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Impact of Front-line Demonstrations on Integrated Crop Management in Watermelon (*Citrullus lanatus* L.)

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ABSTRACT

The present investigation was conducted in ten villages under DAATTC, five each in Nalgonda and Bhuvanagiri districts, Telangana, India operational areas during 2018–19 to 2020–21. Total 30 demonstrations were laid out on farmers' fields in the districts (15 in each district). The main objective of front-line demonstrations (FLDs) was to demonstrate the integrated crop management practices in Water melon for getting higher yields over farmers' practice. The study was undertaken to do a formative and summative (outcome and impact) evaluation of the frontline demonstrations on integrated crop management in watermelon. Data was collected with the help of structured interview schedule. The result of present study revealed that average highest yield recorded was 42.95 t ha^{-1} in demonstration plot over control (30.57 t ha^{-1}) and 40.31% average yield increase was recorded over control plot. The extension gap ranged from 10.4 t ha^{-1} to 16.65 t ha^{-1} and technology gap ranged between 13.15 t ha^{-1} to 27.5 t ha^{-1} respectively with the technology index of 33.92% during the demonstration years. Besides this, the demonstrated plots gave higher gross returns, net return with higher benefit cost ratio when compared to farmers' practice. In present study efforts were also made to study the impact of FLD on horizontal spread which has increased by 115%. The study also revealed that there was significant and positive relationship between farming experience, labour source, farm size and yield whereas age, education and family size didn't have any significant effect on the yield.

KEYWORDS: Demonstrated practice, farmers' practice, frontline demonstrations, watermelon

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1. INTRODUCTION

Watermelon (*Citrullus lanatus* (Thunb.) is one of the important fruits cultivated in the tropics and consumed throughout the world. Watermelon is also known as tarbooz, eriputccha, indrak, tarbuj, tarmuj, kalingad and kalindi in different parts of India. It is a sprawling, monoecious annual vine with highly branched thin, hairy, angular, grooved stem having pinnately-lobed leaves and branched tendrils at each node (Akhoundnejad and Dasgan, 2020). The roots are extensive but shallow with a taproot and lateral root. Fruit is a special type of berry with edible placenta with hard covering termed as pepo (Wehner et al., 2001). Melons are refreshing, thirst-quenching fruits which are consumed mainly in hot season and among the melons (Akhoundnejad and Dasgan, 2019), two species, viz., watermelon and muskmelon are common belonging to cucurbitaceous family (Edwards et al., 2003). Global consumption of this fruit is greater than any other cucurbits. The crop is native of Africa and in India it is widely grown in Rajasthan, Maharashtra, West Bengal, Uttar Pradesh, Andhra Pradesh and Telangana. In India area under watermelon was 116270 ha with a production of 31,56,910 t during the year 2020–21. In Telangana, production of watermelon was around 146.67 mt in an area of 2.36 t ha^{-1}. (Anonymous, 2022). It is a warm season crop and requires relatively high temperature for quality fruit production. A watermelon fruit contains 95% water, 3.3% carbohydrates, 0.3% minerals and 0.2% protein 100 g^{-1} fresh weight (Dhaliwal, 2014). The fruits of watermelon are good source of sugar, vitamin A, C, B1, B2 and B6. Among all members of cucurbitaceous crops, watermelon is rich in iron content. Watermelon with red flesh is a significant source of lycopene. Preliminary research indicates the consumption of watermelon may have antihypertensive effect. The sweet juicy pulp of the ripe fruit is eaten fresh. The fruit is delicious, nourishing and exerts a cooling effect in hot summer. The seed is also eaten as a snack after roasting with salt. The seed kernels are used in various sweets and delicacies. The unripe-fruits are cooked as vegetable in some parts of India. The rind of ripe-fruit is used to make pickles and vegetables. Beer is prepared from the fermented juice in Russia.

The FLD's are important in transfer of latest technologies and package of practices in totality to farmers (Hiremath and Hilli, 2012, Kalita et al., 2019, Kumar and Yadav, 2007) and main objective is demonstration of proven crop production technologies (Choudhary and Suri, 2014, Kumar et al., 2020) and to introduce suitable agriculture practices like seed-treatment, spacing, timely sowing, nutrient-management, growth hormones, pest and disease management practices, HYV in the farmers' field on large-scale under real farming situations (Deka et al., 2021, Kushawah et al., 2016, Meena and Singh, 2019) in different agro-climatic regions accompanied with organizing extension programmes for horizontal dissemination of the technologies (Singh et al., 2016, Venkatarajkumar et al., 2020, Singh et al., 2018, Morwal et al., 2018). FLD's help in changing the scientific treatment of the farmers by seeing and believing principle to have better impact of the demonstrated technologies (Singh et al., 2019, Sagar and Chandra, 2004, Singh et al., 2020, Samui et al., 2000). FLD's were conducted at farmers' field in a systemic manner to convince them about the potential of the technology and to enhance the yields.

Generally, the agricultural technology is not accepted by the farmers as such in all respects (Rana et al., 2017, Balai et al., 2021). There is always a gap between the recommended technology and its modified form at the farmers' level. In view of the above facts, present study has been undertaken to assess the impact of FLD's in watermelon.

2. MATERIALS AND METHODS

DAATTC, Nalgonda has conducted FLDs in 30 locations under real farming situations from 2018–19 to 2020–21 in different villages located in different blocks under DAATTC in Nalgonda and Yadadri Bhuvanagiri districts, Telangana, India. FLDs were conducted along with check plot and they were taken into consideration for the study to find out the impact of integrated crop management in water melon. The area under each demonstration was 0.4 ha from each location along with farmer' practice or check consisting of 0.4 ha. The detailed recommended practices demonstrated in demo plot and farmers' practices are given in Table 2. The improved demonstration comprised of following practices- Spraying of Boron @ 3 g l^{-1} of water once at 2–4 leaf stage and another at flowering stage along with thinning of plants, apical shoot removal, timely irrigations, recommended fertilizer application (RDF) and application of need-based chemicals and pesticides. The differences in the packages were in line with the findings of Singh (2017), Madhushekar et al. (2021) and Morwal et al. (2018).

Data on earliness i.e.; early emergence of female flower, yield and yield attributing characters, fruit cracking %, expenditure incurred by the farmer (Farmers' practice) and expenditure of demonstration plots were collected and analyzed. Gross income was calculated based on local market prices of water melon and net income by subtracting the total cost of cultivation from gross income. B:C ratio was computed by dividing gross returns with cost of cultivation in watermelon.

To estimate the technology gap, extension gap and technology index the following formula as mentioned below were used as suggested by Samui et al. (2000), Sagar and Chandra (2004) and Dayanand and Mehta (2012).

% increase in yield=(Demonstration yield-farmers yield/ Farmers' yield)×100 ....(1)

Technology Gap = Pi (Potential Yield)-Di (Demonstration Yield) ....(2)

Extension Gap = Di (Demonstration Yield)-Fi (Farmers yield) ....(3)

Technology index=(Potential Yield-Demonstration yield / potential yield)×100 ....(4)

The data on adoption and horizontal spread of technologies were collected from selected farmers with the help of schedule. Data were subjected to suitable statistical methods. The following formulae were used to assess the impact on different parameters of water melon crop.

Impact of yield=(Yield of demonstration plot–Yield of control plot/Yield of control plot)×100 ....(5)

Impact on adoption (% change)=(No. of adopters after demonstration-Number of adopters before demonstration /No. of adopters before demonstration)×100 ....(6)

Impact on horizontal Spread (% change)=(After area (ha)–Before area (ha)/Before area)×100 ....(7)

2.1. *Correlation Analysis*

Pearson's correlation coefficient when applied to a sample is commonly represented by the letter "r" and may be referred as the sample correlation coefficient or the sample Pearson correlation coefficient. It is used with two variables (independent and dependent) to determine a relationship/ association.

2.2. *Paired t-test*

A paired t-test is used to compare two population means where you have two samples in which observations in one sample can be paired with observations in the other sample.

3. RESULTS AND DISCUSSION

3.1. *Socio-economic characteristics of respondents*

The data were pooled on different parameters and the results obtained were discussed accordingly. Table 1, shows the socio-economic characteristics of the respondents and it can be inferred from Table 1 that 63.34% of the respondents were middle aged which is the active and agile stage of production, with more than 56.67% having Upper primary school education or above.

Nearly 53.33% of the respondents had less than 5 a of land holding for cultivation of various crops. 46.67% of the farmers had more than ten years of experience in cultivation of different crops. The family size consists of nearly 1–4 members as evident from above table with 46.67% under this category. Most of the farmers i.e., 56.67% of them used both hired and personal family members for carrying out various operations in the farm.

Table 1: Socio-economic characteristics of Respondents (n=30)

Sl. No.	Variables	Category	Frequency	%
1.	Age	Young (22–37)	04	13.33
		Middle (38–53)	19	63.34
		Old (54–69)	07	23.33
2.	Education	Illiterate	06	20.00
		Primary school	07	23.33
		Upper school	08	26.67
		High school	02	6.67
		Above matriculation	07	23.33
3.	Farm Size (in a)	Marginal (0–2.5)	08	26.67
		Small (2.5–5)	16	53.33
		Large (above 5)	06	20.00
4.	Farming Experience (in years)	<5 year (less than 5 year)	07	23.33
		5–10 year	09	30.00
		>10 year (more than 10 year)	14	46.67
5.	Family Size	1–4 members	14	46.67
		5–8 members	10	33.33
		More than 8 members	06	20.00
6.	Labour source	Personal	07	23.33
		Hired	06	20.00
		Both personal and Hired	17	56.67

3.2. *Recommended package of practices*

The demonstrated package and farmers' practice details were given in Table 2. It shows that all the FLD farmers fully adopted the recommended package of practices with slight modifications as per their situation where as non-FLD farmers were unable to adopt the practices. No gap has been observed in the farming situation, with regard to sowing time non-FLD farmers took up sowings earlier as they kept their land fallow in *Kharif* to cultivate watermelon but FLD farmers took up watermelon cultivation after terminating irrigated dry crops in kharif season. Higher seed rate was used for realization of higher yields thereby

Table 2: Difference between demonstrated package of practices and farmers' practice of watermelon cultivation

Sl. No.	Particulars	Water melon	
		Demonstrated package	Farmers practice
1.	Sowing time	January	December
2.	Seed rate	3 kg ha^{-1}	5 kg ha^{-1}
3.	Preparation of raised beds along with drip	Preparation of Raised beds along with drip was practiced by all the farmers	Raised beds with drip was taken up by few farmers
4	Mulching sheet use	Mulching sheet was laid	No mulching sheet was used
4.	Spraying of boron at 2–4 leaf stage	Foliar spraying of Boron@3 g l^{-1} once at 2–4 leaf stage, another at flowering stage (or) 500 mg l^{-1} at 2–4 leaf stage	No boron application
5.	Thinning of plants at 10–15 days after sowing	Practiced plant thinning to maintain optimum plant population	Plant thinning–Not practiced
6.	Apical shoot removal	Apical shoot removal practiced for development of side branches	Removal of apical shoot not practiced
7.	Application of recommended dose of fertilizers (RDF)	100:100:60 kg ha^{-1} NPK fertilizers were applied; Half of the fertilizer as basal dose and remaining half of N and K fertilizers 25 days after planting	Recommended dose of fertilizers were not followed
8.	Fertigation along with mulching	Application of soluble fertilizers along with drip irrigation	furrow method of irrigation
9.	Spraying of need-based pesticides	Need based spray of insecticides and fungicides (Carbendazim 50 WP, Dimethoate, Zineb 68%)	Higher dose of insecticides and pesticides
10.	Weed management	Pre plant application of herbicides trifluralin@1.2 kg ha^{-1}, use of Black polythene mulch on raised beds	3–4 times Hand weeding
11.	Harvesting at proper stage	Fruits are harvested in April on withering of tendril, change in belly colour or fruits surface on the ground level turn to yellow and the mature fruit gives dull sound while thumbing or tapping	Premature harvesting without any thumbing test and ground spot to yellow

increasing the cost of cultivation as seed is the major input in watermelon cultivation, Afzal et al. (2013) also noticed use of high seed rate.

3.3. Effect of Integrated crop management practices on earliness, yield and yield attributes

3.3.1. Earliness attributes

An average node from which first female flower emerged in watermelon under demonstrated package was 11.67 whereas as it was 15.33 in case of farmers practice over pooled data of 3 years of demonstrations. It indicates demonstrated package resulted in earliness over farmers' practice.

3.4. Yield and yield attributing characters

Integrated Crop Management practices in watermelon lead to marked effect on melon fruit yield. The yield performance indicators are presented in Table 3.

The cumulative effect of demonstrated package over three years revealed an average fruit weight of 4.6 kg compared to weight in farmers' practice 2.67 kg. The number of fruits per plant-under demo recorded was 7, 5 and 5 compared to control 4, 4 and 3 during 2018–19, 2019–20 and 2020–21 respectively. The cumulative effect of demonstrated package over three years, revealed an average number of fruits $plant^{-1}$ as 5.67, whereas in control it was 3.67 fruits $plant^{-1}$.

The fruit yield $plant^{-1}$ under demonstrated package was 19.6 kg, 13.5 kg and 14 kg in demonstration plots compared to 10.4 kg, 9.6 kg and 8.1 kg in control plots during 2018–19, 2019–20 and 2020–21 respectively. The cumulative effects of technological interventions over three years revealed an average fruit yield of 15.7 kg $plant^{-1}$ compared to 9.37 kg in control.

The fruit cracking (%) of Water melon under demo recorded were 8.4%, 11.2% and 10.6% in demo plots compared to 20.8%, 21.5% and 18.5% in control plots during 2018–19, 2019–20 and 2020–21 respectively. The cumulative effect of technological interventions over three years revealed an average fruit cracking (%) of 10.06% in demo compared to 20.26% in control.

Table 3: Effect of integrated crop management on earliness, yield and yield attributing characters of water melon

Year	Node from which first female flower emerged		Average fruit weight (kg)		No. of fruits plant^{-1}		Fruit yield plant^{-1} (kg)		Total yield ha^{-1} (t ha^{-1})		Fruit cracking %		% increase in yield
	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	
2018–19	12	15	5.1	2.6	7	4	19.6	10.4	51.85	35.20	8.4	20.8	47.30
2019–20	10	15	4.5	2.5	5	4	13.5	9.6	39.50	29.20	11.2	21.5	35.27
2020–21	13	16	4.2	2.9	5	3	14.0	8.1	37.50	27.1	10.6	18.5	38.37
Average	11.67	15.33	4.6	2.67	5.67	3.67	15.7	9.37	42.95	30.57	10.06	20.26	40.31

The total fruit yield ha^{-1} under demonstrated package recorded were 51.85 t, 39.5 t and 37.5 t in demo compared to 35.2 t, 29.2 t and 27.1 t in control plots during 2018–19, 2019–20 and 2020–21 respectively. The cumulative effects of technological interventions over 3 years revealed an average total fruit yield ha^{-1} as 42.95 t in demo compared to 30.57 t in control plots. The average total yield ha^{-1} of watermelon has increased by 40.31% over the yield obtained under farmers' practice. The year-to-year fluctuations in yield and cost of cultivation can be explained on the basis of variations in prevailing social, economic and microclimatic conditions of that particular location. The above findings are in similarity with the findings of Balai et al. (2021), Meena and Singh (2019), Singh et al. (2019), Ray et al. (2019), Singh et al. (2016), Hiremath and Nagaraju (2009) in water melon.

3.5. Economic parameters

Economic indicators i.e. gross expenditure; gross returns, net returns and BC ratio of Front-Line Demonstrations are presented in Table 4. The data clearly envisages that net returns from the demonstration plot were substantially higher than control plot during all the years of demonstration. Average net returns from demonstration plot were ₹ 1,40,440 ha^{-1} compared to ₹ 82,990 ha^{-1} in control. The average gross expenditure from the demonstration plot was recorded as ₹ 160250 ha^{-1} compared to ₹ 131000 ha^{-1} in control. The average gross returns from the demonstration plot were ₹ 3,00,650 ha^{-1} compared to ₹ 2,13,990 ha^{-1} in control plots. The results are in tune with the findings of Rana et al. (2017) observed average additional net returns, Meena and Singh (2019), Singh et al. (2018) and Kumar et al. (2020) observed additional net returns because of FLD's in Mustard and Toria crops.

Table 4: Cost economics of FLD on ICM in watermelon

Year	Fruit yield ha^{-1} (t ha^{-1})		Gross expenditure ha^{-1} (₹)		Gross returns ha^{-1} (₹)		Net returns (₹)		B:C ratio	
	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check
2018–19	51.85	35.20	142750	108000	362950	246400	220200	138400	2.54	2.28
2019–20	39.50	29.20	173000	145000	276500	204400	103500	59400	1.60	1.41
2020–21	37.50	27.1	165000	140000	262500	189700	97500	49700	1.59	1.36
Average	42.95	30.57	160250	131000	300650	213990	140400	82990	1.88	1.63

1US$= INR 69.43, 76.36, 74.45 for April, 2019, 2020, 2021, respectively.

Economic analysis of the yield performance revealed that benefit cost ratio of demonstration plots was observed to be significantly higher than farmer practice. The benefit cost ratio of demonstrated and control plots were recorded as 2.54, 1.60 and 1.59 and 2.28, 1.41 and 1.36 during 2018–19, 2019–20 and 2020–21 respectively. The cumulative effect of technological interventions over three years, revealed an average benefit cost ratio of 1.88 in demonstration plots compared to 1.63 in control plots.

3.5.1. Technology gap

The technology gap, the difference between potential yield and yield of demonstration plots was 13.15, 25.5 and 27.5 t ha^{-1} during 2018– 19, 2019–20 and 2020–21 respectively (Table 5). On an average technology gap under 3-year FLD programme was 22.05 t ha^{-1}. This may be due to soil fertility, managerial skills of individual farmer's and climatic conditions of the selected area. Hence, location specific recommendations are necessary to bridge these gaps. These findings are similar to Meena and Singh (2019) and Mishra et al. (2009).

Table 5: Fruit yield, extension gap, technology gap and technology index in integrated crop management in watermelon under FLD

Year	Fruit yield ha^{-1} (t ha^{-1})		Technology gap (t ha^{-1})	Extension gap (t ha^{-1})	Technology index
	Demo	Check			
2018– 19	51.85	35.20	13.15	16.65	20.23
2019– 20	39.50	29.20	25.5	10.3	39.23
2020– 21	37.50	27.1	27.5	10.4	42.30
Average	42.95	30.57	22.05	12.38	33.92

*potential yield: 65 t ha^{-1}

3.5.2. Extension gap

Extension gap of 16.65, 10.3 and 10.4 t ha^{-1} was observed during 2018–19, 2019–20 and 2020–21 respectively. On an average extension gap under 3-year FLD programme was 12.38 t ha^{-1}. This emphasized the need to educate the farmers through various techniques, use of new ICT tools for the adoption of improved agricultural production technologies to reverse this trend of wide extension gap. More and more use of latest production technologies along with high yielding varieties / hybrids will subsequently change this trend of galloping extension gap. Ray et al. (2019) observed wide extension gap in Brinjal and paddy where as Morwal et al. (2018) observed in Cumin and pulses under 3-year FLD programme.

3.5.3. Technology index

The technology index shows the feasibility of the demonstrated technology at the farmers' field. The technology index varied from 20.23 to 42.30 (Table 5). On an average technology index of 33.92% 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 watermelon. The results are in unity with the findings of Choudhary and Suri (2014), Kalita et al. (2019), Kumar et al. (2020) and Singh et al. (2020) observed yield increase in Brinjal, Oil seeds, Mustard and Bajra among FLD farmers showing ease of adoption of different technologies.

Data in Table 6 showed that FLD organized in watermelon crop helped to increase area under integrated crop management of watermelon. There was significant increase in area under horizontal spread of the technology from 16–34.5 ha, an increase of 115% under integrated crop management in watermelon.

Table 7 presents the estimates of the parameters of correlation on the factors influencing the yield of watermelon. This study revealed that there was significant and positive relationship between farming experience, labour source, farm size and yield whereas age, education and family size didn't have any significant effect on the yield.

Table 6: Impact of Front-Line Demonstration (FLDs) on horizontal spread of integrated crop management in Watermelon

Name of the technology	Area (ha)		Change in area	Impact (% change)
	Before demon-stration	After demon-stration		
Integrated crop management in watermelon	16	34.5	18.5	115

Table 7: Pearson correlation analysis on the socio-economic characteristics and yield of watermelon

Socio economic characteristics	Pearson Correlation	Significant (1–tailed)	Significance
Age	0.220	0.080	NS
Education	-0.046	0.386	NS
Family size	0.062	0.347	NS
Farming experience	0.248*	0.047	S
Labour source	0.558*	0.000	S
Farm size	0.446*	0.002	S

*Significant at (p=0.05) level, NS: not significant; S: Significant

A two tailed paired t-test was taken up at 23 degrees of freedom, 0.95 confidence levels and 0.05 level of significance, the t-value obtained is 0.91 with p at 0.37, mean of the difference being 1.38, the t-value 0.91 is less than 2.069, the corresponding critical value in the t-distribution table at 23 df and 0.05 significant level hence we reject the Null hypothesis and state that we have significant evidence that the average difference in recommended package of practices and farmers' practice during 2018–19 to 2020–21 is not zero and there was an increase in watermelon yield from -1.76 to 4.54 due to implementation of frontline demonstrations or demonstrated package of practices in watermelon.

3. CONCLUSION

The FLD's helped to attain productivity and profitability through Integrated Crop Management in watermelon with various interventions which helped in getting desirable traits, size and development of good quality fruit. The productivity gain under FLDs was higher over existing farmers' practice which made greater impact. The fruit yield in demonstrated package was 42.95 t ha^{-1} compared to 30.57 t ha^{-1}. The benefit cost ratio also increased from 1.63 in farmers' practice to 1.88 in demonstrated package.

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