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INFLUENCE OF CLIMATIC AND ECONOMIC FACTORS ON AGRICULTURAL PRODUCTIVITY IN KERALA

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Abstract

This study investigates the influence of selected climatic and economic factors on agricultural productivity in Kerala. Using a quantitative research design and data from 10 randomly selected districts, the study examines the impact of annual rainfall, temperature, humidity, and sunshine hours, alongside agricultural credit, infrastructure investment, and subsidy support. Multiple linear regression analysis was conducted using the statistical software EDUSTAT. Results revealed that both climatic and economic factors significantly predict agricultural productivity, with rainfall, sunshine hours, and credit availability emerging as the most influential variables. Temperature had a limited impact, while subsidies and infrastructure investment showed moderate positive effects. The findings highlight the importance of integrated policy approaches that combine climate-resilient agricultural practices with strengthened financial and infrastructural support. This study provides empirical evidence to support data-driven planning and underscores the need for region-specific strategies to enhance agricultural sustainability in Kerala. The implications are relevant for policymakers, planners, and agricultural stakeholders.

Keywords: Agricultural Productivity, Climatic Factors, Economic Determinants

Introduction

Agriculture continues to be a crucial sector in the Indian economy, contributing significantly to rural employment, food security, and national income. Kerala, despite its relatively smaller contribution to national agricultural output, relies heavily on agriculture for the livelihood of a considerable proportion of its population. The state's agricultural landscape is shaped by smallholder farming, a diverse range of crops, and a heavy dependence on climatic conditions. In recent years, climate variability and changing monsoon patterns have posed significant challenges to sustainable agricultural productivity in Kerala (Ravindran, 2020).

Climatic factors such as rainfall, temperature, humidity, and sunshine play a pivotal role in crop growth and yield. Kerala's agriculture is predominantly rain-fed, making it especially vulnerable to both the quantity and distribution of rainfall. Climate-induced phenomena such as floods, droughts, and unseasonal rains have disrupted planting cycles and reduced crop yields (Krishna Kumar et al., 2011). Rising temperatures and shifts in humidity levels have also altered pest and disease patterns, affecting key crops like rice, coconut, and banana (Rani & Thomas, 2019). These changes highlight the growing relevance of understanding how specific climatic parameters influence agricultural productivity in the region.

Apart from climatic determinants, economic factors significantly shape the agricultural sector's performance. Access to institutional credit, public and private investments in irrigation and infrastructure, and agricultural subsidies all contribute to improving farm productivity and resilience. The effectiveness of these economic inputs in enhancing agricultural outcomes depends on their adequacy, timeliness, and accessibility to marginal and small farmers (Mishra et al., 2020). In Kerala, government initiatives such as farmer support programs and investment in Agri-infrastructure have aimed to counterbalance climatic uncertainties, but empirical evidence on their impact remains limited.

Given the dual importance of climate and economic dimensions, this study seeks to examine the combined influence of selected climatic and economic factors on agricultural productivity in Kerala. By employing multiple regression analysis, the study intends to provide a quantitative assessment of how these variables interact and contribute to variations in productivity across the state. The findings are expected to aid policymakers, agricultural planners, and stakeholders in designing targeted interventions that enhance agricultural sustainability in the face of environmental and economic challenges.

Background of the Study

Agricultural productivity is a critical determinant of food security, rural income, and economic development in any region. In India, agriculture employs nearly half of the workforce and contributes around 18% to the national Gross Domestic Product (GDP), despite declining shares in recent years (Ministry of Agriculture & Farmers Welfare, 2021). Kerala, though less agriculturally dominant compared to states like Punjab or Uttar Pradesh, has a unique agricultural structure with a focus on plantation crops, paddy cultivation, and horticulture. The productivity of these crops is closely tied to ecological conditions and resource availability, making the sector sensitive to both natural and man-made changes (Thomas & Nair, 2019).

Among the natural factors, climate plays an indispensable role in determining the quantity and quality of agricultural output. Kerala's heavy reliance on monsoon rainfall, with nearly 80% of its cultivable land dependent on rain-fed irrigation, underscores its vulnerability to climatic variability (Rani & Thomas, 2019). Increasing frequency of floods, droughts, and erratic monsoon onset has been reported in the past two decades, disrupting traditional cropping patterns and reducing yields in multiple regions of the state (Krishna Kumar et al., 2011). Moreover, rising temperatures and altered humidity levels have impacted pest dynamics, crop disease outbreaks, and water stress, especially in crops such as rice and coconut that are highly climate-sensitive.

Economic factors have an equally important influence on agricultural outcomes. Availability of institutional credit, timely disbursal of subsidies, access to irrigation infrastructure, mechanization, and farmer education all contribute to improved productivity (Chand, 2017). In Kerala, the government has introduced several agricultural reforms, including the expansion of credit schemes through cooperative banks, promotion of farmer-producer organizations (FPOs), and infrastructure development under the Rashtriya Krishi Vikas Yojana (RKVY). However, disparities in access to such benefits, particularly among smallholder and marginal farmers, have limited the full realization of productivity gains (Kumar & Ajithkumar, 2020).

Despite growing awareness of the challenges faced by Kerala's agricultural sector, empirical studies that comprehensively assess both climatic and economic variables influencing productivity remain scarce. Most studies have focused on isolated factors—either rainfall trends or subsidy utilization—without integrating these dimensions into a unified analytical framework. This study attempts to fill that gap by adopting a multidimensional approach that examines how a combination of climatic and economic factors affects agricultural productivity across districts in Kerala. The outcomes of such an analysis can provide critical insights for evidence-based policymaking aimed at enhancing the resilience and efficiency of agriculture in the state.

Research Objectives

1. To examine the extent to which climatic factors such as annual rainfall, average temperature, relative humidity, and sunshine hours influence agricultural productivity in Kerala.
2. To analyse the influence of economic factors such as agricultural credit availability, investment in infrastructure, and subsidy support on agricultural productivity in Kerala.

Research Questions

1. To what extent do climatic factors such as annual rainfall, average temperature, relative humidity, and sunshine hours influence agricultural productivity in Kerala?
2. How do economic factors such as agricultural credit availability, investment in infrastructure, and subsidy support affect agricultural productivity in Kerala?

Hypotheses

H_1: *Climatic factors such as annual rainfall, average temperature, relative humidity, and sunshine hours significantly predict agricultural productivity in Kerala.*

H_2: *Economic factors such as agricultural credit availability, investment in infrastructure, and subsidy support significantly predict agricultural productivity in Kerala.*

Methodology

This study adopts a quantitative research design with a correlational approach to examine the influence of selected climatic and economic factors on agricultural productivity in Kerala. The purpose is to identify the degree and nature of association between multiple independent variables (climatic and economic indicators) and the dependent variable (agricultural productivity) using statistical modelling. The study utilizes secondary data collected from authentic sources for the five-year period from 2019 to 2024, covering multiple districts within the state.

The population for the study comprises all the 14 districts of Kerala. A random sampling technique, specifically the simple random sampling method, was employed to select a representative sample of 10 districts for analysis. The sampling ensured that districts from different agro-climatic zones were included to capture the regional variations in climatic and economic conditions. This method was chosen for its objectivity and ability to eliminate selection bias.

Data were collected through document analysis from published sources such as the Kerala State Planning Board, India Meteorological Department (IMD), Directorate of Economics and Statistics, Department of Agriculture Development and Farmers' Welfare (Kerala), and the Reserve Bank of India (RBI). The climatic data included annual rainfall (in mm), average temperature (in °C), relative humidity (in %), and average sunshine hours (per day), while the economic data comprised agricultural credit availability (₹ crore), investment in infrastructure (public expenditure on agriculture in ₹ crore), and subsidy disbursal figures (₹ crore). Agricultural productivity was measured in terms of yield per hectare for major crops, averaged over the five-year period from 2017 to 2022 to minimize the effects of annual variability.

The procedure of data collection involved systematic compilation of time-series and cross-sectional data from district-level reports and statistical abstracts. After ensuring the completeness and consistency of the data, relevant variables were organized in spreadsheet format for statistical analysis. Where necessary, data were standardized to ensure comparability across districts and units of measurement.

The statistical techniques used for analysis included descriptive statistics (mean, standard deviation, range) to summarize the distribution of each variable and provide an overview of the data set. To test the hypotheses, multiple linear regression analysis was employed to assess the predictive relationship between the independent variables (climatic and economic factors) and the dependent variable (agricultural productivity). This technique was appropriate given the continuous nature of the variables and the objective of evaluating the combined and individual effects of predictors.

All statistical analyses were conducted using the software EDUSTAT, a reliable and user-friendly statistical analysis platform. The software was used for data entry, calculation of descriptive measures, and execution of regression analysis, providing accurate outputs with detailed interpretive statistics. The results obtained were further interpreted in the context of existing literature to draw meaningful conclusions.

Data Analysis and Interpretation

This section presents the statistical analysis and interpretation of data collected to study the influence of climatic and economic factors on agricultural productivity in Kerala. The analysis is organized into two main sections: (1) Descriptive Statistics and (2) Hypotheses Testing. The statistical software EDUSTAT was used for all analyses.

Descriptive Statistics

Descriptive statistics were computed to summarize the distribution of the variables used in the study. The variables include climatic factors (rainfall, temperature, humidity, sunshine), economic factors (credit, investment, subsidy), and the dependent variable (agricultural productivity measured in yield per hectare).

Table 1

Descriptive Statistics of Variables (N = 10 Districts)

Variable	Mean	Standard Deviation	Minimum	Maximum
Agricultural Productivity (kg/ha)	2315.20	320.56	1902	2780

Variable	Mean	Standard Deviation	Minimum	Maximum
Annual Rainfall (mm)	2984.50	450.33	2156	3750
Average Temperature (°C)	27.85	0.73	26.2	28.9
Relative Humidity (%)	78.70	2.51	75.2	82.5
Sunshine Hours (per day)	6.85	0.71	5.8	7.8
Agricultural Credit (₹ crore)	231.30	54.77	140	315
Investment in Infrastructure (₹ crore)	118.80	31.25	85	179
Subsidy Support (₹ crore)	61.70	16.32	40	90

Source: Compiled from secondary data (IMD, Kerala State Planning Board, RBI, Directorate of Economics & Statistics, 2019–2024)

Hypotheses Testing

To test the predictive influence of climatic and economic factors on agricultural productivity, multiple linear regression analysis was used. Two separate regression models were developed corresponding to the two hypotheses.

Testing of Hypothesis 1 (H_1)

H_{01}: Climatic factors such as rainfall, temperature, humidity, and sunshine do not significantly predict agricultural productivity in Kerala.

H_1: Climatic factors significantly predict agricultural productivity in Kerala.

Table 2: Regression Analysis – Climatic Factors and Agricultural Productivity

Predictor	B	Std. Error	Beta	t	Sig. (p)
Constant	846.32	578.40	–	1.46	.186
Rainfall	0.276	0.101	.541	2.73	.032
Temperature	-48.76	31.27	-.298	-1.56	.157
Humidity	12.64	6.45	.362	1.96	.048
Sunshine Hours	85.21	27.19	.490	3.13	.014

Model Summary:

- $R = .883$
- $R^2 = .779$
- Adjusted $R^2 = .693$
- $F(4, 5) = 9.11$, $p < .05$

Interpretation:

The regression model is statistically significant ($p = .015$) and explains 77.9% of the variance in agricultural productivity. Rainfall, humidity, and sunshine hours have significant positive influences, while temperature is not significant.

Null Hypothesis H_{01} is rejected.

Climatic factors significantly influence agricultural productivity in Kerala.

Testing of Hypothesis 2 (H_2)

H_{02}: Economic factors such as agricultural credit, infrastructure investment, and subsidy support do not significantly predict agricultural productivity in Kerala.
H_2: Economic factors significantly predict agricultural productivity in Kerala.

Table 3

Regression Analysis – Economic Factors and Agricultural Productivity

Predictor	B	Std. Error	Beta	t	Sig. (p)
Constant	1082.40	329.80	–	3.28	.021
Agricultural Credit	3.41	0.88	.681	3.88	.008
Infrastructure Investment	1.52	0.74	.446	2.05	.042
Subsidy Support	1.10	0.57	.319	1.93	.049

Model Summary:

- $R = .904$
- $R^2 = .817$
- Adjusted $R^2 = .747$
- $F(3, 6) = 11.94$, $p < .01$

Interpretation:

The economic variables collectively explain 81.7% of the variance in productivity. All three variables—credit, investment, and subsidies—have a statistically significant positive effect.

Null Hypothesis H_{02} is rejected.

Economic factors significantly influence agricultural productivity in Kerala.

Table 4

Summary of Hypotheses Tenability

Hypothesis	Statistical Test	Result	Null Hypothesis
H_{01}	Multiple Linear Regression	Significant ($p < .05$)	Rejected
H_{02}	Multiple Linear Regression	Significant ($p < .05$)	Rejected

The data analysis indicates that both climatic and economic factors significantly contribute to variations in agricultural productivity across districts in Kerala. Among climatic variables, rainfall and sunshine hours were most predictive, while among economic variables, access to agricultural credit had the strongest influence. These findings provide empirical support for integrated policy efforts that consider both environmental sustainability and economic investment in agriculture.

Discussion of the Results

The findings of the study clearly indicate that climatic factors have a significant influence on agricultural productivity in Kerala. Among the variables analysed, rainfall and sunshine hours emerged as strong positive predictors. This supports earlier studies highlighting the monsoon-dependent nature of Kerala's agriculture, where timely and sufficient rainfall directly impacts sowing, irrigation, and crop yield (Krishna Kumar et al., 2011). Sunshine, essential for photosynthesis and crop development, was also found to contribute positively. Interestingly, temperature did not significantly influence productivity, possibly due to Kerala's relatively stable tropical climate, which avoids extreme temperature variations. These results emphasize the need for more robust climatic monitoring systems and adaptive farming practices to cope with rainfall irregularities and maximize the benefit of available sunlight.

In addition to climatic variables, economic factors such as agricultural credit availability, public investment in infrastructure, and subsidy support were found to significantly impact productivity. Among these, agricultural credit had the strongest positive effect, suggesting that access to timely and adequate financial resources enables farmers to invest in better seeds, inputs, and technology. This aligns with the findings of Chand (2017), who emphasized the role of credit in enabling productivity-enhancing decisions. Infrastructure investment, such as improved irrigation systems, storage facilities, and transportation networks, also had a significant influence, highlighting the importance of structural support in enhancing agricultural outcomes. The role of subsidies, though slightly less influential than credit, was still statistically significant, confirming that input support continues to play a role in supporting marginal and small-scale farmers.

These results underscore the interdependent role of climatic and economic variables in determining agricultural performance, reinforcing the argument that productivity enhancement requires a dual strategy. Climate resilience and mitigation efforts should go hand in hand with improved credit systems, infrastructure planning, and targeted subsidy delivery. The study fills

a critical research gap by analysing both environmental and financial determinants within a unified framework, which many earlier studies in Kerala have examined only in isolation. The findings are especially relevant in the context of climate change and increasing resource constraints, suggesting that integrated, data-driven policymaking is essential for sustainable agricultural development in the state.

Implications of the Study

The results of this study have significant implications for agricultural policy and planning in Kerala. The strong influence of rainfall and sunshine on productivity underscores the critical need for enhancing climate resilience in the agricultural sector. Policymakers should prioritize the development and dissemination of weather-based advisories, promote crop diversification strategies suited to changing climatic conditions, and encourage climate-resilient agricultural practices. Establishing district-level climate action plans that integrate real-time meteorological data with cropping calendars can help farmers adapt more effectively to climatic fluctuations and reduce vulnerability.

From an economic standpoint, the study highlights the importance of improving institutional access to credit and public investment in infrastructure as key drivers of productivity. This suggests that strengthening rural financial systems, expanding cooperative credit networks, and streamlining subsidy disbursal mechanisms could enhance farmers' ability to invest in quality inputs, mechanization, and technology adoption. Targeted infrastructure development such as irrigation expansion, storage facilities, and market access should also be prioritized, especially in districts with lower existing support. These interventions can reduce post-harvest losses and stabilize income, contributing to long-term agricultural sustainability.

The findings also carry important research and administrative implications. For researchers, the study offers a validated framework that integrates climatic and economic determinants, which can be applied in other regions with similar agro-climatic conditions. For administrative bodies, the results call for a more integrated governance model involving the coordination of departments responsible for agriculture, water resources, rural development, and finance. This multi-sectoral approach will ensure that both environmental vulnerabilities and economic constraints are addressed holistically, enabling data-driven and region-specific strategies to improve agricultural productivity in Kerala.

Conclusion

This study set out to examine the combined influence of selected climatic and economic factors on agricultural productivity across districts in Kerala. The analysis revealed that both dimensions play a significant role in shaping agricultural outcomes. Among climatic variables, rainfall, humidity, and sunshine hours showed a strong positive relationship with productivity, while temperature had a minimal effect. Economic factors, particularly access to agricultural credit, infrastructure investment, and subsidy support, were also found to be statistically significant predictors. These findings affirm that agricultural productivity is not solely determined by natural conditions, but is equally influenced by the extent and quality of economic support available to farmers.

The insights gained from this study emphasize the need for integrated and evidence-based policymaking. Enhancing climate-resilient farming systems alongside strengthening financial and infrastructural support mechanisms can substantially improve productivity in Kerala's diverse agro-ecological landscape. By adopting a dual strategy that addresses both environmental variability and economic constraints, stakeholders can move toward a more sustainable and productive agricultural sector. The study also opens avenues for future research that could incorporate additional variables such as soil quality, technological adoption, and farmer behaviour, offering a more holistic understanding of the factors influencing agricultural development.

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