ISSN: 2347-4688, Vol. 6, No.(2) 2018, pg. 183-187

Current Agriculture Research Journal

www.agriculturejournal.org/

Impact of rainfall on the coconut productivity in Kozhikode and Malappuram Districts of Kerala

M. C. ABHINAV*, T. PAUL LAZARUS, V. PRIYANGA and A.V. KSHAMA

Department of Agricultural Economics, College of Agriculture, Vellayani, Kerala Agricultural University.

Abstract

Rainfall has enormous impact on weather and climate. An investigation on impact of rainfall on coconut productivity was taken place in Kozhikode and Malappuram districts of Kerala, to identify the variation in coconut production on an account of secondary data based on rainfall collected for a time period from 1991 to 2015 (25 years). Panel data analysis revealed that rainfall during 3rd (July-September) and 4th (October-December) quarters was found to have significant negative impact on coconut production. Amount of rainfall observed during 1st (Januvary-March) and 2nd (April-June) quarters has positive non-significant impact on coconut production. The growth trend of rainfall showed an increasing trend in Kozhikode district whereas Malappuram district had a decreasing trend over the years.

Article History

Received: 12 April 2018
Accepted: 29 May 2018

Keywords:

Rainfall,
Coconut productivity,
Climate change.

Introduction

Climate change refers to any deviation in the climatic behavior over a period of time (decades to millions of years) which occurs naturally or due to the intervention of human activities. Agriculture is the most critical factor of any economy that is highly relied on climate and its changes. Large systematic bodies of scientific data and operational models have been developed to predict the impact of climate change in the present and the future. This kind of relevant information is critical in formulation of technological designs and policy decision to mitigate climate change and adapt the situations in the forth coming decades and beyond.

Coconut (*Coco nucifera* L.) the versatile palm popularly known as the Tree of Life' Kalpavriksha' as well as 'God's Gift to Mankind' and its fruit as Lakshmi Phal, the fruit of wealth. Across the world 93 countries grown coconut with a total production of 53 billion nuts per annum and India has an area of 21 lakh hectares and has the excellent productivity of 10,000 nuts or more per hectare[6]. It is the traditional plantation crop grown in India for the last 3000 years and its wide distribution has been favored by its usefulness as well as by its adaptability to different ecological conditions. In India, coconut tracts are laid in the coastal tracts of Kerala, Karnataka, Andhra Pradesh, Orissa, Tamil Nadu, West Bengal,

CONTACT M. C. Abhinav abhinavmc47@gmail.com Department of Agricultural Economics, College of Agriculture, Vellayani, Kerala Agricultural University.

Doi: http://dx.doi.org/10.12944/CARJ.6.2.07

Maharashtra, and Pondicherry and in the islands of Lakshadweep, Andaman and Nicobar. Kerala have coconut tract of 7,81thousand hectares and production of 5384 million nuts, followed by Karnataka, Tamil Nadu, and Andhra Pradesh. These four southern states together account more than 90 % of the total production in the country. The area under the coconut cultivation is highest in two district Kozhikode and Malappuram contributing 15.24 and 13.16%, respectively of the total area under the state in 2016.

Excess rainfall occurred (more than 355 mm/month) during September to December results extreme pest infestation in coconut plantations, which leads to an extremely decreased coconut yield in the Ceylon coconut plantations[1].

A well distributed rainfall and proper adaptation strategies like inclusion of improved coconut cultivars, agronomic adaptations and systematic fertilizer application results an optimum production in coconut plantations in Kerala tracts[8].

The changes in the rainfall pattern threatened the economy with income losses in period of extreme rainfall with crop shortage and support the economy in income during optimum rainfall with crop surplus[2].

A study was conducted to determine the impact of climate change on plantation crops in Wayanad and Idukki districts of Kerala during 1995 to 2011. The work revealed that, Wayanad and Idukki districts of Kerala are more vulnerable to climate change and observed declining trend in rainfall and inclining trend in temperature over the year[9].

Studied the yield trends in coconut with respect to the variation of temperature and CO_2 concentration in the. It showed that Kerala, western coastal region, Karnataka parts of Tamil Nadu, and also in North Eastern states, and Lakshadweep and islands of Andaman and Nicobar had projected an uptrend in coconut production and productivity due to the increased temperature and CO_2 concentration, whereas for West Bengal, Gujarat, Andhra Pradesh, Tamil Nadu and parts of Karnataka and Orissa had declining trend due to the increased CO_2[5].

Rainfall considered as the critical factor defining climate. The extreme conditions of rainfall may results extreme crop losses. Occurrence of rainfall was difficult to predict as well as results, unpredictable impact on the crop production. This study quantifies the impact of rainfall on production of coconut and assesses the growth trend of rainfall over the last 15 years in Malappuram and Kozhikode districts of Kerala.

Materials and Methods

The study is based on secondary data. Data on rainfall was obtained for a period of 25 years from 1991 to 2015 for Kozhikode and Malappuram district. The data was collected from India Metrological Department, Trivandrum. Data on coconut production for both districts for a period of 25 years from 1991 to 2015 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[7]. CAGR was calculated using the 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 rainfall on coconut production using STATA software[4]. Random effects model was fitted as it was found to be a better model to explain the results. Model is fitted by taking the quarterly data of climatic variables for a period of 24 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 many fluctuations in the results. Later, results were expressed in terms of percentages by removing the log of regression coefficients[3]. Model is specified as:

$Production_{it} = f\ (Q1Ri_{t-1}, Q2Ri_{t-1}, Q3Ri_{t-1}, Q4Ri_{t-1})$

$Production_{it}$ = Coconut production of i^{th} region during t^{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 $t-1^{th}$ period.
$Q3R_{it-1}$ = Rainfall during July to September of i^{th} region during $t-1^{th}$ period.
$Q4R_{it-1}$ = Rainfall during October to December of i^{th} region during $t-1^{th}$ period.

For the data collected to check the existence of multicollinearity, VIF (Variance Inflation Factor) test was done[4]. It shows that none of the variables are multicollinear. Test for autocorrelation was done using Durbin – Watson test[4]. D-W value obtained was 3.3 and hence there is no autocorrelation in the data.

Results and Discussion

From the data on rainfall, mean, coefficient of variation and CAGR were calculated and presented in table1. The average rainfall of Kozhikode and Malappuram districts was 3094.96 and 3023.06 mm per annum, respectively. The average rainfall was slightly higher in Kozhikode when compared with Malappuram.

Coefficient of variation for rainfall in Kozhikode and Malappuram were 18.57 and 18.85%, respectively. It showed the relative variability in the rainfall distribution.

In Malappuram district, rainfall (-0.22% per annum) has negative growth trend whereas in Kozhikode district, rainfall (0.18% per annum) showed the positive growth trend. Even though, both districts had similar pattern of rainfall distribution with small deviation in the growth trend.

To quantify the impact of rainfall change on coconut production, panel data analysis was done using the data of Kozhikode and Wayanad districts. Log values of quarterly climatic variable (rainfall) from 1991 to 2015 were taken as independent variable. Log value of production of coconut from 1991 to 2015 was taken as dependent variable. Model was specified as; production is a function of previous year's rainfall. Results were represented in table 2.

Analysis of 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 which model is better Hausman t- test was conducted. The Hausman t- test gave a probability chi square value of 0.1287, which was above 5%. This indicates that we accept null hypothesis and state that random effects model suits well to explain the influence of rainfall on coconut production.

From table 2, it is clear that only Q3 and Q4 rainfall were statistically significant at 5% level of significance and rainfall in Q3 as well as Q4 negatively influencing the coconut production.

Area, production, productivity of coconut was presented in table 3. From the table it was observed that in state level as well as district level cultivated area of coconut was declining over the years, except Malappuram with an annual average increase of 0.08%. In the same time production and productivity of coconut was increasing over the years with an average annual positive growth of 6.98 and 10.34% respectively at state level.

Table 1: CAGR and coefficient of variation of weather parameters (1991-2015)

Particulars	Weather parameters	Kozhikode	Malappuram
Mean (mm)	Rainfall	3094.964	3023.06
Coefficient of Variation (%)	Rainfall	18.57264	18.85809
Compound Annual Growth Rate (% per annum)	Rainfall	0.186525	-0.2297

Table 2: Coconut -Random Effects Model (1991-2015)

Sl. No	Particulars	Coefficients	Standard error	P value	VIF
1	Intercept	5.283	1.567	0.001	
6	Q1 Rainfall	-0.009	0.017	0.601	5.81
7	Q2 Rainfall	-0.598	0.323	0.064	5.66
8	Q3 Rainfall	**-0.834	0.395	0.035	2.72
9	Q4 Rainfall	**-0.484	0.182	0.028	3.96
14	Wald Chi^2	8.54			
15	Prob>Chi^2	0.1287			
	Hausman t test (Prob>Chi^2)				
16	No. of observation	48			
17	No. of groups	2			
18	Observations per group	24			

** Significant at 5% level
Note: The coefficients are obtained with log values

Model obtained: $Y= -0.834X_1 - 0.484X_2$
DW value:3.3

Table 3: CAGR and coefficient of variation of area, production and productivity of coconut (1991-2015)

Region	CAGR (% per annum)			Coefficient of variation(%)		
	Area	Production	Productivity	Area	Production	Productivity
Kerala	-0.62	0.72	1.36	6.03	6.98	10.34
Kozhikode	-0.03	0.10	0.13	3.02	7.92	7.78
Malappuram	0.08	3.09	3.05	6.06	23.55	23.62

By converting the regression coefficients in terms of percentage, one percent increase in Q3, Q4 rainfall reduces coconut production by 0.9 and 0.5%, respectively.

Among the other variables, which are statistically non-significant, Q1 and Q2 rainfall had a positive effect on the production of coconut. Increase in Q3 and Q4 rainfall, decreases the coconut production. However, Malabar region has considered as the wettest region of south India, heavy rainfall will lead to water logging, lack of aeration, low evapotranspiration, low sunshine hours and less intake of nutrition. It may result in high incidence of pest and disease with severe button shedding, ultimately leading to decrease in coconut production, which was observed in 3rd and 4th quadrants.

Conclusion

Changes in the rainfall pattern have negatively influenced the coconut production in Kozhikode and Malappuram districts of Kerala. Panel data analysis was revealed that, rainfall during 1st quarter and 2nd quarter in both the districts, was found to have positive effect (statistically non-significant) on coconut production where as rainfall in 3rd (July-Sept) and 4th (Oct-Dec) quarters have negative effects (statistically significant). Extreme rainfall in this end quarters resulting intense button shedding and heavy pest infestations in the plantations, which leads to a downfall in the production of coconut in the occurred year as well as succeeding years. These negatively influencing factors can be managed by better adaptation practices such as intense agronomical adaptation practices, systematic application of

organic and inorganic fertilizer and introduction of improved cultivars like West coast tall (WCT) and Sakhigopal tall (SKGT).

Acknowledgment
Funding source-Kerala Agricultural University.

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