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Yield Gap Analysis and Impact Assessment of Cotton and Assessment of Front line Demonstrations on Cotton Using *Beauveria Bassiana* against Pink Bollworm in Kutch Region of Gujarat

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Abstract : Front line demonstrations (FLDs) may be crucial to the efficient transfer of technologies and the transformation of farmers' attitudes towards science. Prior to conducting demonstrations, key problems with the current technology were discovered through field visits, farmer meetings and group discussions. Low productivity due to poor adoption of high yielding varieties/hybrids with recommended package of practises is one of the major constraints of traditional cotton farming. Cotton yield enhancement is dependent on integrated pest management (IPM) due to the attack of numerous insect pests. In order to increase cotton productivity during *kharif*, 2018–2019 to 2020–2021, ICAR–CAZRI, Krishi Vigyan Kendra (KVK), Bhuj–Kutch conducted an impact assessment study of FLDs on improved practises with IPM technology. In demonstrated plots, the three year average cotton yield was higher (2561 kg/ha), up 13.89 per cent from the local check's 2241 kg/ha. The average extension gap, technology gap, and technology index for the technology that had been demonstrated were 320.3 kg/ha, 438.7 kg/ha, and 14.62 per cent, respectively. The economics of demonstrations revealed the viability of improved technology, which had a higher net return of 94,723 Rs./ha and a benefit cost ratio (BCR) of 3.06 as compared to Rs. 78471/ha and a BCR of 2.76 in existing technology. A wide range of extension and technology gaps had a negative impact on crop yield and net return. Cotton yield potential can be greatly increased by conducting front-line demonstrations of proven technologies.

Keywords: Adoption, *Beauveria bassiana*, cotton, extension gap, frontline demonstration (FLD), impact, net return, technology index

Cotton, *Gossypium* sp. (Family: Malvaceae) is an important commercial fibre crop grown under diverse agro climatic conditions, is the source of 60 per cent of the world's fibre (Chachral *et al.*, 2008). One fourth of the world's cotton is produced in India, which ranks first in the world with 34 million bales of cotton production, cultivates the crop on around 12 million hectares of land. India's average cotton production is 469 kg/ha, which is less than the 778 kg/ha average for the world. In India, Maharashtra, Gujarat, Telangana, Rajasthan, and Haryana are the leading states where cotton is cultivated extensively(Anonymous, 2021). In arid Kutch, Gujarat, the main limiting constraints in cotton production includes low soil fertility, shortage and poor quality irrigation water, high prevalence of insect pests and soilborne diseases etc. The cultivation of susceptible hybrids, late planting, inadequate fertiliser use, and insecticide spraying were some of the major abiotic factors for insect pest outbreaks (Kranthi, 2015).

Recent attacks of pink bollworm throughout the central and southern zone of cotton production since the *kharif* season of 2015, affecting fields in Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Telangana with anticipated yield losses of up to 30 per cent (Fand *et al.*, 2019 and Naik *et al.*, 2018). In Gujarat, Kutch districts were proffered *Bt* cotton crop in *kharif* season from last 10 years and its gain highest production and productivity. But since last two years the farmers of this area are suffering from heavy attack of pink bollworm pest in *Bt* cotton which caused reduction in production and productivity in 2014-2015 which continuous in year up to 2017-2018. The estimated loss due to pink bollworm pests is up to 30-40 per cent. For this only chemical control measure is not feasible, hence there is a need to use integrated approaches for management of pink bollworm in *Bt* cotton.

It was observed that majority of farmers did not use improved practices like quality seed, suitable plant protection measures, balanced fertilization resulting in a wide extension gap between demonstrated technology and farmers' technique. To bridge that gap, KVK Bhuj demonstrated improved cotton cultivation technology in various farmers' fields as FLDs, which focuses on increasing productivity by providing vital inputs as well as improved packages of practices.

MATERIALS AND METHODS

The current study was conducted by the ICAR-CAZRI, Krishi Vigyan Kendra, Bhuj-Kutch (Gujarat) during the *kharif*, 2018-2019 to 2020-2021 at farmer's fields. A total of 60 frontline demonstrations were held throughout a 24-hectare area at different villages namely Dhaneti, Lakhond, Chapredi, Atal Nagar, Ratnal, Nadapa, Dagara, Nana Reha, Kotda Chakar, Moti Virani and Natharkui of Kutch district in Arid Zone of Gujarat. The soils in the research area were mostly saline and alkaline in nature, with a sandy to sandy loam texture and poor in essential micro nutrients and organic carbon. The yield data was obtained from FLD plots along with local farming practises widely used by farmers in this region, for comparative analysis. Under demonstration plots, we have provided critical inputs such as bio pesticide *Beauveria bassiana* (entomopathogenic fungi), pheromone trap (Gossyplure)to manage the bollworm complex, *neem* oil and magnesium sulphate (MgSO4)and technical advice on integrated crop management (ICM). To monitor the activity of bollworm moths' pheromones trap were installed at the time of first flowering and the lure of trap were change at 25-30 days interval. Not only regular inspection and continuous remove of collected adult from trap but also initial spray of ovicidal insecticide was introduced to overcome the problem. Thereafter, two spraying of *B. bassiana*@ 6 g/ L. of water at the time of pest infestation will help to reduce pink boll worm infestation at the great level. On the other hand, farmers were allowed to continue with their conventional techniques in the event of a local check. Statistical tools such as frequency and percentage were used to collect, tabulate, and analyse the data. The extension gap, technology gap, and technology index were calculated using the Samui *et al.,* (2000) equations;

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - yield under existing practice

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

The cultivation practices followed under the front-line demonstrations (FLDs) and farmers' practices are given in Table-1.

RESULTS AND DISCUSSION

Yield performance

The results of frontline demonstrations (FLDs) conducted at farmers' fields during *kharif*, 2018-2019 to 2020-2021 revealed that the cotton lint yield was significantly increased in demonstrated plots IPM technology as compared to existing practices in all the three years of study (Table 2). The data reported that the pink bollworm infestation was reduced of 35.7 per cent in demo plots due to right time application of biopesticide and botanical insecticides based on pest monitoring with the help of pheromone traps. The cotton yield fluctuated every year due

Table 1. Particulars showing the details of cotton cultivation practices under FLDs and farmers' practices.

S. No.	Operation	Farmer's practice	Demonstrated technology
1.	Seed and seed rate	Use of private hybrids with high seed rate @1.7 kg/ha	Use of private hybrids (Ajeet 155) Seed rate: 1.2 kg/ha
2.	Seed treatment	Generally, not practiced	Imidacloprid 70 FS @ 6-7 ml/kg seed to manage sucking insects and termites
3.	Sowing time	20th June to 15th July	15th June to 1st week of July
4.	Sowing method	Line sowing: R x P = 120 x 45 cm	Line sowing: R x P = 120 x 45 cm
5.	Manure and Fertilizers	FYM: None180: 60: 0 (Kg. N: P: K/ha)	FYM: 10 t/ha 240:40:00 (Kg N: P: K/ha) MgSO4 @ 20 kg/ha
6.	Irrigation	36-38 irrigations	30-32 Irrigations (1-2 extra irrigations in sandy soils)
7.	Weed management	Pre emergence uses of pendimethalin 1.0 kg a.i./ha followed by one hand weeding at 25-30 DAS	Applied pendimethalin @ 1 kg a.i./ha as pre emergence followed by two hand weeding at 30 and 60 days after sowing(DAS)
8.	Plant protection	Broadly used chemicals fungicide monocrotophos or profenophos @30 ml/15 lit. water	→ Installation of Pheromones (Gossyplure) @ 10/ha → Use of *Beauveria bassiana* as foliar spray @ 6g/lit. water → Two foliar sprays with *neem* oil 1500 ppm @ 4 ml/ lit. water at 15 days interval.

to variability in crop management practices, prevailing microclimate during the cropping season, occurrence of insect pests, other social and economic issues *etc*. The average yield recorded under improved practice (IP) demonstrated during the *kharif*, 2018-2019, 2019-2020 and 2020-2021 was 2673, 2648 and 2363 kg/ha over farmer's practice (FP) where it was 2343, 2336 and 2044 kg/ha, respectively. All the three years mean yield was 13.89 per cent higher in demonstration plots (2561 kg/ha) in comparison to 2241 kg/ha obtained from existing practice. Dahiya *et al*., (2018) and Patel *et al*., (2013) both saw similar yield increment in FLDs conducted on cotton crop. The outcomes further demonstrated that the remarkable impact of IPM practises on the cotton growers of the district as they adopted the most recent agricultural technologies that were incorporated in the frontline demonstration plots by the KVK increased the average yield of cotton during the study period.

Yield gap analysis

In the previous years, the trends of cotton yield were not satisfactory because of the poor adoption of management strategies for bollworm complex. The lower yield of cotton in comparison to district average showed the wider extension gap between improved technology and existing practice. As described in Table 2, the extension gap between improved and conventional practise varied between 312 and 330 kg/ha, with an average of 320.3 kg/ha. The extension gap was recorded at its lowest (312 kg/ha) in the second year 2019-2020, indicating the greater adoption of superior technologies of the KVK. The findings of Tetarwal *et al*., (2021) and Dhaka *et al*., (2010) corroborate the conclusions of this study. Further more, the technology gap was 438.7 kg/ha on average with lowest 327 kg/ha recorded in the beginning year (2028-2019) of the study. The technology gap was carried out to know the gap between demonstration and potential yield, variability in soil fertility, irrigation water quality, microclimate, insect pest infestation, farmer crop management level, and other factors are to blame for variations in the technological gap. Hence, need to develop location specific IPM modules to overcome such

Table 2. Yield gap analysis of cotton

Year	No. of Demo	Area (ha)	Demo (IP)* Yield (kg/ha)	Local (FP) Yield (kg/ha)	(%) Yield Increase over FP	Ext Gap (kg/ha)	Tech. Gap (kg/ha)	Tech. Index (%)
2018-2019	20	8	2673	2343	14.08	330	327	10.90
2019-2020	20	8	2648	2336	13.36	312	352	11.73
2020-2021	20	8	2363	2044	14.22	319	637	21.23
Average	**2561**	**2241**	**13.89**	**320.3**	**438.7**	**14.62**		

*IP=Improved Practice; FP= Farmers Practice

Table 3. Economic analysis of front line demonstrations on cotton

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
2018-2019	45600	44000	147015	128865	101415	84865	16550	3.22	2.93
2019-2020	44950	43400	145640	128480	100690	85080	15610	3.24	2.96
2020-2021	43900	42950	129965	112420	82065	65470	16595	2.71	2.39
Average	**44816**	**43450**	**140873**	**123255**	**94723**	**78471**	**16251**	**3.06**	**2.76**

*IP=Improved Practice; FP= Farmers Practice

type of gaps in cotton cultivation for achieving higher yield. The statistics obtained show that the technology index peaked at 21.23 per cent in 2020-2021 and lowest (10.9%) in 2018-2019. The average technology index across the years was 14.62 per cent. The findings of Chauhan *et al.*, (2020) are consistent with current research. A technology's acceptability and practicality are always inversely related to its technology index value; the higher the acceptance of the proven technology, the lower the technology index value (Sagar and Chandra, 2004).

Economic analysis

Economic viability is the fundamental need of an improved technology demonstrated at farmers' fields to determine the profit over existing technology. The cost of cultivation and production data of cotton under frontline demonstrations were collected and analysed to get gross return (Rs/ha), net return (Rs/ha), additional income (Rs/ha) and benefit cost ratio. To evaluate their profit over existing technology, it is critical to understand the economic feasibility of every approach shown on farmers' fields. Over a three year period (Table 3), proven technique produced a greater gross return of Rs. 140873/ha than farmers' techniques (Rs. 123255/ha). Furthermore, with an increased input cost of Rs. 900/ha, the FLD plots provided an average additional return of Rs. 16251/ha and a higher average benefit cost ratio of 3.06 in comparison to farmers practice (2.76). The current findings are consistent with those of Patel *et al.*, (2013) and Meena and Singh (2016).

CONCLUSIONS

The results of the economic analysis show that the technology demonstrated is more profitable and commercially viable. Use of improved package of practices with biopesticide, *Beauveria bassiana* can help produce more cotton at a lower cost. FLDs are essential in encouraging farmers to use contemporary agricultural technology, which boosts output and income. Using this technology, farmers can increase their returns while incurring fewer additional input costs. In order to organise FLDs and large scale capacity development programmes to close the extension gap for better cotton productivity by transferring improved technology to the region, it is also advised that strong ties be established with line departments and other agencies.

REFERENCES

Anonymous 2021. Accessed from agricoop.nic.in. Department of Agriculture, Cooperation and Farmer's Welfare.

Chachral, Q.I., Solangil, A.G. and Verhoef, A. 2008. Influence of sodium chloride on seed germination and seedling growth of cotton (*Gossypium hirusutum*). *Pakistan J. Bot.*, **40**: 183-97.

Chauhan, R.S., Singh, R.K., Singh, P. and Singh, S.R.K. 2020. Impact Analysis of FLDs in Mustard on Technology Transfer and Productivity in Shivpuri District of M.P. *Indian Res. J. Ext. Edu.* **20** :79-82.

Dahiya, R., Yadav, S. and Yadav, S. 2018. Impact of frontline demonstration on cotton production technology. *J. Cotton Res. Dev.* **32** : 300-05.

Dhaka, B.L., Meena, B.S. and Suwalika, R.L. 2010. Popularization of improved maize technology through Front Line Demonstration in South-eastern Rajasthan. *J. Agric Sci.*, **1**:39-42.

Fand, B.B., Nagrare, V.S., Gawande, S.P., Nagrale, D.T., Naikwadi, B.V., Deshmukh, V., Gokte-Narkhedkar, N. and Waghmare, V.N. 2019: Widespread infestation of pink bollworm, Pectinophora gossypiella (Saunders) (Lepidoptera: Gelechidae) on *Bt* cotton in Central India: Anew threat and concerns for cotton production. *Phytoparasitica* **47**, 313–25.

Kranthi, K.R. 2015. Cotton statistics and News. Cotton Association of India, Mumbai, India.

Meena, M.L. and Singh, D. 2016. Producvity enhancement and gap analysis of moth bean, *Vigna acontifolia* (Jacq.) through improved production technology on farmers participatory mode. *Indian J. Dryl. Agricul. Res.*, **31**: 68-71.

Naik, V.C.B., Kumbhare, S., Kranthi, S., Satijaa,U. and Kranthi, K. 2018. Field-evolved resistance of pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae), to transgenic *Bacillus thuringiensis* (*Bt*) cotton expressing crystal 1Ac (Cry1Ac) and Cry2 Ab in India. *Pest Management Science.* **74**: 2544–54.

Patel, M.M., Jhajharia, A.K., Khadda, B.S. and Patil, L.M. 2013. Frontline demonstration: an effective communication approach for dissemination of sustainable cotton production technology. *Indian J. Ext. Edu.*. **21**: 60-62.

Sagar, R.L. and Chandra, R. 2004. Front line demonstration on sesame in West Bengal. *Agricul. Ext. Revi.* **16**: 7-10.

Samui, S.K., Maitra, S., Roy, D.K., Mandal, A.K. and Saha, D. 2000. Evaluation of front-line demonstration on groundnut. *J. Indian Soci. Coastal Agricult. Res.* **18**: 180-83.

Tetarwal, A.S. 2021. Impact of front-line demonstrations on productivity of cumin inarid Kutch of Gujarat. *Ann. Agricult. Res.* **42**: 325-31.

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