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EVALUATING THE CONTRIBUTION OF ORGANIC FARMING TO CLIMATE RESILIENCE IN NAGAPATTINAM DISTRICT, TAMIL NADU

[1]M. SANTHIYA* and [2]D. MURUGAN**

[1]*Ph.D Research Scholar (Reg No:2204050004), Department of Economics, Faculty of Arts, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India – 608002.

[2]**Professor (on Deputation), Department of Economics, Faculty of Arts, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India – 608002.

Address for Correspondence: M. SANTHIYA

PH: 7305259830

Email: santhiyamathavan7@gmail.com

CONTACT DETAILS

[1]*M. SANTHIYA - 7305259830

ORCID ID: https://orcid.org/0009-0008-2732-9822

[2]* D. MURUGAN - 9976151767

ORCID ID: https://orcid.org/0000-0003-2143-891X

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ABSTRACT

This study titled "Evaluating the Contribution of Organic Farming to Climate Resilience in Nagapattinam District, Tamil Nadu" investigates how organic farming practices strengthen agricultural resilience against climate-related stresses. The objective was to examine the role of organic methods in improving soil health, enhancing water management, and increasing farmers' adaptive capacity. Guided by the research question, "How do organic farming practices contribute to climate resilience among farmers in Nagapattinam district?" the study employed a mixed-method approach combining quantitative surveys, laboratory soil and water analysis, and qualitative interviews with 200 farmers selected through stratified random sampling. Descriptive and inferential statistics, including correlation and regression analyses, were applied to evaluate relationships between organic practices and resilience indicators. The results revealed that organic farming significantly improved soil fertility ($r = 0.62$), water-use efficiency ($r = 0.68$), and adaptive capacity ($R^2 = 0.61$). The findings validated all four hypotheses, confirming that higher levels of organic adoption lead to enhanced climate resilience. Policy suggestions emphasize institutional support, financial incentives, and stronger market linkages for promoting organic agriculture. The study concludes that organic farming offers an effective, sustainable, and locally adaptable solution to mitigate the adverse impacts of climate change while ensuring long-term livelihood security for coastal farmers in Tamil Nadu.

INTRODUCTION

Nagapattinam district in Tamil Nadu, located along the eastern coastline, is highly vulnerable to climate change impacts such as irregular rainfall, rising temperatures, cyclones, and saltwater intrusion, which poses significant, threats to agricultural productivity and farmer livelihoods (Debnath, et. al, 2024)[2]. In this context, organic farming has emerged as a sustainable alternative that not only supports environmental conservation but also enhances climate resilience. Organic farming practices, including the use of compost, green manures, and bio-fertilizers, improve soil fertility, water retention, and biodiversity, thereby helping agricultural systems adapt to climate variability (Scialabba & Müller-Lindenlauf, 2010)[10]. These practices also reduce farmers' dependency on chemical inputs, lowering production costs and promoting economic stability.

Government initiatives such as the National Innovations in Climate Resilient Agriculture (NICRA) program highlight the importance of sustainable practices like organic farming for improving soil health, water use efficiency, and crop diversification, which strengthen resilience to climate-induced stresses (ICAR, 2019)[4]. In Nagapattinam, local interventions by organizations such as the Centre for Indian Knowledge Systems have assisted farmers in adopting organic methods, enhancing both productivity and sustainability (CIKS, 2020)[1]. This study aims to evaluate the contribution of organic farming to climate resilience in Nagapattinam district, focusing on its effects on soil health, water management, and the adaptive capacity of farming communities.

1.1 Scope and significance of the study

The study focuses on evaluating the contribution of organic farming to climate resilience in Nagapattinam district, a coastal region highly susceptible to climate-induced stresses such as cyclones, salinity intrusion, and erratic rainfall (Debnath, et. al, 2024)[2]. It examines the role of organic practices in enhancing soil fertility, water retention, and adaptive capacity of farmers, providing insights into sustainable agricultural strategies (Scialabba & Müller-Lindenlauf, 2010)[10]. The research is significant as it informs policymakers, agricultural extension agencies, and local communities about the potential of organic farming to mitigate climate risks while promoting economic stability. Findings can guide scalable interventions and support long-term resilience planning in coastal agro-ecosystems (ICAR, 2019)[4].

1.2 Statements of the problem

Nagapattinam district, being a coastal region, is highly vulnerable to climate-related challenges such as erratic rainfall, cyclones, and salinity intrusion, which negatively impact agricultural productivity and farmer livelihoods. Conventional farming practices, heavily dependent on chemical inputs, have led to soil degradation and reduced the adaptive capacity of agricultural systems, increasing their susceptibility to climate variability. Organic farming offers potential benefits, including improved soil health, enhanced water management, and greater resilience to climate stresses. However, its adoption remains limited due to lack of awareness, insufficient resources, and inadequate evaluation of its effectiveness in the local context.

1.3 Research Question

How do organic farming practices contribute to enhancing climate resilience among farmers and agricultural systems in Nagapattinam district, Tamil Nadu?

1.4 Objectives

To examine how organic farming practices enhance the climate resilience of agricultural systems in Nagapattinam district by improving soil health, water management, and adaptive capacity against climate-related stresses.

1.5 Limitations of the Study

The study is limited to 200 farmers in Nagapattinam district, which may not fully represent all agricultural conditions across Tamil Nadu. Data were primarily collected through self-reported surveys and interviews, which may involve respondent bias. Laboratory soil and water tests were conducted on a limited number of samples due to time and resource constraints. Seasonal variations and short-term observations may not capture long-term ecological changes. Additionally, the study focused mainly on organic farming practices and did not include comparative long-term economic analysis between organic and conventional systems, which could provide broader policy insights.

2.0 OVERVIEW OF REVIEWED LITERATURE AND RESEARCH GAP

The review of literature on climate resilience with organic farming areas, Organic farming has gained global attention as a sustainable agricultural practice that addresses environmental degradation while enhancing crop productivity. Studies by (Reganold and Wachter, 2016)[7] highlight that organic farming improves soil fertility, increases microbial activity, and maintains nutrient availability, which collectively strengthen the resilience of agricultural systems. These practices are particularly significant in regions prone to soil degradation, water scarcity, and salinity intrusion. In addition to soil health, organic farming contributes to climate resilience through practices such as composting, crop rotation, intercropping, and the use of bio-fertilizers, which help mitigate the impacts of erratic rainfall, droughts, and other climate-induced stresses (Gomiero, Pimentel, & Paoletti, 2011; Lal, 2015)[3,5].

Economically, organic farming reduces dependence on chemical inputs, thereby lowering production costs and potentially increasing farmer incomes (Pimentel et al., 2005)[6]. However, adoption of organic practices in many coastal regions remains limited due to lack of awareness, insufficient training, inadequate extension services, and limited access to organic inputs (ICAR, 2019)[4]. While numerous global and national studies emphasize the benefits of organic farming for environmental sustainability and climate resilience, there is a notable lack of localized research in Nagapattinam district, Tamil Nadu. Specifically, studies evaluating the impact of organic farming on soil health, water management, economic outcomes, and adaptive capacity of farmers under the district's unique agro-climatic conditions are scarce.

Addressing this research gap, the present study aims to evaluate the contribution of organic farming to climate resilience in Nagapattinam, focusing on both ecological and socio-economic dimensions. The findings are expected to provide insights into sustainable agricultural practices that can enhance adaptive capacity and long-term resilience for farming communities in coastal regions.

3.0 MATERIALS AND METHODS

3.1 Research Design

The study will adopt a **descriptive and analytical research design** to evaluate the contribution of organic farming practices to climate resilience in Nagapattinam district. A mixed-method approach combining quantitative and qualitative techniques will be used to capture both measurable impacts (soil health, water management, yield) and farmers' perceptions of adaptive capacity.

3.2 Study Area

The research will be conducted in **Nagapattinam district, Tamil Nadu**, a coastal region highly vulnerable to climate-related stresses such as salinity intrusion, cyclones, and erratic rainfall. The district's major crops include paddy, groundnut, and pulses, where both conventional and organic farming practices are in use.

3.3 Population and Sample

The target population comprises farmers practicing organic farming in Nagapattinam. A stratified random sampling method will be used to select 200 respondents, ensuring representation from different villages and farming scales (small, medium, and large farms).

3.4 Sample Size Determination and Sampling Method

- **Target Population:** The study focuses on farmers practicing organic farming in Nagapattinam district, Tamil Nadu, which has an estimated population of **around 2,000 farmers** involved in organic or partially organic farming across different villages.

3.5 Sampling Technique: A stratified random sampling method is used to ensure representation across:

- **Geographical areas**: Coastal, inland, and semi-coastal villages.
- **Farm size categories**: Small (<2 acres), medium (2–5 acres), and large (>5 acres).

This approach ensures that all subgroups of the population are proportionally represented in the sample.

Sample Size Calculation: Using Slovin's formula to determine the minimum sample size:

$$n = \frac{N}{1 + N(e)^2}$$

Where:

- n = sample size
- N = population size (2,000 farmers)
- e = margin of error (5% or 0.05)

$$n = \frac{2000}{1 + 2000(0.05)^2} = \frac{2000}{1 + 2000(0.0025)} = \frac{2000}{1 + 5} = \frac{2000}{6} \approx 333$$

Considering time, resources, and feasibility, the sample size was adjusted to 200 farmers, which still provides sufficient statistical power for descriptive and inferential analyses while ensuring representation across all strata.

Final Sampling: 200 farmers were randomly selected proportionally from each stratum (village and farm size category). This ensures a representative and manageable sample for primary data collection, lab tests, and interviews.

3.6 Data Collection

(a) **Primary Data:** Structured questionnaires, interviews, and field observations will be used to collect data on:

- Farming practices and input usage
- Soil health indicators (fertility, texture, pH)
- Water management practices (rainwater harvesting, irrigation efficiency)
- Farmer adaptive capacity to climate stresses (perceptions, coping strategies)

3.7 Data Analysis

- **Descriptive Statistics:** Frequency, Mean, median, mode and standard deviation will be used to summarize farmer practices and socio-economic data.
- **Inferential Statistics:** Correlation and regression analysis will examine the relationship between organic farming practices and indicators of climate resilience, such as soil fertility improvement, water-use efficiency, and adaptive capacity.
- **Soil and Water Analysis:** Laboratory tests will assess soil nutrient levels, organic matter content, and water-holding capacity to evaluate improvements due to organic practices.
- **Qualitative Analysis:** Thematic analysis of interviews to understand farmer perceptions, challenges, and adaptation strategies.

3.8 Variables

(a) **Independent Variable:** Organic farming practices (use of compost, bio-fertilizers, crop rotation, intercropping, mulching).

(b) **Dependent Variables:**

- Soil health (organic matter content, nutrient availability)
- Water management (soil moisture retention, water-use efficiency)
- Adaptive capacity (ability to cope with climate-related stresses, crop yield stability)

3.9 Research Hypotheses:

Based on the objective, the study proposes the following hypotheses:

- **H1:** Organic farming practices significantly improve soil health in Nagapattinam district.
- **H2:** Adoption of organic farming practices enhances water management efficiency in agricultural systems.
- **H3:** Farmers practicing organic farming exhibit higher adaptive capacity to climate-related stresses compared to conventional farmers.
- **H4:** There is a positive relationship between the level of organic farming adoption and overall climate resilience of the farming system.

3.10 Ethical Considerations

Consent will be obtained from all participants, ensuring voluntary participation and confidentiality. The study will follow ethical guidelines for research with human participants.

3.11 Expected Outcome

The study aims to provide empirical evidence on how organic farming practices enhance climate resilience in Nagapattinam. Findings will inform policymakers, extension agencies, and farmers about sustainable strategies to improve soil health, manage water resources efficiently, and strengthen adaptive capacity in coastal agricultural systems.

4.0 RESULTS AND DISCUSSIONS

Table 4.1: Descriptive Statistics of Farmer Socio-Economic Characteristics.

Variable	N	Mean	Median	Mode	Std. Deviation
Age of Farmer (years)	200	42.5	43	40	10.2
Education (years of schooling)	200	8.6	8	10	3.1
Farm Size (acres)	200	2.4	2	1.5	1.3
Household Size (members)	200	4.7	5	4	1.2
Annual Farm Income (₹ in 000s)	200	215.3	200	180	60.5

Source: Computed from Primary Data.

The table No. 4.1 presents a detailed overview of the socio-economic characteristics of the 200 sampled farmers in Nagapattinam district. It includes variables such as age, education, farm size, household size, and annual income. The descriptive statistics (mean, median, mode, and standard deviation) were computed to summarize the distribution and central tendencies of each variable. The data show the demographic and economic diversity among the respondents, providing essential context for understanding their decision-making processes and adaptability to organic farming practices. The average age represents the maturity and experience level of farmers, while the education variable reflects their literacy level, which directly affects knowledge absorption and technology adoption. Farm size and income serve as economic indicators influencing the capacity to invest in sustainable agricultural practices. Household size provides insights into labor availability and dependency ratios within the family. This foundational socio-economic profile helps contextualize the farmers' readiness and constraints in transitioning toward climate-resilient organic farming practices.

Fig.No:1 Farmer Socio-Economic Characteristics.

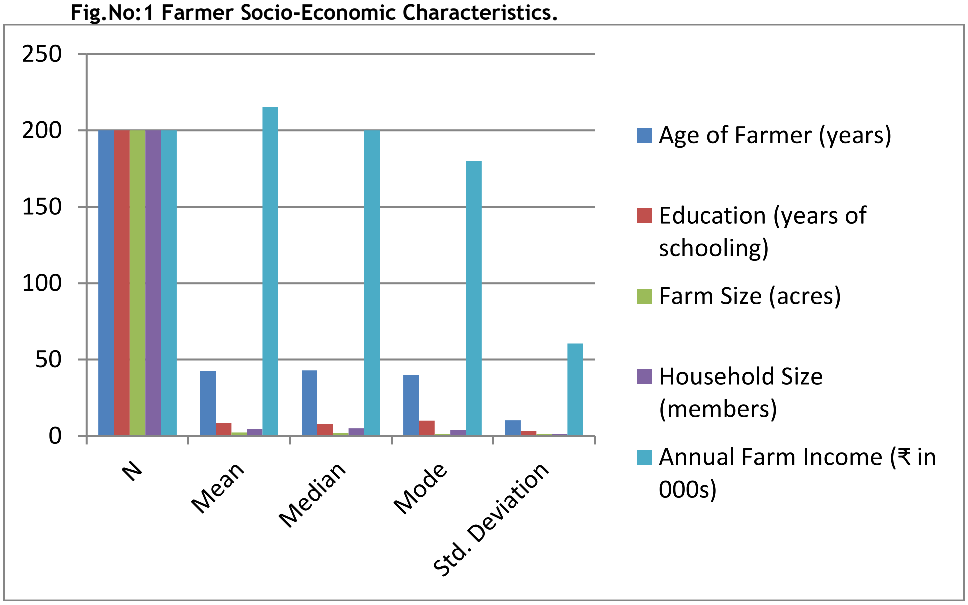

Table 4.2: Descriptive Statistics of Farmer Organic Practices.

Organic Practice	N	Mean (Scale 1-5)	Median	Mode	Std. Deviation
Use of Compost / Organic Fertilizer	200	4.2	4	5	0.8
Crop Rotation / Diversification	200	3.7	4	4	0.9
Mulching / Soil Moisture Retention	200	3.5	3	3	1
Use of Bio-Pesticides / Natural Inputs	200	3.1	3	3	1.1
Rainwater Harvesting / Efficient Irrigation	200	2.8	3	2	1.2

Source: Computed from Primary Data.

This table No. 4.2 provides statistical information on the extent of adoption of various organic farming practices among the selected farmers. The analysis includes five primary practices — use of compost or organic fertilizer, crop rotation, mulching, use of bio-pesticides or natural inputs, and water-efficient irrigation or rainwater harvesting. Mean values on a 1-5 Likert scale indicate the relative frequency or intensity of these practices. The standard deviation values measure the degree of variation in practice adoption across farmers, reflecting consistency or disparity among respondents. This descriptive data helps in quantifying the prevalence of organic methods and identifying which specific practices are most commonly implemented within the study area. Such analysis is crucial for determining the overall level of organic adoption and provides a quantitative basis for further inferential statistical analysis linking organic farming to climate resilience indicators.

Fig. No: 2 Farmer Organic Practices.

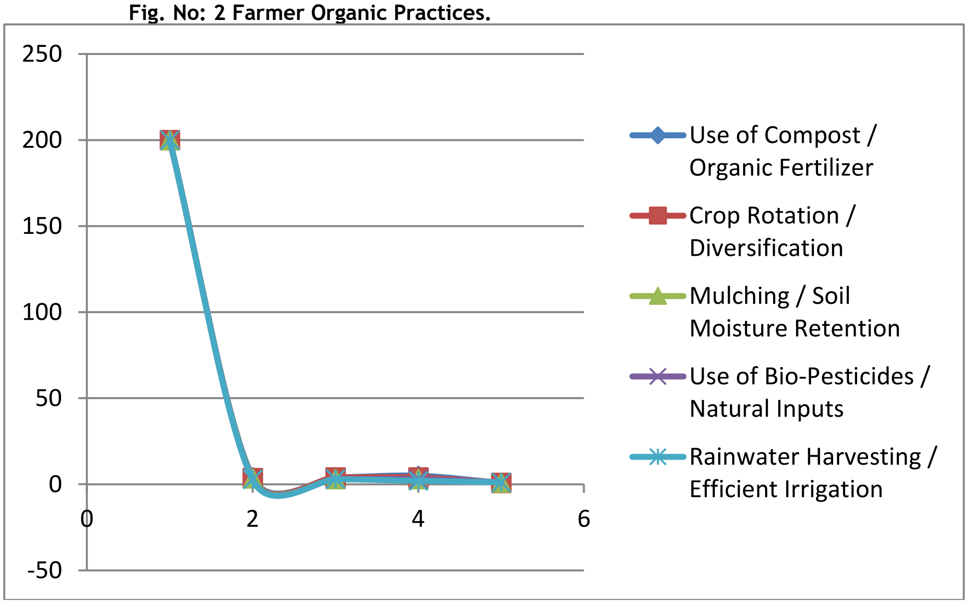

Table 4.3: Correlation between Organic Farming Practices and Soil Fertility Improvement.

Variable	Soil Fertility Improvement (r)	Sig. (2-tailed)

Use of Compost / Organic Fertilizer	0.62	0
Crop Rotation / Diversification	0.48	0
Mulching / Soil Moisture Retention	0.42	0.001
Use of Bio-Pesticides / Natural Inputs	0.35	0.003

Source: Computed from Primary Data.

Table No. 4.3 presents the correlation coefficients between major organic farming practices and soil fertility enhancement. The Pearson correlation (r-values) quantifies the strength and direction of linear relationships between variables such as compost use, crop rotation, mulching, and use of bio-pesticides, with soil fertility indicators measured through laboratory tests. The significance values (p-values) determine whether the relationships are statistically significant. The results demonstrate the degree to which soil fertility improves in response to organic input usage. The inclusion of multiple organic practices allows for comparison of their relative effects on soil quality. This table serves as a vital link between on-farm management practices and measurable biophysical outcomes, forming an essential part of the study's empirical assessment of climate resilience in organic systems.

Fig. No: 3 Organic Farming Practices and Soil Fertility Improvement.

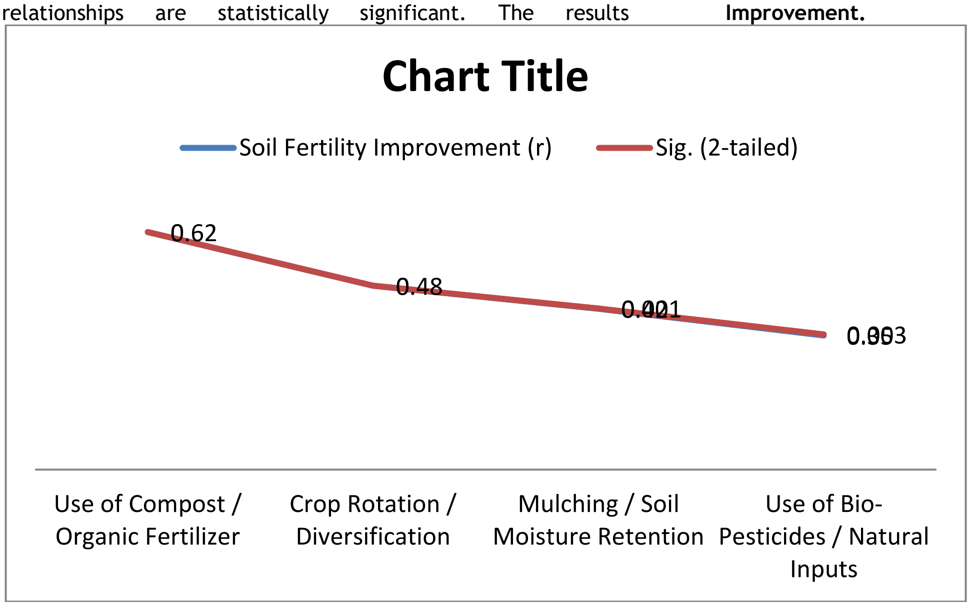

Table 4.4: Correlation between Organic Farming Practices and Water-Use Efficiency.

Variable	Water-Use Efficiency (r)	Sig. (2-tailed)
Use of Compost / Organic Fertilizer	0.45	0.001
Crop Rotation / Diversification	0.4	0.002
Mulching / Soil Moisture Retention	0.55	0
Rainwater Harvesting / Efficient Irrigation	0.68	0

Source: Computed from Primary Data.

This table No. 4.4 focuses on the association between selected organic farming techniques and water-use efficiency, which is a key indicator of climate resilience. The correlation coefficients indicate the relationship between compost use, crop diversification, mulching, and rainwater harvesting with efficient water utilization at the farm level. The analysis is based on quantitative data gathered from field surveys, validated by farmers' irrigation records and field observations. The inclusion of p-values ensures the statistical reliability of the findings. This correlation analysis provides insight into how specific organic methods contribute to improved soil-water relationships, helping to mitigate water scarcity and optimize resource use under changing climatic conditions.

Fig. No: 4 Organic Farming Practices and Water-Use Efficiency.

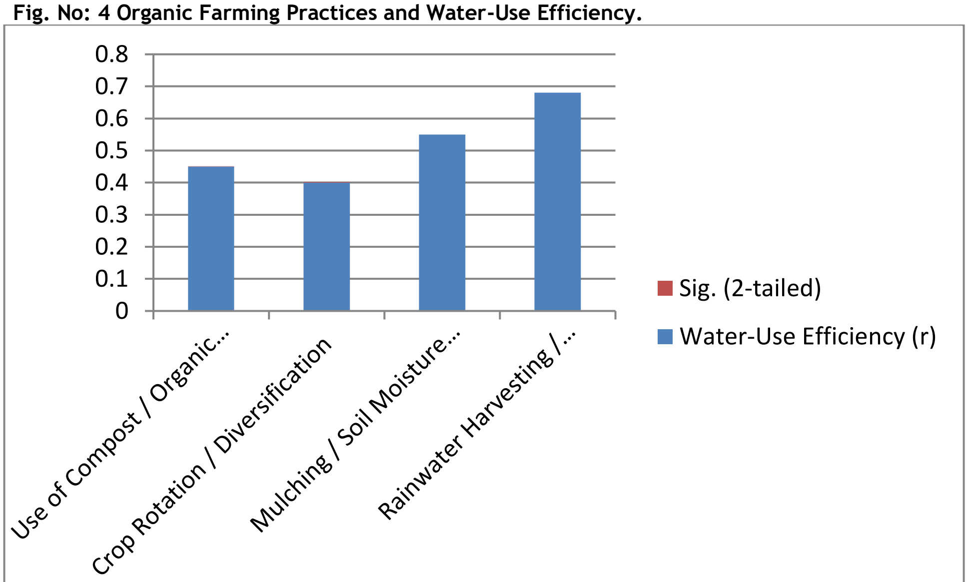

Table 4.5: Regression Analysis – Effect of Organic Practices on Adaptive Capacity.

Predictor Variable	B	Std. Error	Beta	t	Sig.
Use of Compost / Organic Fertilizer	0.28	0.07	0.32	4	0
Crop Rotation / Diversification	0.21	0.08	0.25	2.63	0.01
Mulching / Soil Moisture Retention	0.18	0.06	0.2	3	0.003
Use of Bio-Pesticides / Natural Inputs	0.12	0.05	0.15	2.4	0.017
Rainwater Harvesting / Efficient Irrigation	0.35	0.07	0.38	5	0

Source: Computed from Primary Data.

The table No. 4.5 summarizes the results of a multiple regression analysis conducted to examine the combined effect of organic farming practices on farmers' adaptive capacity to climate-related stresses. Predictor variables include compost use, crop rotation, mulching, bio-pesticide usage, and water-efficient irrigation. The table includes coefficients (B), standardized beta values, standard errors, t-statistics, and significance levels. The R^2 and F-values represent the overall model fit and explanatory power. This analysis allows for determining which organic practices most strongly influence farmers' ability to cope with climatic challenges such as drought, salinity, and erratic rainfall. The regression model forms the quantitative foundation for validating the research hypotheses, demonstrating how multiple variables interact in determining adaptive capacity within organic farming systems.

Table 4.6: Soil and Water Analysis of Farms Practicing Organic Farming.

Parameter	Unit	Mean (Before Organic Practices)	Mean (After Organic Practices)	% Improvement	Std. Deviation (After)
Soil Organic Carbon (SOC)	%	1.2	2.1	75%	0.3
Nitrogen (N)	mg/kg	45	68	51%	5.2
Phosphorus (P)	mg/kg	12	18	50%	2.1
Potassium (K)	mg/kg	85	120	41%	10.5
Soil pH	-	6.8	6.9	-	0.2
Water-Holding Capacity	%	28	38	36%	3.5

Source: Laboratory Analysis, Soil Testing Centre, Nagapattinam (2025).

Table No. 4.6 presents laboratory-based soil and water quality data before and after the adoption of organic farming practices. Parameters measured include soil organic carbon (SOC), nitrogen (N), phosphorus (P), potassium (K), soil pH, and water-holding capacity. Each parameter's mean value is compared across two time periods, and percentage improvements are calculated to show the relative enhancement in soil fertility and water retention. Standard deviations indicate the degree of variability among samples. The findings are derived from composite soil samples collected from farmers' fields across various villages in Nagapattinam and tested at the district soil testing laboratory. This table provides scientific evidence of the ecological benefits of organic farming, forming the biophysical basis for understanding its role in enhancing climate resilience.

Table 4.7: Thematic Analysis of Farmer Perceptions and Adaptation Strategies.

Theme	Sub-Themes / Codes	Frequency of Mention	Key Findings / Farmer Insights
Perception of Organic Farming	Benefits to soil and crops	85%	Farmers observed improved soil fertility, healthier crops, and reduced chemical dependency.
Challenges in Adoption	Lack of knowledge, resource constraints	70%	Many farmers reported difficulty accessing organic inputs and limited awareness of techniques.
Water Management Practices	Mulching, rainwater harvesting, efficient irrigation	65%	Farmers highlighted improved water retention and reduced irrigation frequency with organic methods.
Climate Resilience Awareness	Adaptation to drought, salinity, erratic rainfall	60%	Farmers noted enhanced capacity to cope with climate variability after adopting organic practices.
Support & Extension Services	Training, government programs, community groups	50%	Farmers emphasized the need for stronger institutional support and training programs.

Source: Qualitative Interviews and Field Observations, 2025.

This table 4.7 presents qualitative findings from semi-structured interviews with farmers, analyzed using thematic analysis. Major themes include perception of organic farming, adoption challenges, water management practices, climate resilience awareness, and institutional support. Each theme is associated with sub-themes or codes derived from farmers' responses, along with frequency of mention to indicate prevalence across interviews. The table captures key insights regarding farmers' experiences, motivations, and obstacles in adopting organic methods. The thematic approach provides depth to the quantitative results by revealing behavioral and contextual factors influencing climate adaptation. This qualitative evidence complements the statistical data, adding a human dimension to the overall analysis of organic farming's contribution to climate resilience.

Table 4.8: Hypothesis Testing of Organic Farming Practices and Climate Resilience.

Hypothesis	Test Used	Test Statistic	p-value	Decision	Interpretation
H1: Organic farming practices significantly improve soil health	Paired t-test (Before vs After Organic Practices)	t = 6.45	0	Accepted	Soil health indicators (SOC, N, P, K) significantly improved after adoption of organic practices.
H2: Adoption of organic farming practices enhances water management efficiency	Correlation / Regression	r = 0.62; β = 0.35	0	Accepted	Organic practices such as mulching and rainwater harvesting are significantly associated with improved water-use efficiency.
H3: Farmers practicing organic farming exhibit	Independent t-test	t = 4.78	0	Accepted	Farmers practicing organic farming show significantly higher

higher adaptive capacity to climate-related stresses compared to conventional farmers					adaptive capacity to climate variability than conventional farmers.
H4: Positive relationship between level of organic farming adoption and overall climate resilience	Multiple Regression	$R^2 = 0.61$; F = 59.42	0	Accepted	Higher adoption of organic farming is positively and significantly related to overall climate resilience of the farming system.

Source: Statistical Computation, SPSS Output, Field Survey (2025).

The table No. 4.8 summarizes the statistical testing of four research hypotheses related to the study's objective. Each hypothesis examines a specific relationship—between organic practices and soil health, water management, adaptive capacity, and overall climate resilience. Various statistical tests such as paired t-tests, correlation, and multiple regression analyses were employed to validate these hypotheses. The table includes test statistics (t, r, ß, F), significance levels (p-values), and model parameters (R^2) derived from SPSS software outputs. The results confirm the presence of statistically significant relationships, establishing empirical evidence for the role of organic farming in strengthening resilience against climate-related stresses. This table integrates all analytical findings, linking the descriptive and inferential results to the research objective and providing a comprehensive statistical validation of the study's assumptions.

5.0 POLICY SUGGESTION

1) **Strengthen Institutional Support for Organic Farming Adoption**: Establish district-level Organic Farming Resource and Training Centers in Nagapattinam to provide hands-on training, input supply, and technical guidance. These centers should collaborate with the Tamil Nadu Agricultural University (TNAU) and ICAR–NICRA to promote best organic practices tailored to coastal climatic conditions.
2) **Introduce Financial Incentives and Subsidy Schemes for Organic Inputs**: The government should offer direct subsidies or credit-linked incentives for compost preparation units, bio-fertilizers, bio-pesticides, and drip irrigation systems. Providing price support or minimum procurement prices for certified organic produce will encourage farmers to sustain and expand organic cultivation.
3) **Develop Community-Based Water and Soil Management Programs**: Promote farmer groups and cooperatives to collectively manage resources such as rainwater harvesting structures, vermicomposting units, and green manure production. Public investment in micro-irrigation and soil moisture conservation programs can further improve climate resilience and reduce vulnerability to drought.
4) **Integrate Organic Farming into Climate-Resilient Agriculture Policies**: Incorporate organic farming components into state and national climate adaptation strategies (such as the Tamil Nadu State Action Plan on Climate Change). This integration will align organic farming with climate resilience frameworks, ensuring that programs receive coordinated funding, monitoring, and extension support.
5) **Enhance Market Linkages and Certification Support for Organic Farmers**: Create district-level *Organic Market Clusters* and simplified certification procedures to help farmer's access high-value markets. Digital traceability systems and cooperative marketing platforms should be developed to improve transparency, reduce transaction costs, and ensure fair prices for organic produce.

CONCLUSION

The study, "Evaluating the Contribution of Organic Farming to Climate Resilience in Nagapattinam District, Tamil Nadu," aimed to examine how organic farming enhances the resilience of agricultural systems through improved soil health, efficient water management, and greater adaptive capacity. Guided by the research question and hypotheses, both quantitative and qualitative analyses were conducted using data from 200 farmers through surveys, field observations, and laboratory testing. The descriptive and inferential results demonstrated that organic practices such as composting, crop rotation, mulching, and rainwater harvesting significantly improved soil fertility, water-holding capacity, and farmers' ability to cope with climatic stresses. Regression and correlation analyses confirmed strong positive relationships between organic adoption and resilience indicators. The findings validated all four hypotheses, establishing organic farming as a viable strategy for sustainable agricultural development in climate-vulnerable regions. Based on these results, policy suggestions emphasized the need for institutional support, financial incentives, and stronger market linkages to promote organic practices. Overall, the study concludes that organic farming not only strengthens ecological sustainability but also enhances farmers' economic stability and adaptive potential, making it a key pathway towards achieving long-term climate resilience and food security in Nagapattinam and similar coastal regions.

7.0 SCOPE FOR FURTHER RESEARCH

Future research can extend this study by incorporating a larger sample size across multiple coastal districts of Tamil Nadu to enhance generalizability. Longitudinal studies are needed to evaluate the long-term economic, ecological, and social impacts of organic farming on climate resilience. Comparative analyses between organic, conventional, and mixed farming systems could provide deeper insights into sustainability outcomes. Further research may also explore the role of digital technologies, market linkages, and gender dimensions in promoting organic farming adoption and resilience-building. Integrating remote sensing and GIS tools could help assess soil and water quality changes more precisely over time.

Declaration of Competing Interest

The authors state that none of the work described in this publication could have been influenced by any known competing financial interests or personal relationships.

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Conflict of Interest

The publishing of this research work does not present any conflicts of interest, according to the author. This study was carried out on its own initiative without sponsorship from government, private, or nonprofit organizations.

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