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CHANGING TEMPERATURE PATTERN: A CAUSE OF FOOD INSECURITY IN KERALA

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Abstract

The adverse impact of climate change has become a global consensus in recent days. Climate conditions are the main uncontrollable factors affecting crop production and the main driver of fluctuations in global food production. As the temperature is rising in recent days the production of crops is critical to maintain global food supply. But different studies have yielded different results. Crops are sensitive to climate change, including changes in temperature and precipitation, and to rising atmospheric CO_2 concentration. This paper discusses about the adverse impact of temperature on food security. It finds that in Kerala rise in temperature become a greater challenge, because it adversely affects the selected crops. So that in the study area food security Is critical and the rise in temperature should be curbed to protect the people from food insecurity.

Keywords: Climate change, Food security, Production, Temperature.

Introduction

Climate change poses an emerging challenge to the sustainability of social and economic development, livelihoods, and environmental management across the globe (Kerala

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Development Report 2021). Climate change refers to a shift in average weather conditions, including measures such as temperature, humidity, rainfall, cloudiness, and wind patterns, and changes in the frequency or severity of these conditions. Climate change impacts are manifesting in all sectors of the economy at the global, regional, and national levels (Derbile 2022) and in local food systems, from direct effects on crop production to changes in markets, food prices, and supply chain infrastructure (Sin 2022).

Agricultural production is strongly influenced by weather and climate, and its instability and vulnerability will increase with climate warming. Extreme weather events, such as drought, rise in temperature, heatwaves, and floods, directly threaten food production and security, especially in rural communities with a high population of small-scale producers who are highly dependent on rain-fed agriculture for their livelihoods and food (Xuezheny 2022).

Temperature is the measure of hotness or coldness expressed in terms of any of several scales, including Fahrenheit and Celsius. As reported by the Intergovernmental Panel on Climate Change (IPCC, 2014), increases in the average global temperature result in global warming, which affects precipitation and has severe repercussions on agriculture. (Derbile 2022). Changes in temperature can affect the plant's processes of photosynthesis, respiration, and growth. Earlier, flowering in a warming climate has been documented in crop plants and natural plant populations (Tianhua 2022). By the end of the 21st century, the global mean surface temperature is projected to increase by 1.0-5.7^{O}c. Climate conditions are one of the main uncontrollable factors affecting crop production and the main driver of fluctuations in global food production (Long et al., 2022).

The key factor in agricultural crop production is temperature. It directly affects the crop growth rate and development. A rise in greenhouse gases will increase the yearly air temperature by 1 to 6^{o}c globally by the end of the century. In the next upcoming decades, 2030–50, the change in temperature will be about 2-3^{o}c. Increased temperature affects crop development by increasing the requirement for water, which reduces the economic yield (Srivastava et. al 2021). Livestock is one of the important allied activities of agriculture. The livestock sector currently plays a key role in food supply and food security. Livestock products (meat, milk, and eggs) contribute 15 per cent and 31 per cent of global per capita calorie and protein supplies, with regional variations. About 30 per cent and 6 per cent of global ruminant meat and milk

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production originate from grazing systems on land that is often poorly suited for cropping. Rise in temperature becomes a challenge for the production of livestock in recent days (C.M. Goode, 2021).

As temperature rises, the yield of food and cash crops in South Asia is expected to decline, putting pressure on food security in the region. India, home to 1.4 billion people, is ranked 101 out of 116 countries in the Global Hunger Index, indicating a serious threat.

Over the last 50 years, agriculture has had a special and unique place in Kerala's economy. To begin with, agriculture served as a driver of economic growth by expanding the size of the rural home market. Agriculture was also a successful contributor to structural change in Kerala's economy. In 2018–19, agriculture and allied sectors contributed only nine per cent to the Gross State Value Added (GSVA). One of the important weaknesses of agriculture in Kerala is the low productivity of most of its major crops. Productivity levels are low both in comparison with other States as well as with the maximum attainable productivity under scientific practices (Kerala Development Report 2021).

In Kerala, food crops comprising rice, tapioca, sweet potato, millets, and pulses accounted for 9.88 per cent of the total cropped area in 2019-20, while cash crops (cashew, rubber, pepper, coconut, cardamom, tea, and coffee) constituted 61.6 per cent. The area under crops like rubber, coffee, tea, and cardamom was 27.5 per cent of the total cropped area. Coconut occupies the largest area with 29.3 per cent coverage, followed by rubber with 21.28 per cent. Rice is in third position with 7.37 per cent of the total cropped area. Compared to 2018-19, area under tapioca showed an increase of 0.31 per cent and area under pulses declined by 229.54 ha, with a decline in production by 197 tonnes recording 2260.46 ha and 2103 metric tonnes, respectively. Among other crops, arecanut, coffee, cashew, banana, cardamom, and pepper recorded an increase in area over 2018–19. Ginger, turmeric, tea, and coconut recorded a decline in area. Banana recorded the highest increase in area with 14.7 per cent over 2018-19. There was an increase in production for banana, cashewnut, coffee, and other plantains (Kerala Development Report 2021). But Kerala state faces problems like food security because of an increasing population and climate change.

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According to Zong et al. (2022), the increase in temperature is mainly due to greenhouse gas emissions. It was projected that the global average surface temperature will increase by 1.5^{o}c from 2030 to 2052 when compared with the preindustrial revolution period (1850–1990). The rise in global temperatures causes natural disasters like droughts and floods worldwide. Natural disasters caused by climate change accounted for 90 per cent of all disasters worldwide in 2020, resulting in 15,080 deaths and $171.3 billion in economic losses. As agriculture is an economic activity that sustains the food and nutrition, necessary for human life and plays a pivotal role in socioeconomic development, its production is adversely affected by climate change.

The objective of this study is to find out the impact of temperature on the area under cultivation, production, and productivity of selected food crops in Kerala.

Data and Methods

The present study is based on the secondary data. The data for area under cultivation production and productivity of selected crops have been collected from various issues of Agricultural Statistics of Kerala from 1991-92 to 2020-21. Temperature data was collected from the Indian Meteorological Department Pune. Simple linear regression model and pearson correlation coefficient are adopted to find out the impact of selected crops by temperature. The study reveals the actual impact of the variations in temperature on the crops of Kerala.

Results and Discussion

This section discusses the impact of temperature on food security in Kerala from 1991-92 to 2020-21. Regression result of the impact of temperature on Paddy in Kerala is shown in table 1

Table 1

Correlation and Regression result of the Impact of Temperature on Paddy in Kerala

Values	Area under Cultivation	Production	Productivity
Correlation	-0.780**	-0.728**	0.805**
R^2	0.608	0.530	0.647
F	43.407	31.537	51.377
P	0.000	0.000	0.000
B	-98306.981	-139026.875	0.310
Sig. at	0.000	0.000	0.000

Source: Computed data

Note: ** significant at one per cent level

The results presented in table 1 explains the real impact of temperature on paddy and the correlation between area under cultivation, production and productivity of paddy and temperature. The correlation is significant at one per cent level for area, production and productivity. The R^2 values explains that 60 per cent of the variations in area under paddy, 53 per cent of the variations in production of paddy and 64 per cent of the variations in the productivity of paddy are due to temperature in Kerala. It has been proved by B values that one unit increase in temperature decreases 98306 units of paddy area and 139026 units of paddy production, but it increases the productivity by 0.31 units. The regression and correlation results indicating the impact of temperature on cereals is presented in table 2.

Table 2

Correlation and Regression result of the Impact of Temperature on Cereals in Kerala

Values	Area under Cultivation	Production	Productivity
Correlation	-0.782**	-0.727**	0.809**
R^2	0.611	0.529	0.654
F	43.962	31.445	52.921
P	0.000	0.000	0.000
B	-101358.645	-140073.120	0.323
Sig. at	0.000	0.000	0.000

Source: Computed data

Note: ** significant at one per cent level

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The results shown in Table 2 explores the impact of temperature on cereals. The correlation is significant at one per cent level. It is clear from the correlation results that, rise in temperature decrease the area under cultivation and production of cereals significantly, but temperature and the productivity of cereals are positively correlated and significant at one per cent level. The calculated R square values are 0.61, 0.52, and 0.65, respectively for the area, production and productivity of cereals. It narrates that 61 per cent of the variations in the area under cereals, 52 per cent in production and 65 per cent in productivity are due to temperature. The F value and P value of each area under cultivation of cereals, production, and productivity were statistically significant. It was proved from the B value that, one unit rise in temperature reduces 101358 units of area under cultivation of cereals, 140073 units of production, and increases 323 units of cereals productivity. The impact of temperature on pulses is shown in Table 3.

Table 3

Correlation and Regression result of the Impact of Temperature on Pulses in Kerala

Values	**Area under cultivation**	**Production**	**Productivity**
Correlation	-0.735**	-0.718**	0.311
R^2	0.540	0.516	0.096
F	32.844	29.878	2.989
P	0.000	0.000	0.095
B	-5663.129	-4007.160	0.051
Sig. at	0.000	0.000	0.095

Source: Computed data

Note: ** significant at one per cent level

In table 3, the correlation results indicate that increase in temperature decreases the area under cultivation and production of pulses significantly, but increases its productivity and the value is not significant. The R square value of each of these variables indicates that 54 percent of the variations in area under cultivation and 51 percent of the variations in production of pulses are due to variations in temperature. The F value and associated P value of each area and the production of pulses are significant and for productivity it is not significant. In this analysis if temperature increases by one unit, the area under pulses decreases by 5663 units and production of pulses decreases by 4007 units and there is no change in productivity due to temperature. The impact of temperature on food grains is shown in Table 4.

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Table 4

Correlation and Regression result of the Impact of Temperature on Food Grains in Kerala

Values	Area under cultivation	Production	Productivity
Correlation	-0.780**	-0.728**	0.813**
R^2	0.608	0.530	0.661
F	43.590	31.613	54.503
P	0.000	0.000	0.000
B	-107021.773	-144080.779	0.329
Sig. at	0.000	0.000	0.000

Source: Computed data

Note: ** significant at one per cent level

Food grains serve as the staple food commodities for billions of people in the world. Thus ensuring the protection and safety of food grains could play an important role in hunger suppression and food security. Table 4 explains the correlation values of temperature with area, production and productivity of food grains significant and highly correlated. Here it is clear that increase in temperature tends to decrease the area under food grains and its production. For productivity, the correlation is positive and significant. According to the R square values, temperature is the major climate factor that affects the food grains in Kerala. Temperature alone contributes to 60 per cent of the variations in area under food grains, 53 per cent of the variations in production and 66 per cent of the variations in its productivity. As shown in the table, the results are significant. From the analysis, one unit increase in temperature decreases 107021 units and 144080 units of area under cultivation and production of food grains respectively. But temperature increase 0.32 units of the productivity of food grains. Temperature is the important contributor of the cultivation and production of food grains in Kerala. It becomes a greater challenge in recent days for food security. Because the availability and affordability of food grains has been affected significantly due to temperature. The impact of temperature on the banana crop is shown in Table 5.

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Table 5

Correlation and regression result of the impact of temperature on banana in Kerala

Values	Area under cultivation	Production	Productivity
Correlation	0.660**	0.773**	-0.452*
R^2	0.435	0.598	0.204
F	21.579	41.666	7.193
P	0.000	0.000	0.012
B	1038.021	63337.046	-1.213
Sig. at	0.000	0.000	0.012

Source: Computed data

Note: ** significant at one per cent level, * significant at five per cent level

In Table 5, three dependent variables, such as area under cultivation, production and productivity of banana are tested against temperature through simple regression analysis. The R square value of banana productivity is low which predicts only 20 percent changes due to temperature in Kerala. Moreover, changes in temperature lead to change 43 per cent of the variations in area under banana and 59 per cent of the variations in production of banana. The P values of area under banana and its production are statistically significant, but banana productivity is insignificant. The real impact of temperature on banana is proved by the B values shown in the table. It tells that increase in temperature by one unit increases area under cultivation of banana by 1038 units, production by 63337 units and decreases the productivity by 1.2 units. Table 6 illustrates how far the fresh fruits have been affected by the variations in temperature in Kerala.

Table 6

Correlation and Regression result of the Impact of Temperature on Fresh Fruits in Kerala

Values	Area under cultivation	Production	Productivity
Correlation	0.568**	0.350	-0.063
R^2	0.323	0.122	0.004
F	13.344	3.903	0.111
P	0.001	0.053	0.741

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B	18982.827	60985.664	-0.038
Sig. at	0.001	0.053	0.741

Source: Computed data

** significant at one per cent level

As it is clear from table 6 that there is a positive correlation between temperature, area under cultivation and production of fresh fruits. For area under cultivation the correlation is significant which indicates that in case of the fresh fruits, temperature is necessary and thus it creates a positive impact. Temperature influences 32 per cent of the variations in area under cultivation and 12 per cent in production. But for productivity, temperature has no influence. The P value of the area under cultivation of fresh fruits is statistically significant, but for production and productivity it is insignificant. One unit increase in temperature increases 18982 units of area under cultivation and 60985 units of production of fresh fruits. The productivity is not influenced by temperature as again it is proved by the B value.

Tapioca is one of the important food crops of Kerala. Here, in table 7 the influence of temperature on tapioca is presented clearly.

Table 7

Correlation and Regression result of the Impact of Temperature on Tapioca in Kerala

Values	Area under cultivation	Production	Productivity
Correlation	-0.814**	0.093	0.825**
R^2	0.663	0.009	0.680
F	55.073	0.245	59.529
P	0.000	0.624	0.000
B	-21510.955	15460.139	6.950
Sig. at	0.000	0.624	0.000

Source: Computed data

** significant at one per cent level

In table 7 the correlation results indicate that increase in temperature decrease the area under cultivation of tapioca and increases its productivity significantly. It is because of the reason that tapioca is a less water intensive crop. The R square value of each of these variables indicates that 66 per cent of variations in area under cultivation and 68 per cent of the variations

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in productivity are due to the variations in temperature with significant P values. It is obvious from table 7 that one unit increase in temperature decreases 21510 units of area under cultivation and increases 15460 units of production and 6 units of productivity of tapioca. The impact of temperature on coconut is shown in table 8.

Table 8

Correlation and Regression result of the Impact of Temperature on Coconut in Kerala

Values	**Coconut area**	**Coconut Production**
Correlation	-0.642**	0.298
R^2	0.412	0.089
F	19.586	2.739
P	0.000	0.109
B	-40176.550	134.804
Sig. at	0.000	0.109

Source: Computed data

** significant at one per cent level

Table 8 explains that area under cultivation of coconut is negatively correlated with temperature and the value is significant at one per cent level. Here it is clear that increase in temperature tends to decrease the area under coconut. For production, the correlation is positive and not significant. The analysis shows no influence on the productivity of coconut. So it is omitted in table 8. The R square values make it clear that temperature contributes to 41 per cent of the variations in area under coconut and temperature has a meagre impact on its production. From the analysis a unit increase in temperature decreases 40176 units of coconut area and increases 134 units of the production of coconut.

Conclusion

The analysis made in this paper reveals that in Kerala raising temperature is the serious issue in recent days. The linear regression analysis and the correlation results confirms the real impact of temperature on the area under cultivation, production and productivity of the selected crops. The correlation shows that the impact of temperature is very severe on all the selected crops expect the production and productivity of fresh fruits and coconut and the production of tapioca. Temperature reduces the area under cultivation and production of the important food crops. Again, the regression analysis, explains a significant variation in the area, production and

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productivity of important food crops due to adverse impact of temperature. So rise in temperature in the recent days becomes a greater threat to food security in Kerala. It affects the availability of food. If the availability is affected, it leads to create adverse impact on the affordability of the food grains. At present in the Kerala state food security is under threat. The only way to protect food security is reducing the temperature by taking the climate change mitigation efforts. Otherwise in the near future Kerala state becomes food insecure.

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