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Impact Of Climate Change On Rice Production: Empirical Evidence From India

Mohd Fateh*[1], Dr. Shuchi Singhal[2], Mr. Amarjit Singh[3], Dr Siddarth Singh[4], Dr Sandeep Tiwari[5]
[1]Research Scholar, Department of Agricultural Economics and Business Management, Aligarh Muslim University Aligarh, Uttar Pradesh India, gh5529@myamu.ac.in, 0009-0000-6522-5604
[2]Assistant Professor, School of Management and Commerce, Manav Rachna University, Faridabad, India, Email; id goelshuchi7@gmail.com
[3]Assistant Professor, Department of Economics, Nitishwar Mahavidyalaya, Muzaffarpur (B. R. A. Bihar University, Muzaffarpur), India, amarjitsingheco@gmail.com
[4]Department of Economics DAV PG College Banaras Hindu University. Varanasi, India., siddharthvns19@gmail.com
[5]Department of Economics Arya Mahila PG College, Banaras Hindu University, Varanasi, India. sandeeptiwari6891@gmail.com

Abstract
This research investigates both the long and short-run dynamics between rice production and climatic factors—namely maximum, minimum, and mean temperatures, along with rainfall—using time-series data spanning 1991 to 2023 in India. Employing the Autoregressive Distributed Lag (ARDL) bounds testing framework to assess co-integration, the results confirm the existence of a long-term equilibrium relationship among the variables. The analysis reveals that rainfall exerts a significant influence on rice production: a 1 percent rise in rainfall is associated with a 1.58 percent increase in output, ceteris paribus. Considering the sensitivity of rice yields to temperature fluctuations and the growing risks posed by climate change, it is essential for agricultural researchers to focus on developing temperature-resilient rice varieties to sustain and enhance production levels.
Keyboard: *ARDL, Climate Change, Rice Production, Rainfall, Temperature*

1. INTRODUCTION-

Eradicating extreme poverty and hunger is the primary goal of the Millennium Development Goals established by the United Nations. Rice cultivation plays a significant role in reducing hunger and serves as the source of income for more than 120 million households. More than half of the population's food security depends on rice production, which is also reliant on rice distribution (Lanka, 2004). Climate change (CC) is the leading cause of rising global temperatures, increased emissions of carbon dioxide, nitrous oxide, and methane, as well as the deterioration of ecological assets. These changes result in alterations to temperature, rainfall, droughts, floods, and the degradation of land and water resources. The impact of CC may be harmful, neutral, or positive, depending on the region's geography (Kumar et al., 2021). Climate change presents a severe threat to all sectors of the economy, but it primarily affects the agricultural sector. Assessing the link between climate change and agriculture is crucial for addressing the needs of a rapidly increasing population and reducing hunger. However, climate change may decrease productivity and output in agricultural industries, particularly in low-latitude areas, which is a leading cause of reduced agricultural productivity (Vaghefi et al., 2016). Global temperatures rose above pre-industrial levels by 0.85 °C in the last century and are predicted to exceed 2 °C this century (RCP 8.5 scenario; IPCC, 2013). Higher temperatures and increasing rainfall variability will lead to decreased yields of crops such as maize, wheat, and rice. Rice is one of the most important crops grown and consumed in rainfed areas. Due to its dependence on climate, rainfed rice cultivation is vulnerable to changes in temperature and rainfall. Furthermore, rising temperatures can reduce plant transpiration rates, resulting in leaf rolling and drying, reduced leaf expansion rates, diminished plant biomass, solute immobilization, and increased heat stress on leaves (Singh et al., 2017). Rice is categorized as a C3 plant; higher CO_2 emissions suppress transpiration and enhance photosynthetic activity in C3 crops. These two factors contribute to an increase in rice crop production. However, when temperatures rise, the beneficial effects of CO_2 diminish. From 1950 to 1951, the area under rice cultivation was 668 million hectares, yielding 20.58 million tonnes of rice. Seven decades later, the area under rice cultivation has increased to approximately 2,424 million hectares, producing about 106.54 million tonnes of rice. This increase in agricultural production, particularly rice, is attributed to the Green Revolution that began in the late 1960s. Agricultural policies, expanded irrigation facilities, fertilizers, new seed varieties, and technological advancements have all contributed to enhanced crop yields. Moreover, the area under cultivation has also increased, leading to higher rice production (Kumar et al., 2021; Ansari, and Ansari, 2023). The coordinated efforts to improve rice production through scientific research and development in the 1970s and 1980s enabled global rice production to meet the demands of a growing population, create employment opportunities, increase the income of rice farmers, and enhance access to rice for impoverished populations living in urban centers worldwide. However, the gains made during the Green Revolution have begun to show diminishing returns in recent years. Since 2000, world rice production has been less than rice consumption, and the deficit has been addressed by drawing on rice from buffer stocks. Furthermore, 852 million people continue to suffer from hunger and malnutrition (FAO, 2004). This paper is structured into seven sections: the first provides the introduction, the second presents the review of literature, the third outlines the research methodology, the fourth discusses the results and their interpretation, the fifth offers the conclusion, the sixth puts forth suggestions, and the seventh highlights directions for future research.

2. REVIEW OF LITERATURE

The impact of climate change and ecological and carbon footprint on rice production in India from 1982–to 2016 by using a modified ordinary least square (FMOLS) model.Concluding, ecological footprint and carbon footprint spur long-term rice production(. While rainfall boosts rice crop productivity in the short term, it has a negative long-term impact. (Kumar et al., 2021). An increase in income is due to increased yield and reduced costs. This income is helpful for their farm business expansions and produces rice more sustainably. We need to grow cereals more sustainably, experience positive changes to their livelihoods and strengthen rural development through government involvement at the local and regional levels. (Connor et al., 2022) This study focused on rainfed areas to assess food security risks due to climate change. India is the largest rice producer country, where approximately 50% of rice is production comes under rainfed areas. The projected result shows that 15%–40% of rainfed rice cultivation areas are at risk in India's most eastern and northern parts. This study is useful for those areas where the food security and livelihood of marginal farmers are threatened by climate change. To promote the irrigation facilities and improved rice varieties should be used. (Singh et al., 2017) To analyze the effect of climate change on future rice production, self-sufficiency level of rice, and farmers' gross income in Malaysia. DSSAT model depicts that an increase in temperature and changes in rainfall trend leads to a decrease in the rice yield by 12 and 31.3% by 2030, reducing the income of farmers and their self-sufficiency level. The reduction in rice yield was expected to reduce farmers' gross income and the rice self-sufficiency level of the country. The government actions needed to change the policies. (Vaghefi et al., 2016) They observed that rice production is affected by many factors such as temperature, rainfall, farm size, educational knowledge, land area, and the value of labor input. The finding of this study shows that results showed that during the main season, there is an increasing net revenue by Ringgit Malaysia (RM 1= $0.3277) 4.78 per hectare due to rising temperature, whereas declining revenue by 1.01 due to rising rainfall. On the other hand, there is a declining net revenue of RM 3.02 per hectare due to rising temperature but increasing net revenue by RM 1.32 per hectare due to rising rainfall. To adopt seasonal preventive measurements to cope with climatic uncertainty and vulnerability. (Masud et al., 2014). Using pooled mean group technique to analyze the effects of climate change on rice production in 30 Chinese provinces from 1998-to 2017. To observe the relation between rice production and climatic variables by the Dumitrescu-Hurlin test. The result reveals that, in the long run, the average temperature will negatively affect rice production whereas average rainfall, Fertilizer usage, and the cultivated area will positively affect rice production. In the short run, moderate temperature and cultivated areas affect rice production while rainfall and fertilizers usage does not. They suggested that a new pricing policy and insurance policies for farmers should be implemented to enhance the income of marginal farmers. (Pickson et al., 2022) The above Empirical review depicts that climate change negatively affects Rice productivity in India. Most studies empirically analyzed the impact of climate change on rice production. based on temperature and rainfall only and restrained to one state or region. But assessing the overall effect of climate change on rice production is important because it plays a major role in food security. Many additional factors may affect the level of Rice

Production, including production of commercial crops, the income of the people, geographical region, availability of water, use of fertilizers, availability of labor, Cultivated area food grain market, soil moisture level, etc. Thus, climate change, agriculture productivity,food security, and poverty are directly linked to each other. The main research problem is to study the "the impact of climat change on rice production: evidence from india." This study offers several novel contributions to the existing literature on climate change and agricultural productivity in India. First, unlike many previous works that examine climatic variables in isolation, this research simultaneously evaluates the combined effects of rainfall variability, minimum temperature, maximum temperature, and mean temperature on rice production, providing a more comprehensive assessment of climate–agriculture interactions. Second, by using empirical evidence specifically for India, the study addresses a critical gap in country-level analyses where regional climatic diversity and dependence on rice cultivation are particularly pronounced. Third, the study employs robust econometric techniques to capture both the short-run and long-run impacts of climatic changes, thereby enhancing the reliability of the results compared to traditional correlation-based studies. Finally, this research contributes novel insights to policymakers by quantifying the relative importance of different climatic factors, offering a clearer direction for climate-resilient agricultural strategies in India's rice sector

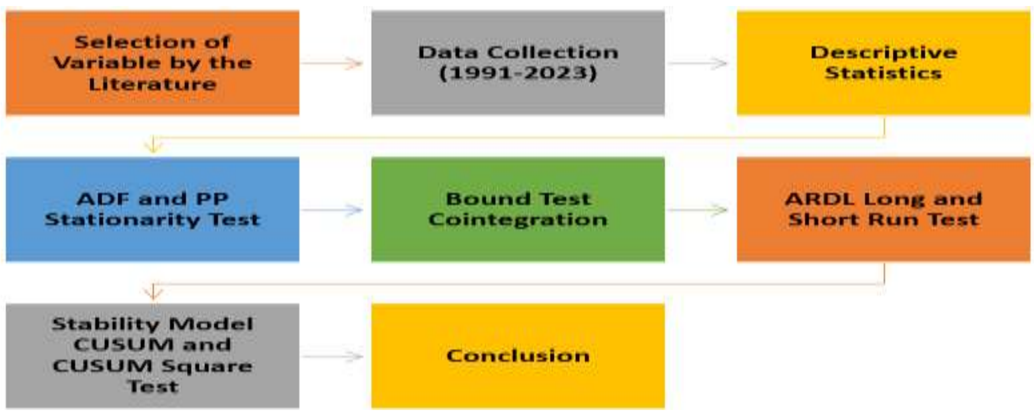

Fig. 1, Framework of the study

3. RESEARCH METHODOLOGY:

The research methodology represents the theoretical framework that guides the identification and selection of variables, as well as the collection of relevant data for the study. It enables the researcher to critically evaluate the overall reliability, validity, and effectiveness of the investigation. Methodological procedures typically involve defining the research problem, gathering data, and employing tools such as surveys, interviews, and other appropriate techniques.

In this study, secondary data has been utilized. The required information was obtained from reliable sources including the *World Development Indicators (WDI)*, the *Indian Economic Survey*, and the *Handbook of Statistics*. The analysis covers a period of 32 years, spanning from 1991 to 2023.

Selected Variables and their definitions

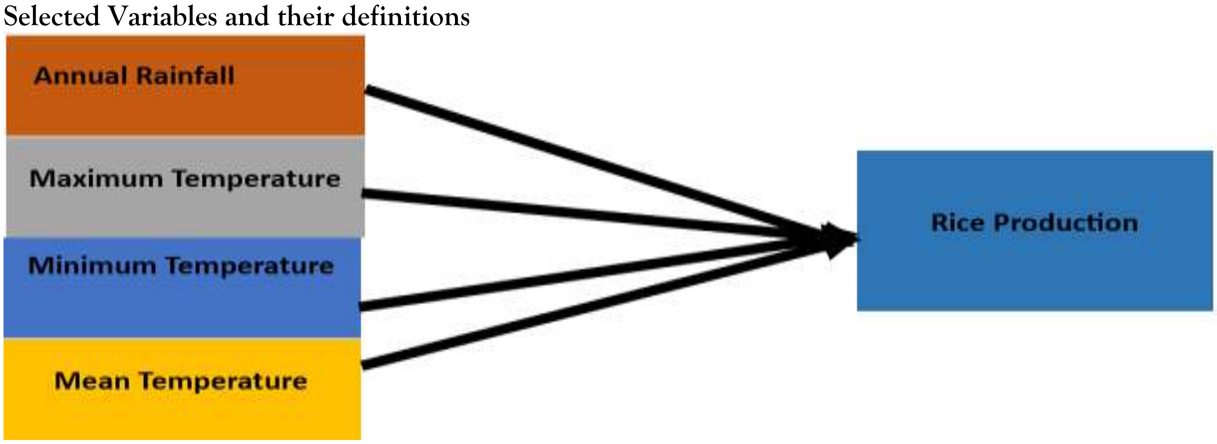

Figure 2, Dependent and independent variable of the study

Table 1: Variable names and description

Symbol	Variable Name	Measurement Unit	Source
RP	Rice production	Rice production (Thousand tonne)	RBI
RF	Rainfall	Rainfall (MM)	RBI
MNT	Minimum temperature	Minimum temperature (Kelvin)	IMD
MXT	Maximum temperature	Maximum Temperature (Kelvin)	IMD
Mean	Mean temperature	Maximum Temperature (Kelvin)	IMD

Sources; RBI Handbook, IMD

Hypothesis Formulation

H0 = climatic change has no positive relationship with rice production india.
H1 = climatic change has positive relationship with rice production india.

Econometric Model:

In order to describe the relationship between rice production, rainfall, maximum temperature, minimum temperature, and mean temperature this study uses the following equation,

$$LNRP_t = \alpha + \beta_1 LNRF_t + \beta_2 LNMINT_t + \beta_3 LNMAXT_t + \beta_4 LNMEANT\varepsilon_t \quad (1)$$

In this specified model, LNRP represents the natural logarithm of the dependent variable, while LNRF, LNMNT, LNMXT and LNMEANT represent the natural logarithms of rainfall, minimum temperature, and maximum temperature respectively. The coefficients α, β_1, β_2, $\beta_3$and $\beta 4$ represent the constant and different elasticities, and ε_t denotes the error terms.

To test for unit roots, the Augmented Dickey–Fuller (ADF) test and Phillips–Perron (PP) test are conducted separately, incorporating intercept and trend. The lag length selection is determined using the Schwarz information criteria (SIC), with lag lengths of 1 and 3 considered appropriate. The ADF test addresses serial correlation in the error term by including the lagged difference of the dependent variable. The ADF unit root equation is expressed in (2), while the formula for the Phillips–Perron unit root test is provided in (3).

$$\Delta Yt = \alpha Y_{t-1} + x_t^l \delta + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_p Y_{t-p} + V \ldots\ldots\ldots_t (2)$$

$$t_\propto = t_\propto \left(\frac{y_0}{t_0}\right)^{1/2} - \frac{T(t_0 - y_0)(Se(\propto)}{2f_0^{1/2} S} \quad (3)$$

The equation employed for ARDL bounds testing in the model, as outlined by Ali, et., al., 2022: Ansari et al. (2022, 2023; 2024; 2024; 2025)), and Khan et al. (2024), is denoted as Equation (4).

$$\Delta LNRP_t = \gamma_0 + \sum_{i=1}^{n} \gamma_{1i}\, LNRP_{t-1} + \sum_{i=1}^{n} \gamma_{1i}\, LNMINT_{t-1} + \sum_{i=1}^{n} \gamma_{1i}\, LNMAXT_{t-1} + \sum_{i=1}^{n} \gamma_{1i}\, LNMEAT_{t-1} + \varepsilon_t \ldots\ldots (4)$$

The long-run ARDL model to be estimated is presented in Equation (5).

$$\Delta LNRP = \beta_0 + \sum_{i=1}^{q} \omega_1\, LNRP_{t-1} + \sum_{i=1}^{q} \omega_2\, LNMINT_{t-1} + \sum_{i=1}^{q} \omega_3\, LNMAXT_{t-1} + \sum_{i=1}^{n} \omega_4\, LNMEANT_{t-1} + \varepsilon_t \ldots\ldots (5)$$

In Equation (5), ω represents the long-run variance of variables. The short-run ARDL model incorporating the error correction term is expressed as follows:

$$\Delta LNRP_t = \beta_0 + \sum_{i=1}^{q} \pi_1 \Delta LNLNRP_{t-1} + \sum_{i=1}^{q} \pi_2 \Delta LNMINT_{t-1} + \sum_{i=1}^{q} \pi_3 \Delta LNMAXT_{t-1} + \sum_{i=1}^{q} \pi_4 \Delta LNMEANT_{t-1} + ECT_{t-1} + \varepsilon_t \ldots\ldots\ldots (6)$$

In Equation (6), π represents the short-run variability of the variables, while ECT denotes the error correction term, indicating the speed of adjustment to disequilibrium. The Error Correction Term (ECT) was estimated with a coefficient ranging between -1 and 0. Explanatory variables' impact on dependent variables was assessed through graphical analysis. Diagnostic tests were conducted to assess model stability, including the Breusch–Godfrey LM test for serial correlation, the Breusch–Pagan–Godfrey test and ARCH test for heteroscedasticity, the Ramsey RESET test for correct specification, and the Jarque–Bera test for evaluating the normal distribution of residuals. Structural stability was examined using two approaches: cumulative sums of recursive residuals (CUSUM) and cumulative sums of squares of recursive residuals (CUSUMSQ).

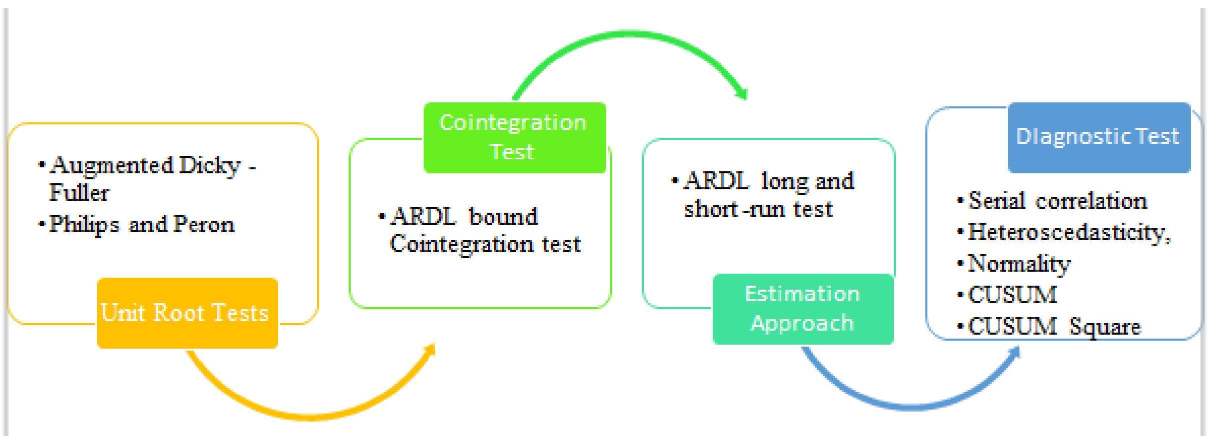

Figure 3, Framework Research Methodology

4. RESULT AND DISCUSSION

5. Table 1: RADAR Descriptive Statistics

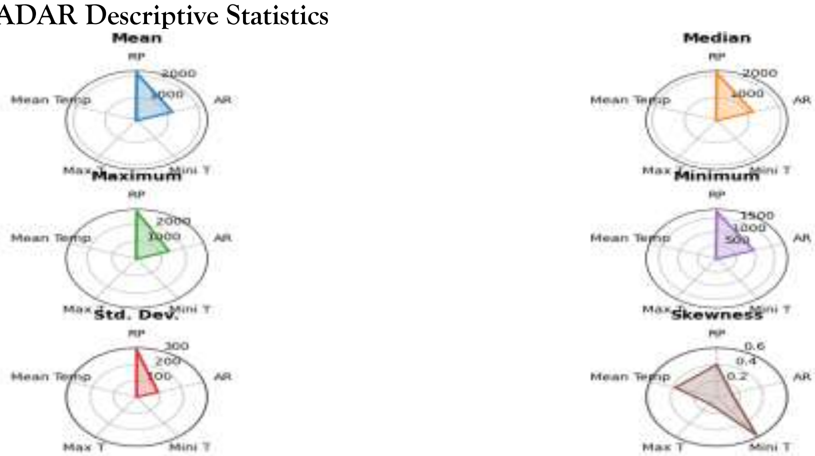

figure 4, Calculated by Author through python Software

Figure, 4 The descriptive statistics indicates about median, mean, minimum, maximum, skewness standard deviation, kurtosis and jarque-bera and the probability. Time series data consist of 30 years of annual observations from 1991 to 2023. This data shows that the average production of is 2125.8. with std. deviation of 289.54 The average rainfall (RAN) rate is 1190.47 with the std. deviation of 96.16. The average or mean value for Minimum Temprature (MIN) is 19.18 with the std. deviation of 0.40. The mean value for Maximum Temprature (MAX) is 29.67 with the std. deviation of 0. 35. and the mean value of mean temperature is

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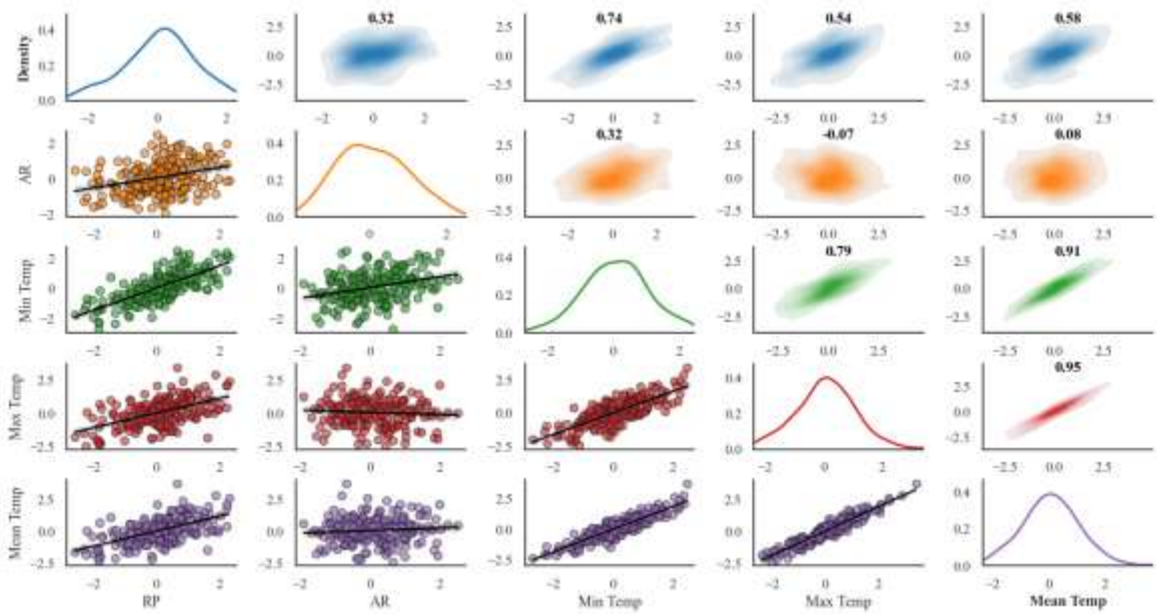
24.13 with the std. deviation of 0.30 All the variables include Rice, Rainfall, min, max and mean temprature are positively skewed. Kurtosis statistic of the variables indicate that rice, rainfall, minimum and mean are platykurtic (lower peak or short tailed) because their value is less than 3. Variables include maximum temperature is Laptokurtic (long tailed or high peak) because their value is greater than 3. The results indicate that Jarque-Bera P (Probability) value of rice is 0.37 that is greater than 10%, therefore, we accept the null hypothesis means data is normally distributed. Jarque-Bera P value of rainfall is 0.85 that is greater than 10%, we accept the null hypothesis as its means data is normally distributed. Therefore, Jarque-Bera P value of all the others variables are greater than 10%, we accept the null hypothesis because the data are normally distributed.

Table 2: Results of Correlation Matrix



Calculated by through Pythone

Table, 2 All the variables are significantly correlated with Rice production. rainfall, minimum tem, maximum temp and mean temp are positively correlated withrice production. The same variables rainfall and rainfall, minimum tem and minimum temp, maximum tempratur and max tem and mean tem. are fully depending on each other. The association between rice production and rainfall is positive 0.35 because r > |0.30|. Degree of association between minimum temprature and rainfall is 0.36 and correlation is moderate because |0.30| < r < |0.70|. Degree of association between rice and mean temperature is 0.55 that shows correlation between them is high.

Table 3: Results of ADF Unit root test

Variable	Level		1st difference		2nd Difference		
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	Intercept	Trend & Intercept	Decision
Rice	0.55	-4.12	-10.3	-10.37	-5.35	-5.13	
	-0.98	-0.01	0	0	0	0	I(0)
Annual Rainfall	-4.66	-4.3	-7.38	-7.21	-7.47	-7.74	
	0	-0.013	0	0	0	0	I(0)
Minimum Temprature	-2.13	-4.47	-6.05	-5.92	-7.63	-7.49	
	-0.23	0	0	0	0	0	I(0)
	-3.1	-3.95	-7.26	-4.4	-5.02	-4.85	

Maximum Temprature	-0.37	-0.02	0	-0.01	0	0	I(1)
Mean Temprature	-2.97	-4.19	-6.54	-6.44	-7.7	-7.6	
	-0.04	-0.01	0	0	0	0	I(0)

Calculated by through Eviews

Table 3 show that the stationary and non-stationary of the individual variables. The stationary of time series data is compulsory for averting spurious regression analysis because it is impracticable to get good results and making predicting with a non-stationary series. Augmented Dickey-Fuller test showed that some variables are stationary at level and other variables are stationary at 1st difference. This results in indicates that Rice is integrated at 1st difference and the t-statistic value is-10.30 with 0.00 probability value. The maximum temprature is also stationary at 1st difference with the t-statistic value is -7.26 with probability value is 0.00. The annual rainfall is integrated at level with the t-statistic value is -4.66 with 0.00 probability value. The minimum temprature is stationary at level with the t-statistic value is -4.47 with the probability value is 0.00. The mean temprature is stationary at level where the t-statistics value is -4.19 with the probability value is 0.00. Time series analysis shows that all the variables are integrated at different orders thus there is no co-integration exists among variables and we can use ARDL model.

Table 4: Results of Bound Test

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.23	10%	2.2	3.09
k	4	5%	2.56	3.49

The above table shows the critical values of the upper and lower-bound I(1) and I(0) respectively. The observed F-Statistic value is 5.23 that is greater than the upper-bound of F-Statistics we reject null hypothesis and accept alternative hypothesis, which describes that there is long run association among the variables

Table 5 Results of long-run relationship between variables

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
RF	1.585	0.66	2.403	0.027
Min. Tem	16.00.	3.75	4.625	0.00
Max. Tem	20.17	5.24	3.708	0.002
Mean Tem	-36.51	9.43	-3.895	0.001
C	-21.94	46.8	-0.47	0.644

Author's calculation through Eviews

Table 5 shows the results of ARDL model which indicate that the co-efficient value of rainfall in the long run is insignificant. It reflects positive association with rice production rate, meaning if one-unit increase in rainfall rate the rice production rate will likely to rise by 1.58 percent. The co-efficient value of minimum temperature is statistically significant and positively related to rice production in the long run. The reason for significant and positive relation in the long run is that the use of HYV, Irrigation and use of modern technology uses .therefore, there is the negative affect of mean temprature on rice. The co-efficient value of maximum temprature in the long run is positive and statistically significant.

Table 6: Results of ECM

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(RF)	0.09	0.24	0.37	0.71
D(Min Tem)	517.09	250.09	2.07	0.05
D(Max. Tem)	460.23	225.45	2.04	0.06

D(Mean Tem)	-933.96	436.47	-2.14	0.05
CointEq(-1)*	-0.6	0.12	-4.95	0

R-squared	0.726692	Mean dependent var	43.86207S
Adjusted R-squared	0.747808	S.D. dependent var	116.4035
S.E. of regression	86.49898	Akaike info criterion	11.91373
Sum squared resid	179569.8	Schwarz criterion	12.14947
Log likelihood	-167.7491	Hannan-Quinn criter.	11.98756
Durbin-Watson stat	2.372359		

The above table shows that rice production is the most important variable in the long run and short-run. The value of ECM co-efficient is -0.60 which is negative and significant. This negative and significant coefficient of error correction model indicates the presence of long-run causal relationship. The value of ECM indicates the speed of adjustment from disequilibrium to equilibrium. The value of adjusted R^2 is 0.52 which reveals that there is 52% variation in rice (Dependent variable) due to the change in independent variables. The probability of F-statistic is also statistically significant at 5% level of significance, which justify that the model is goodness of fit.

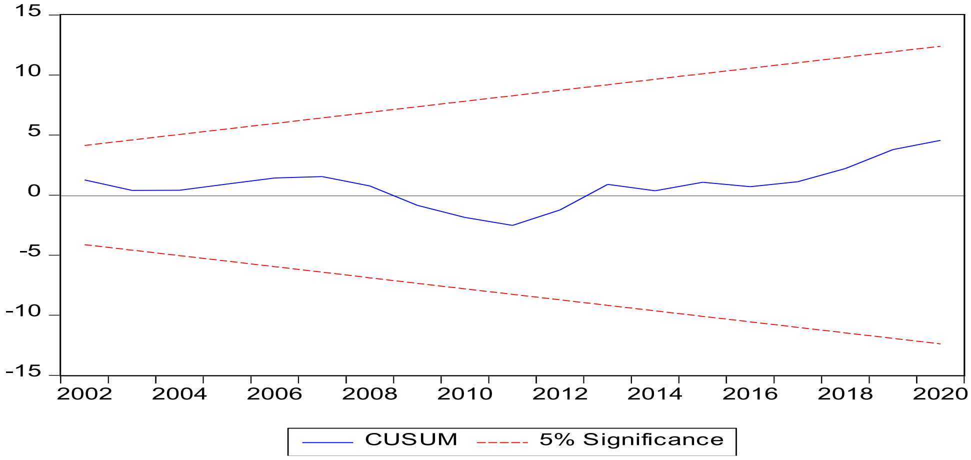
Table 7, Diagnostic test

Diagonastic test	F- statistics	P-value
Breusch-Godfrey Serial Correlation LM Test:	0.25	0.86
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.45	0.30
Normality test	0.37	0.13

Sources; Authors Calculations

Table 7 presents the results of diagnostic tests conducted to identify potential issues in the residuals of the regression model. Specifically, the test checks for serial correlation, that is, whether residuals from one observation are related to those from another. The reported F-statistic is 0.25 with a corresponding p-value of 0.86. Since the p-value is higher than the standard 0.05 threshold, the null hypothesis cannot be rejected, indicating no evidence of serial correlation among the residuals. The test further assesses the homoscedasticity assumption, which refers to the constancy of residual variance across observations. The F-statistic is 0.45 with a p-value of 0.30. As this p-value also exceeds 0.05, the null hypothesis is not rejected, suggesting that the model does not suffer from heteroskedasticity. Additionally, the normality of residuals is examined, which is essential for ensuring valid statistical inference. The test statistic is 0.37 with a p-value of 0.13. Again, since the p-value is greater than 0.05, the null hypothesis is upheld, implying no significant departure from normality. Taken together, the three diagnostic tests confirm that the model satisfies the key assumptions of regression analysis. The absence of serial correlation, heteroskedasticity, and non-normality in the residuals strengthens the credibility and reliability of the study's empirical results.

Stability of the Model: Cumulative sum of recursive residuals (CUSUM) tells about the stability of the model with respect to short-run and long-run relationship between variables. The graph of cumulative sum of recursive residuals is given below



Source: Author's calculation through Eviews

CUSUM Test takes the time series on horizontal axis and residual along vertical axis to check the stability of the model. Figure1 shows that CUSUM is within the range 5% critical lines. This critical boundary is not crossed by the graph. So, we can conclude that the model is stable and there is no major gap. This correct specification model accepts the null hypothesis at the 5% significance level.

6. CONCLUSION:

We discuss the impact of explanatory variables on rice production. The results of ARDL model shows that all the independent variables include minimum tempratur, maximum tempratur and rainfall in the long run as well as in the short-run are significantly and positive related with the rice production in india except mean that has negative effect on rice production. In the study, the value of R-square shows Independent variable has significant impact on dependent variable and the model of the study is goodness of fit. India is an agricultural country, so rice production is vital the economic development in india. Increased in rice production not only fulfills domestic needs but it also creates surplus goods for exports and earn hard needed foreign exchange. The advancement in agriculture sector and the better use of land resources are essential for reducing food scarcity and poverty. The results of our research show the negative affect of mean temperature on rice production in india. Due to low irrigation and existence of feudalism in our country, majority of farmers are poor and incapable to purchase quality seeds, advanced
machineries and high quality fertilizer to make effective use of their soil. Mean temprature is adversely affecting therice production, which ultimately leads to the negative effect on the economic growth of agro-based country like india. Thus, it is focusing more on the advancement of industrial sector than agricultural. As more investments are being made on the formation of infrastructures relating to trade sector, transport sector and education sector, but small resources have always been allocated to the projects related to rice production.

7. SUGUESSTION & POLICY RECOMMENDATIONS:

Research on sustainable agricultural development reveals opportunities to investigate the long-term link between climate change and agriculture. With a agro economy, as well as cereal production Rice grows in a broad range of climates. The cultivation conditions vary widely. Moreover, increased productivity, improved grain quality, and increased stress Grain production must prioritise resistance. everywhere. Increasing Adaptation Strategies Rice productivity will increase in future circumstances. to combine these rice properties in one ultimate goal Improving Rice Quality Without Using Chemicals High yield and pest resistance may have to be sacrificed. constitute a significant challenge for scientists
We would like to make the following recommendations: -

1 Government of india should discourage the existence of feudalism and should provide subsidies to the poor farmers that would be helpful for them to purchase fertilizers, equipment and quality seeds.
2 Government should make more investment in the infrastructures relating to agricultural sector that may enhance economic growth.
3 The government should make investment in the development of dams to create water reservoirs in order to reduce shortage irrigated water.
4 India's government should increase Employment labour force by improving the quality of education in agriculture sector and industrial sector also.
5 The government of india should invest and use modern technology to overwhelm the issue of agriculture.
6 Government should develop and expand irrigation system to deliver water at tail end.

8. STUDY LIMITATIONS AND FUTURE WORK

Other rice production-related factors, such as land area and production-related variables that have been proven as important explanatory variables of rice yield in earlier research, can be incorporated in subsequent econometric analysis. Furthermore, the extension would be affected by other factors such as soil type, soil quality, farm management, and scale/area of operation. With such factors included, it is possible to clearly separate the impacts of each of these variables on rice production and calculate the individual elasticities with maximum and lowest temperatures and rainfall. While gathering data for such factors in india is difficult, such a research would be new in that it would be the first of its sort for a mountainous nation like india.

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