IMPACT OF CLIMATE CHANGE ON FIVE IMPORTANT CROPS IN KANYAKUMARI DISTRICT

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Abstract: ***The primary sector is the most important in any economy in the sense that it provides food to its population and generates employment and income to a significant portion of the Indian rural mass. In India, in between 1951 and 2000, the magnitude and frequency of heavy rain was increasing and the frequency of moderate rain was decreasing. In this context the researcher would like to analyze impact of climate change on agriculture production. The present study is based on primary data. The field experts are the farmers cultivating the five crops. The climate factors like pest and disease, unseasonal rain, water shortage, flood, high temperature, solar radiation, storm and continuous rain affect the five crops. Unseasonal and unpredictable rain, excess rain and lower temperature affect salt production. The distress of dairy farmers should be addressed through suitable measures.***

Keywords: Climate Change, Production and Crops.

INTRODUCTION

The primary sector is the most important in any economy in the sense that it provides food to its population and generates employment and income to a significant portion of the Indian rural mass. It provides employment to around 65 percent of the total workforce in the country. Indian agriculture is characterised by food and non-food crops. The food crops are important for feeding the population while the non-food crops are of commercial importance. The types of food and non-food crops cultivated and the cropping pattern in a country are influenced by many factors. India is the largest producer of milk and has about 15 percent of the total cattle population of the world. India ranks second in the production of fish after China and third in producing salt after USA and China as per the data available in 2011-'12 (Agricultural Outlook, 2012).

As per the 1st Advance Estimates released by Ministry of Agriculture (MoA), Cooperation and Farmers Welfare on 22nd September 2017, production of kharif food grains during 2017-18 is estimated at 134.7 million tonnes, as compared to 138.5 million tonnes (4th Advance estimates) and 135 million tones (1st Advance estimates) in 2016-17. The climate change is caused by the emission of greenhouse gases, deforestation, urbanisation and other economic activities of human beings. The debate of National Action Plan on Climate Change (NAPCC) concluded that, when compared to other developing nations, the impact of climate change in India is very serious. Ultimately the climate change tends to decrease the Gross Domestic Product (GDP) of the Indian economy. Agriculture and allied activities are highly sensitive to climate, particularly temperature, rainfall and humidity (Dar, 2009).

ISSUES

In India, in between 1951 and 2000, the magnitude and frequency of heavy rain was increasing and the frequency of moderate rain was decreasing (Somanathan, 2009). It is evident that in 2008, due to the failure of south-west monsoon, paddy cultivation in the kharif season was delayed and unseasonal rainfall during the time of harvesting damaged the standing crops (Narain, 2003). Cumulative Post-Monsoon Season (CPMS) rainfall for the country as a whole during the period 01st October to 27th December, 2017 has been 10 percent lower than the Long Period Average (LPA). Rainfall in the four broad geographical divisions of the country during the above period has been higher than LPA by 19 percent in East and North East India but lower than LPA by 53 percent in North-West India, 10 percent in South Peninsula and by nine percent in Central India. Out of total 36 meteorological Sub-divisions, 06 met subdivisions received large excess/excess rainfall, 13 subdivisions received normal rainfall and 17 Sub-divisions received deficient/large deficient rainfall. The plant's health and immunity are affected by rise in temperature. This will lead to fall in production and productivity of agriculture (Bhatta, 2009).

Central Water Commission (CWC) monitors 91 major reservoirs in the country which have total live capacity of 161.99 Billion Cubic Metre (BCM) at Full Reservoir Level (FRL). Current live storage in these reservoirs (as on 28th December, 2017) was 87.66 BCM as against 92.58 BCM on 28.12.2016 (last year) and 93.40 BCM of normal storage (average storage of last 10 years). Current year's storage is 95 percent of last year's storage and 94 percent of the normal storage. Due to the rise in temperature many diseases and parasites affect the cattle and hence the milk production from cows and goats declines (Sainath, 2009). The state of Tamil Nadu has received excess rainfall during the South-West monsoon of 2010 after a gap of 14 years. The rainfall was 38 cm against the normal level of 31cm (Ramakrishnan, 2010). Climate is not consistent in India. Regions facing drought during the month of June and July face floods in August and September. Moreover most of the rainfall occurs within 100 hours of a year. This rainfall situation is not good for production and productivity of many crops and affects the poor's livelihood adversely (Swaminathan (2009). The present study to analyse the impact of climate change on the area under cultivation of five important crops namely paddy, banana, tapioca, coconut and rubber in Kanyakumari District.

METHODS

The present study is based on primary data. Primary data have been collected from 260 field experts and 40 subject experts. The field experts are the farmers cultivating the five crops. The survey for collecting primary data was conducted in 2016. The fall in area under cultivation, production and productivity of crops due to climate change is not significant.

ANALYSIS AND DISCUSSION

Both age and gender are useful for understanding the demographic characteristics of the respondents, which are necessary for availing some other service. The gender and age classification of the respondents are presented in table-1.

Table - 1: Age Wise and Gender Wise Distribution of the Respondents

Gender	Age of Respondents							Total
	26-35	36-45	46-55	56-65	66-75	76-85	86+	
Male	19 (7.3)	41(15.8)	69 (26.5)	84 (32.3)	39 (15)	2 (0.8)	1 (0.4)	255 (98.1)
Female	1 (0.4)	2 (0.8)	2 (0.8)	0 (0)	0 (0)	0 (0)	0 (0)	5 (1.9)
Total	**20 (8)**	**43 (17)**	**71 (27)**	**84 (32)**	**39 (15)**	**2 (1)**	**1 (0)**	**260 (100)**

Source: Primary Data
Note: Figures in brackets indicate percentage

The total 260 respondents, 98 percent of them are males and only two percent are females. It shows a low level participation of women in agriculture and allied activities. Eighty four (32.3 percent) male respondents are in the age group of 56 - *65* years and there are 69 males (26.5 percent) in the age group of 46 - 55 years. One of the selected respondent's age is above 86 years. All the five female respondents are below 55 years. Almost 74 percent of the farmers and the workers of the allied activities are in between the age of 46 and 75 years. It shows that the less involvement of the young people in the primary sector. Caste and religion are other social factors that influence the role of individuals in the society. The details of the caste and religion of the respondents are furnished in table-2.

Table -2: Caste and Religion of the Respondents

Religion	Caste					Total
	SC	ST	MBC	BC	FC	
Hindu	12 (4.62)	3 (1.15)	6 (2.31)	75 (28.85)	9 (3.46)	105 (40.38)
Christian	8 (3.08)	1 (0.38)	24 (9.23)	119 (45.77)	0 (0)	152 (58.46)
Muslim	0 (0)	0 (0)	0 (0)	3 (1.15)	0 (0)	3 (1.15)
Total	**20 (7.69)**	**4 (1.54)**	**30 (11.54)**	**197 (75.77)**	**9 (3.46)**	**260 (100)**

Source: Primary Data
Note: Figures in brackets indicate percentage

The caste-wise and religion-wise distribution of the respondents in above table depicts that, 58.46 percent of the total respondents are Christians, 40.38 percent Hindus and only 1.15 percent Muslims. Of the 197 Backward Caste (BC) respondents, 119 (45.77 percent) are Christians and 75 (28.85 percent) are Hindus. The caste-wise analysis shows that the respondents belong to the BC are nearly 76 per cent. The sex-wise educational attainment of the respondents are portrayed in the table given below.

Table -3: Sex-Wise Educational

Educational Qualification	Gender		Total
	Male	Female	
Illiterates	18 (6.92)	1 (0.38)	19 (7.31)
Primary	69 (26.54)	0 (0)	69 (26.54)
High school	97 (37.31)	3 (1.15)	100 (38.46)
Higher secondary	23 (8.85)	0 (0)	23 (8.85)
Graduate	29 (11.15)	0 (0)	29 (11.15)
Post graduate	15 (5.76)	1 (0.38)	16 (6.15)
Technical	4 (1.53)	0 (0)	4 (1.53)
Total	**255 (98.08)**	**5 (1.92)**	**260 (100)**

Source: Primary Data
Note: Figures in brackets indicate percentage

Sixteen (6.15 percent) post-graduates are involved in agriculture and allied activities of the total of 260 respondents. Of them 15 are males and only one is female. Four (1.53 percent) male respondents have completed technical education. Twenty nine (11.15 percent) male respondents have completed graduation and 23 (8.85 percent) completed +2. Hundred (38.46 percent) respondents have completed only high school education. Among the hundred, three are females and 97 are males. Sixty nine (26.54 percent) male respondents have completed primary education. There are also nineteen illiterates among the respondents. The occupation-wise experience is given in table - 4.

Table -4: Experience of the Respondents in Agriculture and Allied Activities

Experience (in years)	Occupation				Total
	Agriculture	Dairying	Salt pan work	Fishing	
Less than 2	1(0.5)	0 (0)	0 (0)	0 (0)	1 (0.38)
3-12	27 (13.5)	2 (10)	3 (15)	2 (10)	34 (13.08)

13-22	35 (17.5)	2(10)	1(5)	6(30)	44(16.92)
23-32	43 (21.5)	10 (50)	2 (10)	7 (35)	62 (23.85)
33-42	55 (27.5)	3 (15)	12 (60)	4 (20)	74 (28.46)
43-52	26 (13)	3 (15)	2 (10)	1 (5)	32 (12.31)
Above 53	13 (6.5)	0 (0)	0 (0)	0 (0)	13 (5)
Total	200 (100)	20 (100)	20 (100)	20 (100)	260 (100)

Source: Primary Data
Note: Figures in brackets indicate percentage

There is no person in dairying, salt work and fishing with less than two years and more than 53 years of experience. Of the respondents doing fishing, 35 per cent of the respondents have 23 - 32 years of experience and 30 percent have 13 - 22 years of experience. Only one respondent from agriculture has less than two years experience and 13 (6.5 percent) have more than 53 years of experience.

Table -5: Income-wise and Caste-wise Distribution of the Respondents

Caste	Monthly Income (in `)					Total	Average Income (in `)
	1001-13000	13001-25000	25001-37000	37001-49000	49000		
SC	18 (6.92)	2 (0.77)	0 (0)	0 (0)	0 (0)	20 (7.69)	7225
ST	4 (1.54)	0 (0)	0 (0)	0 (0)	(0 0)	4 (1.54)	6000
MBC	11 (4.23)	13 (5)	2 (0.77)	2 (0.77)	2 (0.77)	30 (11.54)	12533
BC	163 (62.69)	29 (11.15)	4 (1.54)	1 (0.38)	(0 0)	197 (75.77)	9958
FC	7 (2.69)	7 (2.29)	1 (038)	0 (0)	0 (0)	9 (3.46)	5556
Total	**203 (78.08)**	**45 (17.31)**	**7 (2.69)**	**3 (1.15)**	**2 (0.77)**	**260 (100)**	**9832**

Source: Primary Data.
Note: Figures in brackets indicate percentage.

Eighteen (6.92 percent) Scheduled Caste (SC) respondents, four (1.54 percent) Scheduled Tribe (ST) respondents, 163 (62.69 percent) respondents from backward class and 7 (2.69 percent) respondents from other caste earn `1001 - `13000 per month. Thirteen (5 percent) out of 30 respondents from Most Backward Caste (MBC) earn `13001 - `25000 and 11 (4.23 percent) earn only `1001 - `13000 per month. Two (0.77) respondents belong to MBC earn more than `49000. Only one respondent from BC earns `37001 - `49000 per month. The average income of SC respondents is `7225, ST respondents are `6000, MBC respondents are `12533, for BC respondents it is `9958 and for Forward Caste (FC) respondents it is `5556. The average monthly income of MBC respondents is higher than other groups of respondents as most of MBC respondents are fishermen who earn much more than other groups.

In India, in 2010-11 the area under paddy declined 4.13 percent and the area under banana increased 70.25 percent when compared with 2000-01. The exponential growth of the area under paddy is -0.07 percent and for banana it is 7.8 per cent. Tapioca is also one of the basic food crops in India. The area under cultivation of tapioca at all India level was 251.8 thousand hectares during 2000-01 and it declined to 221 thousand hectares in 2010-ll. But the production and productivity show an increasing trend. The coconut is one of the major cash crops in India. The exponential growth rate of area under tapioca in India between 2000-01 and 2010-11 was six percent and the growth of coconut was only 0.03 percent. Pulses are also very important food crops of the people of India. These crops can be raised both in rain fed and irrigated conditions. They comprise of red gram, green gram, black gram, horse gram, bengal gram, cowpea, mochai, and naripayaru.

It is equally necessary to understand the impact of climate factors on various crops as that of trend of area under cultivation and production and productivity of different crops have been taken for the study. To estimate the impact of one factor on another, the most commonly used tools of analysis are correlation and regression. The correlation coefficient values calculated between climatic factors and the area under cultivation of five crops with their level of significance.

Table - 6: Correlation between Rainfall, Temperature, Humidity and Area under Cultivation of Crops

	Paddy	Sig.at	banana	Sig.at	tapioca	Sig.at	cocount	Sig.at	rubber	Sig.at
Rainfall	0.11	0.29	-0.06	0.39	0.02	0.47	0.06	0.37	0.39	0.02
Temperature	-0.30	0.06	0.08	0.35	-0.06	0.37	0.09	0.32	-0.50	0.005
Relative humidity	0.07	0.35	-0.07	0.36	0.24	0.12	-0.09	0.33	0.01	0.48

There is a positive correlation between rainfall and area under paddy (0.11), tapioca (0.02), coconut (0.06) and rubber (0.39) while there is a negative correlation between rainfall and area under banana (-0.06). It means that higher rainfall increases the area under paddy, tapioca, coconut and rubber but decreases the area under banana. Temperature adversely affects the area under cultivation of three crops, paddy (-0.30), tapioca (-0.06) and rubber (-0.50) while banana (0.08) and coconut (0.09) show a positive influence. During high temperature and monsoon failure, the area under paddy, tapioca and rubber declined and vice versa. However, only the correlation coefficient between climate factors and area under rubber cultivation is significant, and for others it is insignificant. The correlation between rainfall and area under rubber is positively significant at 5% level while between temperature and area is negatively significant at 1% level. The humidity is another factor affects the area under cultivation of crops. An insignificant positive correlation is between the humidity and area under paddy (0.07), tapioca (0.24) and rubber (0.01) and an insignificant negative correlation between humidity and area under banana (-0.07) and coconut (-0.09). However, humidity and area under paddy is positively significant at only 5% level.

Thus the sub-hypothesis that "There is no significant decline in the area under cultivation of crops due to fall in rainfall" is accepted except for area under rubber. Similarly, the sub-hypothesis that "There is no significant decline in the area under cultivation of crops due to rise in temperature" is accepted. In the same way the sub-hypothesis that "There is no significant decline in the area under cultivation of

paddy, banana, tapioca, coconut and rubber due to fall in humidity is accepted. The correlation analysis between the rainfall, temperature and mean relative humidity and production of paddy, banana, tapioca, coconut and rubber explains the influence of the three climate factors on the production of selected crops. The correlation coefficient values and their significant levels are presented.

Table –7: Correlation between Production of Crops, Rainfall, Temperature and Mean Relative humidity

	Paddy	Sig.at	Banana	Sig.at	Tapioca	Sig.at	cocount	Sig.at	Rubber	Sig.at
Rainfall	0.09	0.33	0.09	0.32	-0.10	0.31	-0.09	0.31	-0.05	0.40
Temperature	-0.40	0.02	-0.06	0.37	0.16	0.22	-0.06	0.39	-0.01	0.47
Relative humidity	-0.16	0.22	-0.32	0.05	-0.05	0.40	-0.36	0.03	0.07	0.36

It is observed that there is an insignificant positive correlation between rainfall and the production of paddy and banana. It is because; these two are more water intensive crops when compared with the other three crops. A low degree of negative correlation is recorded between rainfall and the production of tapioca, coconut and rubber. It indicates that very high rainfall adversely affects the production of tapioca. Similarly, during continuous rainfall, rubber production is adversely affected. High temperature is not good for paddy, banana, coconut and rubber as there is a negative correlation between the production of these crops and temperature. High temperature reduces the production of these crops.

The positive correlation between temperature and tapioca production brings to light that even during times of higher temperature, the production of tapioca is not affected as it is a less water intensive crop. The temperature and paddy production are negatively significant at 5% level. The humidity adversely affects the production of paddy, banana, tapioca and coconut as it is evident from the negative values while the humidity positively affects the rubber production. The correlation between humidity and banana production and humidity and coconut production is negative at 5% level of significance.

As it is clear from the above discussion, The sub-hypothesis that "The fall in rainfall leads to reduction in the production of crops insignificantly" is accepted, the sub-hypothesis that "The fall in production of crops due to rise in temperature is not significant" is accepted except for paddy, and the sub hypothesis that "The fall in the production of various crops under study due to fall in humidity is not significant" is rejected for banana and coconut but accepted for paddy, tapioca and rubber. Productivity is nothing but production per hectare. Here the researcher intends to point out the impact of rainfall, temperature and humidity on the productivity of the five crops taken for the present study. The calculated correlation values are depicted.

CONCLUSION

The analysis of data that rainfall and humidity show a declining trend and temperature show a rising trend. All the three climate factors, rainfall, temperature and humidity lose their seasonality in recent time and they have some impact on agriculture and allied activities in Kanyakumari district. The climate factors like pest and disease, unseasonal rain, water shortage, flood, high temperature, solar radiation, storm and continuous rain affect the five crops. Unseasonal and unpredictable rain, excess rain and lower temperature affect salt production. Wind and waves, high temperature, high sea surface temperature and high water current affect fish production. As the mitigation cost is high, the nature cannot be controlled and the impact of climate change cannot be mitigated, government must come forward to reduce the climate changing human activities. Otherwise, as the area under food crops is continuously falling, food crisis cannot be avoided. The distress of dairy farmers should be addressed through suitable measures. If the suggestions mentioned above are carried out with a strong will power, agriculture and allied activities can be protected from the adverse impact o climate change.

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