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Assessment of Vulnerability to Climate Variability

***[1]Dr.Sumathy.M and [2]Dr. Muraleedharan. S**

[1]Assistant Professor, Department of Economics, Government College Chittur, Palakkad
[2]Research Supervisor, Department of Economics, Maharajas College, Ernakulam

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***Corresponding Author**
Email: *sumathyrevathy[at]gmail.com*

ABSTRACT

The IPCC Third Assessment Report defined vulnerability as "The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes". There were so many studies with regard to the vulnerability of climate variability. Vulnerability indices are multivariate in nature and principal component analysis (PCA) is used to assess it. The study selected seasonal (rice), annual (banana) and perennial crops (coconut and mango). The crops like rice, banana and coconut were affected due to climate variability. It was mainly due to high temperature and low rainfall in the study period. In the case of mango production, it was not so affected because the nature of climate variability in 2016 favoured mango production.

1. Introduction

Palakkad is one of the hottest districts in Kerala which is now severely affected due to climate variability. The impact of climate variability like floods and droughts is known to adversely affect the production of food and plantation crops and thus there is an urgent need to adapt the crops to the variability. The IPCC Third Assessment Report defined vulnerability as "The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes". There were so many studies with regard to the vulnerability of climate variability. A study at household scale was done by Huynh et al.,(2018). Their results indicate that large variation in the degree of vulnerability to climate change among households in the same agro-climate zone. These differences are attributable to variations in socio-economic household characteristics and ability to access livelihood assets. The IPCC (1991) established a methodology for vulnerability assessment that included response strategies, focusing on potential sea level rise (Bijlsma et al., 1996).

2. Significance of the study

Crop management, crop improvement and crop protection are the adaptation strategies suggested in line with the projected climate change scenario. According to Rao (2011), an eminent climatologist, the mean temperature in Palakkad is more than 35°C during March, April and May months. Lack of irrigation facilities, improper management and lack of institutional support, etc. worsen the situation with respect to the crops. Therefore a detailed analysis is made here to find out the causes of yield reduction especially in seasonal, annual and perennial crops. Rice was chosen as the seasonal crop, banana was chosen for annual crop, coconut and mango were chosen for perennial crops. These crops are observed to be climate sensitive crops (Agricultural Statistics. Govt of Kerala 2000)

3. Area and Method of study

This is an attempt to study the impact on the crop yield of the selected crops on the basis of primary data analysis in Palakkad district which is more vulnerable due to climate variability compared to other districts of Kerala. The present study focuses on Ricardian multiple regression analysis. Ricardian model was used by Mendelsohn et al (1994) and Gbetibouo &Hassan (2004) in their analysis. Principal Component analysis was used to assess the vulnerability of the selected crops. This tool helps to reduce the number of explanatory variables and bring it under some principal components.

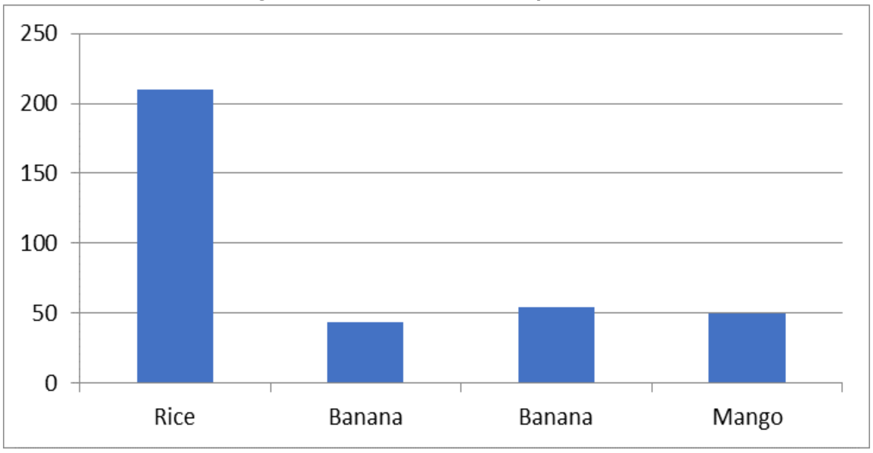
4. Result of the study

Socio-Economic Conditions of the Sample Farmers

Diagrams 1.1 &1.2 shows the number of selected sample farmers cultivating the said crops and their average age. Most of the farmers lie in the average age group of 55-60.

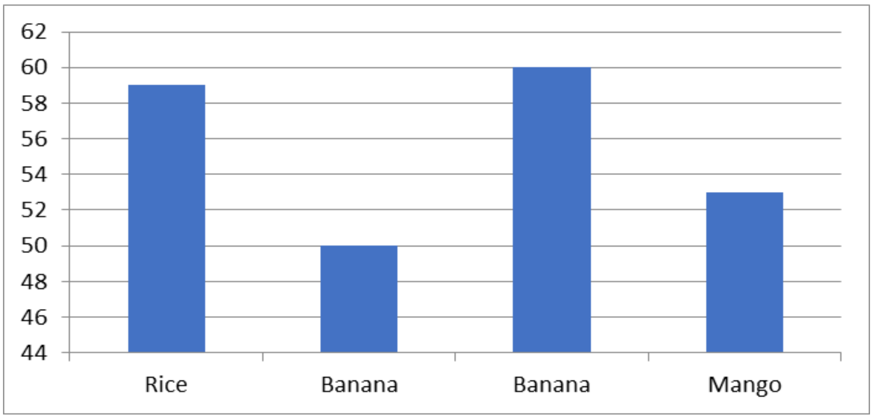
Characteristics of the Sample Farmers

Diagram 1.1: Number of sample farmers



Source: Field Survey 2016-17

Diagram 1.2: Age of farmers



Source: Field Survey 2016-17

In order to study the socio-economic condition of the total sample farmers(357), variables such as educational qualification, monthly income, monthly expenditure, monthly saving, type of house, sanitation facility, etc. are taken into account.

As far as the educational aspect of the farmers was concerned, it was found that most of farmers (86.30 percent) are literates ranging from 92.70 per cent (coconut farmers) to 76.20per cent (banana farmers).In the case of affordances of the farmers, about 77 of respondent farmers were either poor or middle income groups and rich group was minority (table 1.2).However, crop-wise pattern of farmers was not uniform. Paddy farmers were relatively poor[1] and middle[2] income groups while majority of mango and banana farmers were either middle or higher income groups. In the case of coconut farmers, 50.90 per cent of them are in the middle income group (table 1.2).

Diagrams 1.3 &1.4 Shows the Relation between education and family status among farmers

Diagram 1.3 : Educational status

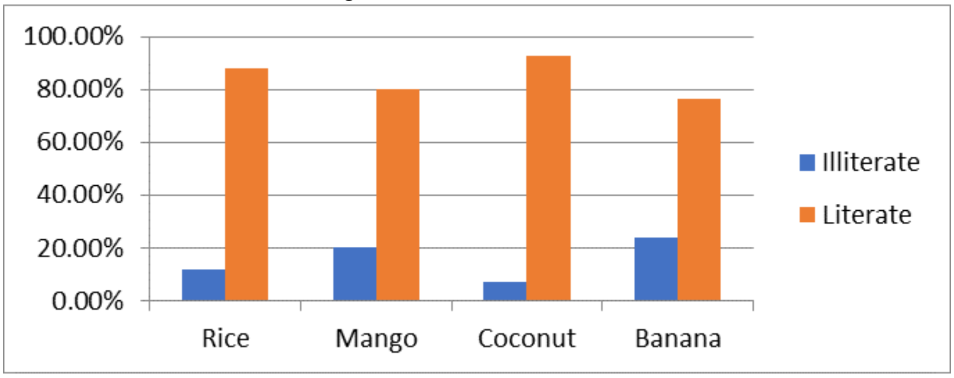
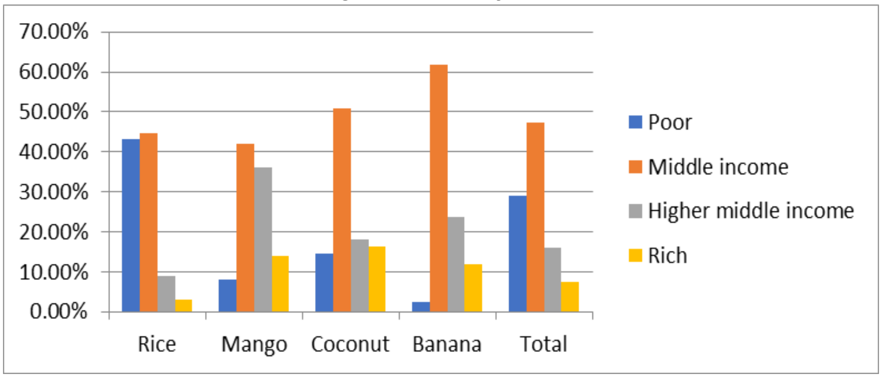


Diagram 1.4: Family status



Source: primary survey 2016-17

From the analysis of the socio-economic conditions, it was found that most of the farmers are in the low income category especially most of the rice farmers. More over the correlation between income and economic status was positive and significant. Majority of the rice farmers were included in low income category. The correlation between income and expenditure was seen to be positive and significant level. As rice farmers were mostly in the low income category, their expenditure also was less compared to others. Expenditure of the rice farmers was seen to be greater than their income. As expenditure was greater than their income, correlation between saving and type of farming was seen to be negative for rice and banana farmers. Only farmers cultivating perennial crops were better than those cultivating rice and banana. Under such situation, agricultural loss leads to no income, no saving and therefore their expenditure for consumption is low. Therefore vulnerability due to climate variability would be high for rice and banana farmers.

Table 1.1 Socio-Economic Characteristics of Sample farmers

CHARACTERISTCS	CORRELATION	LEVEL OF SIGNIFICANCE
EDUCATION	-0.066	0.215
INCOME	0.191	0
ECONOMIC STATUS	0.356	0
MONTHLY EXPENDITURE	0.224	0
TYPE OF HOUSE	-0.1	0.058
SANITATION FACILITIES	-0.049	0.36
MONTHLY SAVING	-0.172	0.001

Source: Field survey, 2016

Vulnerability indices are multivariate in nature. It is possible to apply multivariate statistical analysis tools to obtain weights for the indicators. One such statistical tool is principal component analysis (PCA). Roberts & Martin (2006), Smith (2002), Krishnan (2013) have used this multivariate analysis in their work. Wu et al., (2011) applied this method in the study of climate change, production, socio and economic development and food chemistry.PCA is a multivariate technique for finding patterns in data of high dimension. Gberibouo and Ringler (2009) have applied this method to construct the vulnerability of South African farming sector. They identified a total of 19 indicators; four for exposure component, six for sensitivity component and nine for adaptive capacity component.

5. Principal Component Analysis (PCA)

Principal Components Analysis (PCA) is a variable reduction technique which maximizes the amount of variance accounted for in the observed variables by a smaller group of variables called components. The PCA process allows us to reduce the number of questions or variables down to their principal components.

The usual factor analysis model expresses each variable as a function of factors common to several variables and a factor unique to the variable.

$z_j = a_{j1}F_1 + a_{j2}F_2 + \ldots + a_{jm}F_m + U_j;$

Where:

Z_j = the j^{th}standardized variable

F_i = the common factors

m = the number of factors common to all the variables

U_j = the factor unique to variable z_j

a_{ji} = the factor loading

Table 1.2 shows the descriptive statistics i.e. the mean and standard deviation for 31 statements which were given to the farmers as reflective of the extent of climate impact on the crop yield of the selected crops. Statements 1 to 12 reflect upon the extent of climate variables that influence yield, 13 to 18 relate to non-economic factors that influence production, 19 to 28 represent the stimulus of institutions which help the farmers to increase production, sustain the cultivation and adapt from various types of risks and 29 to 31 relate to the economic variables that help for production. Apart from these statements, other 35 statements were also taken but the factor loading values of those statements is less than 0.5 (Barnett et al.,2015)

Table 1.2: Descriptive Statistics on yield impact

Sl. No.	Statement	Mean	Std. Deviation	No. of respondents
1	Low rain decreases production	2.8291	1.48643	357
2	Low rain decreases profit	3.0616	1.63584	357
3	Low rain affect: ploughing not possible	2.8683	1.51659	357
4	Low rain affect: sowing not possible	3.0028	1.61888	357
5	Low rain affects weeds plucking	2.9412	1.50445	357
6	Low rain affects the growth of plant	3.028	1.61081	357
7	Low rain leads to non-application of fertilisers	2.9188	1.5275	357
8	Low rain at the time of flowering affect the production	3.0336	1.58964	357
9	Low rain increases crop price	2.9384	1.54397	357
10	Low rain affects the food availability	3.0028	1.60494	357
11	High temperature at the time of growing period affects the plant growth	2.5714	1.50787	357
12	Wind helps to increase production during flowering	1.7563	0.94779	357
13	Pests decrease production	2.3585	1.40235	357
14	Diseases decrease production	2.5014	1.56619	357
15	Availability of better high yielding seeds increases production	2.3641	1.37867	357
16	Use of organic fertiliser increases production	2.4958	1.51513	357
17	Irrigation facilities increases production	2.4314	1.40582	357
18	Knowledge, skill and interest of farmers increase production	2.395	1.44303	357
19	Timely availability of loans increase production	2.2829	1.34543	357
20	Non-availability of loans decreases production	2.4202	1.50931	357
21	Timely availability of subsidies increase production	2.3585	1.38421	357
22	Proper guidance from *krishibhavan* increase production	2.4258	1.5096	357
23	Authentic climate information helps the farmers	2.3725	1.4057	357
24	Distribution of seeds by the *krishibhavan* helps the farmers	2.3417	1.45948	357
25	Provision of machineries at subsidised rates helps the farmers	2.3165	1.39545	357
26	Proper supervision by the agricultural experts from agricultural office helps the farmers to increase production	2.3922	1.43305	357
27	Provision of facilities to adapt to climate variability to farmers by *krishibhavan*	2.3165	1.41345	357
28	Proper implementation of rainwater harvesting by the *krishibhavan*	2.3838	1.43436	357
29	Increase in input price decreases production	2.0196	1.25293	357
30	Decrease in output price decreases production	2.000	1.23616	357
31	Low profitability decreases production	2.0392	1.2736	357

Source: Field survey

Result of the PCA

In order to test the compatibility of the data for Factor Analysis, KMO and Barlett'ssphericity tests were used. For this data, the value of KMO is 0.933, and Barlett's test of sphericity is also adequate for analysis and also significant at one per cent. Therefore the ranked variables were used to run factor analysis and then Factor Loading estimated. The factors with a loading value greater than 0.5 were considered as component factors affecting the yield. The analysis derived that mainly four factors are the principal factors affecting the crop yield whose Eigen value is greater than 1. From the analysis, component matrix was obtained but it was not a satisfactory one. For more clarity rotation was done. After rotation factor loading was obtained systematically.

Table 1.3 : Rotated Component Matrix

Sl.No.	Statement	Factor 1
1	Low rain decrease production	0.916
2	Low rain decrease profit	0.94
3	Low rain affect not possible for ploughing	0.935
4	Low rain affect not possible for sowing	0.94
5	Low rain affect the weeds plucking	0.93
6	Low rain affect the growth of plant	0.93
7	Low rain leads to non-application of fertilisers	0.937
8	Low rain at the time of flowering affect the production	0.933
9	Low rain increase crop price	0.924
10	Low rain affect the food availability	0.924
11	High temp at the time of growing period affect the plant growth	0.552
12	Wind helps for increase production during flowering	0.545

Table 1.4

		Factor 2
13	Timely availability of loans increase production	0.897
14	Non availability of loans decreases production	0.918
15	Timely availability of subsidies increase production	0.905
16	Proper guidance from *krishibhavan* increase production	0.908
17	Authentic climate information helps the farmers	0.902
18	Distribution of seeds by the *krishibhavan* help the farmer	0.919
19	Provision of machineries at subsidised rate help the farmers	0.913
20	Proper supervision by the agricultural experts from agricultural office helps the farmers to increase production	0.907
21	Provision of facilities to adapt climate variability to farmers by *krishibhavan*	0.914
22	Proper implementation of rainwater harvesting by the *krishibhavan*	0.918

Table 1.5

		Factor 3
23	Pests decreases production	0.913
24	Diseases decrease production	0.889
25	Availability of better high yielding seeds increases production	0.913
26	Use of organic fertiliser increases production	0.889
27	Irrigation facilities increases production	0.905
28	Knowledge, skill and interest of farmers increase production	0.919

Table 1.6

		Factor 4
29	Increase in input price decrease production	0.894
30	Decrease in output price decrease production	0.928
31	Low profitability decrease production	0.912

Table 1.7

Eigen Value	9.249	8.62	5.32	2.671
Proportion of Variance Explained	29.836	27.808	17.162	8.615
Cumulative Variance Explained	29.836	57.643	74.805	83.42
KMO: Measure of Sampling Adequacy	0.933			
Bartlett's Test of Sphericity Approx. Chi-Square	1.272			

Table1.3 to 1.7 shows that there are mainly 31 variables explain the impact of crop yield. The variables 1 to 12 explain the impact due to climate variability and are termed as climatic factors. The factor loading varies from 0.94 to 0.55. The proportion of variance explained by this factor is 29.836 per cent. The variables (19 to 28) that come under econo-institutional related that affect the yield and are termed as institutional factors. The factor loading values ranges from 0.90 to 0.92 and the proportion of variance explained by this factor is 27.81 per cent. Therefore it is the second component affecting yields. Variables 13 to 18 explain the non-economic factors affecting production and are termed as non-economic factor. The factor loading values lies between 0.88 and 0.92 and the proportion of variance explained by this factor is 17.162 per cent it is the third component. The variables (29 –31) that come from the fourth component are profit affecting factors and are termed as economic factors. The factor loading values span is between 0.89 and 0.93 and states that low price and profitability decrease production and vice versa. The fourth factor explains 8.61 per cent of variance. Altogether, 83.42 per cent of variance is explained. Therefore these four components are important factors affecting yield of the crop.

6. Regression Analysis

To find out the impact of climate variability on selected crops such as rice, banana, coconut and mango, regression analysis is done. For the analysis the independent factors considered are 1) climatic, 2) institutional 3) non-economic and 4) economic. The dependent variable is actual yield of the crop.

Result of the Regression Analysis

To find out the impact of climatic, non-economic, institutional and economic factors that affect the rice yield in autumn/ viruppu (season I) and winter/mundakan(season II), season specific regression models were fit with cross section data collected during2016-17 for the purpose. Rice cultivation needed different levels of temperature at different phases of plant growth. During flowering and fertilisation, temperature ranging between16^{0}cto 20^{0}c and during ripening, temperature between 18^{0}c to 32^{0}c are needed. The temperature beyond 35^{0}c affects rice grain filling (KAU, 2016). In 2016, there was low rainfall (actual rainfall was less than the normal) and high temperature (above 35^{0}c) during summer season. As a result heavy drought, especially affecting agricultural output, was experienced during this year.

Rice cultivation during winter /*mundakan*

Rice is a staple food crop and most of the people depend on it for their livelihood. Sowing for the season starts in September to October and harvesting occurs in December to January. Palakkad sustains its first position in the yield of rice in Kerala . But the area and production of rice crop has declined even though productivity increases. On the basis of the opinions of the farmers, important factors affecting the area and production are traced out through PCA and regression analysis carried out to find the impact of these factors on yield.

Actual yield impact

The table 1.8 illustrates that climatic factor negatively (-556.98) influenced the actual yield of rice in 2016 winter (I season) as the unstandardized beta coefficient takes a negative value and it is significant at five per cent level of significance. That means low rain and high temperature reduced the yield of rice crop hence the study accepts the alternative hypothesis. Institutional factors positively influenced the yield because they have positive beta coefficient and are significant at five per cent. This means that the attitude of banks, other financial institutions and *Krishibhavan* towards farmers is good and to some extent helps to adapt to the climate variability. But the non-economic factors negatively influence the actual yield as it takes on a negative coefficient but it is not significant. Farmers could not control the pests and diseases attack during the growing and flowering period of rice plant. Particular types of diseases were noticed like mungya[1], Olakarichil[2] (inPalakkadan language). Those factors affected the crop growth in its various stages and thereby reduced the yield.

Table 1.8: Regression Coefficients of Rice: Season 1

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	2235.199	238.105		9.387	.000
Climatic Factor	-556.979	238.439	-.122	-2.336	.020
Institutional Factor	585.003	238.439	.128	2.453	.015
Non-economic Factor	-331.584	238.439	-.072	-1.391	.165
Economic Factor	414.220	238.439	.091	1.737	.083

a. Dependent Variable: actual yield of rice

Even though the non-economic factor is negative, it is not significant. Even though rice production is not a profit making occupation in Palakkad, farmers cultivate it mainly for their livelihood and their psychological attachment to the land. The most

[1]Mungya- is a fungal disease that affects the plant growth
[2]Olakarichil –is a disease that affects the growth of plant leaf due to virus

important risk that affected the yield was the adverse weather. Economic factor is favourable for the yield of rice in season 1and is significant at 10 per cent.

The model summery gives an R-squared value of 0.045. Rice yields forecast by the International Rice Research Institute forecast 20 per cent reduction in yields over the region where per degree Celsius of temperature rise. Rice becomes sterile if exposed to temperature above 35 degrees for more than one hour during flowering and consequently produces no grain. International Rice Research Institute (2006) has also revealed that for every 1°C rise in temperature, paddy yield declines by 10 per cent. In the projected climate change scenario, temperature rise is being experienced across the state. An increase of temperature by 2°C by2025 would affect paddy production severely in Kerala. The crop maturity period may also get reduced, which might affect the paddy productivity drastically. This would adversely affect the state where rice is the staple food of majority of the population (Kerala State Action Plan on Climate Change, 2014). Soman et al., (1988) have reported a fall in the annual rainfall in the southern part of Kerala in consequent years showing climate variability.

The annual rainfall in the region is comparatively lesser than that of the entire state. A significant decrease in the annual rainfall, winter rainfall and the south-west monsoon rainfall was also observed. A level of spatial variation (spatial variability of rainfall can lead to significant error in rainfall–runoff processes and hydrological modeling, specifically in the urban area) in the occurrence of rainfall was observed in the Palakkad plains. The average annual rainfall among the stations was found to be in the following decreasing order: Mannarkkad,Malampuzha, Palakkad and Chittur (Azeez et al., 2009). From Mannarkkad, Palakkad (1916 to 2000), Chittur (1930-2000) and Malampuzha (1923-2000).The total annual rainfall of the Palakkad plains is lower than the total annual rainfall for the whole state of Kerala (2817 mm) (Krishnakumaret al., 2009).

Rice cultivation during Autumn/*Virippu*

The sowing period of this season starts during the months of April to May and harvesting is from September to October.

Actual yield impact

Regression was also calculated for second season to find out the yield impact. In second season also, the weather risk negatively impacted the yield of rice as the unstandarised beta value has a negative value (-346.17). So the study accepts alternative hypothesis and is significant at 10 per cent. Institutional factors are positively affecting the actual yield and are significant at one per cent. Non-economic and economic factors are also positively affecting the yield of rice in season II, but not significant. Because of unfavourable weather, yield of rice reduced (Table 1.9).

Table 1.9: Regression Coefficients of Rice: Season 2

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1645.442	192.138		8.564	0
Climatic Factor	-346.167	190.95	-0.123	-1.813	0.071
Institutional Factor	473.493	178.454	0.18	2.653	0.009
Non-economic Factor	277.05	202.492	0.093	1.368	0.173
Economic Factor	91.237	181.835	0.034	0.502	0.616

a. Dependent Variable: actual yield of rice, season 2

The analysis for rice crop shows that climatic factor negatively impacts the yield of crop in both the first and second seasons. Yield reduction by way of crop failure due to climatic variability gives a negative beta co-efficient value (-346.167). The trend analysis also disclosed the same nature of reduction in area and production of rice from 2000-2015.According to National Crime Records Bureaus (NCRB) 2014, Kerala stands at the third position with 23.9 per cent in farmer's suicidal cases. In the state, Wayanad district recorded the highest number of suicides (15) followed by Palakkad and Idukki (Agro-economic Research, 2015)

The model summery gives an R-squared value of 0.060 which indicates that the obtained four factors influence the actual yield of rice in season II up to 6 per cent.

Banana

Banana is an important plantain and it is cultivated for making profit and not as a livelihood crop like rice. Banana is cultivated more in the north western parts and the eastern parts of Palakkad adjoining Tamilnadu. It needs tropical humid lowlands and the optimum temperature level is 27^0 C (KAU, 2016). Weather, institutional, non-economic and economic factors affect the yield of banana. Banana production (both in tropical and sub-tropical regions) is affected due to climate change (Bergh et al, 2012) and also suggests that future climate will be less suitable for the production of banana.

Table 1.10: Regression Coefficients of Banana

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	15352.371	2032.935		7.552	.000
Climatic Factor	-4507.333	1972.745	-.384	-2.285	.028
Institutional Factor	3454.721	1966.986	.271	1.756	.087
Non-economic Factor	3459.096	2094.474	.260	1.652	.107
Economic Factor	-1242.295	2603.838	-.076	-.477	.636

a. Dependent Variable: actual yield of banana in Kg

From the regression analysis it was found that banana yield is negatively affected by the climatic factors at 5 per cent level of significance .Institutional and non- economic factors are positively affecting at 10 per cent level. But economic factor is not significant. Therefore banana cultivators are also facing various problems due to unfavourable weather condition during the different phases of crop cultivation, high prices of inputs, labour shortage etc. in Palakkad district

Coconut

Coconut is an important perennial crop mainly cultivated for making profit. It needs an equatorial climate with high humidity. The coconut palm needs mean annual temperature level of 27^{0}C and 1300mm to 2300 mm rainfall per annum(KAU). In this district coconut farmers are marginal and large farmers, mostly having own irrigation facility. To find the impact of climate and other above mentioned factors regression analysis is done. The result of the analysis is shown in Table 1.11.

Actual yield impact

The model summary shows that the variables explain 35.9 per cent of the variations in yield. The weather factor positively influences the actual coconut yield, but is not significant. Positive yield is because of the favourable weather condition in the previous year. It is well established that the coconut yield in a year is significantly influenced by the rainfall of the t-1th year (Peiris, 2000).Institutional and Non- economic factors are negatively influencing the actual yield and are significant at 10 percent. The institutions like *krishibhavans* or other agricultural organisations did not take any favourable measures to coconut farmers which have increased the vulnerability. Farmers opined that correct meteorological information was not received by them. This was one of the main drawbacks of the agricultural system. Without any adaptation strategies during the drought year, compensation is provided in the next year. Therefore farmers are in critical situation to meet the expenses needed for farm field even though economic factors have a positive impact at 1 per cent level.

Climate variability is projected to increase coconut productivity in western coastal region, Kerala, parts of Tamil Nadu, Karnataka and Maharashtra (provided current level of water and management is made available in future climates as well) and also in North-Eastern states, islands of Andaman and Nicobar and Lakshadweep while negative impacts are projected for Andhra Pradesh, Orissa, West Bengal, Gujarat and parts of Karnataka and Tamil Nadu(Kumar and Aggarwal 2013).

Table 1.11: Regression Coefficients of Coconut

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	17577.746	2444.392		7.191	.000
Climatic Factor	2850.134	2278.541	0.160	1.251	.217
Institutional Factor	-4424.710	2256.169	-0.231	-1.961	.056
Non-economic Factor	-4475.628	2518.795	-0.220	-1.777	.082
Economic Factor	12131.787	3144.538	0.482	3.858	.000

a. Dependent Variable: actual yield of coconuts, in number of nuts

Minimum temperature above 10^{0}C trigger flowering and temperatures <10^{0}C for one month would cause nut fall, while temperatures >40 ^{0}C during April to July in the tropics decrease functional leaf area index, dry matter production and nut yield (Kumar et al., 2008).This was the situation in the district during the year 2016. 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. (**Abhinav** et.al., 2018. Most of the respondents also opined on similar lines at the time of field survey. R^2 gives a value of 0.359 which indicate that 35.9 per cent explained by the climatic, institutional, non-economic and economic factors.

Mango

Mango grows well in areas that are above sea level of up to about 1500 m. It can withstand both fairly dry season as well as heavy rainfall (KAU, 2016). The Muthalamada panchayat in the district is known as the 'Mango city of Kerala'(Agricultural Development Policy, 2013)because of large sections of farmers engaged in mango cultivation. Another important peculiarity of this panchayat is production of mango even during off-season period. More than 70 per cent fruits produced here is sold outside Kerala and abroad. Mangoes are harvested here before the start of the season anywhere in the world. So it has good demand and prices. The rare variety of *Moovandan*is harvested twice a year. The climate and location of Muthalamada, which lies in the lap of the Nelliampathy Hills and the Parambikulam forests bordering Tamil Nadu, are said to be the reason for the twin flowering. The main varieties cultivated here are Alphonso, Suvarnarekha, Mallika, Banganapally and Neelam and the local Moovandan, Chakkarakatty, Chandrakaran and so on. In Muthalamada region, mango farmers are marginal and large farmers and they have own bore well irrigation facilities so that climate variability does not affect the crop. The result of the analysis is shown in Table 1.12

Table 1.12: Irrigation facilities of mango cultivators

Acres of land	No. Of farmers	Irrigation facility		
		Bore well	Canal	Pond
0-5	9	7	2	0
5-10	7	5	1	1
10-15	15	10	3	2
15-20	6	5	1	0
20-25	4	4	0	0
Total	41	31	7	3

Source: Primary data

Actual yield impact

Mango yield in the district is not at all affected by weather, institutional, economic and non-economic factors. Increased temperature help the plant growth and have positive impact on photo synthesis. Drought definitely decreases production but better owned irrigation facilities help the farmers to increase yield to some extent. Mango production is affected only if the temperature is greater than 45 degrees during the flowering period. Upsurge in temperature causes negative floral induction and positively affect the pollen viability and fruit setting. Drought causes floral induction positively and negatively affects the fruit set and retention (Normand et al., 2015). Model summery gives an R-squared value of 0.153 percent which indicates the four components explain the actual yield of mango up to 15.3 per cent.

Table 1.13: Regression Coefficients of mango

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	41275.478	9646.966		4.279	.000
Climatic Factor	14919.628	9483.432	.280	1.573	.124
Institutional Factor	7383.784	9724.511	.123	.759	.453
Non-economic Factor	7644.462	9819.374	.129	.779	.441
Economic Factor	-12729.796	12211.603	-.174	-1.042	.304

a. Dependent Variable: actual yield of mango, in Kg

7. Conclusion

From the primary data analysis it was found that the variables such as climatic, institutional and economic factors are significant that were influencing the yield in season 1 where as non-economic factors were not significantly influencing the yield of rice during that season. But institutional and economic factors were positively swaying whereas climatic factor was negatively inducing the yield. Good institutional support helped the farmers to increase yield. During second season, climatic and institutional factors are significantly influencing the yield. Climatic factor is negatively impelling and institutional factor is positively influencing the yield. But the economic and non-economic factors were not significantly affecting the yield. In both seasons, institutional support helped the farmers to continue to cultivate even though climate was not favourable. For banana crop, climate and institutional factors had significant impact on crop yield. Climate factor had adverse impact the yield but institutional factor was favourable for yield. If the institution provides better facilities to the farmers (as mentioned for rice crop), production will increase. Moreover banana is also a profit oriented business and not a livelihood occupation. Therefore banana cultivators are ready to mitigate and adapt to climate variability.

For coconut farmers, institutional, non-economic and economic factors were significant whereas climate factor was not significant. Institutional and non-economic factors were negatively control the yield while economic factor had positive effect. But for banana farmers institutional factor had positive stimuli on the yield whereas this factor was flimsy to the coconut farmers. Therefore what is needed is a strong institutional support that enhances profit. However, economic factor was positive because the farmers articulated the view that they mobilised resources from other sources. For mango farmers, economic factor negatively impact the yield and the other three factors positively affect. But none of these factors was significantly prompting. Increase in input price, low output price during harvesting and low profitability reduced the farmers' incentive for enhanced cultivation. Therefore institutional support must be needed for the farmers to adapt to the variability of climate and thus grab profit.

From the regression analysis, the study found that the crops such as rice, banana and coconut were affected due to climate variability. It was mainly due to high temperature and low rainfall in the study period. In the case of mango production, it was not so affected because the nature of climate variability in 2016 favoured mango production. Moreover most of the mango farmers are large and cultivation is not a livelihood occupation, but more as an exported oriented business, as revealed from field response. The study exhibits that the crops such as rice (seasonal) and banana (annual) are the important climate vulnerable crops. Institutional support can help to reduce shocks due to climatic variability.

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