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Performance and Impact of Front Line Demonstration of Papaya in Western Rajasthan

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Abstract: Papaya (*Carica papaya* L.) a "wonder fruit of the tropic" has become popular due to its high nutritional and medicinal value and high productivity in shortest possible time. India leads the world (44.4%) in papaya production with an annual output of 5.70 mt from 0.13 mha with a national productivity of 42.85 t ha^{-1} (NHB, 2018). However, productivity is lower in Rajasthan (8.57 t ha^{-1}) due to severe biotic and abiotic stresses and a lack of technical knowledge among the growers (viz. use of black polythene mulch, timely application of plant protection measures, water management, balanced fertilization etc.) and unavailability of genetically pure seeds or seedlings of suitable varieties. Front line demonstrations on improved cultivation practices of papaya variety Red Lady were carried out to address these issues. As a result, papaya production increased by 64.37% (71.05 t ha^{-1}) compared to farmers' practices (43.25 t ha^{-1}). The net economic return was Rs. 7,65,868 ha^{-1} and the benefit-cost ratio was 3.55.

Key Words: Farmers practices, demonstration, Interventions, GAPs, productivity, papaya.

Among the Indian states, Rajasthan occupies the second-largest land area of 3.42 lakh square kilometres with average land holdings of 3.96 ha, compared to national average of 1.57 ha. Agriculture accounts for about 20% of the State's GDP. The Aravalli range, divides the State into two distinct zones. The enormous Indian Thar Desert is the name given to the territory to the west and north-west, which comprises eighteen districts and almost 61% of the State's entire geographic area. This region has sandy soil types that are low in water holding capacity and low in nitrogen. In the western arid and semi-arid regions annual rainfall ranges from 200 to 550. Papaya (*Carica papaya* L.) is known as the wonder fruit of Rajasthan because of its nutritional values and high productivity. Although it has been produced in home gardens for the past several years, but the commercial cultivation of improved variety in the region is restricted by lack of advanced knowledge about papaya cultivation. The majority of papaya orchards suffer from water, nutrient and pest management issues (Kulkarni and Rathod, 2020). At the seedling stage, collar rot is a major issue, and the plants are significantly damaged by mites, mosaic and leaf curl during the flowering stage. In comparison to local and tall varieties, its dwarf variants are more prone to leaf curl. The

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sandy loam and alkaline soil in the Pali district, where papaya is grown are deficient in crucial macro and micronutrients which adversely impact the yield (Bhardwaj and Nandal, 2015). Integrated nutrient management (INM), IPM (integrated pest management), GAP (good agricultural practices) and appropriate irrigation management can increase papaya production and productivity in the area (Auxcilia *et al.*, 2020). In order to increase farmers' income, Krishi Vigyan Kendra (KVK), Pali has followed institutional and technical model of front line demonstrations (FLDs). KVK has established a papaya producers associations, analysed the constraints faced by farmers and provided high-quality Red Lady seedlings along with a regionally standardised package of practices to papaya growers. The results of these FLDs are discussed in the present study.

Materials and Methods

The purpose of the present study was to assess the impact of improved variety (Red Lady 786) on papaya production and productivity on farmer households' socio-economic and nutritional security. Pali is situated in the arid fringes of Rajasthan. Sandy loam to loamy silt are the predominant soils. Temperature in the district ranges from 25 to 48°C and the district receives about 420 mm average rainfall annually. According to Singh *et al.* (2018) front line demonstration (FLD) is one of the powerful tools for technology transfer since it demonstrates in real life the power of new technologies to increase yield and profit. In total, 36 demonstrations were carried out in 36 farmer fields in five chosen villages (Jaitpura, Bagri, Ramawas, Peepaliya Kalan and Lalpura) of the Raipur block of Pali for three years (2018-19, 2019-20 and 2022-23). Demonstrations were initiated during 1st week of August in the farms where farming situation was irrigated and the soil was medium soil textured. Every frontline demonstration was set up on 0.3 ha of land, with the nearby 0.3 ha serving as control (farmer's practise). Farmers were imparted quality training and exposure visit on various aspects of papaya production, technical guidance for agricultural inputs (seedling, fertilizer and plant protection) and marketing (harvesting, grading and packing) of papaya fruits. Field days were also conducted in each cluster to show the results of the FLDs to the farmers of the same and also of neighbouring villages.

Present study was conducted in Raipur block which had maximum area under papaya cultivation out of all the ten blocks of Pali. Data for this study was collected from five villages of Raipur block covering 72 farmers (36 FLDs and 36 non FLDs growers). For collection of relevant data, a personal interview schedule and questionnaire were specially prepared. The constraints and details of package and practices as perceived by respondents were scored and converted into frequency percentage; mean score and the gaps were ranked accordingly.

Information (data) from the demonstration and farmers' practice on production costs and returns was collected through repeated field visits during 2018-19, 2019-20 and 2022-23, and analysed using statistical techniques. After that, average yield, extension gap, technology gap, technology index, cost of cultivation, net returns, and benefit-cost ratio were computed. The collected information was processed, collated, categorised, and examined in terms of mean percent score and ranks in relation to the study's goals. Gross return was calculated by multiplying yield into prevailing local market price of the fruit obtained by the farmers. Further, net return and benefit cost ratio were calculated. The technology gap and technological index (Yadav *et al*., 2004) along with the benefit cost ratio (Samui *et al*., 2000) were calculated using following formula as given below.

$$\text{Extension gap} = \text{Demonstration yield} - \text{Farmer practice yield}$$

$$\text{Technology gap} = \text{Potential yield} - \text{Demonstration Yield}$$

$$\text{Additional return} = \text{Demonstration return} - \text{Farmer practice return}$$

$$\text{B:C ratio} = \frac{\text{Additional return}}{\text{Additional Cost}}$$

$$\text{Technology index (\%)} = \text{Potential yield} - \frac{\text{Demonstraion yield}}{\text{Potential yield}} \times 100$$

The data thus collected were tabulated and statistically analysed to interpret the FLD results.

Results and Discussion

Results of constraint analysis of papaya cultivation based on growers responses, are given in Table 1. 83.33% of the papaya

Table 1. Constraints faced by papaya growers in adoption of recommended practices in papaya cultivation (n=72)

Problems	Frequency	Per cent (%)	Ranks
Adverse climatic factors (abiotic stresses)	65	83.33	I
Heavy occurrence of virus disease	62	78.33	II
Lack of minimum support price and crop insurance.	60	75.00	III
Non availability of quality plant seedling/seed (hermaphrodite variety)	54	71.67	IV
Non availability of papaya experts/consultants within the districts	50	66.67	V
Lack of technical knowledge with respect to use of pesticides	48	63.33	VI
Non availability of fertilizers in time and a lack of knowledge of calculating quantity of fertilizer to be applied (per plant or per ha)	46	60.00	VII
Non availability appropriate plant protection chemicals	45	57.50	IIX
Non availability FYM	40	54.17	IX
High cost of inputs (fertilizer, insecticides, pesticides, herbicide etc).	37	50.00	X
Lack of knowledge about storage and marketing.	35	42.50	XI

Table 2. Details of existing farmer's practices and improved practices used in Papaya cultivation

Intervention	Farmers' practices (FP)	Improved Practices (IP)
Type of seed	Locally available seed	Red Lady786
Seed treatment and sowing method	Not in practice and broadcasting on nursery bed	Treated seed and line sowing on nursery bed
Spacing	2.5 x 2.5 m	1.8 x 1.8 m
Use of plastic mulch	Not in practice	Transplanting on ridge bed with silver black plastic mulch.
Irrigation method	Channel irrigation (Surface irrigation)	Drip irrigation
Application of recommended dose of fertilizer and foliar application of micronutrients	Irregular or imbalance use of fertilizers and no foliar application of micronutrients.	Applied 10 kg plant^{-1} of manures and 200 g each of N, P_2O_5 and K_2O in the pits. Foliar application (4 spray of boron @ 0.3%) of micronutrients.
Application of biological control agent *Trichoderma harzianum.*	Not in practice	Applied in plant basin @ 50g plant^{-1}, during 3rd, 5th and 7th month after transplanting.
Removal of male plant	As soon as the plants flower, the extra male plants are uprooted	No need (Harmaphordite in nature).
Plant protection measures	Irregular use of chemicals.	Spraying of Dimethoate 30% EC (Rogor) @ 1.5% at monthly intervals up to 5 months after transplanting for aphid (vector) control.
Others plant protection measures	None of the others measures follows.	Install pheromone and yellow sticky traps at appropriate period.

growers listed adverse climatic factors (abiotic stresses) as major limitation, followed by heavy occurrence of virus disease (78.33%), lack of minimum support price and crop insurance (75.00%), whereas, 71.67% grower believed that non availability of quality plant seedling or seed restricted papaya cultivation. 60 to 70% grower had faced the limitation of non-availability of papaya experts, lack of technical knowledge and non-availability of fertilizers in time while 50 to 60% grower had faced non availability of appropriate plant protection chemicals, non-availability of FYM and high cost of FYM. Details of improved interventions in FLD and the farmer's practices during papaya cultivation are given in Table 2.

Relative studies of disease and pest occurrence levels between improved practices (IP) and farmer practices (FP) is shown in Table 3. During the period under case study, it was observed that prevalence of damping off disease was lesser where improved practices were followed (13%) *vis-à-vis* farmers practices (33.11%). Average field mortality was lower in demonstration plots (13.78%) as compared to farmer practices (25%). occurrence of leaf curl was also lower in demonstration plot (12.78%) as compared to farmer's practice (23.94%).

Table 3. Comparative disease and pest occurrence in papaya production under FLD and farmers practice

Years	Damping off (%)		Frequency of irrigation in 30 days of planting (DAP)		Field mortality (%)		Leaf curl incidence (%)		Powdery mildew (%)	
	IP*	FP*	IP	FP	IP	FP	IP	FP	IP.	FP
2018-19	14.34	36.56	Once in 3-4th days	Mostly in channel irrigation/ surface irrigation frequency is once in a week or five days depend upon prevailing season (climate).	12.89	28.67	12.56	22.89	4.25	28.45
2019-20	13.67	31.67			16.67	23.34	15.00	27.00	7.67	26.34
2022-23	10.99	31.10			11.78	22.99	10.78	21.93	4.46	24.38
Average	13.00	33.11			13.78	25.00	12.78	23.94	5.46	26.39

* Improved Practice (IP) and Farmer's practice (FP)

Table 4. Comparative Yield and GAP analysis in Papaya production under FLD and farmers practice

Years	Area (ha)	No. of FLDs	Demonstration yield (t ha^{-1})			Yield of farmer's practice (t ha^{-1})	Increased in yield (%)	Potential yield (t ha^{-1})	Extension gap (t ha^{-1})	Technology gap (t ha^{-1})	Technology index (%)
			Highest	Lowest	Average						
2018-19	3.6	12	74.67	63.34	69.00	41.50	66.26	100	27.50	31.00	31.00
2019-20	3.6	12	77.00	71.23	74.11	46.00	61.10	100	28.11	25.89	25.89
2022-23	3.6	12	74.32	65.77	70.04	42.25	65.77	100	27.79	29.96	29.96
Average	3.6	12	75.33	66.78	71.05	43.25	64.37	100	27.80	28.95	28.95

Table 5. Comparative economics studies of Papaya production under FLD and farmers practice

Years	Cost of Cultivation (Rs. ha^{-1})		Gross Return (Rs. ha^{-1})		Net Return (Rs.ha^{-1})		B:C Ratio	
	IP	FP	IP	FP	IP	FP	IP	FP
2018-19	2,88,000	2,65,000	8,69,400	5,22,900	5,81,400	2,57,900	3.02	1.97
2019-20	2,97,500	2,72,250	10,67,184	6,62,400	7,69,684	3,90,150	3.59	2.43
2022-23	3,14,200	2,98,625	12,60,720	7,60,500	9,46,520	4,61,875	4.01	2.55
Average*	2,99,900	2,78,625	10,65,768	6,48,600	7,65,868	3,69,975	3.55	2.33

*Average rate in 2018-19 = 1400/q, 2019-20 = 1600/q and 2022-23 = 2000/q.
**Post harvest loss includes 10% in gross return.

An average of 5.46% of powdery mildew occurrence was recorded in demonstration plot against 26.39% in farmer's practice. The lesser occurrence of diseases in demonstration plots was due to timely follow up of plant protection measures throughout crop growth period and even at nursery stage. Irrigation through drip also restricted the growth of weed and whitefly populations which are the host and vector for spreading of leaf curl disease. Similar results were also recorded by Mitra (2017), Eduardo *et al.* (2016) and Bhardwaj and Nandal (2015) in papaya.

Average yield in 36 FLDs over three years was significantly higher (64.37% and 71.05 t ha^{-1}) as compared to farmers' existing practices (43.25 t ha^{-1}) in Table 4. This yield increased mainly because of improved production technologies, high yielding variety, irrigation and nutrient management, less disease and pest occurrence as well as the change in the places of demonstration plots every year. Similar yield enhancement in papaya was also documented by Bhardwaj and Nandal (2015) in Sirohi district of Rajasthan and Biswas (2010) in West Bengal. The results showed that the improved cultivation practices were better than the farmers' practices. This improvement has also motivated non participating farmers. Front line demonstration yield and potential yield of the variety were compared to estimate the yield gaps which were further classified into technology index. The extension gap of 27.50, 28.11 and 27.79 t ha^{-1} was observed during 2018-19, 2019-20 and 2022-23, respectively (Table 4) which average to 7.80 t ha^{-1} over three years. The average gap in the demonstration yield over potential yield was 28.95 t ha^{-1}. The findings of the present case study are in line with the findings of Singh *et al.* (2018).

On the prevailing prices of different years inputs and output costs the economic viability

of improved technologies over farmer's exercise was calculated (Table 5). The average cost of production of papaya with improved technologies was Rs. 2,99,900 ha^{-1} against an average of Rs. 2,78,625 ha^{-1} in farmer practice. The higher mean gross returns (Rs.10,65,768 ha^{-1}) and net return (Rs.7,65,868 ha^{-1}) with higher benefit ratio (3.55) were recorded under front line demonstrations of papaya as compared to farmer's cultivation. Similar results have been reported by Bhardwaj and Nandal (2015) on papaya production in Sirohi district of Rajasthan, Javed and Kumar (2017) on papaya production in Bidar district of Karnataka.

Conclusion

The aforementioned case study revealed that adopting better varieties along with improved production and management technologies led to substantial increase of yield (64.37%), net return (Rs. 3,95,893 per ha) over local practises. In the semi-arid region of Rajasthan, good orchard management techniques, such as the introduction of improved varieties, need based plant protection practices, mulching with drip irrigation management during acute dry periods may increase papaya production and productivity beside this the Red Lady variety has exceptional fruit quality, long shelf life, hermaphrodite character, tolerance to pest and diseases and economic benefits. We can therefore draw the conclusion that the FLD had a major beneficial impact and offered a chance to illustrate the productivity potential and profitability of cutting-edge technology (intervention) in a practical farming environment.

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