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# Impact of climate variability on rice production – A case study of Nalleppilly grama panchayath in Palakkad district, Kerala



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**Abstract**

*Climate is a long term average weather conditions in a place which exercise some controls and effects on agricultural produce either directly or indirectly. Agriculture being one of the most vulnerable sectors to climate change. Actionaid (2009) confirmed that agriculture contributes to and suffer from negative effects of climate change. This is because farming accounts for 32 percent of greenhouse gas emissions if deforestation is included. The future event of climate change predicts adverse environmental and socioeconomic impact in fishing and forestry sectors, loss of livelihood, food insecurity and diminished supplies; and heightened incidence of certain diseases and pest on people, animals and plants consequences including frequency and intensity of heat waves, droughts, floods and typhoons; altered ecosystem; reduced output and productivity of the agriculture. With the world's population set to reach 9 billion by 2050, agricultural production will need to increase by 60 percent just to meet the growing demand. Over the same period climate change, water scarcity and land degradation could reduce food production by one quarter, leading to further increases in the number of people suffering from hunger. The mean temperature in India is projected*

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*to increase by 0.1–0.3 oC in kharif and 0.3–0.7 oC during Rabi by 2010 and by 0.4–2.0 oC during kharif and to 1.1–4.5 oC in Rabi by 2070. Similarly, mean rainfall is projected not to change by 2010, but to increase by up to 10 percent during kharif and Rabi by 2070. At the same time, there is an increased possibility of climate extremes, such as the timing of onset of monsoon, intensities and frequencies of drought and floods. Variation in atmospheric temperature by 1-2 0 C may lead to 10-20 percent reduction in the yield of rice which is a very serious issue to be taken care of in the district of Palakkad .This paper focuses the impact of climate variability in the district of Palakkad. For the analysis the study utilized two seasons (autumn and winter) agricultural data and climate data. An econometric method of multiple regression analysis is used to find out the impact.*

## I. INRODUCTION

The topic of climate change and variability has received focussed attention in recent years from the international community. There is now incontrovertible evidence that the world's climate has been undergoing change due to global warming resulting from decades of fossil fuels powered economic development which left behind long-lasting green house gases into the atmosphere. Over the past 50 years, nine out of ten natural disasters around the world have been caused by extreme weather and climate events. Storms, floods, droughts, heat waves, dust storms, wild-fires and other natural hazards threaten the lives and livelihoods of millions of people worldwide. Climate models suggest that several weather extremes are likely to increase in frequency and intensity. Floods, storm surges and tropical cyclones could force many people to relocate. Communities exposed to the greatest risk from climate change are mainly living in developing and least developed countries .Godfray et al. (2010) put across four important factors to be considered while formulating policies for designing food production system between now and 2050:factors affecting the demand for food (population growth, changes in consumption patterns, the effects on the food system of urbanization and the importance of income distributions); trends in future food supply (crops, livestock, fisheries and aquaculture, and 'wild food'); exogenous factors affecting the food system (climate change, competition for water, energy and land, and how agriculture depends on and provides ecosystem services) and cross-cutting themes (food system economics, food wastage and links with health).The state of Kerala has about 300,000 rice growers, mostly small and marginal farmers with their average land holding below 0.4 ha—one-fifth the national average. Cultivable land in Kerala got fragmented into small holdings when the state government implemented land reforms Act between 1967 and 1982 to distribute agricultural land to the landless. The Act fixed a limit of 6 ha on farms. Since 1970s, the state has witnessed a steady decline in the area under paddy. In the last four decades, rice fields have reduced by 76 per cent from 875,000 ha in 1970 to 208,000 ha in 2012(economic review 2013).Palakkad District is one of the 14 districts of the Indian state of Kerala. The city of Palakkad is the district headquarters. Palakkad is bordered on the northwest by Malappuram, on the southwest by Thrissur and on the east by Coimbatore district of Tamilnadu. The district is 24.4 percent urbanised according to the census of 2011. Palakkad, the rice granary of Kerala, has about 83,000 ha under paddy cultivation, accounting for 40 per cent of the state's total paddy area (census 2011). The district, along with Kuttanad region in Alappuzha and the coastal areas of Thrissur district, is the main rice producing region. Palakkad has 12 dams constructed exclusively for irrigating paddy fields. The average yield in the district is 4-5 tonnes per ha, higher than the state average of 2.7 tonnes. But rice in Palakkad faces stiff competition from crops like banana, ginger, rubber, coconut and mango. The climate is pleasant for most part of the year; exception is on the summer months. There is sufficient rainfall and it receives more rainfall than the extreme southern districts of Kerala.

## II. IMPORTANCE

Agriculture contributes about 28 per cent of Gross Domestic Product (GDP) in Least Developed Countries (LDCs) on average, compared to around 10 per cent in middle-income countries. In some LDCs, agriculture contributes as much as 57 per cent of GDP and provides employment for a larger proportion of the workforce than in more developed countries. In general, the contribution of agriculture to GDP and employment in national economies declines as countries develop. The forthcoming Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) – which will include a dedicated chapter on food security and food production – will summarize state of the art knowledge on the impacts of climate change, and is expected to emphasize even more strongly than before the effects of climate change on farmers' livelihoods and food security studies that assessed the climate impacts on different crops and suggests that in Africa and South Asia crop yields may decline by 8 per cent by the 2050s.In LDCs, cassava, maize and rice account for about 60 per cent of food production. In Africa, climate change is expected to decrease maize yields by 5 per cent, but no mean change was identified for rice, while results for cassava are inconclusive. Yields of other major crops (such as sorghum and millet) are expected to decline significantly. Extreme climate events, such as droughts, extreme heat and floods also have severe impacts on agriculture. Of 24 countries identified as highly exposed to these climate hazards and also having high numbers or proportions of poor people, are LDCs.

## III. THEORETICAL APPROACH

Ricardian model was developed to solve this problem (Mendelsohn, Nordhaus, and Shaw, 1994). This model assesses the economic impact of climate change by estimating the current value of farmland price as the discounted value of future rent. Basically, it assumes that, in a long-term balanced state in which all production elements that change along with climate change, farmland price represents the quasi-rent which is the profit from utilizing the farmland. The Ricardian model has an advantage with regard to climate change impact assessment as it can include adaptation that cannot be accurately measured or identified. It measures the change in farmland value or revenue by taking into consideration both direct impacts, such as change in crop productivity due to climate change and indirect impacts, such as replacement effect of input production factors and change in farmland utilization, so that it is widely used for analyzing the economic impact of climate change (Kim Chang-gil and *et al*, 2008).

## IV. REVIEW OF LITERATURE

Increasing $CO_2$ concentrations in the atmosphere has a positive effect on crop biomass production, but its net effect on rice yield depends on possible yield reductions associated with increasing temperature. For every 75 ppm increase in $CO_2$ concentration rice yields will increase by 0.5 t ha-1, but yield will decrease by 0.6 t ha-1 for every 1 $^0$C increase in temperature (Sheehy et al., 2005). In a separate study, the simulated yield reduction from a 1ºC rise in mean daily temperature varied from 5-7 percent for major crops, including rice (Matthews et al., 1997). The yield reduction was mostly associated with decrease in sink formation, shortening of growth duration and increase in maintenance respiration (Matthews and Wassmann, 2003). Enclosure studies with $CO_2$ enrichment have generally shown significant increases in rice biomass (25-40 percent) and yields (15-39 percent) at ambient temperature, but those increases tended to be offset when temperature was increased along with rising $CO_2$ (Ziska et al., 1996a,b; Moya et al., 1998). Yield losses caused by concurrent increases in $CO_2$ and temperature are primarily caused by high temperature-induced spikelet sterility (Matsui et al., 1997a), but there is a lack of more detailed studies on $CO_2 \times$ temperature response curves. Increased $CO_2$ levels may also cause a direct inhibition of maintenance respiration at night temperatures higher than 21°C (Baker et al., 2000). Rice response to elevated $CO_2$ also depends on nitrogen supply. If additional $CO_2$ is given when N is limited, lack of sinks for excess carbon (e.g. tillers) may limit the photosynthetic and growth response (Ziska et al., 1996b). There is evidence for genotypic variation in response to increasing $CO_2$ and temperature (Ziska and Teramura, 1992; Ziskaetal., 1996a; Moya et al., 1998), but as of now genes, traits or mechanisms associated with this have not yet been identified. The magnitude of the $CO_2$ fertilization effect remains under debate. More recent measurements using large, free-air $CO_2$ enrichment (FACE) systems have generally found that stimulation of crop yield was smaller than reported from enclosure studies and that acclimation of photosynthesis occurs because crops attempt to maintain balance in N and other resources (Ainsworth and Long, 2005). In a large-scale FACE system dedicated to investigation of rice, located in northern Japan, yield increases due to elevated $CO_2$ (+200 ppm) averaged 7 to 15percent over three years (Kim et al., 2003). There is a lack of FACE studies for measuring $CO_2$ response curves across a wider range of elevated $CO_2$ concentrations under field conditions, which is required for more accurate scaling of physiological results and validation of crop models (Ainsworth and Long, 2005).The simulated yield reduction from a 1 $^0$C rise in mean daily temperature was about 5-7 percent for major crops, including rice (Matthews et al., 1997). The yield reduction is mostly associated

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with decrease in sink formation, shortening of growth duration and increase in maintenance respiration (Matthews and Wassmann, 2003). In addition to quantitative effects on yields, high $CO_2$ levels and temperatures will also affect grain quality, although the impact pathways are not yet clear. One characteristic of poor grain quality is high chalk content mainly because chalky grains break during milling and thus, decrease the yield of edible rice. Rice grown in a glasshouse at 38/21 $^0$C contained more chalky grains than rice grown at 26/15 $^0$ C (Lisle et al., 2000). In another experiment, either higher daytime or higher night time temperature alone increased the percentage of damaged rice grains (Morita et al., 2002). Filed observations in Japan indicated detrimentally affects of high temperature episodes on the grain quality of some varieties (Kobayashi et al., 2007) Changes in monthly temperature, precipitation and potential evapo-transpiration affect output. To study these changes applied it to the observed historical baseline daily time series. The study states changes in temperatures by the 2050s as winter temperature rises by 2$^0$c in the South east of Britain and by around 0.8 $^0$c in the north of it. In summer the range is between 1.8$^0$c and 1.2$^0$c. The increased temperature in the north is lower than the south. The rainfall reduction in summer is approximately 10 percent. These would affect the agricultural production in Great Britain. Climate models have predicted larger temperature rises in temperate regions than in tropical regions. In humid sub region, annual rainfall is often above 2000mm and occurs year round. In the drier tropics, rainfall tends to be seasonal and its total may not exceed 500mm. Agriculture is frequently limited by the seasonal pattern of moisture availability. Precipitation here occurs primarily along front of cyclonic storms, although convective storms occur in the summer season. The temperate region also has many different climate sub-regions with warmer and cooler temperature, characterized by seasonal patterns of rainfall. Crop growth is often limited during the cooler season (NigelArnell1996).

## V. OBJECTIVES

- To examine the variation in rice production due to variation in climatic factors
- To compare the level of profitability of paddy in autumn and winter season agriculture
- To examine how far the climate variables influence the expenditure on paddy cultivation.

## VI. RESEARCH METHOD

In order to study the climate variability on agricultural production a field survey was conducted among the 50 paddy farmers in Nalleppilly Grama Panchayat in Chittur block in Palakkad district, Kerala. Purposive sampling technique was used to select 50 farmers. Reason for selecting this particular area is that Palakkad is one of the district which is severely affected through the climate variability and this effect is so severe in Nalleppilly Panchayath. This panchayath is agricultural oriented primarily paddy is the important

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crop. The period of study includes Autumn(2012) and Winter(2013) seasons. A questionnaire is prepared to collect the necessary data. Data for temperature, rainfall and humidity has been taken from IRTC Mundur, Palakkad the study.

## VII. SOCIO-ECONOMIC ANALYSIS OF FARMERS

From the field analysis it was found that the farmers were included in low income category, that is majority of farmers were included in the monthly income group of 10000-15000 category. Majority farmers were illiterate but they have good practical knowledge about the agricultural practices .the table shows the acres of land hold by the farmers in the study area. The table reveals that most of the farmers hold 0-2 acres of land so majority farmers are marginal farmers.

## VIII. PRIMARY DATA ANALYSIS

While looking the acres of land hold by the sample farmers in this panchayath, most of the paddy farmers were ie, 30 farmers were holding an acres of land with the range of 0-2. 17 farmers were holding 2-4 acres, only 1 farmer was having acres of 4-6 and 2 farmers have 2 acres of land. Therefore most of them were small farmers. The table 1 showed this.

**Table 1: Acres of Land Hold by Sample Households**

| Acres of Land | No.of Household |
|---|---|
| 0-2 | 30 |
| 2-4 | 17 |
| 4-6 | 1 |
| 6-8 | 2 |

***Sourc: Primary Data***

The study period was during autumn (2012) and winter (2013).In order to find out the variation in production due to climate variability a descriptive statistics was carried out. The analysis shows the mean temperature, mean rainfall, mean humidity and mean production in both seasons .The table 1 shows the result of the analysis in autumn 2012.

**Table 2: Minimum, Maximum, Mean and Std.deviation during autumn (2012)**

| Variables | Minimum | Maximum | Mean | Std.Deviation |
|---|---|---|---|---|
| Temperature(in $^0$C) | 33.61 | 37.89 | 35.84 | 1.878 |
| Rainfall (in mm) | .00 | 4.52 | 1.61 | 1.870 |
| Humidity(in percentage) | 78.07 | 84.13 | 81.58 | 2.189 |
| Production(in tonnes) | 45765.96 | 45765.96 | 45765.96 | .00 |

***Source: Calculation based on climate data and primary data***

The minimum and maximum and mean temperature during this season were 33.61$^0$ C, 37.89 $^0$Cand 35.84$^0$ C. Maximum and mean humidity during this season

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were78.07percent, 84.13 percent and 81.58 percent and mean production was 45765.96 tonnes.

**Table 3: Mean temperature, Rainfall, Humidity and Production in winter season 2013.**

| Variables | Minimum | Maximum | Mean | Std.deviation |
|---|---|---|---|---|
| Temperature (in $^0$C) | 27.61 | 32.68 | 30.34 | 2.03 |
| Rainfall(in mm) | 6.48 | 24.05 | 14.19 | 7.61 |
| Humidity(in percentage) | 84.41 | 90.00 | 87.22 | 2.39 |
| Production (in tonnes) | 60553.19 | 60553.19 | 60553.19 | .00 |

***Source: Calculation based on primary data, climate data***

The table shows the minimum, maximum and mean temperature during this season were27.61$^0$ C, 32.68$^0$C and 30.34$^0$C. The minimum, maximum and mean rainfall was 6.48 mm, 24.05mm and 14.19m m .The minimum, maximum and mean humidity was 84.41 percent, 90.00 percent and 87.22percent The mean production is 60553.19 tonnes. While comparing the productions in two seasons, the mean temperature was lower but rainfall and humidity were higher in winter 2013 therefore mean production was higher in this period than autumn in 2012. This states that a favourable climate is necessary for better production and productivity. In order to find out the average revenue and cost in both the seasons a frequency table was calculated

**Table 4: Frequency table showing AR, AC during autumn 2012**

| Acres Of Land | No. Of Household | Revenue(in Rs) | Cost(in Rs) |
|---|---|---|---|
| 0-2 | 30 | 558000 | 620000 |
| 2-4 | 17 | 400275 | 430567 |
| 4-6 | 1 | 50000 | 450000 |
| 6-8 | 2 | 100000 | 334433 |
| Total | 50 | 11,08,275 | 18,35,000 |
| Average | | 22165.5 | 36700 |

***Source: Primary Data***

**Table 5: Frequency table showing AR, AC during winter 2013**

| Acres Of Land | No.of Household | Revenue(in Rs) | Cost(in Rs) |
|---|---|---|---|
| 0-2 | 30 | 1500000 | 407896 |
| 2-4 | 17 | 1100000 | 300000 |
| 4-6 | 1 | 146000 | 50000 |
| 6-8 | 2 | 100000 | 87204 |
| Total | 50 | 28,46,000 | 8,45,100 |
| Average | | 56920 | 16902 |

***Source: Primary data***

To find out the average profit level for these two periods, the following equation was utilised

Average Profit = AR- AC

Where, AR= Average revenue earned from production

AC =Average expenditure incurred for production

A) 22165.5-36700 = -14534.5(autumn)
B) 56920 -16902 = 40018(winter)

Average expenditure during the autumn 2012 was Rs. 36700 and average income was Rs. 22165.5. Therefore average profit was nil and farmers face an average loss of Rs. 14534.5. But the average expenditure and income during winter season was Rs. 16902 and Rs. 56920. So average profit was equal to Rs. 40018. The study reveals that average profit was greater during the winter season than in autumn season.In order to find out how far the climate variables influence the rice production, regression analysis was carried out. For the analysis, expenditure was taken as proxy variable for production. For the analysis regression model is specified as follows

$Y= B_0+ B_1 X_1 + B_2X_2+U$---------------- (1)

Where $B_0$ is an intercept, $B_1$, and $B_2$, are the regression coefficients $X_1$ is rainfall and $X_2$ is humidity.

**Table 6: Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .867[a] | .752 | .682 | .37365 |

***a. Predictors: (Constant), humidity, rainfall***

The model gave .752 of R square value which states that the independent variables like rainfall and humidity can influence 75 percent to the dependent variable expenditure.

**Table 7: Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 15.697 | 6.217 | | 2.525 | .040 | | |
| | rainfall | .098 | .033 | 1.243 | 2.928 | .022 | .196 | 5.096 |
| | humidity | -.080 | .076 | -.444 | -1.046 | .330 | .196 | 5.096 |

a. ***Dependent Variable: ln expenditure***

The model summery shows that rainfall is positively influence the expenditure. For the analysis the study took expenditure as a proxy for the production because climate data was shown on monthly basis but production of rice could not saw in this manner. The rainfall and production shows a positive relation and this statement also was statistically significant. Humidity was negatively related with production as humidity increases production tends to decrease. The model summary shows that expenditure taken as a proxy for production is positively influenced by rainfall. This is evident from the regression coefficient 0.098 which is found to be statistically significant at 5 percent level. Though humidity seems to exert an adverse effect on agricultural production as seen from the negative regression coefficient, this factor does not significantly affect the dependent variable as p value is greater than 0.05.

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## IX. FINDINGS AND CONCLUSION

Agriculture is still a gamble of monsoon because of lack of better irrigation facilities. Due to its geographical location, the climatic condition of the place is different from the rest of the state. .This study found that climate variables definitely influence the production and productivity of paddy in Nalleppilly Panchayat in Palakkad district in Kerala. The production of paddy in rainy season was higher than winter season. This study finds out there is significant deviation of income due to variation in climate. Rainfall has positively influence and humidity was negatively influence the production. Finally the study found that there was a negative influence of humidity on expenditure because as temperature increases the rice plant at the initial stages will damage so there is no need for further expenditure for production.

From the field survey the respondents were also mentioned that the rainfall availability during the study period was very less. Moreover the canal irrigation facilities in this particular region were not so well developed. This was one of the reasons to fail the paddy cultivation in autumn season.

## X. REFERENCES

[1] Ananthakrishnan R., B. Parthasarthy and J. M. Pathan, 1979. Meteorology of Kerala. Contributions to Marine Sciences. India, 123-125.

[2] Ashley W. S., T. L. Mote, P. G. Dixon, S. L. Troti'er, E. J. Powell, J. D. Durkee and A. J. Grundstein, 2003. Distribution of mesoscale convective complex rainfall in the United States. *Mon. Wea. Rev*. **131**, 3003-3017.

[3] Basistha A., N. K. Goel, D. S. Arya and S. K. Gangawar, 2007. Gangawar spatial pattern of trend in Indian sub-divisional rainfall. *Jalavigyansameekha* **22**, 47-57.

[4] Bidin K. and N. A. Chappell, 2006. Characteristics of rain events at an inland locality in northeastern Borneo, Malaysia. *Hydrol. Process*. **20**, 3835-3850.

[5] James E. J., K. E. Sreedharan, G. Ranganna, I. V. Nayak and T. S. Prasad, 1986. Design of rain gauge network using spatial correlation for the Bharathapuzha basin on the Malabar coast of India. Integrated design on hydrological network. Proceedings of the Budapest symposium 1986, IAHS Publ. No.158.

[6] Joseph P. V., A. Simon, V. G. Nair and A. Thomas, 2004. Intra-seasonal oscillation (ISO) of south Kerala rainfall during the summer monsoons of 1901-1995 *Proc. Indian Acad. Sci. (Earth Planet. Sci.)*, **113**, June, 139-150.

[7] Krishnakumar K. N., G. S. L. H. V. P. Rao and C. S. Gopakumar, 2009 Rainfall trends in twentieth century over Kerala, India. *Atmos. Environ.* **43**, 1940-1944.

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