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Financing Climate Change on Global Agriculture-An Overview

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Abstract

Economics and climate will decide the fate of farmers and agriculture in the globe. Addressing climate change and food security are the foremost challenges of the today's world. The study focuses global finance climate, impact of climate change and adaptation strategies and fore see various mitigation measures to protect from climate change on global agriculture. The United Nations Framework Convention on Climate Change (UNFCCC), aim to stabilize greenhouse gas concentrations in the atmosphere. Among the 23 'Conference of the Parties' (COP) conducted so far, COP 3, the Kyoto protocol in 1997, COP 7 in Marrakesh, Morocco, in 2001, COP 16 which established a limit of maintaining temperatures to below 2.0 °C (3.6 °F) relative to the pre-industrial level and COP 18 with the Doha amendment to the Kyoto protocol have been the crucial ones. The Paris Agreement (COP 21) in 2016 introduced the ambitious Nationally Determined Contributions, marking a new beginning. Increasing population and under nourishment are putting more pressure on land leading to further deterioration of the atmosphere by the production of huge amounts of CO2. In turn, the climate change is impacting agriculture in more ways than could be comprehended. Primarily the declining yields of the staple crops are posing a food insecurity situation which must be addressed through technological breakthroughs. The study reveals that adaptation among various sectors to minimize the factors causing climate change is inevitable. Strategies to increase soil carbon pool comprises of carbon sequestration through conservation agriculture, integrated nutrient management, agroforestry etc. The study suggests that the available climate financing in agriculture must be diversified across the food processing sector, wasteland and water management, forest and social forest cover, land use and natural resource management. Being Developed countries have geopolitical and demographic advantage they should share more finance compare to developing countries. However, Conventions and COP's have to frame global formulae to tackle climate change.

Keywords: Impacts; Climate Change; Climate Financing; Adaptations; Strategies and Foresight

Introduction

Economics and climate will decide the fate of farmers and agriculture in the globe. Working towards a world where the people could sustainably live with the nature (World's resources-rivers, forests, seas and wildlife) could only avoid the catastrophic climate change. Among all the efforts, one of the main areas of solicitude is the impact of climate change on agriculture, addressing climate change and food security are the foremost challenges of the today's world. Both these intertwined are problematic to say the least. The biggest environmental challenge of the century-Climate Change-is hitting hard on the human lives with increase in the onset of rising temperatures. Global warming has become an alarming atmospheric deviation, has turned into an unprecedented truth and environmental change is one of the problems that need to be addressed Sun et al. [1].

Living life beyond our means, with burning huge amounts of fossil fuels, breeding huge amounts of methane producing livestock and cutting down swathes of forests, thereby, reducing the natural absorption of carbon dioxide has disturbed the balance of our planet, mother earth. Whatever and how many could be the reasons the urgent threat of climate change is lurking around as a double edged sword in the post industrialized world with an ever increasing population and food security to deal with. The technology revolution could however provide a strategy to deal with climate change.

Adaptation in various societal sectors to the influence of climate change is now considered inevitable Tripathi et al. [2]; IPCC, [3]. To combat climate change, we have to sequester carbon from atmosphere and must store it to long lived pools. Strategies to increase soil carbon pool comprises of carbon sequestration through conservation agriculture, integrated nutrient management, agroforestry etc. With proper management, 75-100 parts per million of CO_2 can be stored in soil and forestry systems Lal [4].

An important step towards tackling climate change is working on the global warming factors-primarily the anthropogenic based carbon emissions. 'Carbon pollution limits are necessary to prevent climate change from damaging the global economy' has been an established truth which facilitated the climate financing. Based on above factors this paper focuses on the following objectives

a) To analyze various major Conference of Parties (COP's) and conventions on financing climate change.

b) To assess the impact of climate change on agriculture.

c) To assess the climate financing flows in the globe.

d) To suggest adaptation strategies and measures to mitigate climate change.

Methodology

This is based on climate financing research. The study tracked information on various COP's and conventions made by world financing organizations, regional and national blocks and UN organizations across globe. The study also reviewed the impact of climate change and adaptation strategies and fore see various mitigation measures to protect from climate change on global agriculture. The study also has done meta-analysis of various funds allocation of Global Climate Finance by Public and Private actors and the average annual climate finance breakdown by region of destination for the year 2015-2016. Finally, the study foresees future vision of financing climate and its impact on global agriculture.

Results and Discussions

UNFCC Convention

Climate financing is the concept of lending/flow of funds channeled through national, regional and international entities for climate change mitigation and adaptation projects. With the United Nations Framework Convention on Climate Change (UNFCCC), an international environmental treaty adopted on 9 May 1992, working at the global level on the cause set in place, world leaders have been proactive. The objective of the framework is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (Article 2 of the UNFCC Convention). However, the non- binding limits on greenhouse gas emissions and no enforcement mechanisms for individual countries coupled with lack of adequate fund commitments have been a great concern with regard to the implementation of the various mitigation and adaptation projects.

Conference of Parties (COP's)

The UNFCCC has 197 parties as of December 2015. The convention enjoys broad legitimacy, largely due to its nearly universal membership (Stavinset.al). To assess the progress in dealing with the climate change, the parties to the convention have met annually from 1995 as the 'Conference of the Parties' (COP). So far, 23 COP meetings have been conducted with the recent COP 23 being held at Bonn, Germany.

After the intensive negotiations at the COP 3, the Kyoto protocol was adopted on 11th December, 1997 and entered into force on 16th February 2005. It recognized that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity; the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities." The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords." Its first commitment period started in 2008 and ended in 2012 (UNFCC Archives). However, the Kyoto protocol established legally binding obligations for developed countries to reduce their greenhouse emissions in the period 2008-2012. COP 16 produced an agreement stating that future global warming should be limited to below 2.0 °C (3.6 °F) relative to the pre-industrial level King et al. [5].

COP 18 is also a landmark meeting, as the Doha amendment to the Kyoto protocol was adopted. The United Nations is encouraging governments to ratify as soon as they can the amendments relating to the second commitment period of the Kyoto Protocol, the international emissions reduction treaty. Ratification of the Doha Amendment to the Kyoto Protocol is a valuable part of the momentum for global climate action for the years leading up to 2020 (UNFCC Process and meetings).

In 2016, the Paris Agreement (COP 21) marked a turning point in the battle against climate change. World leaders from across the globe united for the first time in history to legally ratify action against pollution through the United Nations Framework Convention (Wired, the UK). The governing of emission reductions from 2020 was to be through the commitments of countries in ambitious Nationally Determined Contributions.

Impact of Climate Change on Agriculture

Among all the efforts, one of the main areas of solicitude is the impact of climate change on agriculture, as previously mentioned, addressing climate change and food security are the foremost challenges of the today's world. Both these intertwined are problematic to say the least. Rapidly increasing world population is adding more pressure on the land. As per 'the world population prospects 2017' revised report of the United Nations Department of Economic and Social Affairs (UNDES) the world population is projected to reach 9.8 billion in 2050 and 11.2 billion in 2100.'The State of Food insecurity in the world 2015' report by the International Fund for Agricultural development (IFAD) and World Food Programme (WFP) calculates that there are nearly 795 million people who regularly still don't have enough food to eat i.e.; undernourished. In 1990-92, this number of undernourished was 1 billion. A recent study at the National Academy of Sciences of the USA results consistently showed negative temperature impacts on crop yield at the global scale, generally underpinned by similar impacts at country and site scales. Without CO_2 fertilization,

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effective adaptation, and genetic improvement, each Degree-Celsius increase in global mean temperature would, on average, reduce global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1% Chuang Zhao et al. [6].

Also, yield increase has slowed down or even stagnated during the last years in some parts of the world Brisson et al. [7], and further increases in temperature will continue to suppress yields, despite farmers' adaptation efforts. Intensive agriculture seems to be an option to meet the world food demand. However, intensive agriculture, characterized by monocultures, coupled with the aim to feed farm animals would generate huge amounts of CO_2 emissions. As per the study undertaken by Hedenus and Johansson, 2014 showed that baseline agricultural CO_2-equivalent emissions (using Global Warming Potentials with a 100 year time horizon) will be approximately 13 Gton CO_2 eq/year in 2070, compared to 7.1 Gton CO_2 eq/year 2000.

Impact of Climate Change on Soil Organic Matter

Soil organic matter (SOM) is the driving force for the growth and activity of microbes. Substrate quality of SOM exerts critical control over decomposability and temperature sensitivity of microbial respiration in soil. Low quality of SOM limits the amount of available energy for soil microorganisms, and which in turn affect the rate of SOM mineralization. At any particular instance, the SOC pool represents dynamic equilibrium of gains and losses. The global soil carbon (C) pool of 2500 gigatons (Gt) comprises of 1550Gt soil organic carbon (SOC) and 950Gt of soil inorganic carbon (SIC) and an increase of 1 ton of soil carbon pool could counter balance fossil fuel emissions by 0.4 to 1.2Gt C per year (Lal, [8]).

A warming climate can bring environmental changes that hasten microbial breakdown of organic carbon and thereby release of the greenhouse gases, which in turn accelerate climate change Schuur et al. [9]. The Arrhenius function shows that reactants with higher activation energy comprising less reactive and more recalcitrant fraction should have higher temperature sensitivities Davidson and Janssens [10]. Adequate response was expected between soil respiration (R_s) and temperature with a Q_{10} (rate of change of R_s with an increase in temperature of 10 ^{0}C) of 1.5 Bond-Lamberty and Thomson [11]. Recent experiments provide indistinct results and do not provide assured conclusions on the significance of the mechanisms governing the carbon-climate feedback Heimann and Reichstein [12]. Recent researches demonstrated that molecular structure alone does not control SOM stability: rather, environmental and biological activity outweigh Schmidt et al. [13].

Trade-Off Between Water Availability for Various Resources

Climate change can significantly aggravate water related aspects of crop production and farm management Lobell and Field [14]; Trenberth et al. [15]. Climate change is anticipated to alter water and energy cycles by increase in air temperature and also by altering temporal and seasonal precipitation patterns Adam et al. [16]; Seneviratne et al. [17]. These deviations are likely to control crop water demand Wada et al. [18], irrigation water availability, and agricultural productivity Elliott et al. [19]. Water scarcity can be expected by the imbalance between demand and supply of water Sun et al. [20]. Presently, irrigation is one among the major component for ensuring sufficient food production. In developing countries, the crop yields in irrigated farmland account for 60% of the total crop production Fischer et al. [21]. Rising competition for water between agricultural and other sectors, as well as challenges brought by climate change, future accessible water resources for agriculture production will continue to decline Sun et al. [22]. At the farm level, irrigation efficiency is imperative for productivity particularly during drought years, and development of irrigation efficiency is considered to be an adaptation tactic for recurrent droughts Berbel and Mateos [24]; Heumesser et al. [25].

Warming is expected to increase potential evapotranspiration Douville et al. [26]; Hamlet et al. [27], results in increased evaporative losses and reduce overall irrigation efficiency. Due to the increase in global temperatures, the water holding capacity and the water vapour transport of the atmosphere have increased Sun et al. [28]. Climate change impacts soil moisture through modifying potential evapotranspiration and the seasonality and magnitude of precipitation Holsten et al. [29]; Seneviratne et al. [17]. Altered soil moisture modifies soil hydraulic properties Rawls and Brakensiek [30] that affect the generation of runoff and deep percolation losses. For example, when the soil surface is drier, suction head is higher; this increases the infiltration rate which leads to lower runoff loss. Changing soil water content also impacts hydraulic conductivity, which modifies the water movement in the soil and affects deep percolation losses.

Crop Yield

Small holder farmers are prominently affected and are becoming increasingly susceptible to extreme weather events caused by climate change Altieri and Nicholls [23]; Comoé and Siegrist [31]. Climate change has adversely affected crop production and yields in important agricultural regions of the world Misra [32]; Almaraz et al. [33]. Study by Dimes et al. [34] and Makuvaro [35] indicated that temperature have inverse relation with yield through influence on reduction in number of days to maturity, especially on early maturing varieties than late maturing varieties. Heavy reliance on rainfed agriculture, climate change will increase vulnerability of the rural populations due to food and nutrition insecurity. Communities in most developing countries, particularly those in Africa have been identified as being the most vulnerable to climate change because of multiple stressors and reduced adaptive capacity Parry et al. [36]; Gandure et al. [37].

Adaptive Mitigation Strategies

Adaptation among various sectors to minimize the factors causing climate change is inevitable. To combat climate change, Strategies to increase soil carbon pool comprises of carbon sequestration through conservation agriculture, integrated

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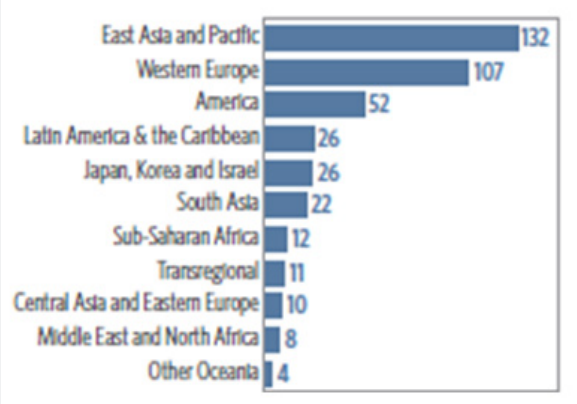
nutrient management, agro forestry etc. Our ability to assess terrestrial carbon cycle-climate feedbacks remains uncertain and obscured. Overall, it is likely that, at least on a global scale, terrestrial ecosystems will provide a positive and amplifying feedback in a warming world, albeit of uncertain magnitude.

The strategies to combat climate change can be co-ordinated effort. Foremost, farmer must take measures to reduce the risk of adverse impact of climate change, eg. Structural protection from flooding. Second, upgrading coping capacity indicates a measure that improves the ability to deal with climate impacts, eg. dealing with the flash flood. Third, improvement in adaptive capacity that increases the ability to deal with climate impacts in the long-term. Finally, efforts must be made to intensify the efforts to decrease the vulnerability in dealing with the climate change impacts on crop production [38-51].

Climate Financing

Agriculture and its allied sectors form a considerable part of global warming and climate change, which necessitates the financing climate change in Agriculture. Public sources of climate finance (US$147 billion in 2014) make up a small portion of the total more general financing (US$388 billion in 2014) that works



Source: Global Landscape of Climate Finance, CPI Report, 2017.

Figure 1: Average annual climate finance breakdown by region of destination 2015/2016.

Table 1: Breakdown of Global Climate Finance by Public and Private Actors for the period 2012-2016 ($bn).

Year	Public Actors	Private Actors	Total Climate Finance
2012	136	224	359
2013	143	199	342
2014	147	241	388
2015	138	299	437
2016	141	242	383

Source: Global Landscape of Climate Finance, CPI Report, 2017.

Climate finance can play a critical role in directing liquidity to agriculture (World Bank paper, 2017). It could be observed from Table 1 that a maximum of climate finance budget was allocated in the year 2015 at 437$ bn. In a broader perspective, the investments in financing climate change in agriculture are those activities that address mitigation and adaption goals. For example, the World Bank has committed to 100 percent of its agriculture operations being climate-smart by 2019; to date 42 percent of the Agriculture Global Practice pipeline projects are already delivering climate-smart investments (World Bank paper, 2017). At the national level a country like India which is among the highest recipient of climate change finances, has been heavily investing in renewable energy projects under National Solar Mission and the projects alike. While it is not clear how much of the total global finance has India received, of the $15.3 billion approved by climate funds, India has got approvals for over $1 billion, more than any other country, and the biggest projects are not surprisingly in the renewable energy sector. (Economic times, 2017). From Figure 1 it could be observed that, in non-OECD regions, East Asia and Pacific remains the largest destination for climate finance with $132 billion/year, or 32% on average for 2015/2016 which was a marked increase of 24% from the 2013/2014 period. South Asian flows saw the largest rise by 48% over the time frame to now reach $22 billion (CPI 2017).

Conclusion

The United Nations Framework Convention on Climate Change (UNFCCC), an international environmental treaty with its aim to stabilize greenhouse gas concentrations in the atmosphere has been encouraging countries to implement various mitigation and adaptation projects. Among the 23 'Conference of the Parties' (COP) conducted so far, COP 3, the Kyoto protocol in 1997, COP 7 in Marrakesh, Morocco, in 2001, COP 16 which established a limit of maintaining temperatures to below 2.0 °C (3.6 °F) relative to the pre-industrial level and COP 18 with the Doha amendment to the Kyoto protocol have been the crucial ones. The Paris Agreement (COP 21) in 2016 introduced the ambitious Nationally Determined Contributions, marking a new beginning. The study emphasizes that addressing climate change and food security are the foremost challenges of the today's world. Increasing population and under nourishment are putting more pressure on land leading to further deterioration of the atmosphere by the production of huge amounts of CO_2. In turn, the climate change is impacting agriculture in more ways than could be comprehended. Primarily the declining yields of the staple crops are posing a food insecurity situation which must be addressed through technological breakthroughs. The study also assessed the various impacts of climate change on soil moisture and the water resources which are essential for crop growth and production. The study reveals that adaptation among various sectors to minimize the factors causing climate change is inevitable. Strategies to increase soil carbon pool comprises of carbon sequestration through conservation agriculture, integrated nutrient management, agro forestry etc. The study suggests that the available climate financing in agriculture must be diversified across the food processing sector, wasteland and water management, forest and social forest cover, land use and natural resource management. This sector must be fine-tuned with the newly designed practices which are sustainable and

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climate-resilient. Farming in particular must be encouraged to have an integrated approach rather than an intensive approach. Integrated not only in terms of horticulture, animal husbandry and other agriculture allied sectors but also with the nature.

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