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IMPACT OF CLIMATE CHANGE ON PRODUCTION OF COFFEE IN KERALA

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ABSTRACT

Coffee is the second largest traded commodity after petroleum and a major source of foreign exchange for many nations in the tropic. The impact of climatic factors including frost have significant implications in the coffee production systems of Brazil as well as India. The current study found that the rainfall and relative humidity of second quarter was critically influenced the production of coffee in Kerala especially in the Wayanad district.

Keywords: Coffee, Climate, Regression, Panel Data Analysis, CAGR.

I. INTRODUCTION

Agriculture is arguably the most important sector of the economy that is highly dependent on climate. Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2016). The change of climate is attributed directly or indirectly to the human activity that alters the composition of global atmosphere (UNFCCC, 2016). Coffee is the second largest traded commodity after petroleum and a major source of foreign exchange for many nations in the tropic. India is the third-largest producer and exporter of coffee in Asia. In India, the majority of the coffee plantations are in the southern states of Karnataka, Kerala and Tamil Nadu and especially in the plantation districts within the Nilgiris. Kerala is characterized by the cultivation of trade-dependent plantation crops that are either export-oriented or import-substituting. Small growers (landholding below 10 hectares) contribute substantially to the coffee sector, in terms of the number of holdings as well as production. They account for over 90 per cent of operational holdings and 70 per cent of the production. Hence, as a labour-intensive production system, coffee is the major source of income for the small and marginal planters as well as for plantation workers. Kerala accounted for 19.2 per cent of the area and 20.3 per cent of the production of coffee in India during the Triennium Ending (TE) 2017-18. The increase in production from 18,893 MT in 1950-51 to 3,16,000 MT in 2017-18, could be attributed to the five time increase in area from 92,523 ha to 4,54,722 ha, along with a fourfold increase in productivity during the period (Coffee Board, 2018). Climatic changes such as reduced rainfall and increased temperature in coffee belts negatively influenced the production and productivity of coffee in India (ITC, 2010). The current study identifies the climatic factors influencing Kerala's coffee production and its causal extensivity in the coffee production system.

II. METHODOLOGY

Two important districts of Kerala for coffee were selected based on its area and production. Area and production data for each crop collected from Directorate of Economics and Statistics. Weather data for each district collected from Regional Agriculture Research Stations (KAU) and IMD in the selected district. Statistical tools such as CAGR and Panel data analysis were used for the analysis, and each variable are categorized based on quadrant basis (Q1, Q2, Q3, Q4) method

CAGR (Compound Annual Growth Rate)

The Compound Annual Growth Rates (CAGRs) of production in terms of quantity, value and unit value were estimated as follows,

$$E = ab^t e_t \qquad \leftrightarrow \qquad \ln E = \ln a + t \ln b$$

Where,

E = Variable for which growth rate is estimated,

$a = Intercept$

$b = regression\ coefficient$

$Compound\ growth\ rate\ (r) = ((Anti \ln b) - 1)) \times 100,$

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$t\ statistics\ (significance) = r/SE(r)$

Where,

$$SE(r) = [100b \times SE(\ln b)]/\ln e$$

Panel data analysis

Panel data analysis intended to analyze two-dimensional data such as cross sectional and longitudinal or time series data within a single frame.

$Y_t = a + bx_{it} + e_t$

Where,

Y_t=Dependent variable

x_{it}= Independent variables

a& b are coefficients i&t are indices

Assumptions about the error term determines fixed effects or random effects. In a fixed effects model e_{it} is assumed to vary non-stochastically over t or i. In a random effect model e_{it} vary stochastically over i or t requiring special treatment of the error variance matrix.

III. MODELING AND ANALYSIS

Compound annual growth rate and coefficient of variation of climatic factors existing in the study area for the last 30 years was depicted in table 1.0. Random effect model for panel data analysis was validated using the same data.

CAGR and Coefficient of Variation of weather parameters (1991-2020) Idukki and Wayanad

Particulars	Weather Parameters	Idukki	Wayanad
Mean	Maximum temperature (°C)	27.08	28.22
	Minimum Temperature (°C)	14.98	16.11
	Rainfall (mm)	1899.93	1876.58
	Morning Relative Humidity (%)	94.89	90.44
	Evening Relative Humidity (%)	76.48	68.96
Coefficient of Variation (%)	Maximum temperature	5.38	1.69
	Minimum Temperature	5.16	6.92
	Rainfall	17.18	17.36
	Morning Relative Humidity	1.25	2.69
	Evening Relative Humidity	11.76	8.82
Compound Annual Growth Rate (%)	Maximum temperature	-0.56	-0.11
	Minimum Temperature	0.74	0.26
	Rainfall	-0.45	-0.33
	Morning Relative Humidity	-0.16	0.41
	Evening Relative Humidity	-0.78	0.56

IV. RESULTS AND DISCUSSION

Climatic factors and their contributions in different quarters and different locations (Wayanad and Idukki) were subjected to panel data regression with random effect assumptions. The results indicates that the rainfall and relative humidity of Q2 was found to be critical in the production of coffee. While a 1% increase in Q2 relative humidity increased production by 0.2% whereas production decreased by 0.2% due to 1% increase in the Q2 rainfall. So, it can be concluded that the effect of increase in rainfall and relative humidity of Q2 is

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antagonistic on production of coffee in the state. These findings were in line with the findings of ITC (2010), climatic changes such as reduced rainfall and increased temperature in coffee belts negatively influenced the production and productivity of coffee in India.

Table 1. Coffee - Random Effects Model (1991-2020)

Sl. No.	Particulars	Coefficients	Standard Error	P value	VIF
1	Intercept	12.052	0.339	0.000	
7	Q2 Rainfall	-0.173*	0.105	0.098	3.48
11	Q2 RH	-0.191*	1.430	0.089	4.3

Compound annual growth rate of area under coffee cultivation and production and productivity of coffee was estimated for the past 30 years. The study revealed that area under cultivation was increased over the last 30 years by 0.12 per cent whereas the production and productivity of coffee was significantly improved over the years due to the cultivation high yielding robusta coffee after 1980s and improved as well as high end usage of chemical fertilizers in the coffee cultivation system of Kerala especially the coffee cultivation system of Wayanad district. Even with a shift from coffee to high profiting pepper cultivation by the farmers, still area counts a 0.12 per cent increase in overall area over the last 30 years. Considering the coffee cultivating districts such as Wayanad and Idukki, area counts a significant 0.03 per cent decline in Wayanad and a significant 0.36 per cent increase in Idukki district. These findings were in line with the observations of Sunil and Devadas (2009), even with a decline in area under coffee cultivation, a significant increasing trend was observed in production and productivity of coffee cultivation in Kerala.

Table 2. CAGR of area under coffee, production and productivity of coffee (1991-2020): Per cent

Region	Coffee		
	Area	Production	Productivity
Kerala	0.12	2.67	2.56
Idukki	0.37	1.35	0.97
Wayanad	-0.03	2.53	2.56

V. CONCLUSION

Climate change is a major challenge for our society. Though Kerala is the gate way to India's south west monsoon, more or less assured amount of rainfall is being received every year over the state. changes in climatic conditions have already affected the production of coffee and future climatic change threatens to exacerbate this. The irregular and insufficient rainfall and connected changes in temperature and relative humidity was significantly influencing the production levels of coffee in the state. The state economy is greatly dependent on production of plantation crops. So, the negative impacts are a major threat to economic security. There must be an international political solution and self-participation of the society to abide combating climate changes and its impacts.

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