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An empirical assessment of socio-economic characteristics and adoption constraints of climate change adaptation strategies in cotton farming: Evidence from Palnadu district Andhra Pradesh

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ABSTRACT

Climate change poses significant challenges to cotton production, particularly in rainfed regions where farmers are increasingly exposed to delayed monsoons, prolonged dry spells, declining soil moisture, pest and disease incidence and production uncertainty. The present study was undertaken to examine the socio-economic characteristics of cotton farmers and identify the major constraints influencing the adoption of climate change adaptation strategies in Palnadu district of Andhra Pradesh. The study was conducted among 180 cotton farmers, comprising 60 adopters and 120 non-adopters, selected from the study area. Primary data were collected from the sample farmers through a structured schedule. The socio-economic characteristics of the farmers were analysed using descriptive statistics, while Garrett's ranking technique was employed to identify and prioritize the major constraints affecting the adoption of climate change adaptation strategies. The findings revealed that adopter farmers were relatively more educated, had larger average operational landholdings, greater access to market information, higher participation in crop rotation, greater access to non-farm income and a higher proportion of land ownership than non-adopters. The constraint analysis revealed that lack of adequate credit facilities was the most important constraint, followed by lack of training on climate change adaptation strategies and high cost of inputs. Other major constraints included inadequate access to weather forecast information, non-availability of quality seeds, lack of market information and price volatility, scarcity of labour and inadequate irrigation facilities. The study recommends strengthening institutional credit, farmer training and extension services, access to climate-resilient inputs, weather information, quality seeds, market information, mechanization and irrigation facilities to enhance farmers' adaptive capacity and promote sustainable cotton production under changing climatic conditions.

Key Words: *Adaptation strategies, Adoption constraints, Climate change, Cotton farmers, Garrett's ranking technique, Palnadu district Andhra Pradesh and Socio-economic characteristics*

Cotton, one of India's most important commercial and industrial crops, is highly sensitive to climatic fluctuations, particularly during critical phenological stages such as flowering and boll formation. Variations in temperature and rainfall patterns directly influence pest dynamics, water availability and yield stability, thereby increasing production risks. India is a leading cotton producer globally and regional variations in climate vulnerability significantly affect the performance of cotton-based farming systems.

Andhra Pradesh is an important cotton-growing state, contributing nearly four per cent to the country's total cotton production and ranking eighth in both area and production (Crop Outlook Reports, ANGRAU, 2023–24). Within the state, Palnadu district occupies a prominent position in cotton cultivation, largely under rainfed conditions. Cotton farmers in this region are increasingly exposed to climate-induced stresses such as delayed onset of monsoon, prolonged dry spells, declining soil moisture and a rising incidence of pests and diseases (Puli et al., 2025). These challenges have intensified production uncertainties and threatened the economic viability of cotton farming.

In response to these climatic risks, cotton farmers have begun adopting a range of climate change adaptation strategies aimed at enhancing resilience and

stabilizing yields. These strategies include the use of drought-tolerant varieties, application of micronutrients, adjustment of sowing dates, adoption of high-density planting systems, mulching, drip irrigation, sowing of trap crops and practicing crop rotation. While such practices have the potential to mitigate climate risks and improve adaptive capacity, their adoption remains uneven across farm households.

Despite the availability of adaptation technologies and institutional support mechanisms, the extent of adoption of climate change adaptation strategies among cotton farmers is often constrained by a combination of socio-economic, technological, institutional and informational factors. Limited access to credit, high cost of inputs, inadequate technical knowledge, weak extension services and risk aversion among farmers frequently impede the effective adoption of recommended practices. Moreover, variations in farmers' socio-economic characteristics—such as education, farm size, farming experience, income levels and access to training—play a crucial role in shaping adaptation decisions. Understanding the socio-economic determinants and constraints influencing the adoption of climate change adaptation strategies is essential for designing targeted policy interventions and strengthening agricultural extension and support systems. In this context, the present study seeks to examine the socio-economic characteristics of cotton farmers and identify the major constraints affecting the adoption of climate change adaptation strategies in Palnadu district of Andhra Pradesh. The findings are expected to provide empirical insights that can assist policymakers, researchers and extension agencies in formulating farmer-centric strategies to enhance adaptive capacity and promote sustainable cotton production under changing climatic conditions.

MATERIAL AND METHODS

Study area

A multi-stage sampling technique was adopted for the selection of the state, district, mandals, villages and farmers. Andhra Pradesh was purposively selected based on its position in cotton production, followed by the purposive selection of Palnadu district based on its high cotton area and production. Three mandals, viz., Veldurthi, Amaravathi and Durgi and two villages from each mandal were selected based on the highest area under cotton cultivation. From each selected village, 10 adopters and 20 non-adopters of climate change adaptation strategies were randomly selected, resulting in a total sample of 180 cotton-growing farmers. Adopters had an adoption index of 50 or above, while non-adopters had an index of 49 or below.

Statistical tools used

Constraints faced by farmers in adoption of climate change adaptation strategies were ranked using Garrett's ranking technique. Accordingly, these ranks were converted to scores by referring to Garrett's table. Garrett's formula for converting ranks into per cent is given by:

$$\text{Per cent position} = 100(R_{ij}-0.5)/ N_j$$

Where,

R_{ij} = Rank given for the i^{th} item by the j^{th} individual

N_j = Number of items ranked by the j^{th} individual

The per cent position of each rank was converted to scores by referring to tables given by Garrett and Woodworth (1969). Then for each factor, the scores of individual respondents were summed up and divided by the total number of respondents. The mean scores for all the factors were ranked. The constraint for which the score value was highest was considered the most important problem faced by the individual.

RESULTS AND DISCUSSION

Socio-economic characteristics of the sample farmers

Age of the Sample Farmers

The age of the respondents is considered as one of the factors that could influence an individual's decisions. Hence the age of the respondents was analysed and the results were presented in Table 1. It was observed that among the adopter farmers majority belonged to the age group of 40-55 years (61.67 %) followed by above 55 years (28.33 %), below 40 years (10.00 %). Among the non-adopters majority belonged to the age group of above 55 years (47.50%) followed by 40-55 years (38.33 %), below 40 years (14.17 %). Majority of the farmers under the age group of 40-55 (middle-aged) have good knowledge and experience on farming practices and

they are ready to adopt new technologies. However, old aged farmers (> 55 years) were still practicing indigenous practices and they are late adaptors.

Gender of the Sample Farmers

Gender of the farmers was analysed and results were presented in Table 1. From the table, it could be observed that, male farmers were dominant over female farmers among . Among the adopter and non-adopter farmers, the per cent of male and female were found to be 93.33 and 6.67 and 86.67 and 13.33 respectively. Male farmers in majority of the households were dominant in taking up farming decisions. Most of the female were involved in household activities while a few took up farming.

Education Status

The formal education of an individual influences their character and enhances their abilities and skills. Hence, the education level of farmers was assessed and the findings were presented in the Table 1. Among the adopter farmers, 21.67 per cent were illiterate, 20.00 per cent had primary education, 33.33 per cent had secondary education, 18.33 per cent completed their intermediate education and 6.67 per cent were graduates. In case of non-adopter farmers, 35 per cent were illiterate, 32.50 per cent had primary education, 20.00 per cent had secondary education and 9.17 per cent had intermediate education and only 3.33 per cent of non-adopter farmers were graduated. The adopter farmers were found to be more educated than non-adopter farmers. Literacy is the crucial aspect to positively influence the farmers towards modern strategy adoption in agriculture.

Table 1. Socio-economic characteristics of sample farmers in the study area

S. No.	Characteristics		Adopters		Non-adopters	
			Frequency	%	Frequency	%
1	Age group	above 55 years	17	28.33	57	47.5
		40 to 55 years	37	61.67	46	38.33
		Below 40 years	6	10	17	14.17
2	Gender	Male	56	93.33	104	86.67
		Female	4	6.67	16	13.33
3	Education status	Illiterate	13	21.67	42	35
		Primary	12	20	39	32.5
		Secondary	20	33.33	24	20
		Intermediate	11	18.33	11	9.17
		Degree	4	6.67	4	3.33
4	Family size (Numbers)	1 to 4	20	33.33	62	51.67
		5 to 6	22	36.67	39	32.5
		7 to 9	18	30	19	15.83

Family Size

Family size of the sample households was worked out and results were presented in Table 1. It was observed that among the adopter farmers 36.67 per cent had the family sizes that ranged between 5-6 members, followed by the family size of 1-4 members with the 33.33 per cent whereas, 30.00 per cent of the adopter farmers had the family size of

Table 2. Operational landholding of sample farmers and its composition

S. No.	Farm size (in ha)	Adopters		Non-adopters	
		Frequency	%	Frequency	%
1	Marginal (less than 1 ha)	14	23.33	53	44.17
2	Small (1-2 ha)	19	31.67	33	27.5
3	Semi-medium (2-4 ha)	21	35	19	15.83
4	Medium (4-10 ha)	4	6.67	11	9.17
5	Large (>10 ha)	2	3.33	4	3.33
	Average landholding (ha)	**2.25**		**1.85**	

range 7-9 members. In case of non-adopter farmers 51.67 per cent had family sizes that ranged between 1-4 members followed by 32.50 per cent with the family size of 5-6 members, while only 15.83 per cent of non-adopters had the family size that ranged between 7-9 members. Households with a larger number of people are likely to be more intensively involved in farming compared to smaller households.

Operational Landholding and its Composition

Average operational landholding particulars of sample farmers was worked out and presented in the Table 2. Among the adopter farmers 35.00 per cent had 2-4 ha of land (semi-medium) followed by 31.67 per cent had 1-2 ha of land (small farmers) and 23.33 per cent had less than 1 ha of land (marginal farmers). Whereas, among the non-adopters 44.17 per cent had less than 1 ha of land (marginal farmers) followed by 27.50 per cent had 1-2 ha of land (small farmers) and 15.83 per cent had 2-4 ha of land (semi-medium). On an average, adopter farmers have larger farm size compared to non-adopter farmers. Average size of holding was found that 2.25 ha for adopter and 1.85 ha for non-adopter farmers, respectively.

Table 3. Farming experience of sample farmers in the study area

S. No.	Farming experience (in years)	Adopters		Non-adopters	
		Frequency	%	Frequency	%
1	<10	3	5	4	3.33
2	10 to 20	16	26.67	13	10.83
3	21 to 30	23	38.33	44	36.67
4	31 to 40	13	21.67	56	46.67
5	>40	5	8.33	3	2.5
	Average experience	**26.62**		**29.57**	
Total		**60**	**100**	**120**	**100**

Experience in Farming

The experience of the sample farmers was assessed and the results were presented in the Table 3. Among the adopter farmers 38.33 per cent had the experience of 21-30 years followed by 26.67 per cent had 10-20 years and 21.67 per cent had 31-40 years. While in case of non-adopter farmers 46.67 per cent had 31-40 years of farming experience followed by 36.67 per cent with 21-30 years and 10.83 per cent had 10-20 years. The average experience of adopter farmers was found to be 26.62 years while for non-adopter farmers, it was 29.57 years, as a whole, non-adopter farmers were three years more experienced than adopter farmers.

Access to market information

Access to market information like prices and demand can give farmers the financial buffer and confidence to experiment with adaptive practices. The information on the access to marketing information was collected, analysed and presented in the Table 4. It was found that 71.67 per cent and 53.33 per cent had access to market information among the adopter and non-adopter farmers, respectively.

Table 4. Access to market information of sample farmers in the study area

S. No.	Access to market Information	Adopters		Non-adopters	
		Frequency	%	Frequency	%
1	Yes	43	71.67	64	53.33
2	No	17	28.33	56	46.67

Crop rotation

Use of crop rotation interrupts pest and disease cycles that build up with monoculture. Data regarding the crop rotation was collected, analysed and presented in the Table 5. It was found that 85.00 per cent of the adopter farmers and 42.50 per cent of the non-adopter farmers practiced crop rotation.

Non-Farm income

Non-farm income serves as an additional source of cash flow, helping to reduce farmers' reliance on seasonal agricultural earnings was analysed and

Table 5. Practice of Crop rotation by the sample farmers in the study area

S. No	Practice of crop rotation	Adopters		Non-adopters	
		Frequency	%	Frequency	%
1	Yes	51	85	51	42.5
2	No	9	15	69	57.5

Table 6. Non-Farm Income of sample farmers in the study area

S. No	Non-Farm Income	Adopters		Non-adopters	
		Frequency	%	Frequency	%
1	Yes	46	76.67	56	46.67
2	No	14	23.33	64	53.33

Table 7. Land ownership particulars of sample farmers in

S. No	Land ownership	Adopters		Non-adopters	
		Frequency	%	Frequency	%
1	Own	33	55	35	29.17
2	Lease-in	12	20	54	45
3	Lease-out	15	25	31	25.83

presented in the Table 6. About 76.67 per cent of the adopters and 46.67 per cent of the non-adopters had non-farm income.

Land ownership Particulars

Landowners are generally more inclined to invest in long-term climate change adaptation measures, as land ownership often serves as a prerequisite for accessing formal credit and participating in government adaptation programs. The land ownership details were analysed and presented in the Table 7. Among the adopters, 55.00 percent owned land, 20.00 percent operated on leased-in land and 25.00 percent had leased out their land, whereas among the non-adopters 29.17 percent owned land, 45.00 percent farm on leased-in land and 25.83 per cent had leased out their land.

Sources of credit

Farmers depend on different sources for their credit requirements, the data on different sources of credit was collected, analysed and presented in the Table 8. Most of the adopter (48.33 %) and non-adopter (57.50 %) farmers in the study area depend on the private money lenders as they are easy to access and provide flexible repayment schedules.

Constraints in adoption of climate change adaptation strategies

Garrett's ranking technique was employed to rank the constraints hindering the adoption of climate change adaptation strategies, as expressed by the farmers in the study area. Major prevailing constraints and suggestions identified during the preliminary survey were organized in ascending order and are presented in the Table 9.

Lack of adequate credit facilities with a mean score of 77.2 was identified as the first major constraint faced by the farmers which hinder the adoption of climate change adaptation strategies. Most of the farmers in the study area are depending on the private

Table 8. Sources of credit of sample farmers in the study area

S. No	Sources of credit	Adopters		Non-adopters	
		Frequency	%	Frequency	%
1	Private money lenders	29	48.33	69	57.5
2	Regional Rural Banks	11	18.33	21	17.5
3	State Co-operative Banks	10	16.67	16	13.33
4	Commercial Banks	6	10	9	7.5
5	Private Banks	4	6.67	5	4.17

Table 9. Constraints hindering the adoption of climate change adaptation strategies, as expressed by the farmers in the study area

S. No.	Constraints	Mean score	Rank
1	Lack of adequate credit facilities	77.2	1
2	Lack of training on climate change adaptation strategies	66	2
3	High cost of inputs	58.5	3
4	Lack of access to weather forecast information	53.9	4
5	Non availability of quality seeds	47.8	5
6	Lack of market information and price volatility	42.4	6
7	Scarcity of labour	38.7	7
8	Inadequate irrigation facility	35.9	8

money lenders like seed shop and fertilizer shop owners as they provide the immediate credit and also the loans provided by the government were not sufficient to purchase the equipment whose initial investment was were using the local varieties which are available at the local seed shops at comparatively lower prices.

Lack of market information and price volatility with a mean score of 42.4 was sixth major constraint. Most of the farmers were unaware of the market information like the market prices and MSP and were selling their produce to the local money lenders in return to the debts taken from them. Similarly Ravi Goud *et al.* (2018) reported lack of awareness about market prices, fluctuating market prices and lack of marketing intelligence among cotton growers in Kurnool district.

Scarcity of labour with a mean score of 38.7 was the seventh major constraint. As the farm labour is not consistent and available only during the crop seasons, most of the labourers in the villages were willing to go to the jobs which pay on monthly basis. Hence, the farmers were facing the problem of scarcity of labour.

Inadequate irrigation facility with a mean score of 35.9 was the seventh major constraint faced by farmers. As the Palnadu region is, rainfed, drought prone and suffers from water scarcity, most of the farmers were facing problem in using the irrigation systems like drip.

CONCLUSION

The study examined the socio-economic characteristics of cotton farmers and the constraints in adoption of climate change adaptation strategies in Palnadu district of Andhra Pradesh. The findings indicated that adopters had better education, larger landholdings, greater access to market information, higher participation in crop rotation, non-farm income and greater land ownership compared to non-adopters. Adopter farmers also showed a relatively higher tendency to use improved and climate-resilient agricultural practices.

The Garrett ranking analysis revealed that lack of adequate credit facilities is the most important constraint to adoption, followed by lack of training on climate change adapt strategies and high cost of inputs. Other important constraints included inadequate access to weather forecast information, non-availability of quality seeds, lack of market information and price volatility, scarcity of labour and inadequate irrigation facilities.

Overall, the study concludes that improving farmers' access to affordable credit, strengthening climate-change training and extension services, reducing the cost of climate-resilient inputs, providing timely weather information, ensuring quality seed availability, improving market information, promoting mechanization and strengthening irrigation facilities are essential for increasing the adoption of climate change adaptation strategies among cotton farmers. These measures can enhance farmers' resilience to climate risks and contribute to more sustainable cotton production in the region.

Suggestions offered for adoption of climate change adaptation strategies

Establish accessible and low-interest agricultural credit schemes through cooperative banks & RRBs.

Organize regular hands-on training and capacity-building programs through agricultural extension services.

Government should provide input subsidies or bulk purchase support to farmers for purchasing climate-resilient seed and technologies.

Develop and promote mobile-based weather forecast services tailored for farmers.

Strengthen local seed distribution systems and promote certified seed production by farmer producer organizations (FPOs).

Create real-time market information systems and link farmers to e-market platforms like eNAM.

Encourage the use of labor-saving technologies and mechanization support for smallholder farms.

Invest in community-based micro-irrigation systems like drip and sprinkler units, supported by government schemes.

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