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# Climate Change Impact on Food

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## I. INTRODUCTION

Climate change is defined as change in climate over time, whether due to natural variability or as a result of human activity. United Nations Framework Convention on Climate Change defines Climate Change “a change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable periods of time”<sup>2</sup>

Climate change poses a serious threat to the productivity of natural resources especially water resources. The adverse effects of climate change defined in UNFCCC clearly disclosed that changes in the physical environment adversely affects the natural ecosystems, socio economic systems and human health.<sup>3</sup>

Climate is changing naturally from the evolution of earth and the same is inevitable in the nature but due to anthropogenic interference the changes has happening rapidly and the same will destroy the species of this globe. In India the direct impact of climate change reflected in our agricultural growth and development. Improper rainfall and temperature reduce the yield because in India most of the areas are dry and practicing rainfed agriculture and irrigated agricultural systems due to lack of rain and short term high intense rain collapsed the agricultural systems which will affect the food security and scarcity of the nation.

The results of Global climate change indicate that increasing temperature and decreasing growth and yield of agricultural crops. Agricultural landscapes are increasing day by day due to low yield and the same causing additional global warming by producing methane and nitrogen gases.

The Third Assessment Report of Inter-governmental Panel on Climate Change (IPCC) projected that, “The impacts of climate change will fall disproportionately upon developing countries and the poor persons within all countries, thereby exacerbate inequities in health

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<sup>2</sup> ARTICLE 1 (2), UNFCCC,1992

<sup>3</sup> "Adverse effects of climate change" means changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare.

status, and access to adequate food, clean water and other resources.”<sup>4</sup> Populations that derive sustenance from agriculture, fisheries and forests are particularly vulnerable to loss of livelihood options. Primarily, this dissertation attempts to enunciate the impact of this climate change on Indian agriculture which struggles to remain unaltered and develop despite the acute food crisis problems prevalent in the country. A recent IPCC report also warned that in the years to come, food security will stand threatened due to climate change coupled with increasing demands of the rising population<sup>5</sup>.

The consequences of climate change on environment are a life-threatening issue because it affects the global food production by affecting the crops and livestock. Today our world has discussing about the prevention and mitigation of climate change impact but all the conference ends up with no concrete solutions.

According to the Indian Meteorological Department, the annual mean temperature in the country has increased by 0.6 degrees Celsius between 1901 and 2018, when compared to pre-industrial levels. Eleven of the 15 warmest years have so far all been within the last 15 years with 2018 being the sixth warmest year in India’s recorded history<sup>6</sup>. As per the recent reports the global temperature is expected to increase between 3-5 degree Celsius by 2100 and India will be affected severely due to its geographical location at tropical region

Climate Change impact also adversely affect the livestock the research reports shown that heat stress has a negative impact on the reproduction traits of cows and buffaloes and the same will affect the dairy industries of the nation<sup>7</sup>

Scientists of the Central Marine Fisheries Research Institute have found that fish species on the east coast may be much more vulnerable to climate change than fish varieties found on the west coast. Climate change will impact ocean current, acidification, temperature and food availability. All of this will affect the production of fish.

## **II. CLIMATE CHANGE IMPACT ON AGRICULTURE**

Increases in drought and flood frequency are projected to affect local crop production negatively, especially in subsistence sectors at low latitudes. Globally, potential for food production is projected to increase with increases in local average temperature over a range of

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<sup>4</sup>Ed. Sudan, K. Falendra “Encyclopedia of Environment and Development- Poverty, Environmental Degradation and Sustainable Development”, Vol. 4, 1st Ed., Serials Publication, New Delhi, 2009, at pp. 973-995

<sup>5</sup> <https://thewire.in/agriculture/climate-change-poses-serious-threats-to-indias-food-security> 19.09.2019 visited on 23.02.21

<sup>6</sup> <https://thewire.in/agriculture/climate-change-poses-serious-threats-to-indias-food-security> 19.09.2019 visited on 23.02.21

<sup>7</sup> The Research at the National Dairy Research Institute, Karnal has found that heat stress has a negative impact on the reproduction traits of cows and buffaloes and their fertility will be adversely impacted.

1-3 °C, but above this range, food production is projected to decrease. At lower latitudes, especially in the seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2 °C), which would increase risk of hunger. With the virtually certain likelihood of warmer and more frequent hot days and nights, there are projected to be increased insect outbreaks impacting agriculture, forestry and ecosystems.<sup>8</sup>

Agriculture sector represents 23 per cent of India's Gross National Product (GNP) and plays a crucial role in the country's development and shall continue to occupy an important place in the national economy. Agriculture is an inevitable part of our life and it sustains the livelihood of nearly 70% of the population. It seems obvious that any significant change in climate on a global scale will impact local agriculture, and therefore affect the world's food supply<sup>9</sup>.

Climate change will have an economic impact on agriculture<sup>10</sup>. The magnitude and geographical distribution of such climate-induced changes may affect our ability to expand the food production as required to feed the populace. Climate change could thus have far reaching effects on the patterns of trade among nations, development and food security.

Agriculture is sensitive to short-term changes in weather and to seasonal, annual and long-term variations in climate. Crop yield is the culmination of a diversified range of factors. Parameters like soil, seed, pest and diseases, fertilizers and agronomic practices exert significant influence on crop yield. Agricultural productivity can be affected by climate change in two ways: first, directly, due to changes in temperature, precipitation and/or CO<sub>2</sub> levels and second, indirectly, through changes in soil, distribution and frequency of infestation by pests, insects, diseases or weeds. Acute water shortage conditions, combined with thermal stress, could adversely affect wheat and, more severely, rice productivity in India even under the positive effects of elevated CO<sub>2</sub> in the future. The mean temperature in India is projected to increase by 0.10 C to 0.30C in kharif (summer) and 0.30C to 0.70C in rabi (winter) by 2010 and to 0.40C to 2.00C in kharif and 1.10C to 4.50C in rabi by 2070 (IPCC, 1996). Mean rainfall is projected not to change by 2010 but may increase by 10% during rabi by 2070. At the same time, there is an increased possibility of climate extremes, such as the timing of onset of monsoon and intensities and frequencies of droughts and

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<sup>8</sup>IPCC AR4

<sup>9</sup>Shakeel A. Khan, Sanjeev Kumar, M.Z. Hussain and N. Kalra "Climate Change, Climate Variability and Indian Agriculture: Impacts Vulnerability and Adaptation Strategies" S.N. Singh (ed.), *Climate Change and Crops*, Environmental Science and Engineering, DOI 10.1007/978-3-540-88246-6 2,)

<sup>10</sup>Economic impact including changes in farm profitability, prices, supply, demand and trade

floods.

### **Strategies for facing the challenge**

Specific measures can only provide a successful adaptive response if they are adopted in appropriate situations. i.e Sustainable Agriculture, Agro- biodiversity, variety of issues need to be considered, including land-use planning, watershed management, disaster vulnerability assessment, consideration of port and rail adequacy, trade policy, and the various programmes countries use to encourage or control production, limit food prices, and manage resource inputs to agriculture.

### **III. CLIMATE CHANGE IMPACT ON HIMALAYAN REGION**

Mountain regions and its agricultural patterns are different than the plain regions, land use change, degradation increasing urbanisation causing serious threat to the food security of mountain regions. Shifting precipitation patterns, increasing temperatures are affecting the agriculture in mountain regions. According to research reports many mountain communities especially Indian Himalaya are unlucky and the reports disclosed that food related insecurity is increased in recent years.<sup>11</sup> According to the reports 65% of agriculture in mountain regions are rain-fed and 35% is irrigated<sup>12</sup>.

Nearly 50 million people reside among the Himalayan mountains, and almost 1.5 billion depend on these mountains for water, food and energy. The Indian Himalayan Region spans Jammu, Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and parts of Assam and West Bengal. The situation is the same in all of the Hindu Kush Himalayan countries. Due to climate change impacts the mountain communities suffer due to either too much or too little water, and face extreme events more often. Himalayan populations are also remote, hardly accessible and depend more on natural resources. The more the latter are depleted, the poorer and more vulnerable these people become, according to the report.

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<sup>11</sup>According to a new assessment, between 2012 and 2017, the rural mountain population vulnerable to food-related insecurity increased from 307 million to 346 million people – i.e. by 12% in only five years. Researchers released the study on September 12, at the UN Convention to Combat Desertification, Land Degradation and Drought (UNCCD) in Greater Noida, near Delhi. The report was prepared by the UN Food and Agriculture Organisation and the UNCCD's Global Mechanism team. Additionally, between 2012 and 2017, the Asian mountain population increased 8.1% to 579 million but the number of people vulnerable to food-related insecurity declined at 7.5%. Asia also logged the highest increase among continents in the number of vulnerable people: 44 million.

<sup>12</sup> <https://thewire.in/environment/climate-change-cop14-hindu-kush-himalaya-land-degradation> 19.09.19 visited on 23.02.2021

#### IV. CLIMATE CHANGE AND RIGHT TO FOOD

“To a man with an empty stomach, food is God”

- *Mahatma Gandhi*

The right to food for all in India is guaranteed in Indian Constitution under Article 21 by way of guaranteeing Right to Life and the object of The Food Protection Act, 2013 is also caring about the food security of the nation and guaranteed the food for all concepts, being a tropical region India will face severe climatic problems, due to global warming which affects food security of the nation.

The global population is expected to increase from 7.7 billion in 2019 to 8.5 billion by 2030 and 9.7 billion by 2050. The Indian population is projected to increase from 1.36 billion in 2019 to 1.5 billion by 2030 and 1.64 billion by 2050<sup>13</sup>.

Food security at the country level necessarily results from the interplay of three determining factors viz. food production, food availability and access to food. The most accepted definition of food security is that of the World Bank (1986)- “access by all people at all times to enough food for an active and healthy life.”<sup>14</sup> For about four decades or so, the concept of food security for India implied the goal of self-sufficiency which can mainly be fulfilled by increased production. However, there is a great deal of talk about the developing countries especially India and China being overpopulated<sup>15</sup>.

Food production while no longer a matter of acute concern in India must have a pivotal role in maintaining sustainable food security.<sup>16</sup> Though India has been very successful in keeping pace with rising food demand of a growing population, yet it is a matter of great concern because its estimated food requirement is increasing day by day.<sup>17</sup>

Dr. Lester Brown has predicted that China and India may have to import over 240 and 60 million tonnes respectively of food grains by the year 2030.<sup>18</sup> Food insecurity is a complex issue having several dimensions such as poverty, unemployment, famine, gender

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<sup>13</sup> According to the United Nation’s World Population Prospects (June 2019)

<sup>14</sup>Lodha, Neeta and Singhvi, Ritu “Food Security and Nutrition- the Greatest Challenge of the Millenium”, Madhya Pradesh Journal of Social Sciences, Vol.8, No. 1, 2003, at pp.37-44

<sup>15</sup>Patnaik, Utsa “Export Oriented Agriculture and Food Security in Developing Countries and India”, Eco. And Pol. Weekly, Vol. 31, 1996, at pp. 2429-2449.

<sup>16</sup>V.P. Raghavan, “Agricultural Trade Policy and Food Security in India: Issues and Challenges”, Social Action, Vol. 56, Jan-Mar, 2006, at pp.1-10 Ra

<sup>17</sup>Ed. Sudan, K. Falendra “Encyclopedia of Environment and Development- Poverty, Environmental Degradation and Sustainable Development”, Vol. 4, 1st Ed., Serials Publication, New Delhi, 2009, at pp. 973-995.

<sup>18</sup>Swaminathan, M.S and Balaji, V. “Food Security for the Poor: What does it take?”, IASSI Quarterly, Vol. 16, No. 1, 1997, at pp.17-35

discrimination, equity, starvation, food, and nutritional practices, human growth, political elements, natural calamities and so on. Poverty has been recognized globally both as a cause and consequence of food security. As a majority of poverty-stricken people live in the rural areas and who mainly depend on agriculture for income and employment, agriculture development is considered to be one of the most important tools to tackle the problem of food security.<sup>19</sup>

Food insecurity has been defined in terms of availability, access, stability and utilization. Food insecurity occurs when there is insufficient food over a limited period of time, such as a “hungry season” prior to harvest, or for extended or recurring periods. Food insecurity may affect individuals, households, specific population groups or a wider population.<sup>20</sup> National policies for sustainable food and nutrition security should ensure that food originates from efficient and environmentally benign production technologies that conserve and enhance the natural resource base of crops, animal husbandry, forestry, inland and marine fisheries.<sup>21</sup>

## **V. STATE STEPS TO COMBAT CLIMATE CHANGE IMPACT**

The government has made some efforts to formulate mitigation strategies to address the impact of climate change on agriculture. Under the NICRA project, ICAR has collected germ-plasm from various locations. These will be used as source material for breeding programmes to develop heat and drought-tolerant wheat and pulses and flood-tolerant rice.

In 2011, research on the impact of climate change on agriculture and possible ideas to mitigate the risk was started by the Union agriculture ministry, named as NICRA<sup>22</sup> The primary objective was to develop suitable technologies for production and risk management for crops, livestock and fisheries. The research reports disclosed that yield of rice in irrigated areas may decrease by 7% in 2050 and 10% in 2080.<sup>23</sup>

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<sup>19</sup>Lodha, Neeta and Singhvi, Ritu “Food Security and Nutrition- the Greatest Challenge of the Millenium”, *Madhya Pradesh Journal of Social Sciences*, Vol.8, No. 1, 2003, at pp.37-44

<sup>20</sup>“Agriculture at a Cross roads”, *Global Report of International Assessment of Agricultural Knowledge, Science and Technology for Development*: available at

[http://www.agassessment.org/index.cfm?Page=Press\\_Materials&ItemID=11](http://www.agassessment.org/index.cfm?Page=Press_Materials&ItemID=11) visited on 15th April 2010.

<sup>21</sup>Swaminathan, M.S and Balaji, V. “Food Security for the Poor: What does it take?”, *IASSI Quarterly*, Vol. 16, No. 1, 1997, at pp.17-35.

<sup>22</sup> The National Innovations on Climate Resilient Agriculture (NICRA) was launched through the Indian Council of Agricultural Research (ICAR). The research was undertaken at seven major institutions of ICAR across India. NICRA has identified 151 climatically vulnerable districts.

<sup>23</sup>Research on impact assessment on crops was conducted using simulation models for climate projections for 2020, 2050 and 2080. NICRA has projected that rice and wheat in Indo-Gangetic plains, sorghum and potato in West Bengal and sorghum, potato and maize in southern plateau are likely to see reduced productivity. The study also found that productivity of soybean, groundnut, chickpea and potato in Punjab, Haryana and western Uttar Pradesh may go up. Similarly, the productivity of apple in Himachal Pradesh may increase. Increase in temperature and rainfall pattern may also result in a lower yield of cotton in north India.

Scientists have been working hard to breed varieties of different crops which are climate-resilient. One such success is Sahbhagidhan<sup>24</sup>, it matures in 105 days while most other varieties take 120-150 days to maturity. Farmers can plant another crop after harvesting this.

IRRI is also breeding a flood-tolerant variety of paddy by manipulating genes to get better strains which can enable paddy rice to survive for up to 15 days of submergence in floodwater. It has identified such varieties in Odisha and Sri Lanka which have a Sub 1 gene. If and when this flood-tolerant variety is released either through breeding or through genetic modification, farmers in flood-prone regions would be keen to accept it, even if activists are opposed to the release of new GM varieties in India<sup>25</sup>.

## **VI. TRADITIONAL KNOWLEDGE VS CLIMATE CHANGE**

Agrobiodiversity — or agricultural biodiversity — is crucial for food security and instrumental in climate adaptation. Studies have revealed that it increases land productivity and maximise the effective use of resources. It also reduces pressure on forests and endangered species while conserving the natural structure of the ecosystem.

The tribal community in odisha named as Kondhs are successfully practicing their traditional agriculture and facing the global warming without any hesitation. Kondhs are practicing their agriculture system by diversifying their crops and allowing insects, pollinators, flies, and birds to thrive on their farmlands. They choose lower hill slopes for their farmlands, where they cultivate a variety of crops ranging from paddy, millets, sorghum, leaves, pulses, legumes, vegetables, and tubers in a farming season and harvest them crop by crop between October and February every year. They are growing over 50 varieties of crops within single farm land<sup>26</sup>.

Kondh farmers say that crop diversity, which ensures optimal use of natural resources, is very effective against soil erosion and land degradation.

The main crops cultivated by the Kondhs, like pearl millet and sorghum, are climate-smart and ideal for environments prone to drought and extreme heat. Traditional upland paddy varieties, which are harvested 60 to 90 days after sowing, consume less water making them resilient to drought-like conditions. These staple food crops are less likely to fail even in extreme heat. The crops can also survive intense and untimely rainfall because of the

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<sup>24</sup> A variety of paddy which was jointly developed by the International Rice Research Institute and Central Rainfed Upland Rice Research Station of ICAR at Hazaribagh. It was released in 2010 and since then, it has gained success in uplands in eastern India in drought conditions.

<sup>25</sup> Research on climate-resilient varieties of wheat, mustard, lentil, chickpea, mung bean, groundnut and soybean are also under progress in various institutions of ICAR.

<sup>26</sup><https://Earth.Org/How-Indias-Indigenous-Farmers-Are-Successfully-Resisting-Climate-Change/>

cultivation pattern. Kondhs do not use harmful pesticides. Instead, they let at least ten species of pests, insects, ants, flies, earthworms, spiders, birds and other pollinators to thrive on their lands.

The agricultural practices of Kondhs not only increase food production, but also build capacity for climate change adaptation. They rejuvenate soil quality, reverse desertification, and conserve biodiversity and natural resources. For Kondhs, agriculture is not just about maximum yield, but it is also about protecting the ecosystem.

## VII. CONCLUSION

The concept of Agro-biodiversity should be implemented effectively to combat the impacts of climate change on food production<sup>27</sup>. Local knowledge and culture can therefore be considered as integral parts of agro-biodiversity, because it is the human activity of agriculture that shapes and conserves this biodiversity to ensure the sufficient food production.

Traditional seed varieties should be utilised to face the temperature increases and water availability for agriculture due to climate change. At least 167 crop species and 320 wild relatives of crops have their primary, secondary or regional centres of diversity here in India making it a mega diversity country endowed with a tremendous wealth of agricultural biodiversity along with associated indigenous knowledge to nurture and Indian farmers grew more than 30,000 different varieties of rice, but in another 15 years, this enormous diversity will be reduced to no more than 50 varieties, with the top ten accounting for over three-quarters of the subcontinent's rice acreage.

Unless their seeds are replanted by the farmers, these outstanding varieties will be lost forever. Many of these "heirloom" varieties (seeds passed down from generation to generation) are still maintained by gardeners, farmers and adivasis in isolated rural and tribal areas, and are often available in the kitchen gardens, courtyards or home gardens.

Today, due to rural-urban migration, tribal acculturation and extinction, and constantly shrinking rural populations, older farmers and seed savers often cannot find anyone who will continue growing their living "heirlooms". The rapid disappearance of many traditional varieties of grain and vegetable crops (rice, wheat, sugarcane, cotton, minor millets, pulses etc.) has been described as a botanical holocaust and these losses have a large role in

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<sup>27</sup> Agro-biodiversity is the result of the interaction between the environment, genetic resources and the management systems used by people. Thus, agro-biodiversity encompasses the variety and variability of animals, plants and micro-organisms that are necessary for sustaining key functions of the agro-ecosystem, including its structure and processes for, and in support of, food production and food security

contributing to the food crisis that India faces.

The effort to conserve of agro-biodiversity serves important purposes. It makes available for farmers traditional seed of crops locally adapted to withstand diverse climactic conditions. It supplies well characterised germ plasma to develop crop varieties more suited to the changing climate, and it acts as a repository of Farmers' Crop Varieties for registration with the National Plant Variety Authority.<sup>28</sup>

Though indigenous rice varieties are still preserved by a few farmers they are getting depleted at an alarming rate. It is becoming increasingly clear that to maintain biodiversity in farmers' fields an alternative system of seed supply has to be created. Although farmers greatly feel the need to regrow some of the traditional varieties they have lost, one has to be able to provide them with sufficient quantities of local seed varieties in order to fulfill this need. The community has to be convinced or has to feel the need to bring back lost biodiversity and any effort should be aimed at the community level. Several groups across the country are trying to preserve these varieties through on farm conservation. CIKS has been involved in setting up farmer's seed banks in villages in different parts of Tamil Nadu.<sup>29</sup>

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<sup>28</sup>Available at:<http://genecampaign.org/agrobiodiversity>

<sup>29</sup> Dr. Richharia, "Organic Farming and Indigenous Seed Conservation Experiences from Tamil Nadu, India"