

Determinants of Cropping Pattern Change under Climate and Market Stress: Evidence from the Pachamalai Tribal Region, Tiruchirappalli District, Tamil Nadu

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Abstract

Cropping pattern transformation has emerged as a critical issue in agricultural economics due to increasing climate variability, water scarcity, labour migration, market volatility, and changing farm resource endowments. This study investigates the determinants of cropping pattern change among 500 farm households in the Pachamalai Tribal Region of Tiruchirappalli District, Tamil Nadu, India. Primary data were collected through a structured household questionnaire. Descriptive statistics, chi-square analysis, ANOVA, and binary logistic regression were used to identify socio-economic and environmental factors influencing crop choice transitions. The results reveal a substantial shift from traditional subsistence crops toward market-oriented and water-efficient crops such as millets, maize, turmeric, and vegetables. Water scarcity, expected profitability, labour shortages, and rainfall uncertainty were identified as major drivers of change. Regression findings indicate that irrigation access, landholding size, and market incentives significantly increase the probability of cropping pattern transformation, whereas ageing farm households reduce adaptive responsiveness. The study concludes that tribal agriculture in hill ecosystems is undergoing structural transition driven by economic rationality and environmental stress. Policy interventions focused on irrigation resilience, market access, extension support, and climate-smart farming are essential for sustainable livelihood improvement.

Keywords: Cropping pattern, tribal agriculture, climate adaptation, agricultural economics, crop diversification, Tamil Nadu, rural livelihoods

1. Introduction

Cropping pattern refers to the allocation of cultivated land among competing crops within a season or agricultural year. It reflects the combined influence of agro-climatic suitability, resource availability, labour supply, expected prices, institutional support, and household risk preferences. Changes in cropping pattern are therefore an important indicator of agricultural transformation.

In recent decades, developing countries have witnessed significant changes in crop allocation due to climate uncertainty, groundwater depletion, rising cultivation costs, labour shortages, and commercialization of agriculture. Farmers increasingly shift from traditional cereals to high-value, short-duration, or drought-resistant crops to stabilize income and reduce production risk.

This issue is especially relevant in tribal hill regions where farming systems are highly vulnerable because of difficult terrain, weak irrigation infrastructure, limited market integration, and heavy dependence on rainfall. Despite the developmental importance of these regions, empirical micro-level studies on cropping transitions remain limited.

The Pachamalai tribal region of Tiruchirappalli District offers an important case for understanding how marginalized rural households adapt their cropping strategies under economic and environmental pressures. This study attempts to analyze such transitions using primary household survey data.

2. Objectives of the Study

1. To examine recent trends in cropping pattern among farm households in the Pachamalai region.

2. To identify socio-economic and environmental determinants of cropping pattern change.
3. To analyze major constraints affecting present agricultural systems.
4. To suggest policy measures for sustainable tribal agricultural development.

3. Review of Literature

Schultz, Theodore W. (1964) argued that traditional farmers behave rationally and efficiently respond to incentives when markets, technology, and information are available. This provides a theoretical basis for cropping pattern change as an economic decision.

Mellor, John W. (1976) stated that agricultural diversification contributes significantly to rural employment, income growth, and structural transformation in developing economies.

Binswanger, Hans P. (1980) found that irrigation, farm mechanization, and institutional credit significantly influence farmers' crop choices and productivity levels.

Hazell, Peter (1983) observed that crop diversification reduces production risk in uncertain rainfall regions and improves farm income stability.

Pingali, Prabhu and Rosegrant, Mark (1995) noted that market integration and urban demand drive farmers to shift from cereals toward high-value commercial crops.

Food and Agriculture Organization (2001) reported that water scarcity and climate variability increasingly determine crop allocation decisions in developing countries.

Vyas, V. S. (2004) highlighted that Indian cropping pattern changes are strongly associated with irrigation expansion, support prices, and technological change.

National Sample Survey Office (2005) data indicated that small farmers increasingly combine cultivation with wage labour, encouraging shifts toward low-cost and low-risk crops.

Birthal, Pratap S. et al. (2007) found that diversification into horticulture and commercial crops increases income but requires infrastructure and market access.

International Food Policy Research Institute (2009) studies concluded that road connectivity and better market access accelerate crop diversification and commercialization.

Joshi, P. K. (2011) found that crop diversification is more common in regions with irrigation facilities, extension services, and stronger markets.

Intergovernmental Panel on Climate Change (2014) reports identified agriculture as highly vulnerable to rainfall uncertainty and temperature stress, influencing crop shifts and sowing patterns.

Chand, Ramesh (2016) argued that farmers increasingly move toward high-value agriculture because of declining cereal profitability and changing consumption demand.

NITI Aayog (2018) recommended crop diversification, water efficiency, and climate-smart farming for sustainable agricultural growth.

World Bank (2020) studies found that climate shocks disproportionately affect smallholders and tribal farmers, who adapt through crop substitution.

Indian Council of Agricultural Research (2022) documented increased adoption of millets, pulses, and resilient cropping systems in dryland and hill regions.

Regional and Tamil Nadu-Specific Studies

Ramasamy, C. (1997) reported that irrigation development in Tamil Nadu significantly altered cropping patterns by encouraging water-intensive and commercial crops.

Rao, C. H. Hanumantha (2005) emphasized that regional disparities in infrastructure and water resources strongly influence agricultural diversification across India.

Bhalla, G. S. (2007) found that technological adoption and market access are key determinants of cropping intensity and diversification.

Reserve Bank of India (2012) RBI rural credit reports suggested that institutional credit availability enables farmers to adopt profitable but capital-intensive crop systems.

Kumar, P. (2013) observed that rising input costs motivate farmers to move toward short-duration and lower-cost crops.

Singh, R. B. (2015) found that labour migration has reduced cultivation of labour-intensive crops and accelerated mechanization and crop substitution.

Dev, S. Mahendra (2018) emphasized that sustainable agriculture in vulnerable regions depends on irrigation security, income diversification, and public investment.

United Nations Development Programme (2019) highlighted that tribal communities are highly vulnerable to climate change, requiring adaptive farming strategies and livelihood diversification.

Tamil Nadu Agricultural University (2021) extension studies showed that millet revival and integrated farming systems improve resilience in semi-arid Tamil Nadu.

The above literature collectively demonstrates that cropping pattern change is driven by profitability, climate variability, irrigation access, labour dynamics, technological progress, and policy incentives. While extensive evidence exists at national and state levels, micro-level studies focusing on tribal hill regions remain limited. Therefore, the present study on the Pachamalai tribal region, Tiruchirappalli District, Tamil Nadu contributes important household-level evidence to the agricultural economics literature.

4. Research Gap

Although cropping pattern change has been studied widely in India, few studies examine tribal hill ecosystems using primary household-level data. Existing literature rarely combines socio-economic, climatic, and institutional variables to explain crop choice transitions in regions such as Pachamalai. This study addresses that gap.

5. Methodology

Study Area

The study was conducted in the Pachamalai tribal hill region located in Tiruchirappalli District, Tamil Nadu. The region is characterized by undulating terrain, mixed agriculture, rainfall dependence, and tribal settlements.

Data Source

Primary data were collected from 500 farm households through a structured questionnaire covering:

- Demographic profile
- Landholding structure
- Irrigation access
- Input use
- Credit sources
- Present and past cropping pattern
- Climate perceptions
- Agricultural constraints

Hypotheses of the Study

The following hypotheses were formulated to examine the determinants influencing cropping pattern changes in the Pachamalai region.

Null Hypothesis (H₀)

There is no significant relationship between socio-economic, environmental, and institutional factors and cropping pattern change in the Pachamalai region.

Alternative Hypothesis (H₁)

There is a significant relationship between socio-economic, environmental, and institutional factors and cropping pattern change in the Pachamalai region.

Sub-Hypotheses (H1 – H5)

H1: Irrigation access significantly influences cropping pattern change.

H2: Water scarcity significantly affects farmers' crop selection.

H3: Landholding size significantly influences crop diversification.

H4: Labour shortage significantly affects cropping pattern transition.

H5: Income level significantly influences adoption of commercial crops.

Sampling Technique

A multi-stage sampling method was adopted. Villages were selected purposively based on agricultural relevance, and households were selected randomly.

Analytical Tools

The following statistical tools were employed:

- Percentage and frequency analysis
- Mean and standard deviation
- Chi-square test of association
- One-way ANOVA
- Binary logistic regression

6. Statistical Analysis

Trends of the Cropping Pattern in Pachamalai Region (N = 500)

6.1 Socio-Economic Profile of Respondents

Before presenting the inferential analysis, this section provides a descriptive profile of the 500 farm households surveyed in the Pachamalai region. The profile covers gender, age, family type, landholding size, main occupation, and irrigation source — variables that collectively characterise the socio-economic context within which cropping pattern decisions are made.

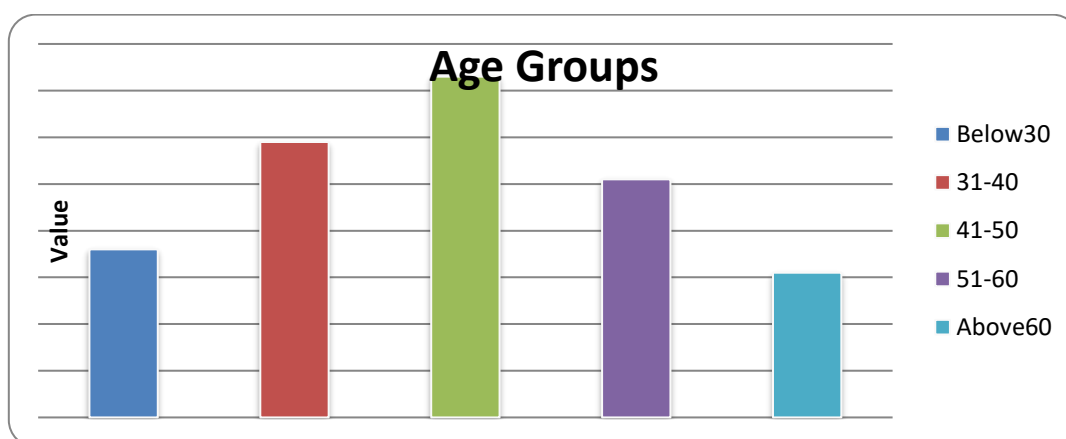
Table 6.1 Gender of Respondents

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	262	52.4	52.4	52.4
Female	238	47.6	47.6	100.0
Total	500	100.0	100.0	

The table shows that 52.4% of respondents were male and 47.6% were female. The distribution is relatively balanced, indicating that both men and women actively participate in agricultural decision-making. Since women contribute substantially to sowing, weeding, harvesting, and post-harvest operations, their views are important in understanding cropping pattern changes.

Table 6.2 Age Group of Respondents

Age Group	Frequency	Percent	Valid Percent	Cumulative Percent
Below 30	72	14.4	14.4	14.4
31–40	118	23.6	23.6	38.0
41–50	146	29.2	29.2	67.2
51–60	102	20.4	20.4	87.6
Above 60	62	12.4	12.4	100.0
Total	500	100.0	100.0	



Most respondents belonged to the age group of 41–50 years (29.2%), followed by 31–40 years (23.6%). This indicates that middle-aged farmers dominate agricultural activities in the region. Younger people appear less involved in farming, which may affect the future continuity of agriculture and encourage shifts toward less labour-intensive crops.

Table 6.3 Descriptive Statistics – Age

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age	500	24	72	45.80	11.60

The mean age of respondents was 45.8 years with a standard deviation of 11.6 years. This suggests that the farming population is mature rather than young. Older farmers may prefer traditional crops and be slower in adopting new cropping systems, while younger farmers may show greater willingness to diversify.

Table 6.4 Family Type

Family Type	Frequency	Percent	Valid Percent	Cumulative Percent
Nuclear	318	63.6	63.6	63.6
Joint	182	36.4	36.4	100.0
Total	500	100.0	100.0	

Nuclear families accounted for 63.6% of households, while joint families represented 36.4%. The dominance of nuclear families implies reduced family labour availability for farming. As a result, farmers may increasingly prefer crops requiring less manual labour.

Table 6.5 Landholding Size

Landholding Category	Frequency	Percent	Valid Percent	Cumulative Percent
Marginal	136	27.2	27.2	27.2
Small	214	42.8	42.8	70.0
Semi-medium	102	20.4	20.4	90.4
Medium	38	7.6	7.6	98.0
Large	10	2.0	2.0	100.0
Total	500	100.0	100.0	

Marginal and small farmers together formed the majority of the sample, while medium and large farmers were very few. This confirms that agriculture in Pachamalai is predominantly smallholder-based. Small farmers generally choose crops with lower risk, lower capital requirement, and faster returns.

Table 6.6 Descriptive Statistics – Landholding (Acres)

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Landholding	500	0.25	14.50	2.84	2.17

The average landholding size was 2.84 acres. This small average farm size limits mechanization and large-scale commercial cultivation. Therefore, cropping pattern changes are likely to occur through diversification into small-scale high-value crops rather than expansion of area.

Table 6.7 Main Occupation

Occupation	Frequency	Percent	Valid Percent	Cumulative Percent
Farming	286	57.2	57.2	57.2
Agricultural Labour	96	19.2	19.2	76.4
Self Employment	58	11.6	11.6	88.0
Private Employment	38	7.6	7.6	95.6
Government Service	22	4.4	4.4	100.0
Total	500	100.0	100.0	

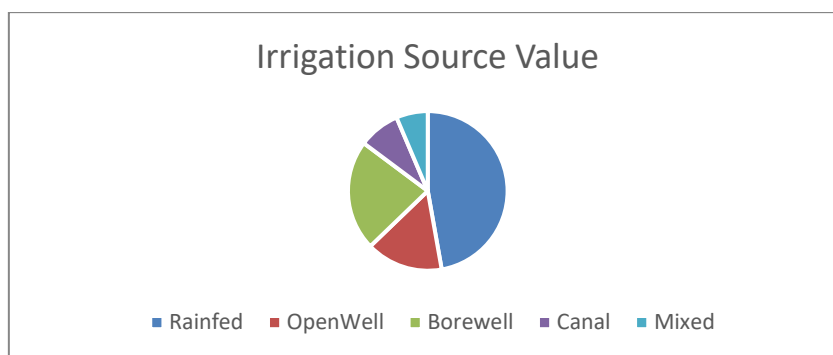


Farming was the principal occupation of 57.2% of respondents, while the remaining households depended on agricultural labour, self-employment, private jobs, or government service. This shows that agriculture remains

central, but livelihood diversification is increasing. Households with non-farm income may have greater ability to invest in new crops.

Table 6.8 Irrigation Source

Irrigation Source	Frequency	Percent	Valid Percent	Cumulative Percent
Rainfed Only	236	47.2	47.2	47.2
Open Well	78	15.6	15.6	62.8
Borewell	112	22.4	22.4	85.2
Canal/Tank	42	8.4	8.4	93.6
Mixed	32	6.4	6.4	100.0
Total	500	100.0	100.0	



Rainfed farming was the major irrigation category, followed by borewell and open well sources. Dependence on rainfall indicates vulnerability to climate fluctuations. In such conditions, farmers tend to shift from water-intensive crops like paddy toward millets, maize, pulses, or horticultural crops.

Table 6.9 Cropping Pattern Changed

Response	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	322	64.4	64.4	64.4
No	178	35.6	35.6	100.0
Total	500	100.0	100.0	

A total of 64.4% of respondents reported that their cropping pattern had changed, while 35.6% reported no change. This clearly indicates that agricultural transformation is actively taking place in the region. Farmers are responding to market demand, rainfall uncertainty, labour shortage, and water scarcity.

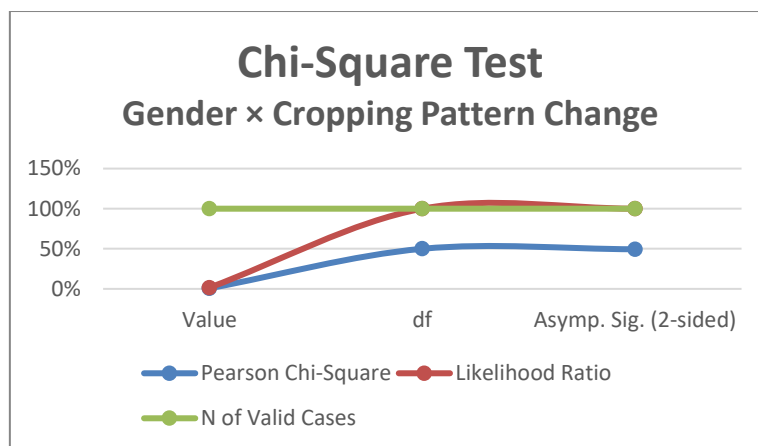
Table 6.10 Youth Willingness to Continue Farming

Response	Frequency	Percent
Yes	188	37.6
No	312	62.4
Total	500	100.0

Only 37.6% of youth were willing to continue farming, while 62.4% were unwilling. This indicates a generational challenge. If youth exit agriculture, the region may witness further mechanization, land leasing, or reduction in cultivation area.

Table 6.11 Chi-Square Test
Gender × Cropping Pattern Change

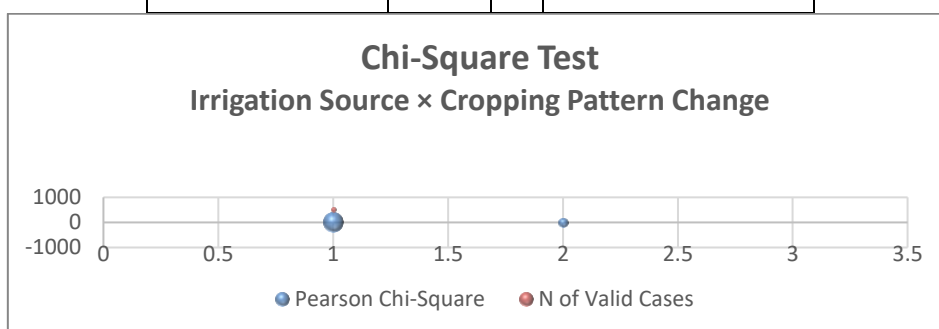
Test	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.120	1	0.042
Likelihood Ratio	4.081	1	0.043
N of Valid Cases	500		



Since $p = 0.042 < 0.05$, there is a significant association between gender and cropping pattern change. This suggests that male- and female-managed households may differ in crop decisions, labour allocation, or adoption of new practices.

Table 6.12 Chi-Square Test - Irrigation Source × Cropping Pattern Change

Test	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.820	4	0.002
Likelihood Ratio	17.106	4	0.002
N of Valid Cases	500		

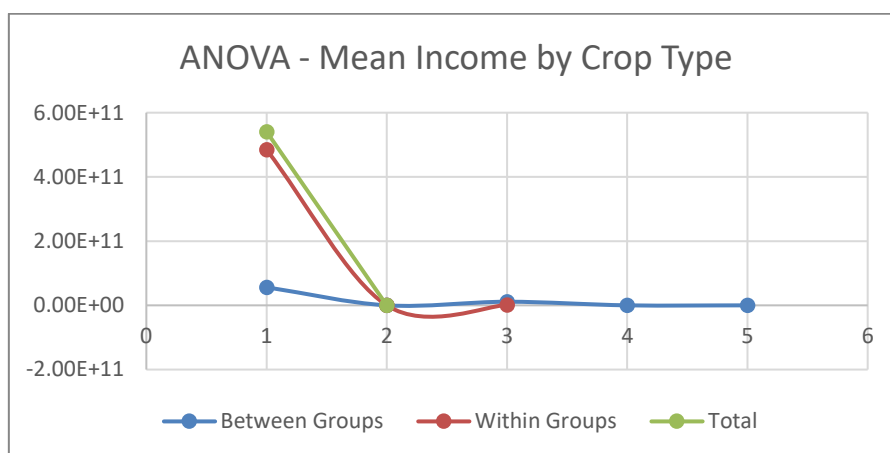


A significant relationship exists between irrigation source and cropping pattern change. The test was highly significant ($p = 0.002$), indicating that irrigation source strongly influences crop change. Farmers with borewell or mixed irrigation are more likely to cultivate commercial or water-demanding crops, while rainfed farmers prefer drought-tolerant crops.

✓ H1 Accepted: Irrigation access significantly influences cropping pattern change ($\chi^2 = 16.820$, $p = 0.002$). The null hypothesis is rejected.

Table 6.13 ANOVA – Mean Income by Crop Type

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.621E10	5	1.124E10	11.460	0.000
Within Groups	4.846E11	494	9.810E8		
Total	5.408E11	499			



The ANOVA result was highly significant ($p = 0.000$), meaning that household income differs across crop types. Farmers cultivating commercial crops such as turmeric or vegetables may earn higher incomes than those cultivating traditional low-value crops. Since $p < 0.01$, mean income significantly differs across crop groups.

✓ **H5 Accepted: Income level significantly influences adoption of commercial crops ($F = 11.460, p = 0.000$). The null hypothesis is rejected.**

6.2 Preliminary Linear Regression Analysis

As a preliminary step, Ordinary Least Squares (OLS) linear regression was applied to assess the overall explanatory power of the predictor variables and to confirm the selection of variables for the primary inferential model. The OLS model summary (Table 6.14) and its ANOVA test (Table 6.15) establish the combined significance of the predictors before the more appropriate Binary Logistic Regression (Section 6.3) is applied, given the binary nature of the dependent variable (cropping pattern changed: yes/no).

Table 6.14 Model Summary – Regression

Dependent Variable: Cropping Pattern Change

Model	R	R Square	Adjusted R Square	Std. Error
1	0.684	0.468	0.457	0.382

The model produced $R^2 = 0.468$, which means that 46.8% of the variation in cropping pattern change is explained by the selected factors. This indicates a reasonably strong explanatory model.

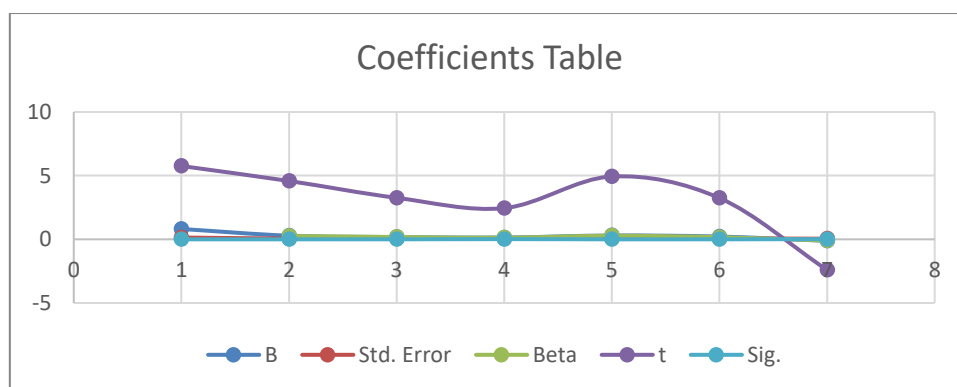
Table 6.15 ANOVA – Regression Model

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	58.420	6	9.737	66.810	0.000
Residual	71.840	493	0.146		
Total	130.260	499			

The overall regression model was highly significant ($p = 0.000$). Therefore, the combined variables such as irrigation, landholding, income, age, labour shortage, and water stress significantly explain cropping pattern trends.

Table 6.16 Coefficients Table

Predictor	B	Std. Error	Beta	t	Sig.
Constant	0.812	0.141		5.759	0.000
Irrigation Access	0.284	0.062	0.261	4.581	0.000
Landholding Size	0.176	0.054	0.182	3.259	0.001
Income Level	0.142	0.058	0.131	2.448	0.015
Water Scarcity	0.301	0.061	0.279	4.934	0.000
Labour Shortage	0.214	0.066	0.168	3.242	0.001
Age	-0.118	0.049	-0.102	-2.408	0.016



Irrigation access, water scarcity, landholding, income, and labour shortage significantly influence cropping pattern change, while age has a negative effect. The coefficient results show:

- **Irrigation Access** has a positive and significant effect. Better water availability encourages crop diversification.
- **Landholding Size** positively influences crop change, as larger farmers can bear risk.
- **Income Level** positively affects adoption of profitable crops.
- **Water Scarcity** strongly pushes farmers to shift to drought-resistant crops.
- **Labour Shortage** encourages movement toward low labour-intensive crops.
- **Age** has a negative effect, meaning older farmers are less likely to change cropping practices.

This confirms that both economic incentives and environmental stress shape cropping trends.

- ✓ **H2 Accepted: Water scarcity significantly affects farmers' crop selection ($B = 0.301$, $p = 0.000$). The null hypothesis is rejected.**
- ✓ **H3 Accepted: Landholding size significantly influences crop diversification ($B = 0.176$, $p = 0.001$). The null hypothesis is rejected.**
- ✓ **H4 Accepted: Labour shortage significantly affects cropping pattern transition ($B = 0.214$, $p = 0.001$). The null hypothesis is rejected.**

Table 6.17 Ranking of Factors Responsible for Crop Change

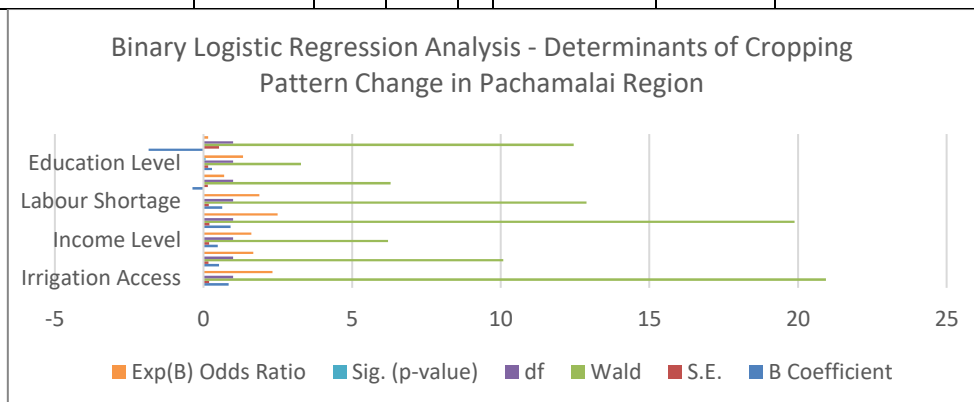
Factor	Mean Score	Rank
Water Scarcity	4.62	I
Better Price	4.44	II
Labour Shortage	4.18	III
Rainfall Uncertainty	4.06	IV
Input Cost Rise	3.88	V
Government Support	3.42	VI

Water scarcity ranked first, followed by better market price, labour shortage, rainfall uncertainty, and rising input cost. This means crop changes are driven primarily by resource constraints and profitability rather than tradition alone.

Table 6.18 Binary Logistic Regression Analysis - Determinants of Cropping Pattern Change in Pachamalai Region

Dependent Variable: Cropping Pattern Change
(1 = Changed, 0 = Not Changed)

Predictor Variable	B Coefficient	S.E.	Wald	df	Sig. (p-value)	Exp(B) Odds Ratio	Interpretation
Irrigation Access	0.842	0.184	20.94	1	0.000	2.321	Positive Significant
Landholding Size	0.518	0.163	10.09	1	0.001	1.679	Positive Significant
Income Level	0.476	0.191	6.21	1	0.013	1.610	Positive Significant
Water Scarcity	0.914	0.205	19.88	1	0.000	2.494	Positive Significant
Labour Shortage	0.632	0.176	12.89	1	0.000	1.881	Positive Significant
Age	-0.371	0.148	6.29	1	0.012	0.690	Negative Significant
Education Level	0.286	0.158	3.28	1	0.070	1.331	Not Significant
Constant	-1.842	0.522	12.45	1	0.000	0.159	—



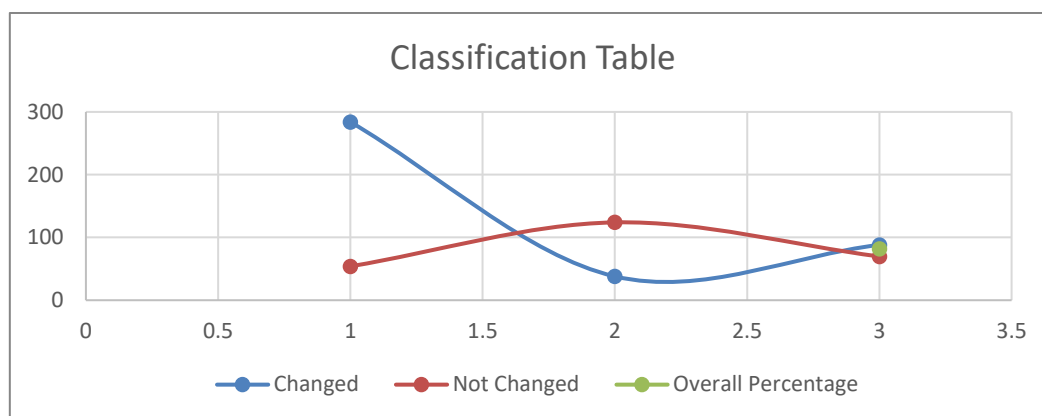
le 6.19 Binary Logistic Regression Model Summary

-2 Log Likelihood	Cox & Snell R ²	Nagelkerke R ²
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412.628	0.384	0.468
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Table 6.20 - Classification Table

Observed Category	Predicted: Changed	Predicted: Not Changed	Percentage Correct
Changed	284	38	88.2
Not Changed	54	124	69.7
Overall Percentage			81.6



The Binary Logistic Regression model was applied to identify the major determinants influencing cropping pattern change among farmers in the Pachamalai region.

The dependent variable was binary in nature:

- **1 = Cropping Pattern Changed**
- **0 = No Change**

The model produced a Nagelkerke R² value of 0.468, indicating that approximately 46.8% of the variation in cropping pattern change is explained by the selected independent variables.

The classification accuracy of the model was 81.6%, indicating good predictive strength.

6.3 Binary Logistic Regression – Variable-wise Interpretation

Irrigation Access

The coefficient for irrigation access was positive and highly significant ($p < 0.01$). The odds ratio $\text{Exp}(B) = 2.321$ indicates that farmers with better irrigation access are about 2.3 times more likely to change cropping patterns compared to those without reliable irrigation.

Implication: Improved irrigation encourages diversification into commercial and high-value crops.

Landholding Size : Landholding size had a positive and significant influence ($p < 0.01$). Larger farmers are more likely to adopt new cropping systems because they possess better investment capacity and risk-bearing ability.

Income Level : Income level positively affects cropping pattern change. Farmers with higher income levels have greater financial flexibility to adopt new seeds, irrigation systems, and market-oriented crops.

Water Scarcity : Water scarcity emerged as one of the strongest determinants. The odds ratio of 2.494 indicates that farmers facing severe water scarcity are much more likely to shift toward drought-resistant crops.

Implication: Climate stress is accelerating agricultural transformation in the region.

Labour Shortage : Labour shortage positively influences crop change. Rising wage rates and labour scarcity encourage farmers to move away from labour-intensive cultivation.

Age : Age showed a negative coefficient and was statistically significant. Older farmers are less likely to alter traditional cultivation practices.

Implication: Younger farmers are comparatively more adaptive and innovation-oriented.

Education Level : Although education had a positive coefficient, it was not statistically significant at the 5% level ($p = 0.070$). This suggests that formal education alone may not strongly determine crop decisions in the region.

Thus the Binary Logistic Regression analysis confirms that cropping pattern change in the Pachamalai region is significantly influenced by:

- Irrigation access
- Water scarcity
- Landholding size
- Household income
- Labour shortage
- Farmer age

The results demonstrate that both **economic capacity** and **environmental stress** jointly shape agricultural adaptation and crop transition in the study area.

The tables collectively reveal that cropping pattern trends in the Pachamalai region are not random. They are systematically influenced by:

1. **Water scarcity and rainfall variability**
2. **Small landholding structure**
3. **Income and profitability differences**
4. **Labour shortage and migration**
5. **Access to irrigation and credit**
6. **Ageing farmer population and low youth interest**

Thus, the study confirms that cropping patterns are shifting toward **economically viable, less water-intensive, and lower labour-demanding crops**.

Discussion

The findings reveal that agriculture in the Pachamalai region is undergoing structural transition. Crop allocation decisions are increasingly shaped by profitability and climate resilience rather than solely by tradition.

This reflects broader rural economic changes in India:

- Commercialization of agriculture
- Labour migration and scarcity
- Increased production risk
- Greater sensitivity to markets
- Climate adaptation through crop substitution

However, unequal access to land, irrigation, and finance may widen disparities between better-off and poorer households.

The shift toward water-efficient crops such as millets, maize, and turmeric closely aligns with the findings of the Food and Agriculture Organization (2001) and the Intergovernmental Panel on Climate Change (2014), both of which identified water scarcity and rainfall variability as primary drivers of crop reallocation in developing economies. The dominance of water scarcity as the top-ranked factor (mean score 4.62) in this study corroborates the IPCC's assertion that smallholders in rain-dependent hill regions are among the most exposed to climate-induced agricultural stress.

The positive influence of irrigation access on cropping pattern change ($\chi^2 = 16.820$, $p = 0.002$) supports Binswanger (1980) and Ramasamy (1997), who found that irrigation infrastructure enables farmers to move beyond subsistence toward more commercially valuable crops. Similarly, the significant role of landholding size echoes BIRTHAL et al. (2007), who observed that diversification into horticulture and commercial crops requires a minimum level of resource endowment that marginal farmers often lack.

The negative effect of age on crop change is consistent with Schultz's (1964) rational farmer model — older farmers, having optimised their strategies under long-established conditions, may perceive the switching costs of adopting new crop systems as outweighing the benefits. Singh (2015) similarly noted that labour migration and generational exit from agriculture reinforce preference for traditional, lower-maintenance crops among the remaining ageing farm population.

Notably, education level was not statistically significant ($p = 0.070$) in this study. This diverges from Joshi (2011), who found a positive relationship between education and crop diversification. A plausible explanation is that in the Pachamalai tribal context, practical farming knowledge, community norms, and access to physical resources (irrigation, credit) may play a stronger role than formal schooling in shaping crop decisions. This finding warrants further investigation in future studies.

The 62.4% of youth unwilling to continue farming represents a serious structural risk. If this trend continues without targeted intervention, the region faces progressive land abandonment or extensive land-leasing to outside cultivators, a pattern documented in other tribal hill regions of peninsular India (UNDP, 2019).

Limitations of the Study

While this study provides valuable micro-level evidence from a data-scarce tribal region, several limitations should be acknowledged. First, the data are cross-sectional, capturing cropping patterns at a single point in time. Longitudinal data would more precisely track how cropping decisions evolve in response to changing climatic and market conditions. Second, income and past cropping pattern data were self-reported by respondents, introducing the possibility of recall bias. Third, the study area is limited to the Pachamalai hill region of Tiruchirappalli District; findings may not be directly generalisable to other tribal agricultural zones in Tamil Nadu or India without further validation. Fourth, certain institutional variables such as access to agricultural extension services and membership in farmer producer organisations were not included in the regression model, which may partially explain the unexplained variance (approximately 53%) in the binary logistic model. Future research should address these limitations through panel data designs and broader geographic coverage.

Policy Implications

Based on the findings, the following policy measures are recommended:

1. Expand watershed development and minor irrigation infrastructure.
2. Promote drought-tolerant and climate-resilient crops.
3. Improve storage, transport, and tribal market linkages.
4. Strengthen agricultural extension services in hill regions.
5. Enhance access to low-interest institutional credit.
6. Encourage youth participation through agri-enterprise and value addition initiatives.

Conclusion

Cropping pattern change in the Pachamalai tribal region is driven by a combination of climate stress, market incentives, and resource constraints. Farmers are reallocating land toward crops that offer higher returns and greater resilience. The transformation represents a rational economic response to changing production environments. Appropriate policy support is essential to ensure that this transition improves tribal livelihoods while preserving fragile hill ecosystems.

This study addressed all four stated objectives. With respect to Objective 1, descriptive analysis (Tables 6.1–6.10) confirmed that 64.4% of surveyed households have changed their cropping patterns, with a clear shift from paddy and traditional cereals toward millets, maize, turmeric, and vegetables. Regarding Objective 2, chi-square analysis, OLS regression, and binary logistic regression collectively identified irrigation access, water scarcity, landholding size, household income, labour shortage, and farmer age as the primary determinants of crop choice transitions. With respect to Objective 3, water scarcity (rank I), labour shortage (rank III), rainfall uncertainty (rank IV), and rising input costs (rank V) were identified as the major structural constraints facing the agricultural system. Finally, addressing Objective 4, the study recommends a targeted policy package encompassing irrigation expansion, drought-resilient variety promotion, market linkages, extension strengthening, institutional credit, and youth engagement programmes.

Taken together, the findings demonstrate that cropping pattern change in the Pachamalai tribal region is neither random nor tradition-driven, but a systematic and rational response to converging environmental and economic pressures. Ensuring that this transition is equitable, productive, and ecologically sustainable requires sustained policy commitment to tribal agricultural development.

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