The Impact Of Climate Change On Agriculture

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ABSTRACT

The unimpeded growth of greenhouse gas emissions is raising the earth's temperature. The consequences include melting glaciers, more precipitation, more and more extreme weather events, and shifting seasons. The accelerating pace of climate change, combined with global population and income growth, threatens food security everywhere. Agriculture is extremely vulnerable to climate change. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. Although there will be gains in some crops in some regions of the world, the overall impacts of climate change on agriculture are expected to be negative, threatening global food security.

This paper provides an insight into the different climate change-related challenges that the agricultural sector will face and explores opportunities for emission reductions and adaptation. Agriculture has not figured very prominently in the climate discussion so far. This paper clearly indicates that the sector deserves more attention when it comes to both climate change threats and opportunities. Understanding interrelations and interactions in the agricultural sector and considering its implications for development cooperation is crucial for adequate development responses.

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INTRODUCTION:

According to the report of the Intergovernmental Panel on Climate Change (IPCC), an international body of leading natural and social scientists sponsored by the United Nations Environment Programme and the World Meteorological Organization, an increase in atmospheric concentrations of greenhouse gases equivalent to a doubling of carbon dioxide (CO2) will force a rise in global average surface temperature of 1.0 to 3.5 degrees Celsius by 2100. Average precipitation also will rise as much 10 to 15 percent because a warmer atmosphere holds more water.

Climate change is real and already taking place, according to the IPCC's most recent Assessment Report (IPCC IV 2007). According to the report, the impacts of climate change and their associated costs will fall disproportionately on developing countries threatening to undermine achievement of the Millennium Development Goals, reduce poverty, and safeguard food security. A major component of development assistance is support for the agriculture sector since agricultural production worldwide is increasingly under pressure to meet the demands of rising populations. At the same time, there is concern also about the contributions that the agriculture sector makes to greenhouse gas emissions and climate change.

Climate change – Meaning

Climate is constantly changing, and the signals indicating that changes are occurring can be evaluated over a range of temporal and spatial scales. Climate can be viewed as an integration of complex weather conditions averaged over a significant area of the Earth (typically on the order of 100 km2 or more), expressed in terms of both the mean of weather represented by properties such as temperature, radiation, atmospheric pressure, wind, humidity, rainfall and cloudiness (among others) and the distribution, or range of variation, of these properties, usually calculated over a period of 30 years.

Natural processes have over the millenniums driven changes in climate, and these mechanisms continue to cause change. “Climate change” as a term in common usage over much of the world is now taken to mean anthropogenically driven change in climate. Such climate change may influence agriculture in a positive way (CO2 fertilization, lengthening of growing seasons, more rainfall) or in a negative way (more drought, faster growth resulting in shorter life cycles, salinization).

Climate change and Agriculture

Global agriculture will be under significant pressure to meet the demands of rising populations using finite, often degraded, soil and water resources that are predicted to be further stressed by the impact of climate change. The ongoing build up of greenhouse gases in the atmosphere is prompting shifts in climate across the globe that will affect agro-ecological and growing conditions. In addition, agriculture and land use change are prominent sources of global greenhouse gas emissions. The application of fertilizers, rearing of livestock, and related land clearing influences both levels of greenhouse gases in the atmosphere and the potential for carbon storage and sequestration. Therefore, whilst ongoing climatic changes are affecting agricultural production, the sector itself also presents opportunities for emissions reductions.

Despite these opportunities, warming of the climate — as the IPCC warns above — is unequivocal. Even if emissions from all sectors were reduced to zero, climate warming would continue for decades to come. As a result, it is of interest to stakeholders in the agricultural sector to understand the kind of impact climate change will have on food and crop production. There will undoubtedly be shifts in agro-ecological conditions that will warrant changes in processes and practices — and adjustments in widely accepted truths — in order to meet daily food requirements.

In addition, climate change could become a significant constraint on economic development in developing countries that rely on agriculture for a substantial share of gross domestic production and employment. Mitigation — or a decline in the release of

stored carbon and other greenhouse gases — must take place. There are opportunities for mitigation in the agricultural sector to help reduce the impact of climate change, and there is significant room for promoting pro-poor mitigation methods. In addition, as a change in climate has already begun, adaptation — or the modification of agricultural practices and production — will be imperative to continue meeting the growing food demands of modern society. Both mitigation and adaptation will require the attention of governments and policy makers in order to coordinate and lead initiatives. It is apparent that a system of regulation to ensure the economic value of carbon sequestration will be an important policy development in the agricultural sector.

GLOBAL IMPACTS

The IPCC report estimates climate change impacts on grain production at the global level and then zeros in on the estimated effect on the developed countries (DCs) of North America and Europe as well as on the less developed countries (LDCs) of Asia, Africa, and Latin America. The sharp difference in impact that climate change is expected to have on grain production in developed as opposed to less developed countries has two main causes. The first one might be called the "physical" factor. The high latitudes will warm more than the tropics. Most of the developed countries (DCs) are in the northern latitudes, and their agriculture would benefit from the longer growing seasons that a warmer climate would bring. Most less developed countries (LDCs), on the other hand, include much terrain in the tropics where the negative effects of a warmer climate would not be offset by other favourable trends.

The second reason might be called the "eco-structural" factor. The IPCC notes that, compared with the less developed countries (LDCs), the developed countries (DCs) have much greater economic resources that can be devoted to helping farmers adjust to climate change. In addition, the institutional structures of the developed countries (DCs)

appear to be more efficient than those in the less developed countries (LDCs) in mobilizing the resources needed to pursue specific social objectives, whether they are adjustments to climate change or anything else. But the effect of the eco-structural factor may be more malleable. In east and Southeast Asia, and to a lesser extent in south Asia, agricultural performance over the last 10 to 15 years has been impressive. Farmers have adopted new, more productive technologies as they have become available and production, both per person and per hectare, has increased. This strong agricultural performance has been part of a generally impressive economic performance in the countries of those regions.

The assessment of the IPCC contemplates a change in global surface temperature of 1.5 to 4.5°C by the year 2050, as a result of enhanced greenhouse gases. There will be significant changes in regional agricultural patterns as a result of climate change. All regions are likely to be affected, but some regions will be impacted more adversely than others. The timing of regional effects--who gains or loses when and for how long--will also be complex.

Increased concentrations of CO_2 may boost crop productivity

Higher levels of CO_2 should stimulate photosynthesis in certain plants; a doubling of CO_2 may increase photosynthesis rates by as much as 30-100%. When plants absorb more carbon they grow bigger and more quickly. This is particularly true for C3 plants (so called because the product of their first biochemical reactions during photosynthesis has three carbon atoms). Increased carbon dioxide tends to suppress photo-respiration in these plants, making them more water-efficient. C3 plants include such major mid-latitude food staples as wheat, rice, and soya bean. The response of C4 plants, on the other hand, would not be as dramatic (although at current CO_2 levels these plants photosynthesize more efficiently than do C3 plants). C4 plants include such low-latitude crops as maize, sorghum, sugar cane, and millet, plus many pastures and forage grasses.

Climate and agricultural zones would tend to shift towards the poles.

Because average temperatures are expected to increase more near the poles than near the equator, the shift in climate zones will be more pronounced in the higher latitudes. In the mid-latitude regions (45 to 60 latitude), the shift is expected to be about 200-300 kilometers for every degree Celsius of warming. Since today's latitudinal climate belts are each optimal for particular crops, such shifts could have a powerful impact on agricultural and livestock production. Crops for which temperature is the limiting factor may experience longer growing seasons.

While some species would benefit from higher temperatures, others might not.

A warmer climate might, for example, interfere with germination or with other key stages in their life cycle. It might also reduce soil moisture, evaporation rates increase in mid-latitudes by about 5% for each 1^0C rise in average annual temperature. Another potentially limiting factor is that soil types in a new climate zone may be unable to support intensive agriculture as practiced today in the main producer countries. For example, even if sub-Arctic Canada experiences climatic conditions similar to those now existing in the country's southern grain-producing regions, its poor soil may be unable to sustain crop growth.

Mid-latitude yields may be reduced by 10-30% due to increased summer dryness. Climate models suggest that today's leading grain-producing areas - in Asia and Africa may experience more frequent droughts and heat waves by the year 2030. Extended periods of extreme weather conditions would destroy certain crops, negating completely the potential for greater productivity through "CO_2 fertilization". The pole ward edges of the mid-latitude agricultural zones - northern Canada, Scandinavia, Russia, and Japan in the northern hemisphere, and southern Chile and Argentina in the southern one - may benefit from the combined effects of higher temperatures and CO_2 fertilization. But the problems of rugged terrain and poor soil suggest that this would not be enough to compensate for reduced yields in the more productive areas.

The greatest risks for low-latitude countries are that reduced rainfall and soil moisture will damage crops in semi-arid regions, and that additional heat stress will damage crops and especially livestock in humid tropical regions.

The impact on net global agricultural productivity is also difficult to assess.

Higher yields in some areas may compensate for decreases in others - but again they may not, particularly if today's major food exporters suffer serious losses. In addition, it is difficult to forecast to what extent farmers and governments will be able to adopt new techniques and management approaches to compensate for the negative impacts of climate change. It is also hard to predict how relationships between crops and pests will evolve.

Agricultural Adaptation to Climate Change in the Developing World

Populations in the developing world, which are already vulnerable and food insecure, are likely to be the most seriously affected. In 2005, nearly half of the economically active population in developing countries—2.5 billion people—relied on agriculture for its livelihood. Today, 75 percent of the world's poor live in rural areas.

International Food Policy Research Institute (IFPRI) presents research results that quantify the climate-change impacts mentioned above, assesses the consequences for food security, and estimates the investments that would offset the negative consequences for human well-being. The results of the analysis suggest that agriculture and human well being will be negatively affected by climate change:

- In developing countries, climate change will cause yield declines for the most important crops. South Asia will be particularly hard hit.
- Climate change will have varying effects on irrigated yields across regions, but irrigated yields for all crops in South Asia will experience large declines.
- Climate change will result in additional price increases for the most important agricultural crops–rice, wheat, maize, and soybeans. Higher feed prices will result

in higher meat prices. As a result, climate change will reduce the growth in meat consumption slightly and cause a more substantial fall in cereals consumption.

- Calorie availability in 2050 will not only be lower than in the no–climate-change scenario—it will actually decline relative to 2000 levels throughout the developing world.
- By 2050, the decline in calorie availability will increase child malnutrition by 20 percent relative to a world with no climate change. Climate change will eliminate much of the improvement in child malnourishment levels that would occur with no climate change.

Climate change and agricultural Production in India

The rise in global temperature owing to climate change will affect agriculture in strikingly different ways in the lower and higher latitudes. While in temperate latitudes a rise in temperature will help developed countries increase food productivity, it will have adverse effects in India and other countries in the tropics. The summer monsoon, which accounts for nearly 75 per cent of India's rainfall, is critical for agriculture. Climate change is likely to intensify the variability of summer monsoon dynamics, leading to a rise in extreme events such as increased precipitation and heightened flood risks in some parts of the country and reduced rainfall and prolonged drought in other areas.

India is among countries most threatened by climate change with experts warning that rising temperatures will lead to more floods, heat waves, storms, rising sea levels and unpredictable farm yields. Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall, but also by shifts in the timing of the rainfall. Higher temperatures reduce the total duration of a crop cycle, leading to a lower yield per unit area, especially for India's wheat and paddy crops. Soil erosion, increased numbers of pests and weeds brought by climate change will also affect agriculture in India. For instance, the amount of moisture in the soil will be affected by changes in factors such as rainfall, runoff and evaporation.

A World Bank report on climate change impact based on case studies in India has focussed on drought-prone regions of Andhra Pradesh and Maharashtra, and flood-prone districts in Orissa on the edge of climate tolerance limits. It highlights the possibility of the yields of major dry land crops declining in Andhra Pradesh. Sugarcane farmers of Maharashtra may see yields go down by as much as 30 per cent. Rice production in Orissa will face a similar fate with yields in the flood-prone coastal regions dropping by12 per cent.

Poor and marginal farmers who own less than one acre of land mostly populate these regions. There is an urgent need to evolve comprehensive climate resilience strategies that must factor in risk assessment, better water management, developing varieties that can do well in stressful conditions, and bringing about certain changes in agricultural practices. Many organisations are already working to develop drought-resistant and saline-resistant crop varieties for the arid regions, and rainfall-tolerant and short-duration varieties for flood-prone regions. But greater and sustained government support for agricultural research will be vital.

At the same time, the government must persuade farmers to take better advantage of the dry rabi season in the flood-prone regions, and also help them supplement their income through non-farm activities such as aquaculture. It may take many years for the devastating effects of climate change on agriculture to be felt fully but now is the time for bold government and public action.

The agricultural sector represents 35% of India's Gross National Product (GNP) and as such plays a crucial role in the country's development. Food grain production quadrupled during the post-independence era; this growth is projected to continue. The impact of climate change on agriculture could result in problems with food security and may threaten the livelihood activities upon which much of the population depends. Climate change can affect crop yields (both positively and negatively), as well as the types of crops that can be grown in certain areas, by impacting agricultural inputs such as water for irrigation, amounts of solar radiation that affect plant growth, as well as the prevalence of pests.

Conclusions and policy considerations

Climate change is also likely to have a significant negative impact on agricultural production, prompting output reductions that will greatly affect parts of the developing world. Mitigation options that are the most technically and economically feasible include better rice, crop- and pastureland management. Adaptation, including crop choice and timing, has the ability to partially compensate for production declines in all regions. As a result of changes in production, food security will be affected by climate change. Indeed, climate change alone is expected to increase the number of food insecure by an additional 5 to 170 million people by 2080, especially in Africa. Even the most aggressive mitigation efforts that can reasonably be anticipated cannot be expected to make a significant difference in the short-term. This means that adaptation is an imperative. Yet, in the face of this imperative, many developing countries are lacking in sufficient adaptive capacity. As a result, there is a large role for national governments, NGOs, and international institutions to play in building the necessary adaptive capacity and risk management structures.

In order to facilitate these roles, global scale assessments should be conducted to help identify intra-regional variations in the effects of climate change. These studies would clarify the range of outcomes possible under plausible climate and adaptation scenarios, which would then assist in the targeting of high priority areas. Once areas of prioritization have been identified, evaluation criteria should be applied, that not only consider net economic benefits, but also environmental and social appropriateness. In addition, adaptation measures should maximize the complementarities between existing rural and sustainable development objectives.

Finally, climate change adaptation and mitigation have to proceed simultaneously. Since adaptation becomes costlier and less effective as the magnitude of climate changes increases, mitigation of climate change remains essential. The greater the level of mitigation that can be achieved at affordable costs, the smaller the burden placed on adaptation. Policies focused on mitigating GHG emissions, if carefully designed, can help

generate a new development strategy; one that encourages the creation of new value in pro-poor investments by increasing the profitability of environmentally sustainable practices. To achieve this goal, it will be necessary to streamline the measurement and enforcement of offsets, financial flows, and carbon credits for investors. It will also be important to enhance global financial facilities and to reform their governance, namely to simplify rules and to increase the funding flows for mitigation in developing countries. There has been a tendency to treat adaptation to climate change as a stand-alone activity, but this should be integrated into development projects, plans, policies, and strategies. Meanwhile, development policy issues must be addressed in association with the climate change community. A combined perspective is required to ensure the formulation and implementation of integrated approaches and processes that recognize how persistent poverty and environmental needs exacerbate the adverse consequences of climate change. Climate change will alter the set of appropriate investments and policies over time, both in type and in spatial location. Effective adaptation therefore requires a judicious selection of measures within a policy context and a strategic development framework, but must also explicitly counter the impact of climate change, particularly with respect to the poor.

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