The Pharma Innovation Journal 2023; SP-12(8): 1776-1780

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(8): 1776-1780

www.thepharmajournal.com
Received: 01-05-2023
Accepted: 05-06-2023

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Adoption study on improved cultivation practices of tomato on yield and economics in Western part of Gujarat

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Abstract
An On-Farm Trial (OFT) was carried out by KVK, CAZRI, Kukma, Kutch (Guj.) for three consecutive years i.e. 2015-16, 2016-17 & 2017-18 to study the impact of improved practices along with high-yielding variety in tomato for adoption of improved cultivation practices at the farmer's field of three Talukas *viz*., Anjar, Bhuj and Nakhatrana of Kutch, Gujarat. For the three years study, a total 4.0 ha area was taken with the involvement of 10 progressive farmers. The fruit yield of the demonstration plot was 378.89 q/ha, 21.70% over the control practices (311.78 q/ha) used by farmer. The extension gap, technology gap, and technology index were 64.78 q/ha, 73.45 q/ha, and 15.80%, respectively. By the application of new techniques and high yielding hybrid variety, farmers profited with an extra income of Rs. 37232.67 per ha.

Keywords: Adoption, B:C ratio, Gujarat, improved practices, tomato, yield

Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop cultivated all over the world (Sun *et al*., 2014) [33]. Tomato contains high amounts of minerals, vitamins and lycopene which is beneficial for human health (Perveen *et al*., 2015) [21]. Tomatoes are most important plant species in the world for its economical value and vit-C rich properties (Stoleru *et al*., 2019) [30]. It has phenolic compounds, vitamin E, β-carotene and high antioxidant properties in our daily diets. (Vinson *et al*., 1998) [34]; (Wilcox *et al*., 2003) [35].

Tomato contains low levels of fat and is reported to have cholesterol-lowering effects; therefore, it is considered a healthy food in our diet. Tomato is also called "poor man's orange" as it has a high nutritional value and can be purchased by poor people (Singh *et al*., 2004) [26]. Tomatoes are botanically called as berry fruit, whereas it is count as vegetable for culinary purpose uses. The red colour in tomatoes is due to the high amount of lycopene pigment present (Marti *et al*., 2016; Perveen *et al*., 2015) [17, 21]. The prevalence of heart disorders is reported to be decreased by the high concentration of lycopene in blood cells (Sesso *et al*., 2004) [29]. The use of tomatoes in our diet reduces the inflammatory disorders like atherosclerosis (Hazewindus *et al*., 2014) [10]. The tomato fruit also used in various forms like raw in sandwiches and salads and in processed forms like ketchup, puree, syrup, paste, etc. (Bose *et al*., 2002) [5]. The soup is prepared for tomato fruit is a excellent remedy for constipation suffering patients because of presence good appetizer properties in the fruit (Kalloo *et al*., 2001) [13].

In the world it ranks second after potatoes, whereas in India it provides 3rd rank after potatoes and onions. China ranks 1st position, whereas India ranks 2nd position in both area and production in the world. Tomatoes are grown on 0.78 million hectares in India, producing 19.75 million tonnes with a productivity of 250 q/ha (Anonymous, 2018) [1]. The area, production and productivity of Gujarat state is 67751 ha, 1961.543 thousand tones and 280.95 q/ha (Anonymous, 2021-22) [2].

Western part of Gujarat farmers was growing tomatoes from many years by using old varieties and old package and practices. The development and use of hybrid varieties with desirable traits have been demonstrated to be a successful strategy for boosting tomato production and productivity (Islam *et al*., 2012) [12]. The climatic situations of arid Kutch is known for their uncertainty rainfall and high temperature. The parts of this region are "hot spot" of almost for all the biotic (insect-pest and diseases) and abiotic stresses (early or late onset of monsoon, erratic and unevenly distributed rainfall). The adoption of hybrid varieties is most suitable for ensuring better yield under such hard agro-ecological situations.

Keeping these in mind, we conducted OFTs on farmers' fields to highlight the significance of the use of high-yielding varieties and improved management techniques to increase productivity and increase net profit from tomato crop in arid parts of Gujarat. In the current study, we also investigated the yield gap, extension gap, technological gap, and technology index between OFT plots and farmers' practices.

Methodology

The current study was trailed on the farmer's field during *rabi* season for three consecutive years i.e. 2015-16, 2016-17 and 2017-18 by the KVK. The demonstrations were conducted on total 40 ha land which covered 0.4 ha for each beneficiaries. The beneficiaries were selected through village surveys, farmers meetings and group discussions. The drawbacks observed during these meetings and surveys for low productivity are unavailability of quality hybrid seed, lack of awareness about good agricultural practices and attacks of insect-pest and diseases were identified. The layout practices, selection of farmers and participation of farmers, etc. were carried out as per suggested by Choudhary (1999) [7]. In the farmers practices (control plots), we not change in any cultural practice as they adopt for the cultivation. For the conduction of trials we trained the farmers with improved package and practices. For the various parameters we collected the data from time to time in demonstrated as well as control (Existing farmer's practice). Table-1 lists the practices compared with existing farming techniques and adopted improved technologies in the study. Table-2 shows characteristics of the variety used under OFT plots. The soils of the study areas were sandy to sandy loam in texture, with a pH range of 8.0 to 8.5, EC ranging from 1.0 to 2.7 dS m^{-1}, and low levels of organic carbon.

Table 1: Particulars showing the details of farmers practice and improved practices

S. No.	Operation	Farmer's practice	Improved technology demonstrated	Gap
1.	Soil and water testing	Not in practice	Done before conducting the trials	Full gap
2.	Seed rate	200 g/ha	150 g/ha	Partial gap
3.	Seed treatment	None	Trichoderma @ 8g/kg seed	Full gap
4.	Sowing method	Flat Bed: 60x30 cm (RxP)	Raised Bed: 120 x 90 cm (R x P)	Partial gap
5.	Manure & Fertilizer application	Uncertain dose	FYM: 10-12 t/ha 250:250:250 (Kg N: P: K/ha) Neem Cake: 250 Kg/ha	Partial gap
6.	Weeding	One Hand weeding	Application of pendimethalin @ 1.0 kg/ha just after transplanting and one hand weeding	Partial gap
7.	Micronutrient spray	Not aware about spray	2 time foliar spray of micro mix @ 0.25% containing (Zn: percent, Cu: 0.5 percent, Fe: percent, Mn: percent & B:0.5 percent)	Full gap
8.	Plant Protection measures	Only chemical spray without recommendation	Integrated pest and Disease management practices applied	Partial gap
9.	Staking of plants	Not practiced	Staking with bamboos	Full gap

Table 2: Characteristics of Tomato variety adopted under OFT

Variety Name	Source of technology	Varietal characters
Arka Rakshak	IIHR, Bangalore	1. F_1hybrid, resistant to early blight, bacterial wilt, and the tomato leaf curl virus. Plants have a dark green foliar cover and are semi-determinate. 2. Fruits are round, medium to large (90–100 g), firm, deep red, and ideal for both fresh market and processing. 3. Fruits are uniform in weight, shape, colour, shelf life (15–20 days), and long transportability.

KVK scientists were also assisted the demonstration farmers from time to time for soil testing, seed treatment, nutrient application, transplanting on raised beds, spraying, weeding, plant protection measures and harvesting. The equations proposed by Sagar and Chandra (2004) [23] and Samui *et al.* (2000) [24] were used for calculating the various technical data.

"Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - yield under existing practice

Technology index = [(Potential yield - Demonstration yield)/Potential yield] x 100"

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return (Rs ha}^{-1})}{\text{Total cost of cultivation (Rs ha}^{-1})}$$

Results and Discussion

Fruit Yield

The fruit yield data of tomato obtained during three consecutive years (2015-16 to 2017-18) of OFT showed in Table 3. The data indicate that the fruit yield ranged from 368 to 397 q/ha in OFT plots and from 306.00 to 336.00 q/ha in control plots. The result also indicated the mean fruit yield of tomato (mean of 3 years) 378.89 q/ha and 311.78 q/ha for demonstration as well as farmers practice, respectively. The results shown in the table clearly demonstrated that the demonstration plots' higher yield over farmers' practices was the result of the adoption of the full package of practices, including the recommended fertiliser dosage, raised beds, mulching, yellow/blue sticky traps, and timely application of plant protection measures. The demo plots also exhibits an increased fruit yield (21.70%) on conventional farmers practice. The results of Singh *et al.* (2011) [28], Ashrafuzzaman *et al.* (2011) [3] and Summers and Stapletion (2000) [31] are in agreement with these results. Similar yield enhancement in different crops by the adoption of full package of practices has been documented under various frontline demonstration programmes documented by Hiremath *et al*. (2007) [11], Mishra *et al*. (2009) [18], Kumar *et al*. (2010) [15], Surywanshi and Prakash (1993) [32], Dhaka *et al*. (2010) [9] and Nagouajio *et al*. (2008) [20].

Table 3: Year wise production data of tomato in OFT programme

Year	Number of OFTs	Area (ha)	Yield (q/ha)		Additional yield over local check (q/ha)	Increased yield over local check (%)
			Demo Yield	Check Yield		
2015-16	3.0	1.2	368.00	306.00	62.00	20.26
2016-17	4.0	1.6	371.66	293.33	78.33	26.70
2017-18	3.0	1.2	397.00	336.00	61.00	18.15
Average		1.33	378.89	311.78	67.11	21.70

Table 4: Comparison of Extension gap, technology gap and technology index

Year	Number of OFTs	Technology Gap (q/ha)	Extension Gap (q/ha)	Technology Index (%)
2015-16	3	82.00	62.00	18.22
2016-17	4	78.34	78.33	17.40
2017-18	3	53.00	61.00	11.78
Average		73.45	64.78	15.80

Technology Gap
The technology gap observed during 2015-16, 2016-17, and 2017-18were 82.0, 78.34, and 53.0 q/ha, respectively. The average technology gap under the three-years OFT program was 73.45q/ha. The differences in the technological gap may be linked to variations in the soil's fertility, salinity, quality of irrigation water, surrounding microclimate, insect-pest risk, and individual management by a farmer, among other things. Therefore, to close this gap, location-specific recommendations are required. Hence, location-specific recommendations are necessary to bridge this gap. These calculated findings were also found by Singh *et al*., (2016) [27] in toria and Chapke (2012) [6] in jute.

Extension Gap
The data showed in Table 4 indicated a wide extension gap between the demonstrated and check plots from 61 to 78.33q/ha. This large extension gap indicated that there was a need to raise awareness among farmers with the improved package of practices to increase productivity level. This higher gap between demo yield and farmers' yield can be bridged by more use of the most recent upgraded technologies. The lowest (61 q/ha) extension gap was recorded in the concluding year 2017-18, indicating the greater adoption of superior technologies by the farmers. The studies of Bhoraniya *et al*. (2017) [4], Lal *et al*. (2013) [16] and Singh *et al*. (2011) [28] was in agreement with the findings of the present study.

Technology Index
The value of the technology index is always inversely correlated with the acceptability of the demonstrated technology; the higher the acceptability of the technology, the lower the value of the technology index. (Sagar and Chandra, 2004) [23]. As such, reduction in the technology index from 18.22 percent during 2015-16 to 11.78 percent during 2017-18 showing the feasibility of the demonstrated technology in this part of the state. An average of three years study OFT programme was 15.80 percent, which shows the effectiveness of technical implications. This facilitates the adoption of demonstrated technical interventions to increase the yield performance of tomato. Similar findings were conclude by Katare *et al*., (2011) [14], Reddy *et al*., (2018) [22], and Dayanand (2012) [8] in mustard.

Economic Analysis
Economic indicators, such as the cost of cultivation, net returns, and B:C ratio, were employed in order to determine whether the demonstrated technologies were economically viable relative to the local practises. Based on the cost of inputs and outputs at the time, the economic viability of the enhanced technology was estimated and represented in terms of the B:C ratio (Table 5). The cost of cultivation of tomato during study period varied from Rs. 67,300/- to Rs. 75,000/- per ha with an average of Rs. 69,266.67/- similarly in under farmers practice the cost varies from Rs. 62,200/- to Rs. 70,000/- with an average Rs. 64,233.33/-. The extra costs increased in the demo plot were due to extra cost involved in fertilizer application, purchase of hybrid seeds, pesticides and insecticides. After evaluation of economics (Table 5) in improved technologies, it was found that there was a greater gross return of (Rs. 242532) net returns (Rs. 172265.33) and benefit: cost ratio (3.39) compared with the local check. These findings can be ascribed to the technological interventions introduced during the on-farm trials conducted. Consequently, a favorable cost-benefit ratio and increased net returns have underscored the economic feasibility of the evaluated technology, compelling farmers to recognize its practical utility within actual farming scenarios. The B:C ratio was recorded to be higher under demonstration than control during all the years of study. The scientific cultivation of tomatoes, approached with recent management technologies, holds the potential to narrow the technology gap to a certain extent. This, in turn, could lead to increased tomato productivity within the district, thereby enhancing the economic well-being of the growers. Furthermore, the extension agencies operating in the district must provide comprehensive technical guidance to farmers through various means to bridge the extension gap and facilitate improved tomato production in the arid region of Gujarat. These findings align with the conclusions drawn by Mokidue *et al*. (2011) [19], Singh *et al*. (2011) [28], Schonbeck (1999) [25], and Reddy *et al*. (2018) [22].

Table 5: Economic analysis of OFT in tomato crop

Year	Cost of cultivation (Rs/ha)		Gross Return (Rs/ha)		Net Return (Rs/ha)		Additional Return (Rs/ha)	B:C Ratio	
	IP*	FP	IP	FP	IP	FP		IP	FP
2015-16	67300	62200	184000	153000	116700	90800	25900	2.73	2.46
2016-17	69500	64500	222996	175998	153496	111498	41998	3.21	2.73
2017-18	75000	70000	317600	268800	242600	198800	43800	4.23	3.84
Average	69266.67	64233.33	241532.00	199266.00	172265.33	135032.67	37232.67	3.39	3.01

*IP=Improved Practice; FP= Farmers Practice

Conclusions

On-Farm Trials with improved package of practices provide profitable and positive outcomes, presenting a valuable opportunity to showcase the productivity potential and profitability of cutting-edge technology interventions within suitable agricultural contexts. Consequently, a targeted extension program aimed at disseminating knowledge and refining the skills of tomato growers, coupled with multiple practical demonstrations, becomes imperative for fostering technology adoption. Such initiatives hold the potential to address prevailing challenges within the technology transfer system in the arid region of Kutch, Gujarat. The substantial productivity gains observed through OFT, as opposed to traditional tomato cultivation practices, have heightened awareness and inspired other farmers to embrace scientifically sound production and protection techniques for tomatoes.

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