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Assessment of Extension Interventions for Management of PBW for Enhancing Cotton Production through Frontline Demonstrations among Cotton Growers in Khammam District of Telangana

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ABSTRACT

Frontline Demonstrations were conducted at Krishi Vigyan Kendra, Wyra, Khammam district, Telangana, India during *kharif* (June–December) from 2019, 2020 and 2021 in different villages of Khammam district. Total 30 demonstrations were laid out on farmers' fields in the district. The main objective was management of PBW with various technological interventions. The study revealed that 70.00% of the respondents had high school or above education, 46.67% of the respondents had more than 10 years of experience in farming, 100.00% gap was observed on use of pheromone traps and Trichogamma cards. The average yield recorded was 2207 kg ha^{-1} in demonstration plot, a 22.75% increase over farmer's practice (1808 kg ha^{-1}). The technology gap under 3 year FLD programme was 1043 kg ha^{-1}, extension gap was 399 kg ha^{-1} with a technology index of 32.09%. The demonstrated plots gave higher gross returns, net return with higher benefit cost ratio when compared to farmer's practice. In present study efforts were also made to study the impact of FLDs on horizontal spread which increased by 221.42%, adoption levels by 130.60%. The study also revealed that there was significant increase in knowledge level of the farmers due to frontline demonstrations, a significant and positive relationship existed between age of the respondent, education, farm size, farming experience, trainings received and extension contacts with yield of cotton.

KEYWORDS: Cotton, frontline demonstrations, gross returns, net returns, yield

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1. INTRODUCTION

Cotton (*Gossypium hirustum* L.) is the most prominent commercially cultivated fibre crop of India after jute producing natural fibre, fuel and edible oil, playing an important role in Indian economy (Prasad et al., 2018) grown in India under diverse agro climatic conditions, varying from 8°–32° N latitude and 70°–80° E longitude (Ramprasad, 2022). It is a perennial semi–shrub grown as an annual crop both in tropical and warm temperate regions (Rahman et al., 2012, Chakravarthy et al., 2012, Sushila et al., 2015) for domestic consumption and export needs of 111 countries in the world hence called "King of Fibres" or "White Gold". India is the largest producer of cotton in the world accounting for about 22% of the world's production. It is cultivated in an area of 123.50 l ha in India, with an output of 340.62 l bales (170 kg bale^{-1}) and productivity of 469 kg ha^{-1} (lint) against the world average yield of 787 kg ha^{-1} (Anonymous, 2021–22). In Telangana, it occupies an area of 20.51 l ha with a production of 65.87 lakh bales with the productivity of 546 kg ha^{-1} (Anonymous, 2021–22).

In India area under cotton cultivation is more than the world, but productivity is low, major yield–limiting factors for low productivity are attack of insect pests in almost all cotton growing countries (Luttrell et al., 1994, Hladik et al., 2014). Cotton crop harboured 1326 insect-species from sowing to maturity in all cotton growing areas of the world (Hargreaves, 1948, Atwal, 2004) and 162 species have been reported on cotton crop in India alone (Kranthi et al., 2002, Puri et al., 1999, Chavan et al., 2010), of which 24 species have attained pest status (Sundramurthy and Chitra, 1992, Kannan et al., 2004). The introduction of *Bacillus. thuringiensis* (*Bt*) reduced the problem of bollworms (Edge et al., 2001, Shelton et al., 2002, Sharma and Pampapathy et al., 2006). *Bt*-Cotton cultivation occupied a major share (>90%) in India (Hofs et al., 2004, Carrière et al., 2015). Among the array of insects, the bollworms (Dhurua and Gujar 2011, Mounica and Goverdhan, 2013) viz., Pink bollworm (PBW), *Pectinophora gossypiella (*Saunders) pose greater threat to cotton production (Ghosh, 2001, Kranthi, 2015).

In recent years' heavy incidence of PBW (Dhawan et al., 1988) in Bt cotton lead to reduction in production and productivity. The survival rate of Pink Boll Worm larvae in *Bt* II cotton hybrids showed progressive increase (Naik et al., 2018, Biradar and Venilla, 2008). Its incidence goes unnoticed to the farmers since young larvae enter the bolls in developing stages and remains inside by feeding on seeds (Ippolito et al., 2015). Its effect will be seen only when bad opened bolls with damaged seeds were found at harvesting stage (Simwat and Sidhu, 1982).

The FLD's are important in transfer of latest technologies, package of practices in totality to farmers (Tankodara et al., 2018, Hiremath and Hilli, 2012) and main objective is demonstration of proven crop production technologies (Choudhary and Suri, 2014, Kumar et al., 2020, Madhushekar et al., 2022) and to introduce suitable agriculture practices on large-scale under real-farming situations (Patel et al., 2013, Kushawah et al., 2016, Meena and Singh, 2019) in different agro-climatic regions accompanied with organizing extension programmes for horizontal dissemination of technologies (Madhushekar et al., 2021, Venkatarajkumar et al., 2020, Singh et al., 2018). FLD's help in changing the scientific treatment by seeing and believing principle to have better impact (Singh et al., 2019, Singh et al., 2020). In view of above facts, present study was initiated to assess the impact of Extension Interventions on management of PBW for Enhancing Cotton Production through Frontline demonstrations among Cotton farmers of Khammam dist.

2. MATERIALS AND METHODS

KVK Wyra has conducted Front Line Demonstrations in 30 locations under real farming situations from 2019, 2020 and 2021 during *kharif* (June–December) in different villages located in different blocks under KVK in Khammam district. FLDs were conducted along with check plot and they were taken into consideration for the study to find out the impact of extension interventions on management of PBW. Each demonstration is conducted in an area of 0.4 ha along with farmer's practice or check consisting of 0.4 ha with improved technologies for monitoring of PBW such as Deep summer ploughing, Timely sowing (Sowing after receiving more than 60mm rainfall), Sowing of non-Bt as refugee crop, Growing of trap crops, Weekly monitoring, Installation of pheromone traps, Collection and destruction of rosette flowers, Damaged bolls, Spraying of neem oil and need based insecticides, Release of Trichogramma cards soon after appearance of bollworms, Termination of crop by December. The FLDs neighbouring plot acted as farmers practice. The detailed recommended practices demonstrated in demo plot and farmer's practices are given in Table 2. The differences in the packages were in line with the findings of Singh et al. (2019), Shah et al. (2019) and Morwal et al. (2018).

Data expenditure incurred by the farmer (Farmer's practice) and expenditure of demonstration plots were collected and analyzed. Gross income was calculated based on local market prices of cotton 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 Cotton. 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).

percent 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 yi eld) ……………..(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 cotton.

Impact of yield=(Yield of demonstration plot- Yield of control plot)/(Yield of control plot)×100 ………(5)

Impact on adoption (percentage change)=(Number of adopters after demonstration-Number of adopters before demonstration/Numbers of adopters before demonstrati on)×100 ………(6)

Impact on horizontal Spread (percentage 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 results from the study conducted on the frontline demonstrations on Management of Pink boll worm in cotton are enumerated, profile characteristics of the selected cotton farmers are given below (Table 1).

It can be inferred from Table 1 that nearly 63.34% of the respondents were in the middle age group, an active and agile group for doing agricultural activities, 70.00% of the respondents had high school or above education levels, with nearly three quarters of the respondents had 2.5 a or above farm size (73.33%), 56.67% of the farmers had 5 a or less than that area under cotton cultivation, 46.67% of the respondents had more than 10 years of experience in farming, 40.00% of the farmers had both Agriculture and horticulture as their farming systems, 43.33% of the respondents had membership in one organization, 50.00% of the farmers participated in one training conducted in

Table 1: Profile characteristics of respondents (n=30)

Sl. no.	Variables	Category	Frequency	Percentage
1.	Age	Young (22–37)	04	13.33
		Middle (38–53)	19	63.34
		Old (54–69)	07	23.33
2.	Education levels	Illiterate	03	10.00
		Primary school	04	13.33
		Upper school	02	6.67
		High school	06	20.00
		Intermediate	08	26.67
		Degree	04	13.33
		Post-graduation	03	10.00
3.	Farm Size (in acres)	Marginal (0–2.5)	08	26.67
		Small (2.5–5)	16	53.33
		Large (5 and above)	06	20.00
4.	Area under cotton (in acres)	Low (<5.0 a)	17	56.67
		Medium (5.1–10 a)	09	30.00
		High (>10 a)	04	13.33
5.	Farming experience	<5 years (less than 5 years)	07	23.33
		5–10 years	09	30.00
		>10 years (more than 10 years)	14	46.67
6.	Farming system	Agriculture only	08	26.67
		Agri+Horti	12	40.00
		Agri+Horti+Dairy	10	33.33
7.	Social participation	No participation	07	23.33
		Membership in one organization	13	43.33
		Membership in more than one organization	08	26.67
		Membership with office bearer	02	6.67
8.	Trainings received/participated	No training	04	13.33
		One training	15	50.00
		Two trainings	08	26.67
		More than 3 trainings	03	10.00

Table 1: Continue...

Sl. no.	Variables	Category	Frequency	Percentage
9.	Annual income	Low (up to ₹ 25000)	07	23.33
		Medium (₹ 25,000 to ₹ 50,000)	14	46.67
		High (more than ₹ 50,000)	09	30.00
10.	Extension contact	Low (<27.13)	07	23.33
		Medium (27.14–43.13)	11	36.67
		High (>43.13)	12	40.00

Cotton by KVK and other extension agencies, 46.67% of the farmers had medium annual income, 40.00% of the farmers had high extension contacts which shows that KVK is well connected with the farmers in the district. The results are in tune with the findings of Madhushekar et al. (2021) who reported similar findings with regard to education and extension contacts whereas Bhattu et al. (2015), Shankara et al. (2014), Islam and Nath (2015) reported similar findings on trainings received by selected respondents.

3.2. *Recommended package of practices*

The Gap between the Recommended practice and farmer's 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. Incorporation of stubbles was taken by most of the FLD farmers and non-FLD with implements like cultivator creating a gap of 83.34%. Awareness on deep summer ploughing and community sowing was observed there the gap is below 30.00%. Unavailability, limited supply of pheromone traps, ignorance on part of the

Table 2: Gap analysis between Recommended package of practices and farmers' practice on Management of PBW in Cotton

Sl. No.	Technology intervention	Recommended practice	Farmers practice	% Gap in the recommended practice
1.	Incorporate crop stubbles in the field by tractor drawn cotton shredder	Stubbles are incorporated based on availability of Shredder	Stubbles are burnt or used as fire wood	83.34%
2.	Deep summer ploughings for elimination of pupal and larval diapause stages.	Summer ploughings are taken up during the last week of May	Partially practiced	30.00%
3.	Adopt community sowing in a particular area/ village or villages in a span of 1 week to 10 days	Sowing on receipt of more than 60 mm rainfall	Partially practiced	26.67%
4.	Install or erect pheromone traps at 45 days after crop sowing @ 4 a^{-1} for monitoring of pest	Method demos are conducted for erecting pheromone traps	Not practiced	100.00%
5.	Increasing pheromone traps @ 8 a^{-1} for mass trapping and control of the pest	Trained to use pheromone traps	Not practiced	100.00%
6.	Take up control measures if pheromone catches exceed 8 day^{-1} $trap^{-1}$ for 3 consecutive days or 10% rosette flowers or 10% damaged green bolls are noticed	Monitoring the pest and using prophylactic measures	Partially practiced	43.34%
7.	Remove and destroy the rosette flowers continuously during early flowering period (45–70 DAS), to avoid/minimize the pest in later stages of the crop	Infested bolls and flowers are collected and destroyed	Partially practiced	30.00%
8.	Spray NSKE 5% or Azadirachtin (1500 ppm) @ 5 ml l^{-1} of water with surf or sandovit@ 1 ml l^{-1} of water as a prophylactic measure at 40–45 days of the crop.	Prophylactic spray with neem oil	Partially practiced	43.34%
9.	Release of Trichogramma egg cards soon after appearance of bollworms	Used based on production and availability	Not practiced	100.00%
10.	Take up spraying of chemicals like Profenophos@ 2 ml l^{-1} or Emamectin benzoate @ 0.5 g l^{-1} alternatively at an interval of 7–10 days depending on pest load	Sprayings based on pest incidence and load	Indiscriminate sprayings	70.00%

Table 2: Continue...

Sl. No.	Technology Intervention	Recommended practice	Farmers practice	% Gap in the recommended practice
11.	spraying of pyrethroids like Cypermethrin or Lambdacyhalothrin 1 ml l^{-1} or Profenophos +Cypermethrin @ 2 ml l^{-1} or Thiomethaxam+ Lamdacyhalothrin @0.4 ml l^{-1} of water once or twice whenever the pest incidence is severe	Sprayings based on pest incidence and load	Indiscriminate sprayings	70.00%
12.	Terminate the crop between 180–200 days and go for second crop with green gram/maize/ sesamum/vegetables/melons etc	Crop duration is not prolonged	Partially practiced	73.34%
13.	Cattle grazing of the leftover field at the end of the crop season	Fully not practiced	Partially practiced	70.00%

farmers on pheromone traps usage resulted in 100.00% gap. Indiscriminate spraying of the insecticides was observed among non-FLD farmers compared to FLD farmers who monitored the pest and used prophylactic sprays with Neem oil, hence a gap of 43.34%. Release of Trichogramma cards was practiced by FLD farmers only, a gap of 100.00% was observed.

Spraying of need based pesticides depending on pest incidence and load showed 70.00% gap, Non-FLD farmers didn't practice the recommended interventions which are critical for pest management and these directly affect the yield. Farmers used high doses of a particular type and others are either applied or not applied fully, partial adoption is followed among Non-FLD farmers, Kundu et al., 2022 also observed similar differences in pest management. The above result of differences in recommended practices to farmers practice are in unity with the findings of Madhushekar et al. (2021), Hiremath et al. (2007), Balai et al. (2021), Singh et al. (2008) and Afzal et al. (2013) who also reported similar findings in paddy, Onion, Mustard, Cotton and Mustard respectively

3.3. Economic parameters

Economic indicators i.e. gross expenditure, gross returns, net returns and BC ratio of Front Line Demonstrations are presented in Table 3. 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 ₹ 69,140.17 ha^{-1} compared to ₹ 41,613.83 ha^{-1} in control. The average gross expenditure from the demonstration plot was recorded as ₹ 64,546.67 ha^{-1} compared to ₹ 67,744.67 ha^{-1} in control. The average gross returns from the demonstration plot were ₹ 1,33,686.83 ha^{-1} compared to ₹ 1,09,358.50 ha^{-1} in control plots. The results are in tune with the findings of Kundu et al. (2022), Singh et al. (2018) observed B:C ratio in groundnut and mustard higher in demo plots than in farmer's practice. Hiremath et al. (2009) observed additional net returns because of FLDs in onion.

Economic analysis of the yield performance revealed from Table 3 showed that benefit cost ratio of demonstration plots was observed to be significantly higher than farmer's practice. The benefit cost ratio of recommended and control plots were recorded as 1.96, 1.56 and 2.62 and 1.63, 1.17 and 1.96 during 2019–20, 2020–21 and 2021–22 respectively. The cumulative effect of technological interventions over three years, revealed an average benefit cost ratio of 2.05 in demonstration plots compared to 1.59 in control plots. High BC ratio during 2021–22 is due to high procurement price of cotton. The results are in conformity with the findings of Deka et al. (2021), Madhushekar et al. (2021), Rai et

Table 3: Cost economics of FLD on management of pink boll worm in cotton

Year	Yield ha^{-1} (kg 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
2019–20	2602	2205	68998	70250	135304	114660	66306	44410	1.96	1.63
2020–21	1659	1308	57052	59949	88756.5	69978	31704.5	10029	1.56	1.17
2021–22	2360	1912.5	67590	73035	177000	143437.5	109410	70402.5	2.62	1.96
Average	2207	1808.5	64546.67	67744.67	133686.83	109358.50	69140.17	41613.83	2.05	1.59

1US$=72.82 INR, January, 2022

al. (2012) and Puniya et al. (2021) in Toria, Maize, Paddy, Sesamum and Mustard.

3.4. Technology gap

The technology gap, the difference between potential yield and yield of demonstration plots was 648, 1591 and 890 kg ha^{-1} during 2019–20, 2020–21 and 2021–22 respectively (Table 4). On an average, technology gap under three year FLD programme was 1043 kg ha^{-1}. The technology gap is very wide and this has to be decreased through various extension interventions in crop, nutrient, pest and disease management. This gap may be due to soil fertility status, nutrient management, weather aberrations, market prices, 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 findings of Tunvar et al. (2017), Shankar et al. (2022) who expressed wide technology gap in groundnut, Cotton and Brinjal.

3.5. Extension gap

The FLD's conducted in cotton on Management of pink boll worm gave an extension gap of 397, 351 and 448 kg ha^{-1} during 2019–20, 2020–21 and 2021–22 respectively. On an average extension gap under three year FLD programme was 399 kg ha^{-1}. This emphasized the need to educate the farmers through various techniques especially on INM, IPM, ICM, IDM, 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 will subsequently change this trend. Shankar et al. (2022), Ray et al. (2019), Morwal et al. (2018) and Shah et al. (2019) observed the same findings in of wide extension gap in Brinjal, Rice, Cumin and Pulses.

Table 4: Cotton lint yield, extension gap, technology gap and technology index in FLDs on Management of PBW in cotton

Year	Cotton lint yield ha^{-1} (kg ha^{-1})		Farmer's practice	Percentage increase in productivity	Technology gap (kg ha^{-1})	Extension gap (kg ha^{-1})	Technology index
	Potential	Demo					
2019–20	3250	2602	2205	18.00	648	397	19.94
2020–21	3250	1659	1308	26.83	1591	351	48.95
2021–22	3250	2360	1912	23.29	890	448	27.38
Average	3250	2207	1808	22.75	1043	399	32.09

3.6. Technology index

The technology index results from Table 4 shows the feasibility of the demonstrated technology at the farmer's field. The technology index varied from 19.94% to 48.95% (Table 4). On an average, technology index of 32.09% was observed during the three years of FLD programme, which shows the effectiveness, efficacy and ease of adoption of management practices for control of Pink boll worm in cotton. The results are in unity with the findings of Shankar et al. (2022), Choudhary and Suri (2014), Kumar et al. (2020) and Singh et al. (2020). It was also observed from Table 4 that percent increase in productivity was 18.00, 26.83 and 23.29 during 2019–20, 2020–21 and 2021–22 respectively. The results are in uniformity with the results of Narula et al. (2009), Madhushekar et al. (2021), Tankodara et al. (2018).

In present study, efforts were made to study the impact of FLD's on Management of PBW in Cotton and its horizontal spread. It is inferred from Table 5 that FLD's organized in the target area helped to increase the area under Management of Pink Boll Worm in Cotton as the technology was feasible, profitable, easy to adopt, further the damage caused due to PBW is also high among non-FLD farmers. There was significant increase in area and horizontally spread was observed from 14–45 ha, the change in area being 31 ha and % change observed was 221.42%.

The result of improved technology interventions on Management of PBW in Cotton brought out that adoption of recommended technology, before demonstration was negligible, which increased by 130.60% after demonstration. It can also be inferred from Table 6 that farmers were showing keen interest in use of insecticides for management of PBW compared to adoption of other

Table 5: Impact on horizontal spread due to FLDs on management of pink boll worm in cotton

Name of the technology	Area (ha)		Change in area	Impact (% change)
	Before demon-stration	After demon-stration		
Management of pink boll worm in cotton	14	45	31	221.42

Table 6: Impact on adoption due to front line demonstrations (FLDs) on management practices for PBW in cotton

Technology interventions	Number of adopters		Change in no. of adopters	Impact (percentage change)
	Before demonstration	After demonstration		
Incorporate crop stubbles in the field by tractor drawn cotton shredder	18	38	20	111.11
Deep summer ploughings for elimination of pupal and larval diapause stages.	23	50	27	117.39
Adopt community sowing in a particular area/ village or villages in a span of 1 week to 10 days	13	29	16	123.08
Install or erect pheromone traps at 45 days after crop sowing @ 4 a^{-1} for monitoring of pest	14	32	18	128.57
Increasing pheromone traps @ 8 a^{-1} for mass trapping and control of the pest	15	32	17	113.33
Take up control measures if pheromone catches exceed 8 day^{-1} $trap^{-1}$ for 3 consecutive days or 10% rosette flowers or 10% damaged green bolls are noticed	08	34	26	325.00
Remove and destroy the rosette flowers continuously during early flowering period (45–70 DAS), to avoid/minimize the pest in later stages of the crop	11	27	16	145.45
Spray NSKE 5% or Azadirachtin (1500 ppm) @ 5 ml l^{-1} of water with surf or sandovit 1 ml l^{-1} of water as a prophylactic measure at 40–45 days of the crop	15	35	20	133.33
Release of Trichogramma egg cards soon after appearance of bollworms	12	25	13	108.33
Take up spraying of chemicals like Profenophos @ 2 ml l^{-1} or Emamectin benzoate @ 0.5 g l^{-1} alternatively at an interval of 7–10 days depending on pest load	16	39	23	143.75
spraying of Pyrethroids like Cypermethrin or Lambdacyhalothrin 1 ml l^{-1} or Profenophos+Cypermethrin @ 2 ml l^{-1} or Thiomethaxam+Lamdacyhalothrin @ 0.4 ml l^{-1} of water once or twice whenever the pest incidence is severe	14	31	17	121.43
Terminate the crop between 180–200 days and go for second crop with green gram/maize/sesamum /vegetables/melons etc	13	27	14	107.69
Cattle grazing of the leftover field at the end of the crop season	11	23	12	109.09
Overall impact	183	422	239	130.60

technological interventions. The overall adoption increased by 130.60% due to FLD's conducted by KVK (Table 6). The findings are in uniformity with the findings of Tunvar et al. (2017), Subbaiah and Jyothi (2019) in groundnut.

It can be noted from Table 7 that yield change noticed due to FLDs on Management of PBW in Cotton as 397, 351 and 448 kg ha^{-1} during 2019–20, 2020–21 and 2021–22 respectively, the average change in yield was 399 kg ha^{-1}. The % change in yield observed due to FLDs was 22.05%.

Table 7: Impact on yield due to FLDs on management of pink boll worm in cotton

Year	Yield (kg ha^{-1})		Change in Yield (kg ha^{-1})	Impact (percentage change)
	Demonstration plot	Control plot		
2019–20	2602	2205	397	18.00
2020–21	1659	1308	351	26.83
2021–22	2360	1912	448	23.43
Average	2207	1808	399	22.05

3.7. Increase in knowledge

Knowledge level of respondent farmers on various aspects of improved PBW management interventions in cotton before conducting the frontline demonstration and after implementation was measured and compared by applying independent 't' test. It could be seen from Table 8 that farmers mean knowledge score on PBW management had increased by 41.49 after implementation of frontline demonstrations. The increase in mean knowledge score of farmers observed was significantly higher. As the computed value of 't' (5.24) was statistically significant at 5% probability level. The results are at par with Narayanaswamy and Eshwarappa (1998), Singh et al. (2007) and Shah et al. (2019). It means there was significant increase in knowledge level of the farmers due to frontline demonstrations. This shows positive impact of frontline demonstrations on knowledge of the farmers that has resulted in higher adoption of technological interventions for management of PBW in Cotton. The results so arrived might be due to the concentrated educational efforts in the form of trainings, On-farm trials, method demonstrations and others made by the scientists of Krishi Vigyan Kendra.

Table 8: Comparison between knowledge levels of the respondent farmers about improved pest management practices of cotton

Sl. No.	Mean score			
	Before FLD implementation	After FLD implementation	Mean difference	Calculated "t" value
1.	28.18	69.67	41.49	5.24*

* Significant at (p=0.05) probability level

3.8. Relationship between personal characteristics with Yield

Positive and significant correlation (Table 9) was observed between age, education, farm size, farming experience, trainings received and extension contacts with yield of cotton. Most of the farmers selected were middle aged which is an active and agile working period, variable education provides the respondent a broader horizon on any technology. More the education more will be the farmer's outlook towards various sources of information. Because of education, the farmers could perceive the importance of technology better, thereby impacting on the yield. Farm size, farming experience were directly correlated with yield, bigger the farm size the farmer will be able to plan his activities properly and experience in farming will be an added advantage along with trainings on management of PBW and extension contacts with Scientists of KVK and personnel of various extension agencies helped the farmers to solve their queries. This study also revealed that Area under cotton, farming system, social participation and annual income didn't have any significant effect on the yield.

Table 9: Pearson correlation analysis on the socio-economics characteristics and yield attributes of cotton

Sl. No.	Socio economic characteristics	Pearson correlation	Significance
1.	Age	0.206*	S
2.	Education Levels	0.173*	S
3.	Farm size	0.221*	S
4.	Area under cotton	0.106^NS	NS
5.	Farming experience	0.248*	S
6.	Farming system	0.124^NS	NS
7.	Social participation	0.142^NS	NS
8.	Trainings received	0.293*	S
9.	Annual Income	0.139^NS	NS
10.	Extension contact	0.277*	S

* Significant at CD (p=0.05) level of significance

4. CONCLUSION

Conducting of FLDs of proven technologies helped to demonstrate productivity potential and profitability. Management of PBW with technological interventions helped to realize an additional net returns of ₹ 27,526.27 ha^{-1}. The average yield of demonstration was 2207 kg ha^{-1} compared to farmer's practice of 1808 kg ha^{-1}. The benefit cost ratio also increased from 1.59 in farmer's practice to 2.05 in demonstration. The impact of FLD's was also observed and there was significant increase in area, increase in adoption and increase in knowledge levels of the respondent farmers.

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6. REFERENCES

Afzal, A., Guru, P., Kumar, R., 2013. Impact of frontline demonstrations on Indian mustard through improved technologies. Indian Research Journal of Extension Education 13(1), 117–119.

Anonymous, 2022. Annual Report, 2021–22. India Crop Coverage Report. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmer Welfare, Ministry of Agriculture and Farmer Welfare, Govt. of India, Krishi Bhavan, New Delhi. Available at www.agricoop.nic.in. Accessed on 17.09.2022.

Atwal, A.S., 2004. Agricultural pests of South Asia and their management. Ludhiana, Kalyani Publishers, New Delhi, India, 221.

Balai, L.P., Singh, N., Sharma, D.R., 2021. Impact on cluster frontline demonstrations on the productivity of mustard (*Brassica juncea*). International Journal of Bio-resource and Stress Management 12(4), 295–302.

Bhattu, B.S., Dhaliwal, A.P.S., Singh, S., Singh, G., 2015. Impact of vocational trainings on adoption of dairy enterprise in South-Western districts of Punjab. Journal of Krishi Vigyan 3(2), 62–65.

Biradar, V.K., Venilla, S., 2008. Pest management for *Bt*-cotton: Need for conversation biological control. Current Science 95(3), 317–318.

Carrière, Y., Crickmore, N., Tabashnik, B.E., 2015. Optimizing pyramided transgenic *Bt* crops for sustainable pest management. National Biotechnology 33, 161–168.

Chakravarthy, V.S., Reddy, T.P., Reddy, V.D., Rao, K.V., 2012, Current status of genetic engineering in cotton (*Gossypium hirsutum* L): An assessment. Critical Review Biotechnology 34, 144–160.

Chavan, S.J., Bhosle, B.B., Bhute, N.K., 2010. Estimation of losses due to major insect-pests in desi cotton in Maharashtra. Journal of Cotton Research and Development 24(1), 95–96.

Choudhary, A.K., Suri, V.K., 2014. Front line demonstration program: An effective technology transfer tool for adoption of oilseed production technology in Himachal Pradesh, India. Communications in Soil Science and Plant Analysis 45(11), 1480–1498.

Deka, P., Rabha, H., Ojha, I., Borah, P., Borah, D., 2021. Impact assessment of cluster frontline demonstration on popularization of Toria in Udalguri District of Assam. Asian Journal of Agricultural Extension, Economics & Sociology 39(3), 52–59.

Dhawan, A.K., Sidhu, A.S., Simwat, G.S., 1988. Assessment of avoidable loss in cotton (*Gossypium hirsutum* and *G. arboreum*) due to sucking pests and bollworms. Indian Journal of Agricultural Sciences 58(4), 290–292.

Dhurua, S., Gujar, G.T., 2011. Field-evolved resistance to Bt toxin Cry1Ac in the pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae), from India. Pest Management Science 67(8), 898–903.

Edge, J.M., Benedict, J.H., Carroll, J.P., Reding, H.K., 2001. Bollgard cotton: An assessment of global economic, environmental and social benefits. Journal of Cotton Research and Development 5, 121–36.

Ghosh, P.K., 2001. ISCI Silver Jubilee Lecture Series - Lecture on "Genetically modified crops in India with special references to Bt-cotton". Journal of Indian Society of Coastal Agricultural Research 18(4), 106-107.

Hargreaves, H., 1948. List of Recorded Cotton Insects of the World. Commonwealth Institute Entomology, London, 50.

Hiremath, S.M., Hilli, J.S., 2012. Performance of front line demonstration of onion in Dharwad district of Karnataka. Indian Research Journal of Extension Education 7(3–4), 191–194.

Hiremath, S.M., Nagaraju, M.V., 2009. Evaluation of frontline demonstration on onion in Haveri district of Karnataka. Karnataka Journal of Agricultural Sciences 22(5), 1092–1093.

Hiremath, S.M., Nagaraju, M.V., Shashidhar, K.K., 2007. Impact of front line demonstrations on onion productivity in farmer's field. In: Proceedings of National Seminar on Appropriate Extension Strategies for Management of Rural Resources. University of Agriculture Sciences, Dharwad, December, 18–20.

Hladik, M.L., Kolpin, D.W., Kuivila, K.M., 2014. Widespread occurrence of neonicotinoid insecticides in streams in a high corn and soybean producing region, USA. Environmental Pollution 193, 189–196.

Hofs, J.L., Schoeman, A., Vaissayre, M., 2004. Effect of *Bt*-cotton on arthropod biodiversity in South African cotton fields. Communications in Agricultural and Applied Biological Sciences 69(3), 191–194.

Ippolito, A., Kattwinkel, M., Rasmussen, J.J., Schafer, R.B., Fornaroli, R., Liess, M., 2015. Modeling global distribution of agricultural insecticides in surface waters. Environmental Pollution 198, 54-60.

Islam, R., Nath, P., 2015. Impact of training programmes and frontline demonstration on adoption of vanaraja Birds in Sivasagar district of Assam. Veterinary Research 3(1), 16-19.

Kannan, M., Utamasamy, S., Mohan, S., 2004. Impact of insecticides on sucking pests and natural enemy complex of transgenic cotton. Current Science 86(4), 726–729.

Kranthi, K.R., 2015. Pink bollworm strikes Bt cotton. Cotton Statistics News 35(1), 1–6.

Kranthi, K.R., Jadhav, D.R., Kranthi, S., Wanjari, R.R., Ali, S.S., Russell, D.A., 2002. Insecticide resistance in five major insect pests of cotton in India. Crop Protection 21(6), 449-460.

Kumar, M., Meena, K.L., Rajkhowa, D.J., 2020.

Impact assessment on frontline demonstration for popularization of Toria in Longleng district of Nagaland. Journal of AgriSearch 7(2), 104–106.
Kundu, R., Biswas, S., Poddar, R., Chatterjee, S., 2022. Impact of demonstrations on improving production and income from groundnut in farmers' field of Purulia district of West Bengal. International Journal of Economic Plants 9(2), 127–129.
Kushawah, S., Kumar, S., Singh, A.K., 2016. Adoption of improved late sown mustard cultivation practices in Bihar. Indian Journal of Extension Education 52(3–4), 153–156.
Luttrell, R.G., Fitt, G.P., Ramalho, F.S., Sugonyaev, E.S., 1994. Cotton pest management: Part 1. A worldwide perspective. Annual Review of Entomology 39, 517–526.
Madhushekar, B.R., Narendar, G., Avil Kumar, K., 2021. Impact of front-line demonstrations on extent of adoption and horizontal spread of direct seeding in rice with drum seeder in Nalgonda district of Telangana. The Pharma Innovation Journal 10(9), 784–788.
Madhushekar, B.R., Narendar, G., Goverdhan, M., Avil Kumar, K., 2022. Impact of frontline demonstration in transfer of groundnut production technologies for the livelihood improvement of oilseed farmers. International Journal of Bio-resource and Stress Management 13(8), 806-814. DOI https://doi.org/10.23910/1.2022.3137.
Meena, M.L., Singh, D., 2019. Dissemination of salt tolerant mustard varieties through frontline demonstrations approach for sustainable mustard production in Pali district of Rajasthan. Journal of Oilseed Brassica 10(2), 122–129.
Morwal, B.R., Pagaria, P., Kanthwa, S.L., Das, S., 2018. Performance of frontline demonstration on yield enhancement of cumin in Barmer district of Rajasthan. Journal of Krishi Vigyan 6(2), 176–178.
Mounica, D., Goverdhan, V., 2013. Innovative front line demonstrations in tribal areas to enhance Bt cotton income through integrated pest management. International Journal of Social Science 4(1), 155–159.
Naik, V.C.B., Kumbhare, S., Kranthi, S., Satija, U., Kranthi, K.R., 2018. Field-evolved resistance of pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae), to transgenic *Bacillus thuringiensis* (Bt) cotton expressing crystal 1Ac (Cry1Ac) and Cry2Ab in India. Pest Management Science 74(11), 2544–2554.
Narayanaswamy, C., Eshwarappa, G., 1998. Impact of front line demonstrations. Indian Research Journal of Extension Education 34(1–2), 14–15.
Narula, A.M., Shashikumar, S., Chougala, D.G., 2009. Impact of cotton IPM demonstration. Indian Journal of Extension Education 45(1), 81–84.
Patel, M.M., Jhajharia, A.K., Khadda, B.S., Patil, L.M., 2013. Frontline demonstration: An effective communication approach for dissemination of sustainable cotton production technology. Indian Journal of Extension Education & Rural Development 21, 63–67.
Prasad, B.R., Rahman, S.J., Sudarshanam, A., Raghu, P.R.R., 2018. Assessment of different modules for management of pink bollworm, *Pectinophora gossypiella* (Saunders) in Bt cotton. Journal of Entomological Science 6(6), 132–135.
Puniya, M.M., Singh, I., Kumawat, S.R., Nagal, G., 2021. Impact assessment of improved production technologies of Indian mustard (*Brassica juncea*) through frontline demonstrations. Journal of Oilseed Brassica 12(1), 28–31.
Puri, S.N., Murthy, K.S., Sharma, O.P., 1999. Integrated pest management for sustainable cotton production. In: Sundaram, V. (Ed.), Handbook of Cotton. Indian Society of Cotton Improvement, CIRCOT, Mumbai, 233–245.
Rahman, M., Shaheen, T., Tabbasam, N., Iqbal, M.A., Ashraf, M., Zafar, Y., Paterson, A.H., 2012. Cotton genetic resources: A review. Agronomy for Sustainable Development 32(2), 419–432.
Rai, A.K., Khajuria, S., Lata, K., Jadav, J.K., Khadda, B.S., Kumar, R., 2012. Impact of front line demonstration on sesamum production in Panchmahal district of Gujarat. Indian Journal of Extension Education 48(3–5), 45–48.
Ramprasad, B., 2022. Bioefficacy of sulfoxaflor and other insecticides against sucking pests of cotton. International Journal of Bio-resource and Stress Management 13(6), 535–542.
Ray, S.K., Barman, K.K., Paul, S., Chilo, R., Rajkhowa, D.J., Baishya, S., Deka, B.C., 2019. Utilization of rice fallow through cluster frontline demonstration programme: An adaptive research trial on mustard. Journal of Community Mobilization and Sustainable Development 14(3), 439–446.
Samui, S.K., Maitra, S., Roy, D.K., Mondal, A.K., Saha, D., 2000. Evaluation of front line demonstration on groundnut (*Arachis hypogea* L.) in Sundarbans. Journal of Indian Society of Coastal Agricultural Research 18(2), 180–183.
Shah, K.A., Nayak, P., Lad, A.N., 2019. Impact of cluster frontline demonstration of scientific cultivation practices of major pulses in Navsari district of

Gujarat. Gujarat Journal of Extension Education 30(1), 38–41.

Shankar, A., Prabhakar Reddy, T., Jaganmohan Reddy, M., Afifa, J., Rajashekhar, M., Rajashekhar, B., Ramakrishna, K., Bhatt, P.S., 2022. Impact of front line demonstration on integrated management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) in Nagarkurnool district, Telangana state. International Journal of Bio-resource and Stress Management 13(3), 292–298.

Shankara, M.H., Mamatha, H.S., Srinivasa, R.K.M., Desai, N., 2014. An evaluation of training programmes conducted by KVK, Tumkur, Karnataka. International Journal of Farm Sciences 4(2), 240–248.

Sharma, H.C., Pampapathy, G., 2006. Influence of transgenic cotton on the relative abundance and damage by target and non-target insect pests under different protection regimes in India. Crop Protection 25, 800-813.

Shelton, A.M., Zhao, J.Z., Roush, R.T., 2002. Economic, ecological, food safety, and social consequences of the deployment of *Bt* transgenic plants. Annual Review of Entomology 47, 845–881

Simwat, G.S., Sidhu, A.S., 1982. Mortality of diapausing larvae of pink bollworm, *Pectinophora gossypiella* in cotton stalks during summer in Punjab. Indian Journal of Entomology 44, 182–184.

Singh, A., Vasisht, A.K., Ranjit, K., Das, D.K., 2008. Adoption of integrated pest management practices in paddy and cotton: A case study in Haryana and Punjab. Agricultural Economics Research Review 21(2), 221-226.

Singh, A.K., Singh, R.P., Singh, R.K., Upadhyay, S.P., 2019. Effect of cluster frontline demonstration on rape seed mustard in Gorakhpur district of Uttar Pradesh. Indian Journal of Extension Education 55(3), 123–127.

Singh, C., Singh, S.K., Ankur, Kumar, A., Singh, N.V., Kumar, M., 2020. Impact of improved technology and package of practices to sustain the productivity of mustard in district Auraiya (U.P.). The Pharma Innovation Journal 9(9), 424–427.

Singh, D., Kumar, C., Chaudhary, M.K., Meena, M.L., 2018. Popularization of improved mustard (*Brassica juncea* L.) production technology through frontline demonstration in Pali district of Rajasthan. Indian Journal of Extension Education 54(3), 115–118.

Singh, D.K., Gautam, U.S., Singh, R.K., 2007. Study of yield gap and level of demonstrated crop production technology in Sagar district. Indian Research Journal of Extension Education 7(2–3), 94–95.

Subbaiah, V., Jyothi, V., 2019. Impact of front line demonstrations on improved management practices in groundnut and sesamum. Journal of Oilseeds Research 36(3), 126–133.

Sundramurthy, V.T., Chitra, K., 1992. Integrated pest management in cotton. Indian Journal of Plant Protection 20, 1-17.

Sushila, N., Sreenivas, A.G., Bheemanna, M., Hanchinal, S.G., 2015. Management of sucking insect pests of *Bt cotton* by buprofezin 70% DF. Pesticide Research Journal 27(2), 160-164.

Tankodara, K.D., Gohil, G.R., Thakar, D.S., 2018. Impact of training programme on knowledge level of farmers regarding scientific cultivation technologies of horticultural crops. Gujarat Journal of Extension Education 29(1), 69–71.

Tunvar, M.A., Patel, A.J., Prajapati, V.V., 2017. Impact of front–line demonstration on groundnut conducted by Krishi Vigyan Kendra, Deesa. Gujrat Journal of Extension Education (Special Issue on National Seminar), 56–58.

Venkatarajkumar, B., Naiik, R.V.T.B., Bhavyamanjari, M., Kumar, P.V., Kumar, B.K., Muddam, S., Padmaveni, C., 2020. Enhancing the yield, quality and productivity in tomato (*Lycopersicon esculentum* mill.) through trellis technology in Northern Telangana zone of the state. Multilogic in Science 10(33), 519–521.