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Climate Change and Agrarian Distress in India

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***Abstract*: This project aims to shed light on and bring some clarity to a subject that has only been pursued bleakly for research purposes till now. Climate change and Agrarian Distress are usually seen as a cause and effect scenario but the extent and span of the phenomenon has not been distinctly defined till now. Through this paper I shall explore the topic but limit my scope regionally to India to effectively arrive at a conclusion as to the magnitude of climate change and the resulting agrarian distress and how to design policies to tackle the same.**

***Keywords*: Agrarian distress, Climate change, Climate change in India.**

1. Introduction

Strong trends in climate change around the world are already evident with the increasing likelihood of further changes occurring. The humongous scale of potential climate impact gives disruptive urgency to the overall environmental status quo. Concern over the potential effects of long-term climatic change on agriculture has motivated a substantial body of research over the past decade and although much literature has been written about Climate Change and Agricultural Distress, they are more-or-less treated as two distinct, complex problems. The link between them has received little attention. Understanding the link between the two has become vital for the formulation of effective policy responses to climate change. Through this paper, we aim to hit at the research gap between climate change and agrarian distress in the Indian context. The relation between climate change and the possible physical effects of climatic change on agriculture, such as changes in crop and livestock has been thoroughly researched in the context of countries like China, Tanzania and the United States of America and expansive studies on protection of agriculture resources against the impending doom of climate change have been conducted in the continents of Europe and Africa. We realized the lapse in thorough research on relationship between climate change and agricultural upheaval, natural calamities and the thereby resultant farmer distress. Seeing the opportunity and scope for the kind of good literature that can be produced on the topic, we have chosen and would attempt to bridge the aforementioned gap in research. We have chosen India as our base country for a few imperative reasons- one, being its truly diverse natural splendor and our familiarity with its natural abundance, two, in our capacity as students we can only research on a national and not global scale and lastly because we have noticed some astounding trends in our chosen area of research in the Indian subcontinent. Throughout the paper, we show some interesting and eye-opening linkages between climate change and agrarian distress in India with the help of facts, data figures statistical analysis and mathematical tools. We hope to raise awareness with the same and towards the end we have made suggestive policies to take a step towards overcoming the problem.

2. Literature Review

Significant concerns about the impacts of climate change and its variability on agricultural production are rising worldwide (Tubiello, Velhuizen, Fischer, & Shah, 2005). Food security is a prominently result of dangerous anthropogenic interference on Earth's climate. Countries worldwide are naturally concerned about potential damages and benefits that may arise from climate change over the coming decades since it affects domestic and international policies, trading patterns, regional planning, resource use and ultimately the welfare of its people. Recent research developments confirm that while crops respond positively to heightened CO2 levels in the absence of climate change, the other associated impacts of climate change like high temperatures, altered patterns of precipitation and increased frequency of extreme events such as drought and floods, combine to depress yields and increase production risks in many regions worldwide, widening the gap between rich and poor countries. Consensus has emerged that confirms that developing countries are more vulnerable to climate change than developed countries because of the predominance of agriculture in their economies, the scarcity of capital for adaptation measures, their warmer baseline climates and their heightened exposure to extreme events. Therefore, climate change may have particularly serious consequences in the developing world where some 800 million people are undernourished.

The impact of Climate Change on agriculture has been fairly researched on a global level and continues to be a hot topic for debate worldwide (Kumar, Climate Change Studies in Indian Agriculture, 2007). Agriculture being a climate-sensitive sector that provides livelihood for 60 % of India's population has been subject to a large number of studies over the past decade that have tried to assess the impacts of climate variability and change. Some of the relevant research questions that emerge in the context of climate change and Indian agriculture are: (a) Is Indian agriculture likely to get adversely affected by climate

change? If yes, what is the extent of impact? (b) How does one characterize the vulnerability of a farmer to climate change? Which regions are relatively more vulnerable to climate change? (c) How does one assess the effectiveness of adaptation options in ameliorating the present and future vulnerability? To answer these questions, there are two broad approaches for assessing the economic impact of climate change related agrarian distress- (a) The Agronomic-Economic approach and (b) The Ricardian Approach. The Argo-Economic approach estimates the macro level impact of climate change. It is seen that under doubled carbon dioxide concentration levels, in the latter half of 21st century, the gross domestic product (GDP) would decline by 1.4 to 3 percentage points due to climate change. More significantly, there is an estimated increase in the proportion of population in the bottom income groups of the society in both rural and urban India under climate change conditions. Since the scope for incorporating adaptation into the agronomic-economic approach is rather limited, an alternative approach, called the Ricardian approach, was proposed. The approach is based on the argument that, "by examining two agricultural areas that are similar in all respects except that one has a climate on average (say) 3 ^{o}C warmer than the other, one would be able to infer the willingness to pay in agriculture to avoid a 3 ^{o}C temperature rise". While all possible adaptations are accounted for in the impact estimation, the constant relative prices assumption could lead to biases in the results of this approach. Kumar has extended the analysis to include climate variation terms in the Ricardian approach and estimated that a 5 per cent increase in climate variation along with the climate change scenario would result in an almost 10 per cent drop in the farm level net revenue. With India being home to 16% of the world population and agriculture contributing to 14% of the Gross Domestic Product, these are serious repercussions.

Apart from the obvious effects of climate change which results in agrarian distress, India faces an indirect threat to its agricultural fabric. This is due to the emerging phenomenon of Climate Migration. Architesh Panda (Panda) takes an in-depth look into the implications of climate refugees and their contribution to the on-going agrarian distress. Climate Change effects human migration in three distinct ways- First, warming of the atmosphere in some regions reduces the agricultural potential and undermines the ecosystem services such as fertile soil and water affecting people's livelihoods. Second, increasing extreme weather events generate mass displacement. Third, sea level rise destroys the low-lying coastal areas because of which people have to relocate permanently. With the increasing certainty of the effects of climate change, it is believed that a large-scale forced migration of people will happen, especially in and around the Indian subcontinent. India increasingly faces two distinct patterns of climate migration- first, migration within India due to the effects of climate change such as drought, desertification, sea level rise, water scarcity and low food productivity, and melting glaciers. Second, increased flow of migrants from neighboring countries like Bangladesh, Sri Lanka and Nepal due to the accelerated effects of climate change. This migration would put pressure on the already scarce resources of India. India is already struggling to provide good quality agricultural products for its own population and a further addition of immigrants would only make the situation worse. Besides, these immigrants are estimated to be mostly from the lower socio-economic strata of the society and are mostly involved in an agricultural livelihood. This means they would add to the booming population of farmers in the country. This is going to worsen the agricultural output due to further fragmentation of land holdings which would eventually lead to land infertility and low crop yields thereby adding to the burden of farmer debt, farmer suicide and economic growth slowdown.

3. Research Objectives

1) To study the magnitude of Climate change measured in terms of percentage change in temperature over a time line and agrarian distress in India, in terms of the per capita produce. This is done to quantify our research variables and give more targeted facts and understand the intricate nuances of the PESTLE effects of the same.
2) To find evidential relationship between the change in climate crisis and the agricultural aftermath in terms of food security for the rising population and assessing the degree of correlation across the various socio-economic groups to find relationship between battling climate risks on personal lives.
3) To give policy recommendations to aid rising farmer suicides in India caused by agricultural distress due to climate change in quantifiable terms and assess its viability in comparison with existing policy framework in the country.

4. Data and Methodology

The foundational crux of this research lies in first establishing the relationship between Climate change and Agricultural output, building on which, we will further show the direct linkage between worsening of Climate and its multi-fold addition to the already overwhelming Agrarian Distress in India.

To be able to establish such a relationship, we first take Indian Meteorological and Agricultural Data for the past 50 years. We have taken 50 years as the time frame for historic data since it is fairly sufficient to establish any Agricultural or Meteorological pattern. Now for Meteorological factors we have considered rainfall levels as our judging parameter and as for Agricultural developments we have taken Total Production, Gross Cropped Area and Yield per

hectare of food grains (i.e., Pulses and Cereals). The reason to choose Agricultural output of food grains only and not non-food grains (i.e., Oilseeds, Fruits and Nuts, Fibers and Tubers, etc.) is the simple premise that the output of food grains far outweighs that of non-food grains. Statistically, the total

production of food grains in India is 9.28 times of non-food grains, the gross cropped area of food grains is 5.2 times that of non-food grains and the Yield per hectare of food grains is 1.75 times of non-food grains. As for Meteorological parameters, we have only chosen rainfall for the fact that it's the simplest to gauge and interpret rainfall levels. Temperature is an extremely complex parameter given the seasonal changes in temperatures and given the geographical expanse and meteorological diversity of India. Natural Calamities shall be considered in the research but only to the extent to show how the increasing occurrence of natural disasters are ruining the country's agricultural prospects.

The historic data for both Meteorological and Agricultural parameters show a haphazard pattern over the last 50 years but there's an almost certain and distinctive, albeit minor, dip in Agricultural output indicators alongside decrease in rainfall levels, increase in average temperatures and increase in the occurrence of natural calamities. Alongside, there is a massive increase in long term agricultural credit lent out.

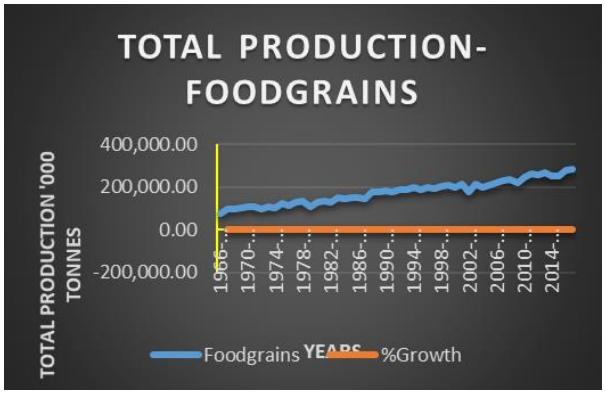

Fig. 1. Total production of food grains (India) '000 tonnes

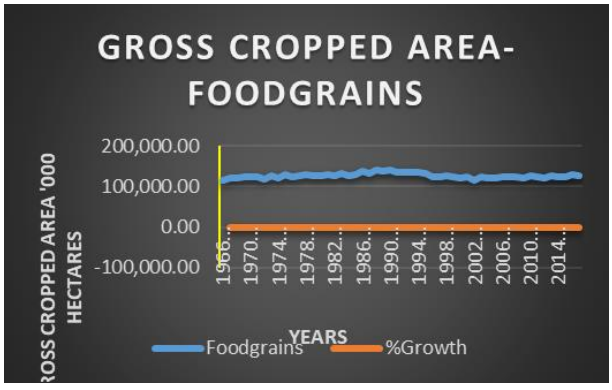

Fig. 2. Gross cropped area for food grains (India) '000 hectares

We run a univariate regression analysis each between Rainfall levels and Total Productions of food grains, Rainfall levels and the Gross Cropped Area for Food grains and Rainfall Levels and Yield per hectare of food grains. Upon performing the Regression, we obtain the regression equations for each one of these. Further we find out the Rainfall Levels for the next 10 years by using the Compounded Annual Growth Rate (CAGR) Method. We then use this predicted value for rainfall to predict the Agricultural output by making use of the regression equation.

We then find out the correlation between Agricultural Output and Agricultural credit and predict values for Long Term Credit extended to the Agricultural Sector.

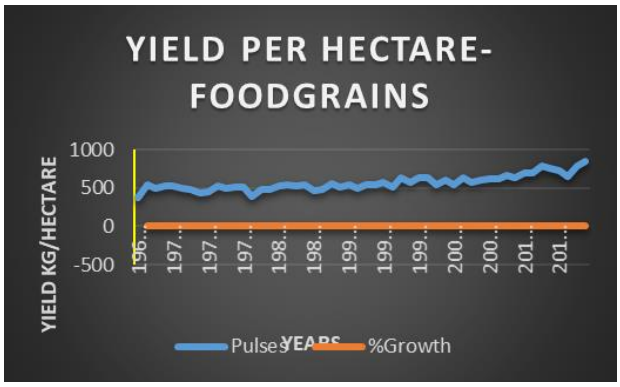

Fig. 3. Yield kg per hectare of food grains (India)

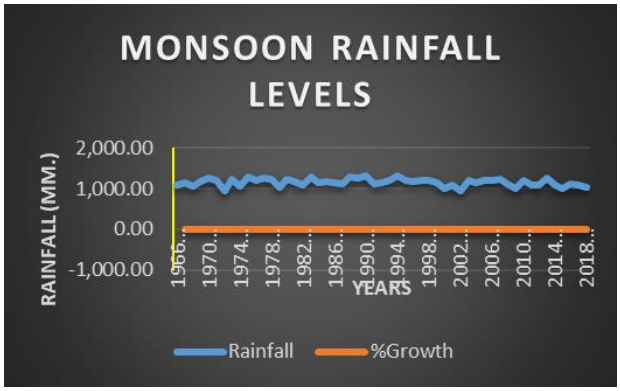

Fig. 4. Total annual monsoon rainfall levels in millimeters (India)

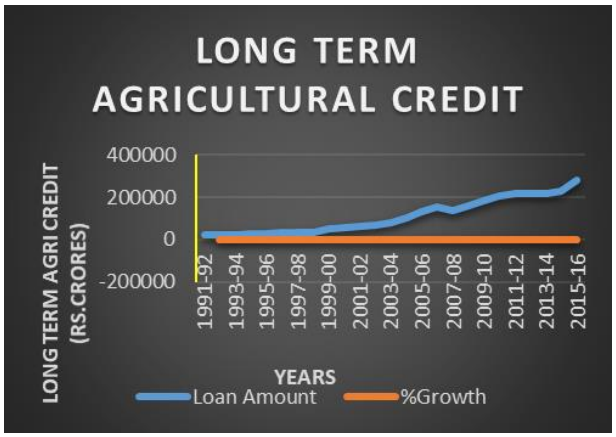

Fig. 5. Total long-term agricultural credit extended (India) in rupees' crores

5. Results, Analysis and Interpretation

On running a univariate regression analysis each between Rainfall levels and Total Productions of food grains, Rainfall levels and the Gross Cropped Area for Food grains and Rainfall

Levels and Yield per hectare of food grains in India, we obtained similar results. All of the Agricultural Parameters had high correlation with Rainfall levels. It was found that rainfall levels have been increasing at a decreasing rate of 1.14% annually and resulting total Production of food Grains is predicted to increase at a decreasing rate of 1.94%, Yield per hectare of food grains is predicted to increase at a decreasing rate of 2% and Gross Cropped Area is predicted to increase at a decreasing rate of 0.37%. If the predicted values stand to be true, Agricultural produce in India can easily be expected to be on a downturn already. As the trend suggests, we are at a risk of exhausting our agricultural resources completely in the coming two centuries. In fact, India's booming population which is expected to be ever increasing in foreseeable future, coupled with depleting agriculture, would be a complete disaster. Food scarcity and ultimately starvation could be reality for the county. Given India's current Total Production of food grains at 291950000 tonnes, Gross cropped area at 127524000 hectares, Yield per hectare of 2234.97kg/hectare and peak monsoon Rainfall level of 1025.60 millimeters, perhaps, it might not even take that long for India to lose its agricultural splendor because apart from rainfall there are other key factors like increasing average temperature, growing pollution, increasing incidences of natural disasters, soil erosion, fresh water scarcity, melting ice caps of the Himalayas and rising sea levels in both Eastern and Western Ghats which play a role in escalating agrarian distress. Further, due to the decreasing agricultural output, farmer loans will increase. Farmers will take both long term and short-term agricultural credit in desperate attempts to boost the output. This will only add to the burden of farmer loans in the country. They will then invest the same in fertilizers, chemical enzymes, irrigation and the like but that seems to have a narrow scope to boost output given how global groundwater levels are shrinking annually and soil is increasingly losing its nutrients and productive capacities. On being unable to repay these loans, the farmers usually resort to suicide. Given India's current farmer suicide rate of 10 farmers daily, we are standing on a dangerous cliff. If the farmer suicide rates increase, it will wreak havoc on the foundation of India's economy, i.e., the agricultural sector. In order to contain the magnitude of farmer suicides and agrarian distress, the government would have to issue fresh loans, waive off older loans, extend subsidies and financial support and finally but most importantly spend enormous amounts of money in conservation and replenishment of environment. In order to save, replenish and boost India's agricultural splendor, it's important to pay heed to the ticking time bomb that the environment is. If not enough efforts are made to do the same, we can easily and rightly expect both India's economy and natural resources to be drained.

6. Conclusions and Policy Recommendation

The following policies, if implemented, will lead to wholesome results not only in terms of decelerating the ongoing environmental damage but also replenishing agriculture and ensuring that the agrarian distress does not get any worse than what it already is:

A. Increasing central funding for combating climate change

A hands on special action plan is needed to tackle climate change. There needs to be an increase in awareness both among farmers and the masses as to how they can contribute to mitigating climate change. Central funding needs to be provided for extensive research on the same. In fact, there should be an establishment of a special fund solely dedicated to the purpose.

B. Design and implement good overall development policies and programs

The uncertainty around location specific effects of climate change, given India's huge geographic expanse and biodiversity, good overall policies and programs are the best climate change adaptation investments. A pro-growth, pro-environment development agenda that supports agricultural sustainability alongside contributing to food security is essentially what is needed.

C. Increase investments in agricultural productivity

Even without climate change, greater investments in agricultural science and technology are needed to meet the demands of a booming population. Climate change places new and more challenging demands on agricultural productivity. Crop productivity enhancing research, including biotechnology, will be essential to help overcome stresses due to climate change. Crops that are doing well in a range of production environments rather than extremely well in a narrow set of climatic conditions should specially focused on to replicate their traits in other crops.

D. Improving rural infrastructure

Rural infrastructure is important if farmers are to be equipped to battle the adversities of Climate Change and take advantage of improved crop varieties and management techniques. Higher yields and more cropped area require maintaining and increasing the density or rural road and communication networks to increase access to resources and reduce transaction costs. Investments in irrigation infrastructure should also be taken specially to improve the efficiency of water use.

E. Reinvigorate national research and extension programs

Investment in laboratory scientists and the infrastructure they require is needed. Partnerships among national systems and international centers are a part of the solution. Collaboration with local farmers, input suppliers, traders and consumer groups are also essential for effective development and dissemination of locally appropriate, cost effective techniques and to help revitalize communication among farmers, scientists and other stakeholders to meet the challenges of climate change.

F. Farmer loan easing

Government should continue with its policy of farmer loan easing but with special care to alleviate those who are most threatened by climate change. Cheap loans should be granted to farmers in special risk zones. Further, a more effective strategy would be to grant advanced inputs for farming at a subsidized rate.

G. Improve data collection, dissemination and analysis

Climate change will have dramatic consequences for agriculture. However, substantial uncertainty remained about where the effects will be greatest. These uncertainties make it challenging to move forward on policies to combat the effect of climate change. Collecting and disseminating data on the spatial nature of agriculture needs to be strengthened. Funding for national statistical programs should be increased so that they can fulfil the task of monitoring changes.

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