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IMPACT OF CLIMATE CHANGE ON AGRICULTURE SECTOR OF RAJASTHAN

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Abstract

This study was undertaken to study the effect of climate changes on agriculture in Rajasthan on the seasonal crops of Rabi and Kharif. Among the major elements of climate- temperature ,pressure ,wind ,humidity ,area and rain ,the present study focuses on temperature (Minimum & Maximum) ,rain fall and area under production . It was found that the Barley the Rabi Crop was the most effected crop and Sikar was the most effected district among the 21 districts taken under the study.

Keywords: *Climate change, Rabi, Kharif*

Introduction: Rajasthan is the largest state of India in terms of area. Rajasthan has 32 districts. It has a rich and colourful history making it one of the most popular tourist destinations in India. According to State Action Plan on Climate Change (SAPCC), it was found that Rajasthan has been identified as one of the four most vulnerable states. This desert comprises a very dry part. And it is one of the most prone areas to climatic changes. Due to the unpredictable climatic patterns, the crop production is highly affected in this state.

Climate and Climate Change: Climate refers to the prevailing or average weather conditions of a place, as determined by the temperature and meteorological changes over a period of years. There are several elements that make up the climate of a place. The major of these elements are five in number: temperature, pressure, wind, humidity, and rain. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate change refers to a change in the typical or average weather of a region for example, a change in the average annual rainfall or average temperature of a region. It may also be defined as a change in the statistical distribution of the weather patterns when that changes last for an extended period of time (i.e. decades to millions of years). It may be

caused by various factors such as biotic processes, variations in solar radiation received by earth and volcanic eruptions. Certain human activities have also been identified as significant causes of recent climate change. Climate change is global phenomenon and no country is immune to it.

Effects of Climate Change on Agriculture: Depending upon the natural resources, agriculture sector is vulnerable to climate change and vagaries of nature. Climate change is likely to negatively affect crop production in low latitude countries. Climate change affects agriculture in a number of ways including through change in average temperatures, rainfall and climate extremes (e.g., heat waves); changes in pests and diseases; change in atmospheric carbon dioxide and ground-level ozone concentrations; changes in the nutritional quality of some foods; and change in sea level. Climate change is impacting the natural ecosystems and is expected to have substantial adverse effects in India, mainly on agriculture on which 58% of the population still depends for livelihood.

Climate Scenario in Rajasthan: Rajasthan has been identified as one of the four states most vulnerable due to climate change by State Action Plan On Climate Change (SAPCC). Rajasthan being the largest state in India with two-thirds of its area as Thar Desert is particularly characterized by low and erratic rainfall, high air and soil temperature, intense solar radiation and high wind velocity, and then too the soil of Rajasthan does support a substantial agricultural population (almost 80%) who harvest protein rich crops like Jowar & Bajra. Also, the agricultural sector accounts for almost 22.5% of the States GDP. Rajasthan is the largest producer of Rapeseed & Mustard that accounts for 44.61% of the total national produce. Also, wheat, corn & millets are the three most important crops of the region, along with pulses.

Climate Change is increasing the pressure on already scarce resources and if proper measures are not taken, migration towards the cities will soon reach new heights. Given the fragility of the resource base in much of Rajasthan, agriculture is a high risk activity.

Climate change poses formidable challenges to the animal husbandry sector as well. Rajasthan is the second highest producer of milk in the country (amounting to nearly 17lakh kg per day). But the current annual loss in milk production due to heat stress in Rajasthan is 98.65, 40.55 and 29.74 litres per animal per year in crossbred cows, local cows and buffaloes respectively, states the report by Rajasthan State Action Plan on Climate Change(RAPCC). On the other side, it would affect the demand and corresponding changes in crop prices. The harvest prices of food grains, pulses, vegetables and spices have constantly been on the rise. Yield-temperature response curves show that there is a decrease in grain yield of wheat in

Rajasthan at the rate of 2.49 quintals per hectare per degree rise in seasonal temperature, 0.92 quintals per hectare decrease in yield of mustard, reads the report by RAPCC. Shifting cropping patterns to more heat adapted and less water consuming varieties is a strategy already practiced by farmers. The following crops were chosen for the study:

Kharif	**Rabi**
Jowar	Barley
Maize	Gram
Moth	Masur
Small Millets	Matar
Tur(Arhar)	Rapeseed & Musturd

Review of Related Literature:

To ensure thorough understanding of the topic and identifying knowledge gaps that demand further investigation following research papers were reviewed:

Hanif et al.(2010) made a study on Economic Impact Of Climate Change On Agri-cultural Sector Of Punjab . The main objective of the study was quantification of the impact of change in climate on the development of agricultural sector both at country and regional level. A one-way fixed effect panel model for eleven districts over time period 1970-2009 which was estimated by FGLS (Feasible generalized Least Square) panel regression technique. The results of panel regression of precipitation, maximum and minimum temperature are derived on Punjab Agricultural Land. The climate variable considered was Kharif and Rabi Seasons. As a result to their study it was found that the climatic factor-Precipitation in Rabi season has significant negative relationship. It was interpreted that decrease in Rabi Precipitation coupled with increase in maximum Rabi Temperature will tend to increase the land price in the season. Also, it was observed mean maximum Kharif temperature is not significant with the land prices. however, with precipitation opposite is the case mentioned.

Deressa et. al.(2005) employed a Ricardian model that captures farmers adaptation to analyze the impact of climate change on South African Sugarcane production under irrigation and dry land conditions. The study utilized time series data for the period 1977 to 1998 pooled over 11 districts. Results showed that climate change has significant nonlinear impacts on net revenue per hectare of sugarcane in South Africa with higher sensitivity to future increases in temperature than precipitation. Irrigation did not prove to provide an effective option for mitigating climate change damages on sugarcane production in South Africa. The study suggests that adaptation strategies should focus special attention on technologies and management regimes that will enhance sugarcane tolerance to warmer temperatures during winter and especially the harvesting phases.

Justification of the Study: Climate change is one of the biggest factors responsible for food insecurities around the globe. The problem of food insecurities leads to various kind of another problems. The main reason behind food insecurities can be the less production of crops than the demand for the same. In India, Rajasthan is one of the states which are badly affected from food insecurities. The main reason behind it is the less production of crops due to climatic changes.

Statement of the Problem:

"IMPACT OF CLIMATE CHNAGE ON AGRICULTURE SECTOR OF RAJASTHAN"

Objectives of the Study:

- To study the impact of climate change on the production of crops of Rabi and Kharif.
- To study the impact of climate change on the production of Crops in different Districts of Rajasthan.
- To study the impact of climate change on production of crops during the time period 2007 - 2011.
- To compare the impact of climate change on the production of Rabi and Kharif crops.

Design of the Study:

As the study aims to reflect the impact of climate change on agricultural sector of Rajasthan, a panel data for 10 major crops that are been grown in Rajasthan is analyzed for 21 districts of the state for the years 2007-2011 using R software.

Panel data, also called longitudinal data, contain periodically repeated observations of the same subjects. A major advantage of panel data is in- creased precision in estimation which is the result of an increase in the number of observations owing to combining or pooling several time periods of data for each individual. For carrying out the study, the data of 21 districts of

Rajasthan namely Ajmer, Banswara, Barmer, Bikaner, Bundi, Chittorgarh, Churu, Dholpur, Ganganagar, Jaipur, Jaisalmer, Jalore, Jhalawar, Jhunjhunu, Jodhpur, Kota, Pali, Sawai Madhopur, Sikar, Sirohi and Udaipur has been collected.

The crop growing seasons of Rajasthan have broadly been divided into two main seasons viz., Rabi and Kharif. The Rabi crops are winter crops and are sown in the months of October and November and are harvested in the months of March and April and include Barley, Gram, Wheat and Oil seeds. The Kharif crops are the crops that are grown in the summer season and are seeded in the months of June and July. These crops are harvested in

the months of September and October and include Bajra, Pulses, Jowar, Maize and Ground nuts. For this study data of 10 major growing crops (5 Rabi & 5 Kharif) in Rajasthan is collected. The reason for selection of these crops is that their production graph has shown a decreasing trend over time and also they are the most demanded crops by the masses.

In order to study the impact of climate on agricultural productivity a linear regression model with the Production (in tonnes) of a crop as dependent variable and rainfall (in centimetres), minimum temperature(in oC) , maximum temperature (in oC) & area under production (in hectares) as independent variables, is fitted. A backward elimination approach on the following model is applied to find out the best fitted regression model for the available data.

Production = β0 +β1 Rain +β2 Min_t +β3 Max _t+β4 Area +Di +Ti +€ where, Production denotes the dependent variable of annual production of crop in tonnes, Rain denotes the independent variable which measures annual rainfall in centimetres, Min _t denotes the independent variable which measures minimum annual temperature of the district, Max _t denotes the independent variable which measures maximum annual temperature of the district, Area denotes the independent variable which measures area under production of a particular crop in a district, and Di is the dummy variable for i^{th} district & Ti is the dummy variable which denotes time; i=1,2...20, j=1,2,3,4

A Fixed Effect-Least Square Dummy Variable model allows intercept to vary across cross-sections and time by using the dummy variables. All the results are being tested at 5 % level of significance. The data was found free of multicollinearity and autocorrelation which were tested using Variance Inflation Factor (VIF) and Durbin-Watson test respectively. As for the homoscedasticity is concerned data for all the crops except Matar is heteroscedastic and hence their model is fitted using the method of Generalized Least Squares (GLS) while that of Matar is fitted using Ordinary Least Squares (OLS) method. Apart from obtaining a regression model for each of the 10 crops, district (cross-section) fixed effects have also been studied. The reason to include place (district) fixed effects is that district fixed effects can absorb unobserved time invariant determinants of the dependent variable. When Cross section fixed effect is applied, model have constant slopes but intercept differ according to time. The source of variation in the intercept is some unobserved attributes (i.e. preference for agricultural occupations in specific districts, agricultural practices etc.). These unobserved attributes vary from one district to the other but are constant over time.

A linear regression model that best fits the available data is found for each of the 10 crops using the backward elimination approach to find the independent variables that

significantly affect the crop productivity. In order to get a broad view of the effect of climate change on the crop growing seasons of Rajasthan a comparative study of Rabi & Kharif crops is done.

Finding of the study:

- Among all the crops included in the study Barley is most affected by climate change.
- Out of the 21 districts considered in the study the crop production in only 10 of them viz.,Banswara, Bikaner, Chittorgarh, Churu, Ganganager, Jaipur, Jhunjhunu, Sawai Madhopur, Sikar & Udaipur is significantly affected.
- For the time period considered in the study i.e., 2007-11 the production of Jowar, Maize, Moth, Masur, Matar, Rapeseed & Musturd is not significantly affected in any of the districts. A significant effect on the production of Small Milletes, Tur, Barley & Gram is seen in Banswara whereas Barley's production is significantly affected in all the districts except Ajmer, Jaipur & Sikar.

Conclusion: 1) Barley is the most affected crop because with 1^{o} C change in maximum temperature, the production is decreased by 4485.67 tonnes.

Table 1: Individual Crop Effect

Variable	Coefficient	P_value
Intercept	174064.38	0.0550
Rainfall	-16.18	0.5448
Maximum Temperature	-576.22	0.5862
Minimum Temperature	-4485.67	0.329
Area	3.42	0.0000

2) Out of the 21 districts considered in the study the crop production in only 10 of them viz.,Banswara, Bikaner, Chittorgarh, Churu, Ganganager, Jaipur, Jhunjhunu, Sawai Madhopur, Sikar & Udaipur is significantly affected.

Table 2: Districts Fixed Effects

District	Fixed Effect	P-value
Ajmer	16518.15	0.0589
Banswara	24902.60	0.0045
Barmer	7472.97	0.3923
Bikaner	22830.20	0.0091
Bundi	17106.65	0.0504
Chittorgarh	51783.35	0.0000
Churu	22935.08	0.0088
Dholpur	9931.80	0.2556
Ganganager	55432.65	0.0000
Jaipur	36630.40	0.0000
Jaiselmer	7738.28	0.4073
Jalore	11562.20	0.1858
Jhalawar	17011.35	0.0517
Jhunjhunu	21400.10	0.0145

Jodhpur	15808.30	0.0706
Kota	15676.60	0.0729
Pali	11749.92	0.1787
Swai Madhopur	20408.82	0.0197
Sikar	20294.82	0.0203
Sirohi	6860.20	0.4322
Udaipur	29914.75	0.0006

3) Effect of Time: This concludes that which of the district's crop productivity is significantly affected over the time.

Table 3: Effect of Time

Crop	District
Jowar	No District
Maize	No District
Moth	No District
Small Milletes	Banswara
Tur	Banswara
Barley	All except Ajmer,Jaipur & Sikar
Gram	Banswara & Udaipur
Masur	No District
Matar	No District
Rapeseed & Musturd	No District

4) Individual Year Effect: It can be concluded that in all the four Years of study, except for the year 2009-2010, most of the crops '(7 out of 10)' production is affected.

Table 4: Individual Year Effect

Years	**Crops**
2007-08	Jowar, Maize, Moth ,S.Milletes, Tur, Matar, Rapeseed & Musturd
2008-09	Barley, Jowar, Maize, Tur, Gram, Matar, Rapeseed & Musturd
2009-10	Rapeseed & Musturd
2010-11	Barley, Jowar, Maize, Moth, S.Milletes, Gram, Rapeseed & Musturd

References:

Deressa T, Hassan T and Poonyth D. MEASURING THE IMPACT OF CLIMATE CHANGE ON SOUTH AFRICAN AGRICULTURE: THE CASE OF SUGERCANE GROWING REGIONS. A grekon(Agriculture Economics Association of South Africa), Vol. 44, No.4, December 2005.

Hanif Uzma, Syed Shabib, Ahmad Rafique and Malik Kuser Abdullah. ECONOMIC IMPACT OF CLIMATE CHANGE ON AGRICULTURE SECTOR OF PINJAB. The Pakistan Development Review, 2010.

www.censusindia.gov.in

www.indianenvironmentalportal.org.in

www.krishi.rajasthan.gov.in

www.mapsofindia.com

www.rajasthanstat.com

www.rpcb.rajasthan.gov.in

www.statistics.rajasthan.gov.in

www.waterresources.gov.in