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SOCIO-ECONOMIC IMPACTS OF CLIMATE CHANGE ON SELECTED CROPS AND DOMESTICATED ANIMAL PRODUCTION IN INDIA

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Abstract: **India is second most populated country in the world, where the majority of rural population is still dependent on agriculture for their livelihood and over 600 million farmers are involved in agriculture related activities. Agriculture and allied activities contribute about 13.9% to the gross domestic product of India. India has 52% of cultivable land and varied climates. With arable land area of 168 million hectares, India ranks second only to the U.S. in size of agricultural area. India, a developing nation quite vulnerable to climate change, can also cause tremendous impact on world food demand. This study seek to understand how the severity of climatic effect (most vulnerable regions or states) in particular regions in India caused drastic reduction in agriculture production and growth rate of yield and analyse the rate of agricultural production decrease due the climate change in some selected regions of India**

Keywords: **Climate Change, Impacts, Production, Vulnerability, India.**

1. INTRODUCTION

Agriculture has been the backbone of the Indian economy and it will continue to remain so for a long time. It has to support almost 17 per cent of world population from 2.3 per cent of world geographical area and 4.2 per cent of world's water resources. The economic reforms, initiated in the country during the early 1990s, have put the economy on a higher growth trajectory. Annual growth rate in GDP has accelerated from below 6 percent during the initial years of reforms to more than 8 percent in recent years. This happened mainly due to rapid growth in non-agriculture sector. The workforce engaged in agriculture between 1980-81 and 2006-07 witnessed a very small decline; from 60.5 percent to 52 percent. The present cropping intensity of 137 per cent has registered an increase of only 26 per cent since 1950-51. The net sown area is 142 Mha. The net irrigated area was 58.87 Mha in 2004-05. Presently, the total net irrigated area covers 45.5 per cent of the net sown area, the remaining 54.5 per cent is rain fed. The degradation of land and surface as well as ground water resources results in fast deterioration of soil health. Losses due to biotic (insect-pests, diseases, weeds) and abiotic (drought, salinity, heat, cold, etc.) stresses account for about one- fourth of the value of agricultural produce. The storage, transportation, processing, value addition and marketing of farm produce need to be improved to enhance household food, nutrition and livelihood security.

Average size of farm holdings gradually reduced from 2.58 ha to 1.57 ha Small and marginal farmers have limited resources especially in rain-fed regions where only animate power is used resulting in low productivity. Though agricultural production is high, the per hectare productivity is much lower than world average. There is an urgent need to increase productivity (MM Pandey, 2009)

2. MATERIAL AND METHODS

I. Study Area

II. Location

The Indian mainland extends between 8°4' North and 37°6' North latitudes and from 68°7' East and 97°25' East longitudes. Thus, the latitudinal and the North-south extent is 3214 km and East-west extent is 2933 km. India accounts 2.42% of the total world land area. India lies entirely in the northern hemisphere, and eastern hemisphere. The Tropic of Cancer (23°30'North) passes through the centre of the country. It divides the country into almost two equal parts Northward of this latitude is North India and South of it is known as south India. Similarly, 82°30' East longitude passes almost from the middle of the country. It is known as Standard Meridian of India. India is part of Asian continent. India is surrounded by water from three sides, Arabian sea in west, Bay of Bengal in the east and Indian ocean in the south. Towards its north west is Pakistan and Afghanistan. China, Bhutan, Tibet and Nepal lies to its north. Bangladesh and Myanmar lies to its east Srilanka and Maldives are located in the Indian Ocean towards its south. The southernmost point of the country is Indira Point (Nicobar Islands) which lies on 6°4'N latitudes and Kannya Kumari is southernmost point of Indian mainland which lies on 8°4'N latitudes.

Drainage systems in India refer to the system of flow of surface water mainly through rivers. An area drained by a river and its tributaries is called a drainage basin. The drainage system is related to a number of factors like slope of land, geological structure, amount and velocity of water. A river through its drainage system performs several tasks. These are excess water removal from a particular area, transportation of sediments from one place to other, providing natural source for irrigation and maintaining the water table of a region. Traditionally, rivers were useful as a source of abundant fresh water and navigation. In today's world rivers importance has risen to include hydro power generation and setting up water-based industries. These are also important tourist attraction for activities such as boating, river rafting and cliff jumping. Because of their utility, rivers are important for life and hence regarded as lifeline. Many cities are located along the rivers and are densely populated. Delhi on the banks of Yamuna, Patna along Ganga, Guwahati along Brahmaputra, Nasik along Godavari and Cuttack along Mahanadi are some examples. On the basis of the origin the drainage can be divided in to two parts: (a) The Himalayan drainage system (b) The Peninsular drainage system 3.5 Climate of India The whole of India has a monsoon type of climate. But the combination of elements of the weather, however, reveal many regional variations. These variations represent the subtypes of the monsoon climate. It is on this basis that the climatic regions can be identified. A climatic region has a homogeneous climatic condition which is the result of a combination of factors. Temperature and rainfall are two important elements which are considered to be decisive in all the schemes of climatic classification. The classification of climate, however, is a complex exercise. There are different schemes of classification of climate. Major climatic types of India based on Koppen's scheme have been described below: Koppen based his scheme of Climatic classification on monthly values of temperature and precipitation. He identified five major climatic types, namely: (i) Tropical climates, where mean monthly temperature throughout the year is over 18°C. (ii) Dry climates, where precipitation is very low in comparison to temperature, and hence, dry. If dryness is less, it is semiarid (S); if it is more, the climate is arid(W) (iii) Warm temperate climates, where mean temperature of the coldest month is between 18°C and minus 3°C. (iv) Cool temperate climates, where mean temperature of the warmest month is over 10°C, and mean temperature of the coldest month is under minus 3°C. (v) Ice climates, where mean temperature of the warmest month is less than 10°C. (NCERT,2006)

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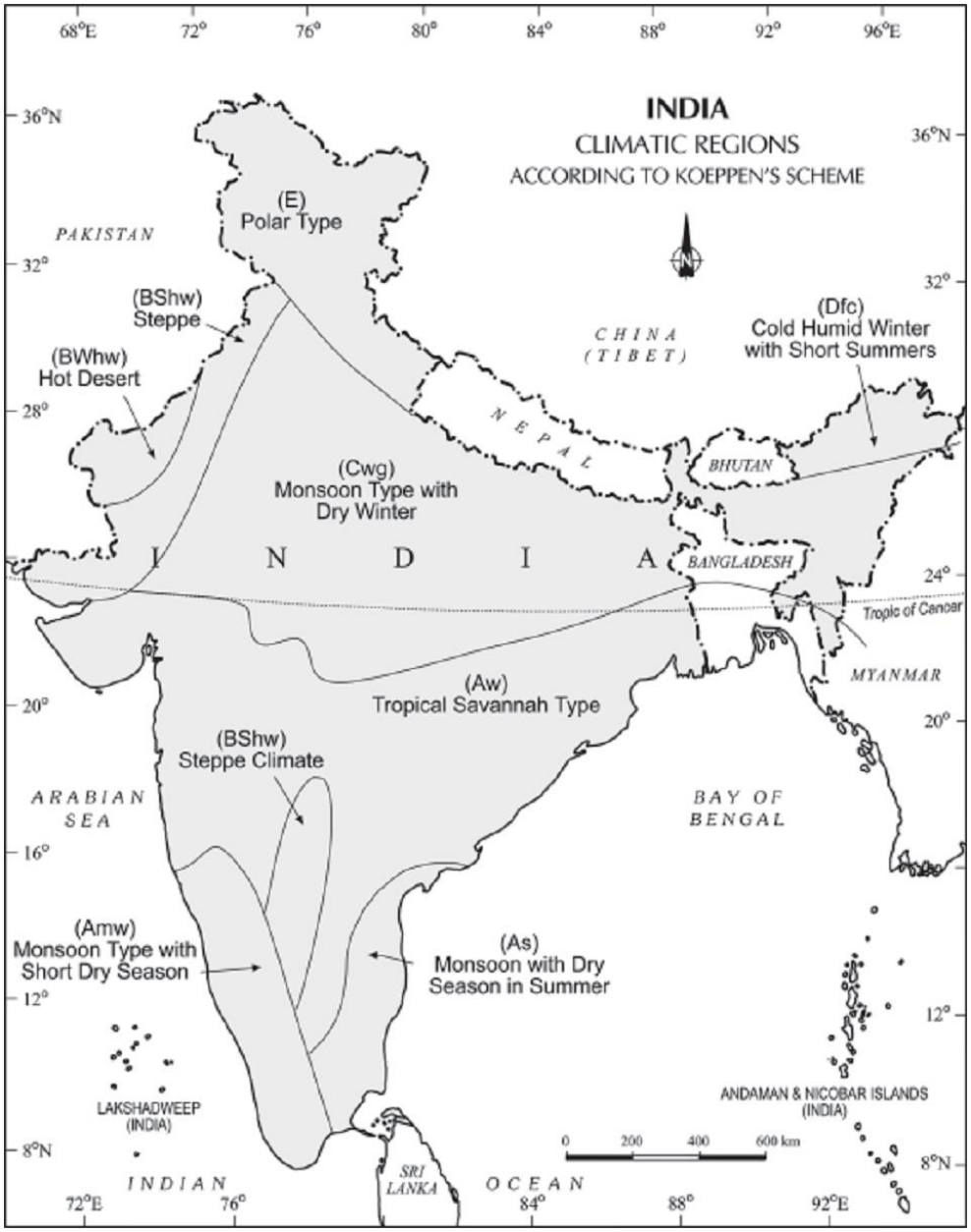

Figure 1: Map of India Showing Climatic Regions according to Koppen's scheme

Source: (NCERT,2006)

3. METHODOLOGY

This study has used secondary data collected from various published sources, viz. input data on fertilizer use, irrigation facility, area under high-yielding varieties (HYVs) by farm-size, etc. were taken from various volumes of the Input Surveys published by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India (GOI). The analytical measures like simple tabular analysis, growth rate, and fertilizer imbalance index were applied to evaluate accessibility and use of production resources by smallholders versus other farmers. Meanwhile, strategic planning method used to evaluate the strength, weaknesses, opportunities and threats (SWOT) involved in the research, which specify the and identify the internal and external factors that are favorable and unfavorable to the farmers. Interviews and consultations with national and international experts, also regional, national and international level to generate necessary information.

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Table 1: Growth Domestic Product by Economic Activity at Current Prices in India

Industry	2004-05	2010-11	2011-12$	2012-13*	2013-14**
(1)	(2)	(3)	(4)	(5)	(6)
1. Agriculture, forestry & fishing	**565426**	**1319686**	**1499098**	**1644926**	**1906348**
Industry	**829783**	**1968450**	**2284366**	**2460445**	**2594171**
2. Mining & quarrying	85028	204866	222716	222416	222652
3. Manufacturing	453225	1072489	1236182	1320907	1350039
4. Elect. gas & water supply	62675	119560	135670	157132	203049
5. Construction	228855	571535	689798	759990	818432
Services	**1576255**	**3960723**	**4608227**	**5283505**	**5972288**
6. Trade, hotels & restaurant	477303	1250472	1457565	1615865	1728836
7. Transport, storage & communication	250417	529158	614707	708830	781072
8. Financing, insurance, real estate & business services	437174	1165243	1381524	1617076	1939482
9. Community, social & personal services	411361	1015850	1154431	1341734	1522898
10. Gross Domestic Product at factor cost (1 to 9)	**2971464**	**7248860**	**8391691**	**9388876**	**10472807**
11. Total Net Domestic Product at factor cost	2651573	6488641	7511795	8372744	9299345
12. Net Factor Income from Abroad	-22375	-81807	-76830	-116766	-128300
13. NNP at Factor Cost	2629198	6406834	7434965	8255978	9171045
14. Per Capita NNP (in ₹)	24143	54021	61855	67839	74380

Source: Central Statistical Office of India, 2005

Agricultural sector provides 23 % of Gross National Production (GNP) of our country and it is the important livelihood for nearly about 70 % of the population. (Khan *et al.*, 2009). The large variability in topography, climate, cultivation and management practices increase the complexity of the climate change analysis. The 4x4 assessment conducted by Indian Network for Climate Change Assessment (INCCA) shows the importance of sectorial and region vice assessment of climate change impact over India. If the ecosystem under consideration is mountainous, then it becomes more difficult to understand the impact of climate change due to its complexity in topography and orographic features, (ICIMOD, 2010)

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Figure 2: Percentage Share of Major Economic Activities in GDP at Constant (2004-2005) Prices

Source: Central Statistical Office of India, 2005

From the statistical analysis of food production, it is evident that supply response of food production is greatly influenced by irrigation and fertilizer usage. Irrigation has been and is a crucial factor for reducing the fluctuation in food production in last decade. It is however, true that now with over 50% of rain fed the area under rainfall is still one of the most important factors determining average yield. Due to vagaries in rainfall, fluctuations in yield were observed. In the year 2006 out of 89 million tonnes of rice production nearly 30 million tonnes were produced in area without irrigation. In case of wheat, out of 56 million tonnes only 6 % of the total production comes from rain fed area.

There is also a growing concern about the growth rate of yield. In the period 1980-1990, yield of food grain was increasing at 3.2% per year but in the next decade the growth has slowed down to 1.7%. The slow growth in yield may be contributed by declining groundwater table, salinity intrusion and overuse of fertilizer. This slow growth of yield is prominent in the north zone where growth in food grain yield is not significantly higher compare to other geographic zones. This is also the region where fertilizer usage is very high and contributes more than 30% of the relative change in yield.

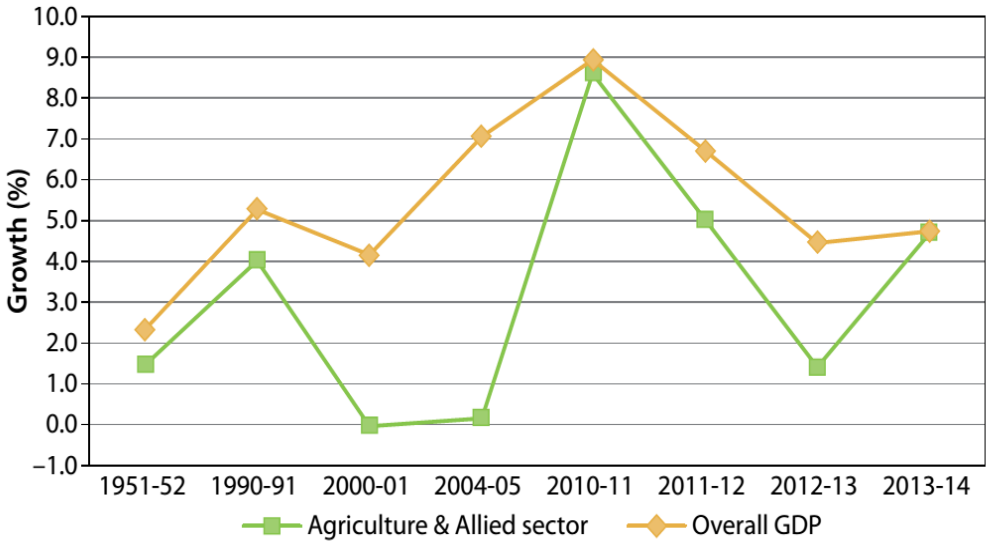

Figure 3: Growth of Agriculture and Allied Sector GDP and Overall GDP at Constant (2004-2005) Prices

Source: Central Statistical Office of India, 2005

4. RESULTS AND DISCUSSIONS

4.1 Impact on Maize Production

Table 1: Impact of climate change on maize production

Model used	Region	Temperature (°C)	CO_2 (ppmv)	Impact on yield	Reference
	Punjab	+1	Normal	-10.4%	Hundal and Kaur,1996
		+2		-14.6%	
		+3		-21.4%	
CERES-maize	North India	up to +4	350	Continuous yield reduction	Sahoo,1999
		Normal	700	+ 9%	
		+ 0.6	700	Nullified the beneficial effect of CO_2 fertilization	

Field Survey, 2016

Climate change affects the yield of maize by 10%-21.4% deficit in Punjab and will nullify the beneficial effect of $C0_2$ fertilization in Northern India respectively

4.2 Impacts on Fruits Production

- Shift in apple cultivation to higher elevations due to nonfulfillment of chilling requirement
- Increase in temperature did not show any significant impact on productivity of other temperate fruits like Peach, Plum and Pear
- Unseasonal rainfall in March 2008 – cashew was affected
- The tea crop in mid hill regions also showed a decrease in yield with increasing temperature and decreasing rainfall

4.3 Climate Change Impacts on Animals

4.4 Impacts on Livestock

Heat wave reduce a milk yield by 10-30% in first lactation and 5-20% in second and third lactation periods in cattle and buffaloes it also affects the growth, puberty and maturity of crossbreed of cows and buffaloes

4.5 Impact on Fish Production

Mortality of fish lings in shallow water ponds and there will be reduction in fish catch in the water bodies due to movement of fish into the deeper layers caused by the increase of temperature resulted from global warming

4.6 Climate change and poultry production

Under the ICAR Network Project on Climate Change, the impact of high ambient temperature on survivability and performance was evaluated. As the ambient temperature reached ≥34°C the mortality due to heat stress was significantly high in heavy meat type chickens (8.4%) as compared to light layer type (0.84%) and native type (0.32%) chickens. Feed consumption decreased from 108.3 g/bird/day at 31.6°C to 68.9 g/ bird/day at 37.9°C. The egg production also decreased both in broiler (by 7.5%) and layer (by 6.4%) breeders as compared to their standard egg production. The body temperature increased from 41 to 45°C as the shed temperature rose from 28 to 42°C and the critical body temperature at which the birds succumbed to death was 45°C, which was observed at the shed temperature of 42°C. Naked neck birds performed significantly better than the normal birds with respect to thermos tolerance, growth, feed efficiency and immunity at high temperatures.

5. CONCLUSION

Agriculture as the backbone of development if face with numerous challenges invarious regions of India. Persistent climatic variability has drastically affected both crop and animal production in India. Therefore, this study conclude that if appropriate measures are not take crop and animal production will continue to decline which has negative impacts as may lead to hunger, poverty and starvation among others. Therefore, this study recommends various measures to tackle the socio-economic impacts of climate change in India.

6. RECOMMENDATIONS

1. Poverty reduction and economic growth can be the prime objectives of national policy.

2. Despite the uncertainties surrounding climate change, the risks of potentially adverse impacts on the food chain, coastal zones and increased occurrence of extreme events should be avoided by early action.

3. Creating a vulnerability profiles for India to climate change and agricultural trade liberalization is proposed at district level. The vulnerability mapping revealed regions of high double exposure.

4. Identification of national and international public policy measures supporting adaptation responses in regions of India vulnerable to climate change and globalization.

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