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Cultivating cotton the smart way: A glimpse into Bathinda farmers' adoption of Bt cotton cultivation practices

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Abstract

Cotton is one of the oldest and most significant commercial crops in terms of global economic, political and social concerns. Farmers in Punjab began to switch their crops from non-Bt cotton to Bt cotton. Since Punjab is one of the top producing states for cotton, experts were interested in the potential for growth and productivity of Bt cotton farming. Given Bathinda's prominence as Punjab's cotton-growing district, a study was carried out there. Bathinda district comprises nine blocks. Out of nine blocks, two were selected randomly. From each selected block, two villages were selected and from each village, 20 respondents were selected randomly to make a sample size of 80 respondents. Study showed that a smaller number of farmers adopted the recommended seed rate in the Sangat block and none of the farmers in Talwandi Sabo block adopted the recommended seed rate. Less than 50% farmers in both the blocks adopted the recommended dose of urea. None of the farmers adopted the recommended quantity of DAP and SSP in both the blocks. Only 7% of farmers in Sangat block adopted the recommended quantity of MOP; none of the farmers adopted the recommended quantity of MOP in Talwandi Sabo block. A very low percentage of farmers adopted the recommended dose of herbicide and pesticide in both the blocks.

Keywords: Adoption, Bt cotton, recommended, herbicide, farming

Introduction

Cotton, being one of the most ancient and economically vital crops, holds substantial global significance with implications reaching into economic, political and societal domains. In Punjab, a key cotton-producing state, a notable shift has occurred as farmers transition from cultivating non-Bt cotton to Bt cotton varieties. Bt cotton, known as transgenic cotton, is a crop that has undergone genetic engineering. The soil-borne bacterium *Bacillus thuringiensis* (Bt) is the source of the toxic protein-inducing gene found in this Bt cotton. This gene allows the crop to produce a toxin, which reduces bollworm infestation, reduces the need for insecticides, increases productivity and improves the quality of "kapas". (Rajput and Chinchmalatpure, 2016) [8]. Cotton is susceptible to insect-pests attack and adoption of suitable plant protection measures has a significant effect. (Khan *et al.*, 2015) [4]. Numerous extension initiatives have been started all over the world to increase farmers' adoption of suggested techniques for raising yields and reducing poverty. Increased area planted with cotton thanks to the Integrated Cotton Development Programme (ICDP), which was implemented in India during the 1970s, contributed to an increase in cotton production (Sabesh *et al.*, 2014) [9]. Government of India (GOI) launched technology mission on cotton in 2000 with the objective of improving the cotton

production through improved seeds and integrated nutrient and insect-pest management. In Punjab, 'Cotton Development Program' was launched by the state Government during 2016 to reduce the cost of cultivation, while enhancing productivity of Bt cotton crop in the state. During 2015-17, numerous training and awareness programmes were organized and field trials/demonstrations were conducted to make the cotton growers aware regarding recommended Bt-cotton hybrids, optimum seed rate, fertilizer doses and application of recommended insecticides based on economic threshold level (ETL). (Singh *et al.*, 2022) [13]. The success of any extension programmes is judged by the adoption of improved practices and thus evaluation of the extension programmes has significant importance. (Sharma *et al.*, 2021) [11].

During the 2002-2003, Bt cotton was allowed to be released for commercial production by the Genetically Engineered Approval Committee. It is getting the most attention from planners, scientists, social workers, farmers and the general public because it was the first and only crop in India to gain environmental clearance as a Genetically Modified Organism. Since its introduction, the area planted with Bt cotton has been steadily growing in every state in the union. On 29072 hectares, Bt cotton was grown in the first year alone. In 2003, it was enlarged to 92000 hectares. In 2004, it was enlarged by a further fourfold, bringing the total to

nearly 500,000 hectares (524, 000 ha). The amount of Bt cotton grown in India was increased by 160% from 2004 to 2005, reaching 1.3 million hectares (Anonymous, 2020) ^[1]. The adoption rate in India continued to rise at a historic rate in 2006, almost doubling to 3.8 million hectares from 1.3 million hectares (Jambhule, 2023) ^[3].

Farmers typically do not fully adopt agricultural technology in all respects. There always seems to be a disconnect between the technology that experts advise using and how farmers actually use it. This technology divide is a significant obstacle to raising agricultural production. When it comes to growing crops, plant protection is crucial. One of the key components of managing pests and diseases is adopting plant protection recommendations. Despite this, farmers are not fully implementing the guidelines, so it is crucial to consistently utilize plant protection methods to control pests and diseases. (Sardhara *et al.*, 2020) ^[10].

Materials and Methods

A multistage random sampling approach was utilized to identify the respondents for the present investigation. The study was carried out in Bathinda district of Punjab, which was intentionally selected because of its leading role in cotton production within the state. The district is administratively organized into nine blocks: Bathinda, Sangat, Nathana, Rampura Phul, Phul, Maur, Goniana, Bhagta Bhaika and Talwandi Sabo. During the first phase of sampling, two blocks were chosen randomly. In the second phase, two villages were randomly selected from each of the chosen blocks. In the final phase, 20 respondents from each selected village were drawn using simple random sampling, resulting in a total sample size of 80 respondents. Primary data were collected through a systematically designed and

pre-tested interview schedule. The collected data were examined using appropriate descriptive and inferential statistical techniques, including mean, standard deviation, independent *t*-test and *z*-test, to analyze and compare variations between the two selected blocks.

Results and Discussion

The results indicate significant differences in landholding patterns between the two selected blocks. Respondents from Sangat block possessed a considerably higher mean operational landholding (21.31 ± 15.07 acres) than those from Talwandi Sabo (12.70 ± 6.78 acres) and the difference was statistically significant ($t = 3.296$; $p = 0.0001$), with an overall average of 17.01 ± 12.39 acres. Marginal farmers represented a negligible proportion in both blocks (2% each), whereas the share of small farmers was significantly higher in Talwandi Sabo (22%) compared to Sangat (7%) ($|z| = 3.488$; $p = 0.0004$). Although a higher percentage of semi-medium farmers was observed in Sangat (17%) than in Talwandi Sabo (10%), the difference was statistically non-significant ($z = 1.655$; $p = 0.096$). Medium landholders were predominantly concentrated in Talwandi Sabo (62%) as compared to Sangat (40%) and this variation was statistically significant ($|z| = 2.013$; $p = 0.0001$), while large farmers were overwhelmingly represented in Sangat block (32%) relative to Talwandi Sabo (2%), showing a highly significant difference ($z = 6.785$; $p = 0.0001$). Furthermore, the mean area allocated to cotton cultivation was significantly greater among respondents of Sangat block (5.46 ± 4.14 acres) than those of Talwandi Sabo (3.66 ± 1.98 acres) ($t = 2.934$; $p = 0.0001$), with an overall average cotton area of 4.79 ± 3.61 acres. These outcomes align with the findings of Peshin *et al.*, (2007) ^[7].

Table 1: Land holding status and farm size of the Bt cotton growers

Parameters	Blocks		Statistical (p value)	Overall n = 80
	Sangat n = 40	Talwandi Sabo n = 40		
Average operational land holding (in acre)	21.31 ± 15.07	12.70 ± 6.78	$t = 3.296^{**}$ (0.0001)	17.01 ± 12.39
Categorization of average operational land (% respondents)				
Marginal (< 2.5 acre)	1 (2)	1 (2)	-	2 (2)
Small (2.5-5 acre)	3 (7)	9 (22)	$ z = 3.488^{**}$ (0.0004)	12 (15)
Semi medium (5-10 acre)	7 (17)	4 (10)	$z = 1.655$ (0.096)	11 (14)
Medium (10-25 acre)	16 (40)	25 (62)	$ z = 2.013^{**}$ (0.0001)	41 (51)
Large (25 acre and above)	13 (32)	1 (2)	$z = 6.785^{**}$ (0.0001)	14 (17)
Average cotton land (in acre)	5.46 ± 4.14	3.66 ± 1.98	$t = 2.934^{**}$ (0.0001)	4.79 ± 3.61

The findings related to the use of mass media sources by the respondents reveal considerable variation in their frequency of exposure. Television emerged as the most frequently accessed medium, with a large majority of respondents (72%) reporting regular use, while only a small fraction (4%) indicated that they never relied on it. Agricultural fairs and exhibitions were also widely utilized, as 67% and 61% of respondents, respectively, reported regular participation, suggesting their importance as key platforms for information dissemination. Radio was found to be the least preferred medium on a regular basis, with only 7% of respondents using it regularly, whereas a substantial proportion (62%) reported no use of radio at all. Newspaper readership showed a mixed pattern, as 26% of respondents accessed it regularly, 39% did so occasionally and 35% never used it. Similarly, printed literature such as leaflets and booklets was used occasionally by nearly half of the

respondents (47%), while equal proportions (26% each) reported regular use and non-use, indicating moderate dependence on this source for information. Similar findings were revealed by Nagesh *et al.*, (2018) ^[5] and Singh *et al.*, (2023) ^[14] who also reported that respondents participated in extension activities like demonstrations (56.11%), group meetings (45.56%) and Krishi mela (21.11%).

Table 2: Mass media exposure of the Bt cotton growers (% Bt cotton growers)

Sources of mass media	Regularly	Occasionally	Never
Radio	6 (7)	24 (30)	50 (62)
Television	58 (72)	19 (24)	3 (4)
News paper	21 (26)	31 (39)	28 (35)
Printed literature	21 (26)	38 (47)	21 (26)
Exhibition	49 (61)	25 (31)	6 (7)
Agricultural fair	54 (67)	22 (27)	4 (5)

In the agricultural practices of Sangat and Talwandi Sabo blocks, notable variations were observed. The average seed rate adopted by the farmers was 1.36 and 1.42 kg/acre in Sangat and Talwandi Sabo blocks, respectively. However, only 10% in Sangat and none in Talwandi Sabo adhered to the recommended seed rate. The average quantity of urea adopted by the farmers for application during the cropping season was 110.81 kg/acre in Sangat block and 114.75 kg/acre in Talwandi Sabo block. The majority of farmers adopted the recommended quantity of urea in both blocks. The average quantity of DAP adopted by the farmers was 32.37 kg/acre in Sangat block and 46.87 kg/acre in Talwandi Sabo block. None of the farmers adopted the recommended quantity of DAP in both blocks. The average quantity of MOP adopted by the farmers was 18.82 and 28.75 kg/acre in Sangat and Talwandi Sabo blocks, respectively. Only 7% of farmers in Sangat block adopted the recommended quantity of MOP; none of the farmers adopted the recommended quantity of MOP in Talwandi Sabo block. The average quantity of SSP adopted by the farmers was 28.30 and 18.75 kg/acre in Sangat and Talwandi Sabo blocks, respectively. None of the farmers adopted the recommended quantity of SSP in both blocks. The herbicides adopted by the farmers for the control of weeds were Pendimethalin 30 EC and Hitweed Maxx 10 MEC. The average quantity of Pendimethalin 30 EC

adopted by the farmers was 0.57 and 0.45 ltr/acre in Sangat and Talwandi Sabo blocks, respectively. The average quantity of Hitweed Maxx 10 MEC adopted by the farmers was 0.04 ltr/acre in Sangat as well as Talwandi Sabo block. The pesticides adopted by farmers for the control of pests were confidor, ulala 50 WG and actara 25 WG. The average quantity of confidor adopted by the farmers was 40.87 and 50.00 ml/acre in Sangat and Talwandi Sabo blocks, respectively. The average quantity of ulala 50 WG adopted by farmers was 63.50 and 72.75 g/acre in Sangat and Talwandi Sabo blocks, respectively. The average quantity of Actara 25 WG adopted by the farmers was between 57.50 and 71.50 g/acre. Significant differences were also observed in both blocks in the average seed rate, average quantity of FYM before sowing, average quantity of DAP, average quantity of MOP, average quantity of pandy methaline, average quantity of ulala 50 WG and average quantity of actara 25 WG. Very few respondents followed the recommended guidelines for using FYM, urea, DAP, MOP, SSP, herbicide, insecticide and pesticide. To address this issue, it's the department's responsibility to educate farmers about the correct fertilizer amounts and the appropriate dosages of insecticides and herbicides. These findings are in accordance with the findings of Singh *et al.*, (2022) ^[13], Singh *et al.*, (2017) ^[12], Patra *et al.*, (2023) ^[6] and Dhawan *et al.*, (2011) ^[2].

Table 3: Adoption of Bt cotton practices followed by the farmers

Parameters	Blocks		Statistical (p value)	Overall n = 80
	Sangat n = 40	Talwandi Sabo n = 40		
Average seed rate (Kg/acre)	1.36 ± 0.17	1.42 ± 0	t =2.123** (0.0001)	1.39 ± 0.13
Recommended seed rate (0.95 Kg/acre)	4 (10)	0	-	4 (5)
Average quantity of urea (Kg/acre)	110.81 ± 23.56	114.75 ± 22.67	t = 0.762 (0.841)	112.78 ± 2.58
Recommended (90 Kg/acre)	17 (42)	18 (45)	z =0.225** (0.0001)	35 (44)
Average quantity of DAP (Kg/acre)	32.37 ± 16.48	46.87 ± 11.58	t = 4.551** (0.0001)	39.62 ± 15.93
Recommended (27 Kg/acre)	0	0	-	0
Average quantity of MOP (Kg/acre)	18.82 ± 3.27	28.75 ± 24.38	t = 1.962** (0.004)	23.79 ± 2.57
Recommended (20 Kg/acre)	3 (7)	0	-	3 (4)
Average quantity of SSP (Kg/acre)	28.30 ± 5.29	18.75 ± 5.28	t= 1.278 (0.541)	23.52 ± 3.75
Recommended (75 Kg/acre)	0	0	-	0
Herbicide				
Average quantity of Pendimethalin 30 EC (ltr/acre)	0.57 ± 0.11	0.45 ± 0.09	t= 0.824* (0.037)	0.51 ± 0.07
Recommended (1 ltr/acre)	3 (7)	7 (17)	z = 2.439* (0.014)	10 (12)
Average quantity of Hitweed Maxx 10 MEC (ltr/acre)	0.04 ± 0.01	0.04 ± 0.01	-	0.04 ± 0.009
Recommended (0.5 ltr/acre)	0	0	-	0
Pesticides				
Average quantity of Confidor (ml/acre)	40.87 ± 9.19	50.00 ± 8.99	t = 0.710 (0.636)	45.44 ± 6.40
Recommended (150 ml/acre)	2 (5)	1 (2)	z= 0.588 (0.555)	3 (7)
Average quantity of Ulala 50 WG (g/acre)	63.50 ± 41.54	72.75 ± 35.12	t = 1.075* (0.026)	68.12 ± 38.50
Recommended (80 g/acre)	6 (15)	5 (12)	z= 0.709 (0.477)	11 (14)
Average quantity of Actara 25 WG (g/acre)	57.50 ± 54.71	71.50 ± 35.12	t = 1.259** (0.019)	64.50 ± 49.93
Recommended (40 g/acre)	0	0	-	0

Conclusion

The study revealed significant differences in landholding patterns and adoption of Bt cotton practices between Sangat and Talwandi Sabo blocks of Bathinda district. Although television, agricultural fairs and exhibitions served as major sources of information, adoption of recommended seed rates, fertilizer doses and plant protection measures was generally low. Wide deviations from scientific recommendations indicate a substantial technology adoption gap, particularly in nutrient and pest management practices.

Strengthening extension efforts through focused training, demonstrations and timely advisory services is essential to improve farmers' knowledge, optimize input use and promote sustainable Bt cotton production.

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