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A study on technological gap in cultivation of cotton in Warangal district of Telangana

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Abstract

Cotton is India's foremost commercial fibre crop, yet significant yield gaps persist due to gaps between recommended scientific practices and actual farmer adoption. This study empirically assessed the technological gaps in cotton cultivation among 120 farmers from Warangal district of Telangana. A structured interview schedule was used to measure practice-wise adoption levels and their determinants. Results revealed that (40.00%) of farmers exhibited medium technological gap, (32.50%) low gap and (27.50%) high gap with a mean technological gap index of 70.18. High adoption was recorded for visible and yield-driven practices such as sowing time (74.17%), spacing (71.67%), Bt hybrid selection (70.83%) and bollworm management (64.17%). However, large gaps were seen in seed treatment (18.33%), certified seed procurement (24.17%), biofertilizers (05.00%), drip irrigation (15.00%), IPM (38.33%) and leaf spot management (22.50%). Correlation analysis revealed significant negative relationships between technological gap and education, annual income, scientific orientation, extension contact, decision-making ability and achievement motivation. The findings suggest that targeted extension strategies especially those focused on preventive technologies, micronutrient management, IPM, strengthening KVK-FPO linkages, providing input subsidies and building farmer capacity are critical to promoting sustainable cotton cultivation in Telangana.

Keywords: Cotton, technological gap, adoption, IPM, biofertilizers, extension strategies

1. Introduction

Cotton is one of the most important commercial crops of India, cultivated across diverse agro-climatic regions and playing a vital role in the national economy through employment generation and foreign exchange earnings. India holds the largest cotton acreage globally, accounting for nearly 36 per cent of the world's cotton area and remains among the leading producers of cotton. Nearly two-thirds of the cotton fibre produced is utilized by the textile sector, which forms the backbone of India's agro-industrial economy. Cotton cultivation directly engages about 6 million farm households, while the broader cotton value chain including ginning, processing, marketing and textile manufacturing supports the livelihoods of nearly 40-50 million people.

Over the years, significant technological advancements such as the development of high-yielding varieties and improved cultivation practices have been introduced to enhance cotton productivity and profitability. Despite the availability of these technologies and sustained efforts by research and extension agencies to disseminate scientific knowledge, the actual yield realized by farmers remains considerably below its potential. A substantial gap persists between technology generation and its adoption at the field level.

Under Indian conditions, the cotton yield gap is considerably higher compared to global productivity levels and a similar situation has been observed in Warangal district. This gap can largely be attributed to inadequate technical knowledge and partial or poor adoption of recommended cotton cultivation practices by growers. In view of these challenges, the present study was undertaken to assess the extent of farmer's knowledge regarding recommended cotton cultivation practices and to examine the level of adoption of these technologies among cotton growers.

2. Methodology

The present study was conducted in Warangal district of Telangana state, where cotton constitutes a major component of the prevailing cropping system. A purposive-cum-random sampling technique was employed to select the respondents, considering the district's diverse cotton-growing ecosystems and variations in the level of technology adoption. A total of 120 cotton farmers were selected for the study. An ex post facto research design was adopted, as the key variables such as farmer's profile characteristics, level of adoption and technological gaps had already occurred and could not be manipulated by the researcher. Data were collected using a structured and pre-tested interview schedule, which was designed to capture information on farmer's socio-personal and psychological characteristics, adoption of recommended cotton production technologies, constraints faced in adoption and suggestions. The extent of technological gap was quantified using the technological gap index, calculated as the difference between the maximum possible adoption and the actual percentage of adoption.

3. Results and Discussion

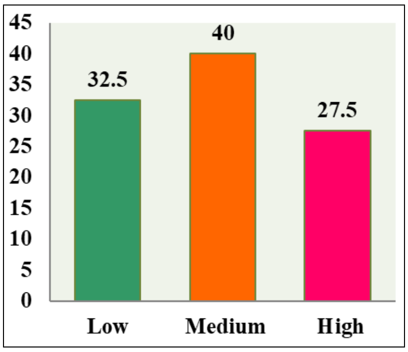
Table 1: Distribution of the cotton growers by their overall technological gap N=120

Sl. No.	Category	Frequency	Per cent
1.	Low (<68.57)	39	32.50
2.	Medium (68.57-71.78)	48	40.00
3.	High (>71.78)	33	27.50
		Mean=70.18	SD= 3.20

Overall technological gap in cotton cultivation

The results in Table 1 reported a distinct pattern in the technological gap among cotton growers. A considerable proportion two-fifth (40.00%) fell within the medium technological gap category, indicates that many farmers are adopting recommended practices selectively, possibly prioritising those that are cost-effective, less labour-intensive or proven to suit their local agro-climatic conditions. Nearly one-third (32.50%) of respondents were placed in the low gap category, reflected relatively high compliance with recommended cultivation technologies. On the other hand, more than one-fourth (27.50%) of the growers exhibited a high technological gap, indicates significant barriers to adoption.

The mean technological gap score of 70.18 and a standard deviation of 3.20 relatively narrow variations across the population, suggests that while adoption levels differ most farmers operate within a moderately similar range of technology uptake.



Practice-wise technological gap by respondents in cotton cultivation

The data presented in Table 2 revealed considerable variation in the adoption of recommended cotton cultivation practices across different stages of the crop cycle, ranging from preparatory operations to harvesting.

At the preparatory cultivation stage, adoption levels were mixed. Deep summer ploughing was fully adopted by more than half of the respondents (53.33%), indicates awareness of its role in improving soil structure and aeration. In contrast, the use of pre-emergence herbicides recorded partial adoption by 43.34 per cent of farmers, likely due to high input costs and the belief that manual weeding is adequate during early crop growth. Basal application of organic manures (50.83%) and fertilizers (49.17%) was only partially adopted by about half of the respondents, suggests awareness of the practices but constraints related to cost, availability and technical knowledge limiting full adoption.

During the seed selection and sowing stage, the adoption of *Bt* cotton hybrids was high (70.83%), reflecting farmer's preference for high-yielding and pest-tolerant varieties. However, procurement of seed from recommended sources was low (24.17%), with most farmers depending on local and unregulated markets. Seed treatment showed alarmingly low adoption (18.33%), indicated negligence or inadequate awareness at the pre-sowing stage. In contrast, practices directly linked to yield optimization such as recommended spacing (71.67%), sowing time (74.17%) and seed rate (59.17%) exhibited strong adoption. Depth of sowing was partially adopted by (49.17%) respondents, indicates inconsistent practice due to gaps in technical guidance. Notably, the dibbling method of sowing was universally adopted (100.00%), reflects its traditional acceptance among cotton growers.

In the crop maintenance stage, gap filling was fully adopted by 40.00 per cent of farmers, while others either partially adopted or neglected the practice, potentially affecting plant population and yield. Intercropping recorded moderate adoption (31.67%), suggest farmer's efforts toward income diversification and risk management. Intercultivation was adopted by 46.67 per cent of respondents, reflects moderate awareness of its role in weed control and soil aeration. Weed management practices showed moderate adoption through both chemical (35.00%) and cultural methods (32.50%), with higher partial adoption indicating a blended approach based on weed intensity and resource availability.

Water management practices varied considerably. Ridge and furrow irrigation recorded relatively high adoption (60.00%), whereas drip irrigation adoption was very low (15.00%), primarily due to high installation costs and maintenance requirements. Canopy management practices such as detopping (35.00%) and application of plant growth promoters (23.33%) were moderately adopted, possibly due to limited technical knowledge and inconsistent field response. Management of physiological disorders showed higher adoption for flower and boll drop control (61.67%) compared to leaf reddening (42.50%), indicated farmer's prioritization of practices with immediate yield implications. Nutrient management trends revealed a strong preference for chemical fertilizers (71.67%) over organic manures (36.67%) and bio-fertilizers (05.00%), highlights reliance on quick-response inputs rather than sustainable alternatives.

With regard to plant protection, bollworm management recorded high adoption (64.17%), driven by severe pest pressure and availability of effective control measures. Moderate adoption was observed for the management of sucking pests (41.67%), red cotton bug (40.00%) and integrated pest management practices (38.33%), with partial adoption predominating due to irregular extension contact and variable pest incidence. Disease management practices showed relatively higher adoption for rust control (56.67%), while lower adoption was observed for black arm (38.33%) and leaf spot (22.50%), reflects selective adoption based on perceived disease severity.

At the harvesting stage, partial adoption of the recommended picking time (165-175 DAS) was observed among 62.50 per cent of respondents, with no cases of complete non-adoption. The recommended number of pickings (3-4) was fully adopted by 56.67 per cent of farmers, while partial adoption by others may be attributed to labour constraints and market price fluctuations.

Overall, the findings indicate that cotton growers readily adopt practices that provide immediate and visible benefits in terms of yield and income such as sowing time, spacing and bollworm control. Conversely, practices contributes to long-term sustainability such as seed treatment, organic manure application, bio-fertilizers and drip irrigation exhibited lower adoption levels. This pattern underscores the need for focused extension strategies, demonstration-based learning and supportive financial incentives to enhance awareness, affordability and adoption of critical yet underutilized technologies.

Table 2: Distribution of respondents according to practice-wise technological gap in cotton cultivation

Sl. No.	Recommended Technologies	Cotton growers					
		Full adoption		Partial adoption		No adoption	
		F	%	F	%	F	%
I	**Preparatory cultivation**						
1.	Deep summer ploughing	64	53.33	32	26.67	24	20.00
2.	Usage of pre-emergence herbicides	46	38.33	52	43.34	22	18.33
3.	Application of organic manures to soil	35	29.17	61	50.83	24	20.00
4.	Application of fertilizers in soil	30	25.00	59	49.17	31	25.83
II	**Seeding pattern**						
A.	**Selection of seed variety**						
5.	Cotton varieties (*Bt* hybrids)	85	70.83	35	29.17	00	00.00
6.	Source of seed	29	24.17	74	61.66	17	14.17
B.	**Sowing of seed in main field**						
7.	Seed treatment	22	18.33	00	00.00	98	81.67
8.	Spacing (90 x 60 cm)	86	71.67	34	28.33	00	00.00
9.	Time of sowing (June-july)	89	74.17	31	25.83	00	00.00
10.	Seed rate (2-2.5 kg)	71	59.17	31	25.83	18	15.00
11.	Depth of sowing (4-5cm)	42	35.00	59	49.17	19	15.83
12.	Method of sowing (dibbling)	120	100.00	00	00.00	00	00.00
III	**Maintenance of established crop**						
13.	Gap filling	48	40.00	53	44.17	19	15.83
14.	Inter cropping	38	31.67	59	49.16	23	19.17
15.	Intercultivation	56	46.67	43	35.83	21	17.50
A	**Weed management**						
16.	Chemical method	42	35.00	64	53.33	14	11.67
17.	Cultural method	39	32.50	32	26.67	49	40.83
B	**Water management**						
18.	Ridge & furrow	72	60.00	28	23.33	20	16.67
19.	Drip irrigation	18	15.00	00	00.00	08	85.00
C.	**Canopy management**						
20.	Plant growth promoter	28	23.33	18	15.00	74	61.67
21.	Detopping	42	35.00	59	49.16	19	15.83
D	**Physiological disorder**						
22.	Leaf redding	51	42.50	58	48.33	11	09.17
23.	Flowers & premature boll dropping	74	61.67	40	33.33	06	05.00
E	**Nutrient management**						
24.	Organic fertilizers	44	36.67	50	41.67	26	21.67
25.	Bio fertilizers	06	05.00	00	00.00	114	95.00
26.	Chemical fertilizers	86	71.67	34	28.83	00	00.00
IV	**Plant protection measures**						
A	**Insect/pest management**						
27.	Control of aphids/ thrips/ jassids	50	41.67	70	58.33	00	00.00
28.	Control of bollworms	77	64.17	43	35.83	00	00.00
29.	Control of red cotton bug	48	40.00	53	44.17	19	15.83
30.	Integrated pest management	46	38.33	49	40.83	25	20.84
B	**Disease management**						
31.	Management black arm in cotton	46	38.33	52	43.34	22	18.33
32.	Management rust	68	56.67	23	19.17	29	24.16
33.	Management leaf spot	27	22.50	67	55.83	26	21.67
V	**Harvesting stage**						
34.	Time of picking (165-175 DAS)	45	37.50	75	62.50	00	00.00
35.	Number of picking (3-4)	68	56.67	52	43.33	00	00.00

Relationship between independent variables with technological gap in cotton cultivation

The analysis of correlation results presented in Table 3 showed a clear picture of how various socio-economic and psychological traits influence the technological gap in cotton cultivation. Several factors emerged as statistically significant, shedding light on the dynamics of technology adoption among cotton growers.

Significant variables at the five per cent level: Landholding (r = 0.139, p = 0.013) and market orientation (r = 0.201, p = 0.029) displayed a positive correlation with the technological gap, indicates that larger landholders or those with strong market-driven decision-making may sometimes delay or selectively adopt certain technologies, possibly due to scale-related constraints or profit-risk calculations.

Interestingly, education showed a negative correlation (r = -0.352, p = 0.036) with the technological gap, implies that better-educated farmers tend to adopt recommended cotton technologies more efficiently, thereby narrowing the gap. Similarly, extension orientation (r = -0.360, p = 0.026) exhibited a negative association, implies that farmers who actively seek guidance and information from extension services are more likely to implement modern practices effectively. Farming experience (r = -0.108, p = 0.011) indicates that experienced farmers are more likely to adopt or at least be aware of recommended cotton technologies, leading to a slight reduction in the technological gap. Scientific orientation also showed a negative relationship (r = -0.322, p = 0.023), indicated that farmers with greater reliance on scientific methods are more willing to adopt recommended practices, reduces the gap.

Significant variables at the one per cent level: Annual income emerged as a powerful factor (r = -0.531, p = 0.001), with higher-income farmers showing a smaller technological gap likely due to their greater financial capacity to invest in inputs and innovations.

Table 3: Relationship between independent variables with technological gap in cotton cultivation

Sl. No.	Independent variables	Correlation coefficient (r)	p-value
1	Age	0.089^{NS}	0.298
2	Education	-0.352^{*}	0.036
3	Land holding	0.139^{*}	0.013
4	Farming experience	-0.108^{*}	0.011
5	Annual income	-0.531^{**}	0.001
6	Extension orientation	-0.360^{*}	0.026
7	Market orientation	0.201^{*}	0.029
8	Decision making ability	-0.638^{**}	0.001
9	Risk orientation	0.285^{NS}	0.182
10	Innovative proneness	0.029^{NS}	0.835
11	Scientific orientation	-0.322^{*}	0.023
12	Achievement motivation	-0.412^{**}	0.002
13	Cropping intensity	-0.287^{**}	0.004

N=120

^{NS}: Non-significant, *: Significant at 5 per cent, **: Significant at 1 per cent

Constraints and suggestions from the cotton growers

The study of cotton cultivation from Table 4 revealed a complex web of challenges that farmers encounter, impacting both productivity and profitability. Among the constraints identified, price fluctuation at harvest emerged as the most pressing concern, with (93.33%) of farmers ranking it highest. This underscores the vulnerability of cotton growers to volatile market conditions, where even optimal production may not translate into fair returns, making price stabilization and market support critical for sustaining farmer incomes.

Labour scarcity and escalating labour costs were the second major challenge (90.00%), reflects the increasing difficulty in accessing affordable human resources for various farm operations, particularly during peak seasons such as sowing and harvesting. Closely following this, pest and disease incidence (88.33%) significantly hampers cotton productivity, emphasizing the need for integrated pest management and timely extension services to mitigate losses.

The suggestions gathered from cotton growers in Table 4 highlighted a proactive and solution-oriented mind-set, reflected their readiness to embrace measures that could enhance productivity, income and sustainability. Integrated Pest Management (IPM) practices emerged as the top suggestion, with (91.66%) of farmers emphasizing its adoption. This illustrates that growers recognize the critical importance of sustainable pest and disease management to safeguard yields while minimizing environmental and chemical risks.

Closely following, enhancing procurement and ensuring minimum support prices by government agencies was advocated by (86.66%) of respondents. This indicates that farmers are acutely aware of market volatility and the need for institutional mechanisms to stabilize income and protect them from price shocks.

Subsidized inputs, including seeds, fertilizers and machinery ranked third (82.50%), reflects the financial burden posed by modern cultivation practices and the need for government intervention to make essential resources accessible and affordable.

Table 4: Constraints and suggestions from the cotton growers N=120

Sl. No.	Constraints	Frequency	Percentage
1.	Price fluctuation or lower price at the time of harvest	112	93.33
2.	Labour scarcity & high labour charges	108	90.00
3.	High incidence of insect pests & diseases	106	88.33
Sl. No.	**Suggestions**	**Frequency**	**Percentage**
1.	Popularize the IPM practices for management of pests and disease	110	91.66
2.	Increase the procurement quantity of produce at minimum support price by the government agency	104	86.66
3.	Government should provide the inputs like seeds, fertilizers, machines *etc* at subsidised price	99	82.50

4. Conclusion

The study revealed that cotton farmers in Warangal district still face a considerable technological gap, mainly due to selective adoption of recommended practices. Farmers readily adopt technologies that offer quick and visible benefits, while practices supporting long-term sustainability remain largely neglected. Education, income, extension contact and scientific orientation significantly helped farmers reduce this gap, highlights the importance of knowledge-driven farming. Market price fluctuations, labour scarcity and pest incidence continue to be major hurdles affecting adoption and profitability. Farmers strongly emphasized the need for effective IPM promotion, assured minimum support prices and subsidized inputs. Bridging the technological gap therefore requires farmer-centric extension, strong market support and policy interventions that make sustainable cotton technologies both affordable and rewarding.

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