Research Article

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Consequences of front line demonstration of Tomato cv. Arka Rakshak in Pali district of western Rajasthan

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ABSTRACT

Tomato plays an important role in supplementing the income of small and marginal farmers of major area of the India. The main constraints of low quality and productivity of this vegetable in arid region of Rajasthan (India) may be due to partial adoption of improved production technology practices by the tomato growers. The present study was undertaken by ICAR-CAZRI, Krishi Vigyan Kendra, Pali-Marwar (Rajasthan) to address the yield gap through Front Line Demonstrations (FLDs) on tomato crop during three different years (2019-20, 2022-23 and 2023-24) at three selected villages (total 45 demonstrations) of the Pali district. Prevailing farmer's practices were treated as control for comparison with recommended practices. In the three years data it was observed that improved practices helped in managed the incidence of pest and diseases, increased productivity and quality of the produced. Due to this an average yield of 429.17 q/ha was obtained in demonstrated plot over control (364.23 q/ha) with an additional yield of 64.94 q/ha and the increasing the average tomato productivity by 17.75 per cent. The average extension gap and technology gap ware 64.94 q/ha and 320.83 q/ha, respectively, with the average technology index of 42.77 per cent during the demonstration years. Besides this, the demonstrated plots gave higher gross return (Rs. 5,31,871), net return (Rs. 3,60,704) with higher benefit cost ratio (3.08) when compared to farmer's practice. The performance of demonstrated package of practices even though after FLD programme, which shows positive impact of FLD on adoption of demonstrated production technology.

Introduction

Tomato (*Solanum lycopersicum*) is grown almost throughout the world including tropical and temperate regions. It is cultivated both in the green houses on protective structures as well as under natural conditions. It ranks first among processed vegetables. It is consumed fresh in salad, fried in culinary preparations and processed in various forms *viz*. Ketchup, sauces, puree, paste, powder, juice, soup and chutney etc. The fast foods such as pizza, burger, noodles, *etc*. will not taste the same without addition of tomato sauces. Tomato is a rich source of vitamins A and C and is referred to as "poor man's orange". It adds variety of colours to the food. Tomato is a very good appetizer and its soup is said to be a good remedy for patients suffering from constipation. Lycopene that imparts red colour to ripe tomatoes is reported to possess anti-cancerous properties. It also serve as a natural anti-oxidant as the Beta-carotene functions to help prevent

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and neutralize free radical chain reaction and ascorbic acid is an effective scavenger of superoxide, hydrogen peroxide, singlet oxygen and other free radicals. It is one of the most sensitive vegetable crops and fails miserably if growing conditions are too harsh. It is highly sensitive to frost and dry and hot weather results in flower drops and poor fruit set. In India during 2021-22 it was cultivated in 8.41 million hectare area with a production of 203.36 Lakh Tonne (Anonymous, 2021-22). In Rajasthan its area and production were 18,120 hectare and 88,730 tonnes respectively. In Rajasthan the productivity of tomato was recorded 4.90 t/ha, which was almost three time lower than the India's productivity *i.e.* 25.04 t/ha (Anonymous, 2017-18). Average productivity of tomato crop is quite low and there exists a good scope to improve its average productivity in Rajasthan as well as in India to fulfil both domestic and national needs. The growth, yield and fruit quality of tomato are largely dependent on number of interacting factors. On the other hand tomato is a long duration crop with high yield which removes large quantities of nutrients from the soil. Like macronutrients, micronutrients are equally significant in plant nutrition. There is a need to go for balanced fertilization of both macro and micronutrients since micronutrients play a profound role in various metabolic functions of plant. The other reason of low productivity it might be due to the unavailability of disease resistant varieties, the farmers of Pali district were facing a reduction in tomato yield as well as quality.

The main objective of front line demonstration (FLD) is to introduce suitable agriculture practices like high yielding varieties, disease resistant variety, seed treatment, spacing, timely sowing, nutrient management including micronutrients, growth hormones, pest and disease management etc. among the farmers accompanied with organizing extension programmes (field day) for horizontal dissemination of the technologies. FLD is playing a very important role for transfer of technologies and changing scientific treatment of the farmers by seeing and believing principle. In order to have better impact of the demonstrated technologies for farmers and field level extension functionaries, Front Line Demonstrations was conducted at farmer's field, in a systemic manner, to show case the high yielding new varieties, to convince them to about the potential of improved production technologies to enhance yield of tomato. Generally, the agricultural technology is not accepted by the farmers as such in all respects. There is always gap between the recommended technology by the scientist and its modified form at the farmer's level which is major absentee in the efforts of increasing agricultural production in the country. It is need of the hour to reduce this technological gap between the agricultural technology recommended by the scientists or researchers and its acceptance by the farmers on their field. In view of the above facts, front-line demonstrations were undertaken in a systematic manner on farmer's field to show the worth of improved practices and convince the farmers to adopt in their farming system.

Material and Methods

The Krishi Vigyan Kendra (Farm Science Centre), a cutting-edge scientific organisation, is crucial in connecting research experts and farmers. The primary goal of KVK, Pali is to shorten the time gap between technology production at the research facility and its distribution to the farmers in order to steadily increase productivity and income from the agricultural and related sectors. Front Line Demonstration is one of these powerful tools for technology transfer since it demonstrates in real life the power of new technologies to increase yield and profit. The purpose of the current study was to determine the effects of improved variety on Arka Rakshak (First F_1 hybrid with triple disease resistance to tomato leaf curl virus, bacterial wilt and early blight) with improved production technology on farmer households' socioeconomic development. The soil of the farmer's field was sandy clay loam in texture while depth of soil is moderate too deep about 50 to 75 cm. It is suitable for cultivation but for low rainfall and high evaporation causes saline (pH 7.93 to 8.20) nature. Organic carbon at the farm field soil ranges from 0.22 to 0.33% and Nitrogen in surface layer is low (231.75 to 277.00 kg/ha) whereas P_2O_5 (14.33 to 15.00 kg/ha) and K_2O (210.33 to 214.33 kg/ha) is medium. The mean minimum and maximum annual temperature was 4.1°C and 41.2°C, respectively and total mean rainfall was 323.21, 450.30 and 552.60 mm during the demonstration year 2019-20, 2022-23 and 2023-24, respectively.

In total, 45 demonstrations were conducted at 45 farmer fields in five chosen villages (Dayalpura, Kurki, Kanawas, Sinla and Ras) of the Jaitaran block of Pali (Rajasthan) where farming situation was irrigated medium soil. Every frontline demonstration was set up on 0.1 ha of land, with the nearby 0.2 ha serving as the comparison control (farmer's practise). By providing them quality training in various aspects of tomato production, technical guidance for agricultural inputs (seed of Arka Rakshak, fertilizers and plant protection) and marketing (harvesting, grading and packing) of tomato. To illustrate the results of the front line demonstration to the farmers of the same village and neighbouring villages, field days were also conducted in each cluster.

KVK scientists, collected information (data) from the demonstration and farmers' practice on production costs and returns through repeated field visits from front-line demonstration plots and farmers' execution plots and analysed with using simple statistical techniques. After that, average yield, extension gap, technology gap, technology index, cost of cultivation, net returns, and benefit–cost ratio were computed. An average of cost of cultivation, yield and net returns of different farmers was analysed by the formula as given below.

Table 1. Use of improved production technology of tomato in the study area and adoption gaps

S. No.	Practices (Technology intervention)	Demonstrated Improved practices (IP)	Farmer's practices
1.	Variety	Arka Rakshak (Triple disease resistant hybrid variety)	Private hybrids
2.	Soil testing	Have done in all locations	Not in practice
3.	Seed rate and sowing method	200 g/ha and line sowing in nursery bed	400-500 g/ha and broadcasting
4.	Seed treatment	Seed was treated with Carbendazim	Not in practice
5.	Neem cake application	Apply @ 250 kg/ha before final bed preparation	Not in practice
6.	Transplanting method	Transplanting in raised bed distance at 90 cm x 60 cm	Flat bed transplanting at 75 cm x 45 cm spacing
7.	Mulching	Follow the silver black plastic mulching	Not in practice
8.	Sowing & transplanting time	1st week of September & 2nd week of October	1st week of September & 2nd week of October
9.	Irrigation method	Micro/Drip system	Channel/ furrow method (surface irrigation)
10.	Fertilizer dose	On the basis of soil test recommendation	Application without recommendation
11.	Weedicide dose	Pendimethalin @ 1.0 kg/ha was applied immediately after transplanting	Hand weeding/ rarely used
12.	Training of plant	Stake the plant after 30 days of transplanting and remove the branches up to 30 cm height	Stake the plant at flowering stage and no removal of branches
13.	Multiplex nutrient spry	@ 2.5 g/ litter water and three (03) spray. First spray just before flowering, second spray during flowering or 25 days after first spray and third spray when fruits are bean size	No application of any type of supplement/ micronutrient
14.	Plant protection measures	Need based three spray of Imidacloprid 17.8 % SL or Thiamethoxam 25 WP (0.3 g/l) and other systematic fungicide	Irregular use of chemicals
15.	Other plant protection measures	Install of yellow sticky traps at appropriate period for indication of white flies and regular spray of neem oil	Not followed

Average = $[F_1 + F_2 + F_3 .....Fn] / N$ F_1 = Farmer, N = No. of farmers (45)

Gross return was calculated by multiplying yield into prevailing local market price of the fruit obtained by the farmers. The technology gap and technological index along with the benefit cost ratio were calculated by using following formula as given below.

The data thus collected were tabulated and statistically analysed (Kumar and Singh, 2023) to interpret the FLD's results.

Results and Discussion

The data were analysed, and the technology gap, extension gap, and technology index were calculated according to the formula and an economic analysis was performed according to procedure, with the results presented in Table 2 and 3.

Yield analysis

The perusal of data (Table 2) indicate that due to initiation of front line demonstrations the tomato yield ranged from 402.67 q/ ha to 454.34 q/ha in demonstration practice plots and from 351.78 q/ ha to 376.4 q/ha in farmer's practice plot in three years of demonstrations conducted. An average yield of 429.17 q/ha was obtained under demonstration practice plots as compared to farmer's practice plots 364.23 q/ha in

consecutively. The per cent increase in yield over farmer's practice was highest (20.70) during 2023-24. However variations in the yield of tomato in different years might be due to the variations in soil moisture availability, improved variety (Arka Rakshak), improved production techniques and change in the location of demonstrations every year. The average yield of tomato is increased by 17.75 per cent over the yield obtained under farmer's practices of tomato cultivation. The result revealed the positive effects of FLD over the farmer's practices as it enhanced the yield of tomato in Jaitaran block of Pali (Rajasthan). The improved tomato yield in the demonstration practices was attributed primarily to the use of improved hybrids Arka Rakshak with improved technologies such as seed treatment, mulching, transplanting methods, spacing, balanced nutrient application and spray including secondary and micronutrients, integrated pest and disease management, weed management and irrigation methods. The results confirm the findings in different crops by Misra *et al*. (2019), Chaitanya *et al*. (2020), Parmar *et al*. (2020), Rathod *et al*. (2022) and Singh *et al*. (2022).

Extension gap

Extension gap of 50.89, 66 and 77.94 q/ha was observed (Table 2) during 2019-20, 2022-23 and 2023-24 respectively. On an average extension gap in three years FLD programme was 64.94 q/ha. This emphasized the need to educate the farmers through various techniques for the adoption of improved agricultural production technologies to reverse this trend of wide extension gap. More and more use of latest production technologies like trellising in tomato with high yielding variety/hybrid will subsequently change this alarming trend of galloping extension gap. Similarly, extension gap in different location in front line demonstrations were documented by Misra *et al*. (2019), Chaitanya *et al*. (2020), Parmar *et al*. (2020), Rathod *et al*. (2022) and Singh *et al*. (2022) in tomato and other crops.

Technology gap

The technology gap, the differences between potential yield and yield of demonstration practice plots was 347.33, 319.50 and 295.66 q/ha (Table 2) during 2019-20, 2022-23 and 2023-24, respectively. On an average technology gap under three year FLD programme was 320.83 q/ha. This may be attributed to dissimilarities in soil fertility, salinity and to erratic rainfall and other vagaries of weather in the demonstration area. Hence, location specific recommendations may become necessary to narrow down the gap. These findings are similar to the finding of Singh *et al.* (2018), Rai *et al*. (2019), Misra *et al*. (2019), Yadav and Tripathi (2019) in other crops.

Technology index

The technology index shows the feasibility of the demonstrated technology at the farmer's field. The technology index varied from 39.42 to 46.31 (Table 2). On an average technology index of 42.77 per cent was observed during the three years of FLD programme, which shows the effectiveness of technical interventions. This accelerates the adoption of demonstrated technical interventions to increase the yield performance of tomato. The results of the present study are in consonance with the finding Singh *et al.* (2018), Rai *et al*. (2019), Misra *et al*. (2019), Yadav and Tripathi (2019), Rathod *et al*. (2022) and Singh *et al*. (2022). From these results it is evident that the performance of the technology demonstrated was found to be better than the farmer's practice under same environment conditions. The farmers were motivated by seeing the results in term of productivity and they are adopting the technologies. The yield of the front line demonstrations and potential yield of the crop was compared to estimate the yield gaps which were further categorized into technology index and technology gap.

Economic returns

In order to find the economic feasibility of the demonstration technologies over and above the control, some economic indicators like cost of cultivation, net return and B: C ratio was worked out. The economic viability of improved demonstrated practices over farmer's practices was calculated depending on prevailing price of inputs and outputs cost and represented in terms of B: C ratio (Table 3). It was found that the cost of production of tomato under demonstration practices varied from of Rs.1,51,200 to 1,92,200 per ha with an average of Rs.1,71,167 per ha as against Rs.1,42,300 to 1,84,500 per ha with an average Rs.1,63,650 per ha under farmer's practice. The additional cost increased in demonstration was mainly due to more cost involved in balanced fertilizer application, procurement of improved hybrid seed and IPM practices. The cultivation of tomato under improved technologies gave higher net return of Rs. 2,91,737 per ha, Rs. 3,46,500 per ha and Rs. 4,43,876 per ha in the year 2019-20, 2022-23 and 2023-24 respectively with an average net return of Rs. 3,60,704 per ha while in farmer's practices it was Rs. 2,86,789 per ha. The average additional net return was Rs. 73,915 per ha and the benefit cost ratio of tomato ranged from 2.92 to 3.30 in demonstration practice plots and from 2.66 to 2.85 in farmer's practice plots during three years of demonstration with an average of 3.08 in demonstration and 2.74 under farmer's practices. This may be due to higher yield obtained and lower cost of cultivation under improved technologies compared to farmer's practice. The B: C ratio was recorded to be higher under demonstration against control during all

the years of study. Extension agencies in the district need to provide proper technical support to the farmers through different extension methods to reduce the extension gap for better tomato production in the Jaitaran block of Pali (Rajasthan). These results are in accordance with findings of Singh *et al.,* (2018), Rai *et al.* (2019), Yadav and Tripathi (2019), Misra *et al.* (2019), Parmar *et al.* (2020), Rathod *et al.* (2022) and Singh *et al.* (2022) in different crops.

Table 2. Productivity and gap analysis of frontline demonstration of improved production technology of tomato

Years	Area (ha)	No. of farmers	Yield (q/ha)			Additional yield over FP (kg/ha)	Increase in yield (%)	EG (q/ha)	TG (q/ha)	TI (%)
			PY	DP	FP					
2019-20	3.00	15	750	402.67	351.78	5089.00	14.46	50.89	347.33	46.31
2022-23	2.40	12	750	430.50	364.50	6600.00	18.10	66.00	319.50	42.60
2023-24	3.60	18	750	454.34	376.40	7794.00	20.70	77.94	295.66	39.42
Average	-	-	750	429.17	364.23	6494.34	17.75	64.94	320.83	42.77

PY = Potential yield, DP = Demonstrated practice, FP = Farmer's practice, EG = Extension gap, TG = Technology gap, TI = Technology index

Table 3. Comparative B: C analysis of tomato under demonstration practice and farmer's practice

Years	Cost of cultivation		Gross return (Rs./ha)		Net return (Rs./ha)		Additional net return (Rs./ha)	B:C ratio	
	DP	FP	DP	FP	DP	FP		DP	FP
2019-20	1,51,200	1,42,300	4,42,937	3,86,958	2,91,737	2,44,658	47,079	2.92	2.71
2022-23	1,70,100	1,64,150	5,16,600	4,37,400	3,46,500	2,73,250	73,250	3.03	2.66
2023-24	1,92,200	1,84,500	6,36,076	5,26,960	4,43,876	3,42,460	1,01,416	3.30	2.85
Average	1,71,167	1,63,650	5,31,871	4,50,439	3,60,704	2,86,789	73,915	3.08	2.74

Average rate in 2019-20 = Rs. 1100/q, 2022-2023 = Rs. 1200/q and 2023-24 = Rs. 1400/q

Conclusion

The study clearly demonstrated that demonstration practice plots consistently achieved higher yields compared to farmer's traditional practices. This was primarily due to the adoption of a new variety, better knowledge dissemination, and the implementation of a complete package of improved practices. The FLDs significantly impacted productivity and profitability, highlighting the potential of modern technology in real farming conditions. The FLDs conducted by KVK, Pali, played a crucial role in the horizontal spread of improved tomato cultivation techniques. To further enhance technology adoption, targeted training programs on improved vegetable production techniques, coupled with multiple demonstrations, are essential. This approach can help overcome challenges in the existing technology transfer system in the Jaitaran block of Pali district, Rajasthan. The success of FLDs in tomato cultivation serves as an inspiration for non-tomato growers to embrace improved cultivation methods, ultimately contributing to the overall growth of vegetable farming in the region.

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Conflict of Interest

The authors have no conflict of interest.

Data Sharing

All relevant data are within the manuscript.

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