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Assessment of Yield Gaps and Economics through Frontline Demonstration on Cumin (*Cuminum cyminum*) Cultivation in Western Rajasthan

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ABSTRACT: The frontline demonstration is an effective and appropriate tool to demonstrate recommended technologies among the farmers. FLDs of cumin were conducted at farmers' field by Krishi Vigyan Kendra, Jodhpur-II (Rajasthan) during *rabi* season of 2018-19, 2019-20, 2020-21 and 2021-22. The FLDs on cumin crops covering 27.5 ha area of farmers' field to exhibit the latest crop production technologies and to compare with farmers' practices. A total of 55 frontline demonstrations were conducted on farmer's fields in four villages' *viz*., Sirmandi, Nosar, Sukhmandla and Bhande ki dhani of Jodhpur district. The findings of the study observed that the demonstrated technology recorded an average yield of 776 kg/ha which was 34.96% higher than farmers' practices (578 kg/ha). In percent terms, scaling in productivity following improved technologies ranged from 28.78 to 42.30 percent. Moreover, the average yield gap for extension, technology, and technology index was 199, 724 kg/ha and 48.30 percent, respectively. Improved technology also fetched an average gross return of (₹118933/ha), net return (₹84225/ha), and additional return (₹27376/ ha) as compare to farmers' practices. The FLDs of improved technologies also resulted in realizing a higher ICBR (8.77) with a B:C ratio of (3.40) as compared to the farmers' practices (2.80) during *rabi* season of 2018-19, 2019-20, 2020-21 and 2021-22. The FLDs conducted on cumin crop at farmers' fields observed that the adoption of improved technologies significantly enhanced the crop yield and the net returns as compared to farmers' practices.

Keywords: Frontline demonstration, Cumin, Profitability, Yield gap.

INTRODUCTION

One of the essential seed spices, cumin (*Cuminum cyminum* L.) is mostly farmed in India's desert regions, particularly in Gujarat and Rajasthan. India is the biggest producer, importer, and user of cumin worldwide. Cumin drops, oil, oleoresin, powder, and drinks are all utilized for therapeutic purposes. Cumin, a member of the Apiaceae family, is one of the most important seed spices. It is also a lucrative cash crop that is primarily grown in the Indian states of Gujarat and Rajasthan. Cumin, coriander, fennel, and fenugreek are among the more than 20 different seed spices that are produced. In 2022–2023, India would produce 11.26 MT of spices from an area of 4.31 Mha (DASD, 2024). Although seed spices account for 38.56 and 16.24 per cent of the country's total area (1.66 Mha) and production (1.83 MT), they only accounted for about 6 per cent of the country's production this year and were relatively low in productivity when compared to other horticultural crops and even the total number of spices. Thus, there is a need and opportunity to increase the productivity of seed spices using every technique available, primarily to close the current yield gap (Pagaria and Sharma 2019). However, because of the poor quality seed, careless fertilizer use, and inadequate plant protection measures, the crop's average productivity in this zone is extremely low. Due to the higher cost of cultivation, farmers are using chemical fertilizers, insecticides, and fungicides in huge quantities and without a recommendation for the cumin crop. They believe that this will enhance plant growth and production, but due to the higher cost of cultivation which will ultimately reduce their net profits.

For the reasons listed above, farmers' fields were used for these demonstrations of adopting improved HYVs of cumin (GC-4) with improved PoP in order to increase cumin productivity. There is a big need of adoption of improved agricultural practices of cumin crop by the farmers so that production and income can be raised. FLDs were started in cumin to generate production data and feedback information to various development agencies, which are engaged in dissemination of technological advances through researchers to the farmers' fields. For achieving better yields, selection of proper genotypes, optimum plant population, and improved production technologies are also additive factors and FLDs is an best method of transferring the newly technologies to farmers Singh *et al.* (2012): Patil *et al.* (2019). Through this, farmers learn the latest technologies of oilseeds and pulses production under the real farming situation in their field. Further, these demonstrations are designed carefully where provisions are made for speedy dissemination of demonstrated technology among the farming community through the organization of other supportive extension activities, such as field days and farmers' conventions. The FLDs' main objective is to demonstrate the most recent crop production and protection technology, together with crop management techniques, on farmers' fields across a range of agroclimatic zones and farming scenarios. Scientists must research the elements that lead to increased crop production as well as field production limits in order to generate production factor and feedback information while demonstrating technology in farmers' fields. To further influence the shown technology on farmers and field-level extension workers with a comprehensive set of practices, FLD is carried out on a ten-hectare parcel of land. Keeping in mind the above factors the present demonstrations was conducted to analyze the crop performance and to promote the frontline demonstration on cumin crop which would ensure livelihood and socio- economic status of farming community at faster rate.

MATERIALS AND METHODS

The present study was conducted in the jurisdiction area of Krishi Vigyan Kendra, Phalodi (Jodhpur-II) which falls in the Agro-climatic Zone Ia-Arid Western Plains Zone in the irrigated condition in the Jodhpur district of Rajasthan state. The participatory rural appraisal was carried out in each village before the selection of villages and respondents. A total of 55 FLDs were conducted on randomly selected farmers' fields in four villages of *viz*., Sirmandi, Nosar, Sukhmandla and Bhande ki dhani of Jodhpur district of Rajasthan, during *rabi* season of 2018-19, 2019-20, 2020-21 and 2021-22 in irrigated condition. Each demonstration was conducted on an area of 0.5 ha, and adjacent to the demonstration plot was kept as farmers' practices.

The demonstrations used a package of practices of improved technologies such as line sowing, nutrient management, seed treatment, and the full package. The varieties of cumin GC-4, was demonstrated in FLDs. The comparison of the scientific cultivation and farmers' practices are given in Table 1. In general, the soils in the demonstrated area were loamy fine to coarse, with medium to low fertility. Results concerning seed yield from FLDs plots and fields cultivated following local practices adopted by the farmers of the area were collected and evaluated. The potential yield was taken into consideration based on standard plant population and average yield per plant under a recommended package of practices as crop geometry. Different parameters as suggested by Yadav *et al.* (2004) was used for gap analysis, technology index, and calculating the economic parameters of cumin.

Estimation of productivity and yield enhancements. The random plot cutting technique was used to gather information on yields and farming techniques from the participating farmers, and personal interactions were then made. The yield gain in FLDs over farmers' practices was computed using the analysis formula proposed by Choudhary (2009):

% yield increase over farmer's practice =

$$\frac{\text{Average demonstration plot yield} - \text{Farmer's average plot yield}}{\text{Farmer's average plot yield}} \times 100$$

Estimation of gaps analysis & ICBR. The estimation of technology and extension gaps, technology index and other economic analysis was done this formula by Kadian *et al.* (1997); Samui *et al* (2000):

Extension gap = Average demonstration plot yield – Farmers' average plot yield

Technology gap = Potential yield –Average demonstration plot yield

Technology index = Potential yield —Average demonstration plot yield /Potential yield × 100

Additional cost (₹) = Demonstration cost (₹) – Farmers' practices cost (₹)

Effective gain = Additional returns (₹)–Additional cost of cultivation (₹)

Additional returns = Demonstrations returns (₹)– Farmers' practices returns (₹)

B:C ratio =Gross output/total costs of cultivation

ICBR =Additional returns /Additional cost

RESULTS AND DISCUSSION

Improved technology v/s farmer's practices: Before conducting of FLDs at the farmers' field, the participatory rural appraisal was undertaken. Based on this, the gap between farmers' practices and improved technology of cumin cultivation in the Jodhpur district of Rajasthan was worked out (Table 1). Among varying technology interventions, no gap was observed under the farming situation, whereas a full gap was observed under soil treatment, seed treatment and method of sowing. However, a partial gap was observed for the particulars *viz*., variety, seed rate, time of sowing, fertilizer, weed management and plant protection measures. The poor speed of extension equipment paired with unreachable public extension services or better technologies is blamed for these gaps in farmers' fields, particularly among smallholder farmers and other vulnerable populations (Das and Willey 1991; Badhala and Bareth 2013).

Impact of FLDs on seed production: To indicated (Table 2) that average demonstration yield of 850 kg/ha was recorded in 2020-21, followed by 845 kg/ha in 2021-22, 740 kg/ha in 2019-20, and 670 kg/ha in 2018-19 which were found higher over local check/ FP 660, 640, 520 and 490 kg/ha, respectively. It is clearly shown that 42.30 percent yield increase over farmers' practices during *rabi* season of 2019-20 followed by 36.73 percent in 2018-19, 32.03 percent in 2021-22, and 28.78 percent in 2020-21 due to the use of HYVs, better quality inputs and scientific backup by KVK specialists time to time. The level of yield is considerably low under local check /farmers' practices due to poor adoption of improved practices depending upon the amount of risk involved in terms of cost, skill, and knowledge about the improved practices. These findings conform to the results of a study carried out by Balai *et al.* (2012) in rapeseed and mustard crops, Sharma and Choudhary (2014) in wheat FLDs.

Gap analysis: Technology gap: The findings of the FLDs (Table 3) observed that a technology gap of 650 to 830 kg/ha was found between improved technology and farmers' practice and on an average basis the technology gap was 724 kg/ha during four years of demonstrations for cumin cultivation in Jodhpur district. Technology gap was maximum (830 kg/ha) with demonstrated variety GC-4 during 2018-19 and minimum with (650 kg/ha) during 2020-21. Similar findings were reported by Kumari *et al.* (2020).

Extension gap: The study of FLDs (Table 3) indicated that an extension gap ranging from 180 to 220 kg/ha was recorded between improved technology and farmers' practices during demonstrations. The extension gap was highest (220 kg/ha) during 2019-20 and minimum with (180 kg/ha) during 2018-19. On an average basis, the extension gap was 199 kg/ha during demonstrations for cumin cultivation in the Jodhpur district. These finding was with the findings of Meena *et al.* (2021).

Technology index: The study of FLDs (Table 3) indicated that the technology index for all demonstrations in the study was in the feasibility of the employing improved technology in the farmer's field. The lower the value of the technology index more is the feasibility of the employing improved technology. Results on the technology index showed that it varies from 43.43 to 55.33 percent during four years of demonstrations and the highest technology index was 55.33 percent and the lowest 43.43 percent was recorded during the year 2018-19 and 2020-21, respectively.

Economics: Different variables like a seed, fertilizers, bio-fertilizers, and insecticides were includes as cash input for the demonstrations as well as farmers' practices, and on average additional investment of ₹ 3120 per ha was observed under improved technology. The economics of improved technology as compared to farmers' practices were evaluated depending upon the local market price of input and output for the demonstrations year. It was found that the gross cost under cultivation of cumin range from ₹33400 to ₹35990/ha with an average ₹34708/ha under improved technologies. Whereas, the gross cost of cumin ranged from ₹30500 to ₹32730/ha with an average of ₹31588/ ha under farmers' practices. Improved technology have also higher net returns ranged from ₹57810 to 147000/ha with an average of ₹84225/ha under improved technologies. Whereas, the net returns of cumin varied from ₹33370 to 106850/ha with an average of ₹56849/ha (Table 4) recorded under farmers' practices. The average additional cost and net returns of ₹3120 and 27376/ha, respectively were recorded with the ICBR ratio of 8.77 (Fig. 1). On average, the benefit-cost ratio (BCR) under improved technologies and farmers' practices were 3.40 and 2.80, respectively. Higher additional returns and effective gains recorded through FLDs may be attributed to improved technology, non-monetary factors, timely crop cultivation operations, and scientific monitoring. Hence, favorable benefit-cost ratio proved the economic viability of the technology interventions made under demonstrations and motivated the farmers on the utility of interventions. Similar findings with that reported of Lal *et al.* (2013); Singh *et al.* (2013).

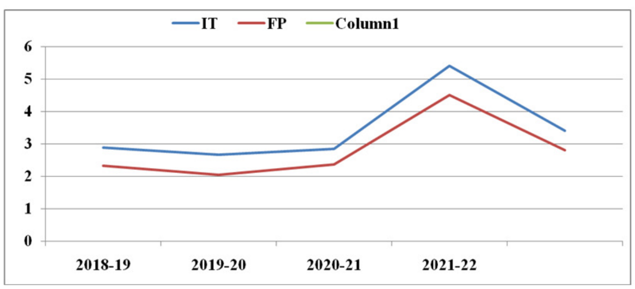

Fig. 1. ICBR of cumin demonstration in Jodhpur district of Rajasthan.

Table 1: Details of technology intervention and farmers' practices under FLDs on cumin in Jodhpur district of Rajasthan.

Technology Component/Particulars	Improved technology/ FLDs	Farmers' practices	Gaps
Farming situation	Irrigated	Irrigated	Nill
Variety	GC-4	Private cultivar (Dinkar & Avani)	Partial
Seed rate (kg/ha)	12 kg/ha	15-20	Partial
Soil treatment	Trichoderma @ 2.5 kg/ha cultured with 100 kg FYM	No use	Full
Seed treatment	Carbendazim 50 WP @ 2.0 g/kg Seed + Trichoderma spp. @ 4 g/kg Seed	No seed treatment	Full
Time of sowing	Mid November	First week of December	Partial
Method of sowing	line sowing, 30 cm (row to row)	Broadcasting	Full
Fertilizer management	30:20:15:10 (NPK Zn kg/ha)	No use of Potash and zinc	Partial
Weed management	Application of pendimethalin as pre-emergence and oxyfluorfen 50 gm/ha at 18-20 DAS followed by manual weeding at 35 DAS	Only use pendimethalin as pre-emergence	Partial
Plant protection	Aphid-Thiamethoxam 25 WG 100 gm/ha Blight- Thiophanate methyl 2 gm/lit Powdry mildew- Sulphur dusting 25 kh/ha	Products & chemicals suggested by local pesticide dealers	Partial

Table 2: Technical impact of cumin crop demonstrations during 2018-2019 to 2021-22.

Year	Variety	Technology Demonstrated	Area (ha.)	No. of Demo.	Potential yield (q/ha)	Yield under IT (q/ha)			Yield under FP (q/ha)	Increase in yield (%)
						Highest	Lowest	Average		
1	2	3	4	5	6	7	8	9	10	11
2018-19	GC-4	Timely sown HYV	5	10	15	700	640	670	490	36.73
2019-20	GC-4	Timely sown HYV	5	10	15	830	660	740	520	42.30
2020-21	GC-4	Timely sown HYV	5	10	15	1050	800	850	660	28.78
2021-22	GC-4	Timely sown HYV	12.5	25	15	1070	800	845	640	32.03
Mean	—	—	27.5	55	15	913	725	776	578	34.96

Table 3: Yield gap analysis of cumin under FLDs and farmer's practice during investigation year.

Years	Variety	Technology gap (Kg/ha)	Extension gap (Kg/ha)	Technology index (%)
2018-19	GC-4	830	180	55.33
2019-20	GC-4	760	220	50.66
2020-21	GC-4	650	190	43.43
2021-22	GC-4	655	205	43.66
Mean	—	724	199	48.30

Table 4: Economic analysis of FLDs on cumin.

Year	Average Cost of Cultivation (Rs/ha)		The additional cost in demo. (Rs/ha)	Average Gross Return (Rs/ha)		Average Net Return (Rs/ha)		Additional returns in demo. (Rs/ha)	Benefit-Cost Ratio	
—	IT	FP	—	IT	FP	IT	FP	—	IT	FP
2018-19	34750	31490	3260	100500	73500	65750	42010	23740	2.89	2.33
2019-20	34690	31630	3060	92500	65000	57810	33370	24440	2.66	2.05
2020-21	35990	32730	3260	102330	77895	66340	45165	21175	2.84	2.37
2021-22	33400	30500	2900	180400	137350	147000	106850	40150	5.40	4.50
Mean	34708	31588	3120	118933	88436	84225	56849	27376	3.4	2.8

CONCLUSIONS

It is concluded that FLDs were effective and appropriate methods for enhancing the production of cumin. The FLDs conducted on cumin at the farmers' field found that the adoption of improved technologies significantly improved the yield and also the net returns of the farmers. On average, higher gross return (₹ 118933), net returns (₹84225), ICBR (8.77), and benefit-cost ratio (3.40) were fetched under improved technologies over farmers' practices. Thus, it is necessary to spread the improved technologies among farmers through organized extension methods such as Kisan chaupal, on and off-campus trainings, field days, exposure visits, field visit demonstrations, and OFTs on local issues. Additionally, soil and water samples must be tested prior to demonstrations. In order to increase net returns and economic gains, farmers should be encouraged to implement the suggested set of activities. The engagement and trust between the KVK team and farmers were also improved by these demonstrations. As a result, the district's farming community's net income and socio-economic standing will both rise.

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