initial irrigation. If required, first hand weeding inside lines and thinning were done between 15 and 25 DAS, followed by 45 and 50 DAS for second-hand weeding. The crops were appropriately plucked at the perfect time of maturity. The bulk of the soils in the study ranged in pH from 6.5 to 7.5 and had a silty loam texture. The AICRP on Mustard emphasised significant components in demonstration plots, including balanced fertilisation, timely weeding, high-quality seeds of superior varieties, need-based pesticide use, irrigation at critical times, and comparison with current practices (Table 1). The procedures for choosing the location and producers, as well as organising the demonstration, were followed as advised by [1].

For local checks, the customary procedures were upheld. The extension gap, technology gap, and technology index, in addition to the benefit-cost ratio, were calculated as proposed by [16]. the data input was obtained from both FLD plots as well as control plots.

Technology gap = Potential yield – Demonstration yield
Extension gap = Demonstration yield – Famers yield
Technology index = Technology / Potential yield x 100
* Recommendation Practices and ** Farmers Practices

III. RESULTS AND DISCUSSION

The data in Table 3 indicates annual variations in mustard yield in demonstration plots, with the yield over three years estimated at 617 kg/ha, significantly higher than the farmer's practice of 347 kg/ha. The highest yield was recorded in 2023–2024, while the lowest was in 2021–2022 (417 kg/ha). The percentage increase in yield over farmer's practices during this period ranged from 64.17% to 89.61%, with an average yield increase of 78.38% under the Front-Line Demonstration (FLD) plots. Similar findings have been reported by [22], [21], [19] and [20]. The data emphasizes the effectiveness of FLD in improving mustard yields in Eastern Vidarbha, Maharashtra, compared to traditional farming methods. During the research, a strong emphasis was placed on educating farmers through various approaches to address the wide extension gap and encourage the adoption of improved agricultural technologies.

The extension gap, representing the difference between farmer practices and established technologies, ranged from 163.00 to 437.92 kg/ha, with an average gap of 269.31 kg/ha over three years. This gap can be attributed to the implementation of superior technologies in the demonstration plots, which resulted in higher grain output than traditional methods. Using advanced production technologies along with high-yielding varieties like TAM-108-1 is expected to gradually reduce the extension gap. Prior studies by [6] and [1], [2] and [3] reported similar results.

The technology gap, which reflects the difference between potential and actual yields, was recorded at 783 kg/ha in 2021–2022, 762 kg/ha in 2022–2023, and 204.76 kg/ha with an average gap of 583.25 kg/ha. This gap can be explained by several factors, including the gradual feasibility of new recommended technologies over time. The technology index, representing the practicality of the demonstrated technologies, averaged 48.60% over the study period, indicating that the showcased technologies were largely feasible. A high technology index, however, suggests the need for further refinement and testing of the technologies to maximize yield potential in farmers' fields. This index highlights the limitations of the current package of practices, reflecting issues related to soil fertility, climatic conditions, varietal compatibility, and the adoption of advanced methods.

Reports by [9], [12], [15], and [17] similarly indicated that technologies tested in demonstrations showed promise but required further research and refinement. The participation of farmers in the demonstrations allowed them to interact with scientists and implement recommended practices, which likely contributed to the high success rates in mustard production under the FLD program.

In terms of economic analysis, the input costs for labour, herbicides, fertilizers, and seeds were considered crucial for both demonstration plots and farmer practices. The data on gross returns, cost of cultivation, net returns, and benefit-cost ratio (B:C) were calculated based on the prevailing input and output prices during the study. Over the three years, variations in economic returns were observed, largely influenced by grain yield and the Minimum Support Price (MSP) set by the government. During 2021–2022 to 2023-2024, a higher MSP sale rate and increased grain yield resulted in a higher Average Net Monetary Return (ANMR) of 29811 Rs/ha in recommendation practices from 15457 Rs/ha from farmers practices. The B:C for 2021–2022 to 2023–2024 was 1.67 to 2.81, respectively, reflecting improved returns under demonstration conditions due to scientific monitoring, timely crop management, and better technologies. The overall average B:C was 2.04, in line with findings from studies by [18], [13], [4], [5], [7], [10], and [23], who reported similar results for oilseed and pulse crops under FLD programs.

The study concludes that adopting scientific methods in mustard cultivation can significantly narrow the technological gap and increase yields in Eastern Vidarbha. The observed extension gap, which ranged from 163.00 to 437.92 kg/ha,

underscores the importance of educating farmers through multiple channels to encourage the adoption of improved agricultural practices. Furthermore, the technology index's average score of 48.60% indicates that the technologies demonstrated were feasible and performed well. However, a high technology index suggests the need for continued technological improvements and practice to optimize outcomes in farmers' fields.

Ultimately, the study emphasizes that front-line demonstrations play a crucial role in disseminating advanced technologies to farmers, enabling them to improve mustard yields. Progressive farmers, in particular, stand to benefit from these demonstrations as they can serve as sources of knowledge for their peers and suppliers of high-quality seeds for subsequent cropping seasons. The findings from this research are supported by studies conducted by [11], [14], and others, who have similarly highlighted the positive impact of FLD programs on agricultural productivity and farmer adoption of new technologies.

IV. CONCLUSION

The study concludes that the adoption of enhanced technologies in mustard cultivation has significantly boosted productivity, with an average yield increase of 78.38%. The integration of advanced practices, particularly the introduction of improved mustard varieties, has the potential to bridge the gap between available technologies and the existing extension gap in farming methods. As older, less productive varieties are replaced by newer, high-yielding ones, both production levels and net profitability are expected to rise. The recommended techniques have been well-received by farmers, indicating their suitability to the current farming environment, thereby confirming their practical applicability in real-world scenarios.

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Table.1 Comparison between recommended practices and farmers' practices under mustard crop

Sr. no	Particulars	Mustard crop	
		Recommended practices	**Farmers practices**
1.	Farming situation	Irrigated	Irrigated/rainfed
2.	Variety	TAM-108-1	Local
3.	Time of sowing	15 Oct to 15 Nov	Improper sowing time
4.	Method of sowing	Line sowing	Broadcasting
5.	Seed treatment	Thirum at 3gm/kg	Without seed treatment
6.	Seed rate	5 kg/ha	As per requirement of farmer
7.	Thining	15-20 DAS	No thining practice
8.	Fertilizer dose	NPK (50:40:00)	Improper fertilizer dose
9.	Irrigation management	Three irrigations at critical stages i.e seedling, flowering and siliqua development stage	Application of irrigation not considered in justification of critical stages
10.	Weed management	Preemergence such as pendimethalin application	No weed management
11.	Plant protection	Sulphur treatment for powdery mildew and dimethoate for aphid infestation	No plant protection
12.	Harvesting and threshing	Right away as the pods start to turn yellow and the seed moisture content reaches roughly 40%, the crop is harvested. At the time of storage, the seed need has a moisture level of less than 8%.	The shattering of grains is a result of harvesting overripe crops. Seed moisture levels at harvest and storage are not taken into consideration.

Table 2. Production potential and profitability of whole package demonstration on mustard during Rabi 2021-22, 2022-23 and 2023-24 in Eastern Vidarbha

Technology with a whole package of practices and improved Variety TAM-108-1										
***Rabi* 2021-22**										
	Seed yield		YI (%)	GMR (Rs/ha)		COC (Rs/ha)		ANR (Rs/ha)	B:C ratio	
	RP*	FP**		RP*	FP**	RP*	FP**		RP*	FP**
Bhandara District										
Bhandara	430	285	58	23207	15414	14520	13320	5593	1.60	1.25
Mohadi	475	354	34	25646	19103	14520	13320	4343	1.77	1.55
Lakhani	457	330	40	24654	17822	14520	13320	4632	1.70	1.45
Lakhandur	460	345	35	24831	18624	14520	13320	4008	1.71	1.51
Average	455	329	42	24585	17741	14520	13320	4644	1.69	1.44
Gondia District										
Deori	444	247	85	23993	13349	14520	13320	8444	1.65	1.08
Gondia	447	301	52	24121	16232	14520	13320	5688	1.66	1.32
Goregaon	449	309	48	24272	16710	14520	13320	5362	1.67	1.36
Sadak Arjuni	447	212	144	24138	11463	14520	13320	10675	1.69	0.93
Average	447	267	83	24131	14438	14520	13320	7543	1.67	1.17
Chandrapur District										
Bhadravati	402	280	48	21723	15135	14520	13320	4388	1.50	1.23
Mul	385	229	71	20803	12370	14520	13320	6233	1.43	1.00
Chandrapur	358	184	109	19348	9923	14520	13320	7225	1.33	0.81
Warora	412	231	99	22242	12468	14520	13320	7574	1.53	1.01
Average	389	231	82	21029	12474	14520	13320	6355	1.45	1.01
Gadchiroli District										
Wadasa	346	155	135	18710	8366	14520	13320	9144	1.29	0.63
Armori	369	179	124	19904	9655	14520	13320	9049	1.37	0.72
Kurkheda	408	226	87	22021	12221	14520	13320	8600	1.52	0.92
Gadchiroli	389	199	107	21015	10772	14520	13320	9043	1.45	0.81
Average	378	190	113	20413	10254	14520	13320	8959	1.41	0.77

***Rabi* 2022-23**										
Bhandara District										
Sakoli	627	328	106	33877	17738	23642	12460	13940	2.33	1.44
Tumsar	297	202	30	16019	10906	23642	12460	3793	1.10	0.89
Pawani	514	287	76	27734	15474	23642	12460	10324	1.91	1.26
Bhandara	646	355	91	34903	19151	23642	12460	13553	2.40	1.55
Average	521	293	76	28133	15817	23642	12460	10402	1.94	1.28
Gondia District										
Amgaon	441	223	95	23836	12031	23642	12460	9781	1.64	0.98
Tiroda	463	301	60	24997	16232	23642	12460	6565	1.72	1.32
Morgaon Arjuni	517	309	72	27916	16710	23642	12460	9006	1.92	1.36
Salekasa	481	208	168	25987	11247	23642	12460	12740	1.81	0.91
Average	476	260	99	25684	14055	23642	12460	9523	1.77	1.14
Chandrapur District										
Sindewahi	327	170	70	17646	9158	23642	12460	6904	1.22	0.74
Chimur	379	199	89	20456	10759	23642	12460	7761	1.41	0.87
Bhramhpuri	395	144	171	21332	7763	23642	12460	11809	1.47	0.63
Nagbhid	390	185	112	21083	9994	23642	12460	9329	1.45	0.81
Average	373	175	111	20129	9419	23642	12460	8951	1.39	0.76
Gadchiroli District										
Dhanora	383	155	168	20705	8366	23642	12460	11139	1.43	0.63
Chamorshi	378	179	163	20394	9655	23642	12460	9539	1.40	0.72
Mulchera	328	217	67	17738	11720	23642	12460	4818	1.22	0.88
Average	363	184	133	19612	9914	23642	12460	8499	1.35	0.74
***Rabi* 2023-24**										
Bhandara District										
Bhandara	995	557	81	53743	30096	19155	13807	18300	2.81	2.18
Average	995	557	81	53743	30096	19155	13807	18300	2.81	2.18

Table. 3. Grain yield and gap analysis of front-line demonstrations on mustard at farmer's field and Gross return (Rs./ha), Cost of cultivation (Rs./ha), Additional net monitory return (Rs./ha), and B:C ratio as affected by improved and local Technologies

Year	Area (ha)	No. Farmers	Seed yield (g/ha)		Increase (%)	Technology gap (kg/ha)	Extension gap (kg/ha)	Technology index (%)	Gross Return (kg/ha)		Cost of cultivation (kg/ha)		ANMR (Rs. /ha)	B:C ratio	
			RP *	FP**					RP *	FP**	RP *	FP**		RP *	FP**
2021-22	160	388	417	254	64.17	783.00	163.00	65.25	22539	6875	14520	13320	6875	1.67	1.18
2022-23	150	375	438	231	89.61	762.00	207.00	63.50	13151	9400	23642	12460	9400	1.63	1.00
2023-24	14	37	995	557	81.36	204.76	437.92	17.06	53743	30096	19155	13807	18300	2.81	2.18
Average	108	266	617	347	78.38	583.25	269.31	48.60	29811	15457	19106	13196	11525	2.04	1.45

**Recommendation Practices and ** Farmers Practices*

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