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RESEARCH ARTICLE

IMPACT OF CLIMATE CHANGE ON BLACK PEPPER PRODUCTION IN IDUKKI AND WAYANAD DISTRICTS OF KERALA

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ABSTRACT

Climate change is the major non price factor responsible for reduced production of food crops. A study was conducted in Idukki and Wayanad districts of Kerala to analyse the impact of climate change on black pepper production based on the secondary data collected for a period of 30 years from 1987 to 2016. From the panel data analysis, it was revealed that temperature during 3rd and 4th quarters has negative impact on pepper production. Rainfall during 2nd quarter was found to have positive impact on pepper production but was statistically insignificant. Compound annual growth rate of the climatic variables showed that, rainfall and maximum temperature had negative growth trend, while minimum temperature had positive growth trend in both the districts. Morning and evening relative humidity of the two districts showed opposite trends which was positive for Wayanad district and negative for Idukki district.

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INTRODUCTION

Agriculture is arguably the most important sector of the economy that is highly dependent on climate. Large bodies of scientific data and models have been developed to predict the impacts in the contemporary and future. Such knowledge is critical as we contemplate the design of technologies and policies to mitigate climate change and facilitate adaptation to the changes in the next several decades and beyond. UNFCCC (2007) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is, in addition to natural climate variability, observed over comparable time periods". Black pepper (*Piper nigrum* L.) is famous as "King of Spices" and it is also called as "Black Gold". It is one of the important spice commodities of commerce and trade in India. Annual pepper exported from India during 2016 was 28,100 tons which is worth of Rs. 1730.42 crore. Out of the total pepper production in the country 80-90% is from Kerala alone.

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The two major pepper producing districts in Kerala are Idukki and Wayanad. Both, Idukki and Wayanad together contribute 64.21% of area under black pepper and 76.16% of production of the state. Rao *et al.* (2011) studied climate change projections and impacts on plantation crops in Wayanad and Idukki districts of Kerala during 1995 to 2011. The study reported that, Wayanad and Idukki districts of Kerala are more vulnerable to climate change. Since last 16 years, from 1995 to 2011, rainfall in Wayanad is declining. During 2003-2004 black pepper gardens were wiped out in summer. There was time when oranges were grown extensively. Now it is extinct. Even cardamom cultivation of Idukki district has become a peril. A record rise in maximum temperature and fall in minimum temperature is observed over this region. Kandiannan *et al.* (2014) studied the impact of climate change on black pepper production in Wayanad and Idukki districts of Kerala from 1870 to 2014. It is reported that, annual rain fall of Kerala is 2817 ± 406 mm. However, a spatial variability was observed in Wayanad. Reduction in rainfall and increase in temperature are observed over Ambalavayal. 140 years of long series climatological data over Kerala in the humid tropics of India revealed the cyclic pattern in rainfall with a reduced annual and southwest monsoon rainfall during the past 60 years. Along with this, there was an increase in post monsoon rainfall, revealing likely shifts in rainfall patterns. This has led to severe decline in the productivity of black pepper.

MATERIALS AND METHODS

The study is based on secondary data. Data on rainfall, temperature and relative humidity were collected for a period of 29 years from 1987 to 2015 for Idukki and Wayanad districts from Cardomom Research Station, Pampadumpara and from Regional Agricultural Research Station, Ambalavayal. Data on pepper production for both districts for a period of 30 years from 1987 to 2016 was collected from the Directorate of Economics and Statistics, Thiruvananthapuram. Compound Annual Growth Rate (CAGR) was used to measure the past performance of economic variables (Lazarus *et al.,* 2016). CAGR was calculated using following formula:

$$Y = ab^t e_t$$

Where, Y= dependent variable for which growth rate was estimated

a= Intercept
b= Regression co-efficient
t= Time variable
e= Error term

Panel data analysis was done to quantify the impact of climate change on black pepper production using STATA software. Random effect was fitted as it was found significant to explain the results. Model is fitted by taking the quarterly data of climatic variables for a period of 25 years from 1991 to 2015, as quarterly data was not available before 1991. Natural logarithm was taken for both dependent and independent variables to avoid too much fluctuations in the results. Later results are expressed in terms of percentage by removing the log of regression coefficients. Model is specified as:

$Production_{it} = f(Q1T_{it-1}, Q2T_{it-1}, Q3T_{it-1}, Q4T_{it-1}, Q1R_{it-1}, Q2R_{it-1}, Q3R_{it-1}, Q4R_{it-1}, Q1RH_{it-1}, Q2RH_{it-1}, Q3RH_{it-1}, Q4RH_{it-1})$

$Production_{it}$ = Pepper production of i^{th} region during t^{th} period.
$Q1T_{it-1}$ = Temperature during January to March of i^{th} region during $t\text{-}1^{th}$ period.
$Q2T_{it-1}$ = Temperature during April to June of i^{th} region during $t\text{-}1^{th}$ period.
$Q3T_{it-1}$ = Temperature during July to September of i^{th} region during $t\text{-}1^{th}$ period.
$Q4T_{it-1}$ = Temperature during October to December of i^{th} region during $t\text{-}1^{th}$ period.
$Q1R_{it-1}$ = Rainfall during January to March of i^{th} region during $t\text{-}1^{th}$ period.
$Q2R_{it-1}$ = Rainfall during April to June of i^{th} region during $t\text{-}1^{th}$ period.
$Q3R_{it-1}$ = Rainfall during July to September of i^{th} region during $t\text{-}1^{th}$ period.
$Q4R_{it-1}$ = Rainfall during October to December of i^{th} region during $t\text{-}1^{th}$ period.
$Q1RH_{it-1}$ = Relative Humidity during January to March of i^{th} region during $t\text{-}1^{th}$ period.
$Q2RH_{it-1}$ = Relative Humidity during April to June of i^{th} region during $t\text{-}1^{th}$ period.
$Q3RH_{it-1}$ = Relative Humidity during July to September of i^{th} region during $t\text{-}1^{th}$ period.
$Q4RH_{it-1}$ = Relative Humidity during October to December of i^{th} region during $t\text{-}1^{th}$ period.

For the collected data to check the multicollinearity VIF (Variance Inflation Factor) test was done and presented in table 3. It shows that multicollinearity was not a serious problem. Test for autocorrelation was done using Durbin – Watson test. D-W value was 2.11 and hence there is no autocorrelation in the function.

RESULTS AND DISCUSSION

From the collected data of climatic variables mean, coefficient of variation and CAGR was calculated and present in table 1. When compared to Idukki average maximum temperature, average minimum temperature and average rainfall were high in Wayanad, i.e., 27°C, 18°C and 1863 mm respectively. Morning and evening relative humidity of Idukki was higher than Wayanad i.e., 94% and 77% respectively. Coefficient of variation was high for rainfall in Idukki and Wayanad i.e., 17% and 18% respectively, indicating high variability of rainfall in these two regions. Morning relative humidity in Idukki and maximum temperature of Wayanad had the least coefficient of variation i.e., 1% and 2% respectively, indicating that relative humidity has remained constant over a period of time. In Wayanad district, Maximum temperature (-0.03%) and rainfall (-0.22%) has negative growth trend and minimum temperature, morning and evening relative humidity showed positive growth trend. In Idukki district, only minimum temperature (0.63%) showed the positive growth trend, indicating that, Idukki and Wayanad both are warming over the years. To quantify the impact of climate change on pepper production panel data analysis was done using the data of Idukki and Wayanad districts. Log values of quarterly climatic variables such as temperature, rainfall and relative humidity from 1991 to 2015 were taken as independent variables. Log value of production of pepper from 1992 to 2016 was taken as dependent variable. Model was specified as, production is a function of previous year's climatic condition. Results are represented in Table 2 and Table 3.

Panel data consists of two models i.e., fixed effects model and random effects model. Null hypothesis states that random effects model is good and alternative hypothesis states that fixed effects model is good. To decide this Hausman t test was conducted. The Hausman t test gave probability value of 11% for chi^2 which was above 5%. This indicates that we accept null hypothesis which states that random effects model suits well to explain the influence of climatic variables on pepper production. From Table 3, it is clear that only Q3 and Q4 temperature are statistically significant at 5% level of significance. Both Q3 and Q4 have negative coefficients. This means that increased in temperature during this period resulted in decreased production of pepper in both districts. Upon converting the regression coefficients in terms of percentage, one percent increase in temperature during Q3 will decrease the production by 3.41% and one percent increase in temperature during Q4 will decrease the production of pepper by 2.69%. Q3 and Q4 is the important growth stage in pepper which coincides with flowering, pollination and berry formation. The results obtained from this analysis are in harmony with the results obtained by Gopkumar (2011) who conducted studies on impact of climate variability on agriculture in Kerala in Wayanad during 1986 to 2010. Among the other variables which are statistically insignificant Q2 and Q4 rainfall had a positive effect on the production of pepper. In case of relative humidity, Q1 and Q3 relative humidity had negative coefficients, indicating that increase in the relative

Table 1. CAGR and coefficient of variation of weather parameters (1987-2015)

Particulars	Weather Parameters (Annual average)	Idukki	Wayanad
Mean	Maximum temperature (°C)	26.08	27.22
	Minimum Temperature (°C)	16.98	18.11
	Rainfall (mm)	1856.93	1863.58
	Morning Relative Humidity (%)	93.89	91.44
	Evening Relative Humidity (%)	77.48	67.96
Coefficient of Variation (%)	Maximum temperature	5.48	1.79
	Minimum Temperature	6.16	7.92
	Rainfall	17.11	18.36
	Morning Relative Humidity	1.36	2.79
	Evening Relative Humidity	12.76	9.82
Compound Annual Growth Rate (%)	Maximum temperature	-0.48	-0.03
	Minimum Temperature	0.63	0.19
	Rainfall	-0.38	-0.22
	Morning Relative Humidity	-0.04	0.27
	Evening Relative Humidity	-0.78	0.56

Table 2. Fixed effects model (1991-2016)

Sl. No.	Particulars	Coefficients	Standard Error	P value
1	Intercept	39.67	19.835	0.053
2	Q1 Temperature	3.951	2.755	0.160
3	Q2 Temperature	1.398	1.254	0.272
4	Q3 Temperature	-2.077	3.575	0.565
5	Q4 Temperature	-5.203	2.785	0.070
6	Q1 Rainfall	-0.044	0.051	0.397
7	Q2 Rainfall	0.161	0.209	0.446
8	Q3 Rainfall	-0.139	0.235	0.556
9	Q4 Rainfall	-0.09	0.080	0.905
10	Q1 RH	-0.698	1.09	0.529
11	Q2 RH	0.042	0.201	0.833
12	Q3 RH	-4.827	3.579	0.186
13	Q4 RH	0.022	0.213	0.917
14	F		1.53	
15	Prob>F		0.1595	
16	No. of observation		50	
17	No. of groups		2	
18	Observations per group		25	

Table 3. Random effects model (1991-2016)

Sl. No.	Particulars	Coefficients	Standard Error	P value	VIF
1	Intercept	71.44	21.545	0.061	-
2	Q1 Temperature	-1.938	2.760	0.483	2.37
3	Q2 Temperature	0.765	1.474	0.604	2.90
4	Q3 Temperature	-8.013	3.855	0.038**	2.83
5	Q4 Temperature	-6.303	3.286	0.050**	1.84
6	Q1 Rainfall	-0.022	0.061	0.712	1.11
7	Q2 Rainfall	0.045	0.245	0.852	1.52
8	Q3 Rainfall	-0.325	0.273	0.234	1.19
9	Q4 Rainfall	0.028	0.094	0.766	1.43
10	Q1 RH	-0.990	1.300	0.446	3.59
11	Q2 RH	0.069	0.238	0.787	4.09
12	Q3 RH	-2.048	4.162	0.623	6.72
13	Q4 RH	0.093	0.252	0.711	4.94
14	Wald Chi^2		34.37		
15	Prob>Chi^2		0.0006		
16	Hausman t test (Prob>Chi^2)		0.119		
17	No. of observation		50		
18	No. of groups		2		
19	Observations per group		25		

humidity during this period will lead to decrease in the production of pepper. These results were also in line with results obtained by Gopkumar (2011). Increase in rainfall, increases the pepper production. However, heavy rainfall and high relative humidity will lead to water logging, lack of aeration, low evapotranspiration, low sunshine hours and less intake of nutrition may result in high incidence of pest and disease, ultimately leading to decrease in pepper production, which was observed in Q1 and Q3 rainfall and relative humidity.

Conclusion

From the analysis it was revealed that, rainfall during 2nd and 4th quarters in both the districts, was found to have positive effect on pepper production. Temperature during 3rd and 4th quarters was found to have significant negative influence on pepper production. There are two important measures to counteract climate change *viz.,* mitigation and adaptation. Mitigation is measures to bring back the climate to its original form which is more costlier than adaptation. Adaptation is to adapt to the present climatic condition. Thus, it is appropriate to adopt the adaptation practices by farmers such as mulching, moisture conservation tillage, spraying 1% lime solution, shading young plants, supplementary irrigation as a means to counteract the climate change.

REFERENCES

Gopakumar, C. S. 2011. Impacts of climate variability on agriculture in Kerala. PhD (Atmospheric Science) thesis, Cochin University of Science and Technology, Cochin, 286p.

Kandiannan, K., Krishnamurthy, K. S., Gowda, S. J. A., and Anandaraja, M. 2014. Climate change and black pepper production. *Indian J. Arecanut Spices Med. Plants.* 16(4): 31-37.

Lazarus, T. P., Kumar, A. P., and Prema, A. 2016. Exploitation of marine fisheries in Kerala – an analysis. *Madras Agric. J.,* 103(7-9): 286-292.

Rao, G. S. L. H. V. P., Rao, A. V. R. K., Krishnakumar, K. N., and Gopakumar, C. S. 2011. Climate change projections and impacts on plantations in the humid tropics. In: Rao, G. S. L. H. V. P. (ed.), *Climate Change Adaptation Strategies in Agriculture and Allied Sectors* (1st Ed.). Scientific Publishers, India, 330p.

UNFCCC (United Nations Framework Convention on Climate Change). 2007. *Climate change: Impacts, vulnerability, adaptation in developing countries.* United Nations Framework Convention on Climate Change, Bonn, Germany, 68p.

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