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Effects Of Climate Change On Agriculture

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Abstract

Agricultural sector susceptibility to both climate change and instability is well known in the literature. The general opinion is that temperature and precipitation shifts will result in adjustments in land and water systems that would ultimately impact the production of agricultural products. This research has also shown that impacts on agricultural production are projected to be especially detrimental especially in tropical areas, including most of the poorest countries. Such countries' weakness is often actually more likely to be severe in the face of financial, technical, and institutional constraints. Although forecasts indicate that global food output is likely to remain strong, analysts anticipate tropical regions would see both a decline in agricultural yields and an increase in rates of deprivation as livelihood conditions are progressively vulnerable to projected climate pressures for those engaged in the agriculture sector. Although contemporary policy discourse has concentrated on reducing pollutants that cause climate change, policy proposals that can tackle climate impacts have been fairly minimal..

Key words: Agriculture, Climate Change, Mitigation Strategies, Policy Changes, Ecosystem, Environment.

Introduction

The agricultural sector is influenced and driven by various influences. Price volatility, adjustments in inland and foreign agricultural strategies, supervision activities, conditions of exchange, sort and affordability of proficiency and expansion, legislation for the usage of the land and biophysical features (soil quality, diseases, pests, carrying potential) are the major parts of fundamental influences [1]. Agricultural development is often at the whim of uncertainty caused by climate change, including adverse events like drought and flooding, despite its intrinsic connection with natural resources. Throughout the last decade, climate change (in the form of long-term shifts in typical precipitation or mean temperature, and also increased occurrence of severe climate effects) has increasingly been recognised as an external influence that, with other traditional constraints, would have a major impact on agricultural production in terms of form, size, temporal and spatial affect.

Climate instability and transition impacts on the agriculture sector are expected to emerge gradually directly through changes in water and land systems, the possible primary conduits of transform. Changes are anticipated in the frequency and severity of droughts, floods and storm destruction. Environmental change is likely to contribute to long-term water and other food deficits, deteriorating agricultural quality, famine and desertification, sea-level increase, livestock and crop disease and insect outbreaks, and so on. Vulnerable areas are likely to experience declines in agricultural production, largely as a consequence of crop yield reductions [2].

Growing use of arable land for agriculture (particularly within smallholder farms) is projected as the land's abundance and capacity for productivity continue to decline. Conversely, climate change is also supposed to have some beneficial results, particularly in temperate regions. The prolongation of rising seasons, the impact of carbon fertilization and enhanced crop growth conditions are expected to accelerate increases in crop production in high-latitude regions. Consequently, climate change's possible impacts on the agriculture industry have sparked alarm about the extent of potential global food supply. Early global forecasts expect a 30-40 per cent drop in grain output (without taking into account the impact of CO2 adaptation or fertilization). Investigators are estimating (without adjustments) global changes in the agriculture sector within expenses of US$ 60.1 billion and revenues of US$ 0.199 billion based on agronomic studies in low elevation countries [3].

Although necessary changes, this compares to US$ 37 billion in damages and US$ 70 billion in revenue. And lately, investigations that simulate the effects and adaptations of CO2 fertilisation have found that global agricultural supply is relatively stable even if global temperatures rise moderately. Significant declines are anticipated globally, but, in the most extreme climate change scenarios despite the extent of warming projected by the science community, national and local differences in impacts on agricultural productivity are possibly significant. As a consequence, analysts expect a geographic change in crops and farming activities to polar and temperate regions away from tropics. Drylands are expected to be among the most insecure regions. Total outcome is bound to slow across much of Africa as well as East and South Asia (for instance like Thailand, Myanmar, Western India), while rising in nations like Switzerland, Malaysia, Indonesia, and portions of India and China. According to scientists, future climate regimes could reduce rice production in Asia by 3.6 percent (forecasted at 420 tonnes) compared to 2000 levels.

Taking into account the connection between agriculture and deprivation, concerns impacts of climate change are elevated. The influence on the agriculture industry, in especially, is expected to exacerbate the incidence of rural poverty. In industrialized economies, where agriculture is the primary source of survival for the majority of the rural population, the effects on poverty are predicted to be severe. In Nigeria, around 51%–82% of people are dependent on the farming sector for employment and the integrated production nearly 33% of GDP per country on average. More than 70 percent of people are engaged in agriculture and stock-farming in rural areas in the West African Sahel alone, and the two industries contribute about 34 percent of GDPs in the nations. Despite smaller supplies of equipment and resources, the agriculture industry is unable to survive the increased stresses faced by climate change without a coordinated solution plan in these weaker developed countries. Compared to some figures, up to 10 per cent of GDP may be the cumulative economic effect of climate change on agriculture sector [4].

As work progresses on the geographical variability of climate change and its resulting effects, it is becoming increasingly clear that exposure to climate effects may be complex around and within regions. Another concern is the high expense of maladaptation, where measures are not completely enforced or badly planned to tackle climate change. The extension of human populations into marginal land and vulnerable places like low-lying and deltas coastlines and other climatically-sensitive areas in developed countries has undeniably led to worsening the anticipated problems. In brief, it is clear that many societies would be best prepared and placed to cope with the multiple potential consequences correlated with abrupt or incremental climate scenarios [5].

Climate Concerns Through Adaptation

So far, politicians have concentrated primarily on combating climate change by reduction of human-induced greenhouse gas pollution and carbon sequestration to mitigate the anticipated stresses on both the agriculture and other economic sectors. However, it is becoming generally recognized that mitigation alone, as a climate strategy, is impossible to suffice. As awareness increases the working of habitats and socio-economic processes, and the degree of their possible vulnerability to climate triggers, Modern political dialogue is increasingly driven to offset attempts toward reduction with varying reasons as yet another preventive care of climate change. It has added thrust to fostering adapting to the recognition that only certain countries (particularly advanced economies, and especially the impoverished sections of society within states) could not avoid the impact of climate change. In especially, under-preparation for high seasons of famine or longer duration, extreme weather events and environmental degradation (e.g. catastrophic events) may be prohibitively expensive and may seriously weaken significant long-term investments [6].

As a result, multiple investigations have also shown the need to respond to strategies of reduction. The Intergovernmental Panel on Climate Change says that resilience is a key factor in reducing the predicted negative impact or improving the beneficial effects of global warming by means of changes in 'processes, processes, or systems.' Adaptation is considered a critical part of effects of climate change and risk assessments. Researchers argue that a realistic solution approach is to enhance sensitivity to climate change, including severe events, in the sense of growth. This is, by enhancing sensitivity to climate change and severe weather conditions, that the resilience of infrastructure designs and projects will yield rapid benefits. Adaptation is seen as a key move towards improving local ability to combat anticipated and unforeseen climatic conditions [7].

A comprehensive literature on the effects of climate change on agriculture has also been established, with the earliest concentrating primarily on sector vulnerability. The general lesson to come from this literature is that a broad variety of local environmental and management influences are dependent on the degree of exposure of the agricultural sector to climate change. Main features typically involve local biological conditions like soil quality, type of crop being cultivated, degree of knowledge and awareness of predicted climate change, nature and objectives of agricultural management regimes (i.e. optimizing production or profits, etc.), level of government and other external (private) agencies funding, and capacity of key stakeholders. In a way, an additional issue to be solved by farmers is the growing volatility of the environment impact. For e.g. low soil quality, financial restrictions, and lack of market access may restrict agricultural productivity to start with, irrespective of climate impacts. Climate change therefore represents an extra burden for farmers which translates into output risks involved with crop yields, probability of extreme events, scheduling of field operations and scheduling of investing in new technologies.

Consequences of Climatic Impacts on Agricultural Crops:

Researchers identify 4 forms in which environment can affect crops physically. Next, precipitation and temperature improvements can alter the distribution of the agro-ecological areas. Variations in soil moisture and material, and the frequency and length of increasing seasons in various areas of the world can be influenced in many ways. Researchers note that higher temperatures would extend growing seasons in middle and higher latitudes and increase crop production areas pole-to-pole, helping countries in these regions [8]. Although less productive soils will mitigate some of the benefits of an extended growing season in higher latitudes, it is not obvious to what degree additional soils would be a real limitation, provided that various other influences (such as shifts in precipitation rates, usage of fertilizer, availability of irrigation, etc.) would also have a major effect on the final outcome. In comparison, higher temperatures are likely to adversely affect optimum conditions in lower latitudes, particularly in areas where temperatures are near to or at the optimum level for beginning crop production. The supply and demand for irrigation would also be impacted by both weather rises and precipitation [9].

Precipitation loss is likely to increase more agricultural aquifer extraction and put increased pressures on other non-agricultural uses of surface and groundwater services (like industrial and urban needs). An increase in possible evapotranspiration is likely to intensify the stress of drought, particularly in semiarid tropics and subtropics. Temperatures in Africa are predicted to increase below the global average, which would have various impacts depending on the form of agro-ecological zone underlying. That is, effects would depend on temperatures initially set. Researchers are investigating the effect of climate change on Kenya and found that rising temperatures in highland areas will have a significant influence. Based on a land use model to predict improvements in land supply suitable for cropping, researchers have shown that a 65 percent increase in "strong potential" land is expected to occur in highland areas of western Kenya in reaction to an average temperature rise of 2.4 °C. In comparison, increasing atmospheric temperatures can have a detrimental impact on many lowland areas, particularly semiarid ones. For certain crops, plant metabolism starts to break down above 50 °C, rising growing times may minimize yields due to accelerated growth [10].

The impacts of carbon dioxide are projected to have a beneficial influence leading, for example, to better productivity of water usage and higher photosynthesis levels. Numerous studies on the agronomic impact of climate change include the following reason for carbon dioxide emissions predicted to increase by as much as 56% by 2040. Increasing amounts of carbon dioxide in the environment are essential to farming as they improve the rate of photosynthesis and the productivity of water usage. For plants with the photosynthetic pathway C3, which involves crops including wheat, soybean, and rice these results are greatest.

Carbon dioxide accumulation for C4 plants like millet, maize, and sorghum and other grasses (and thus weeds) is also good-but not by as many. Researchers predict that doubling the amounts of carbon dioxide will result in yield increases varying from 20-40 percent. Researchers say that the productivity of water usage should grow within the same period. Although higher atmospheric CO_2 concentrations may boost crop production and improve photosynthesis by decreasing evapotranspiration, the net effect could be moderated by costly infestations of pests and weeds [11]. At the same period, there is a controversy over whether predicted efficiency gains attributed to CO_2 have been overstated. Researchers claim that while global temperature changes occur at a long pause (after increased greenhouse gas concentration), fertilization will occur nearly instantaneously. And, considering the elevated concentration of CO_2 that has arisen, it was believed that the results of fertilization in crop yields would already be evident. Of note, the impact of carbon fertilization could be responsible for some of the massive development changes witnessed across the globe.

Several reports have looked at the impact of forest carbon fertilization. There is evidence to think, in natural ecosystems, the benefits of carbon fertilization may be reduced by deficiencies of certain resources (citation). Clearly this is less of an agricultural issue, where farmers routinely supplement nutrients through fertilizers. Researchers look at the relationship between the reported 20 percent rise in CO_2 over the past two hundred years and land-use effects on Australian vegetation and infer that ephemeral and annual herbaceous plant foliage cover seasonally green leaves are approximately the same over that time [12].

Furthermore, their findings demonstrated that the rise in evergreen cover is possibly attributed to the raise in CO_2 concentrations, although it is impossible to be the primary trigger of the transition alone. Researchers note in another paper that crop growth under elevated CO2 induced harm to the spring freeze in field-grown snow gum seedlings (*ex Spreng, Eucalyptus pauciflora Sieb*), a typically freeze-tolerant eucalyptus. Their result indicates an increase in susceptibility to frost can decrease possible productivity gains from fertilization with CO_2. Water supply (or runoff) is a vital element in assessing climate change impacts in many countries, especially in Africa. A variety of reports say precipitation and the duration of the growing season are important in deciding how climate change impacts agriculture positively or negatively. However, as outlined earlier, the theoretical capacity to forecast patterns in rainfall with great certainty abounds with restrictions. There is less trust in precipitation for many other regions of the world, too, than other climate changes.

Environmental instability and the increased occurrence of weather events such as droughts and flooding or increases in temperature and precipitation fluctuations may lead to agricultural losses. For various factors varying from plant transpiration to distribution, a higher occurrence of droughts would possibly raise the burden on water sources. In comparison, rainfall level changes in other regions may contribute to higher soil erosion levels, leaching of agricultural chemicals, and runoff. Environmental instability and the increased occurrence of weather events such as droughts and flooding or increases in precipitation and temperature fluctuations may result in agricultural losses. For various factors varying from plant transpiration to distribution, a higher incidence of droughts would possibly raise the burden on water sources. In addition, growing rainfall intensity in other regions may result in higher soil erosion rates, leaching of agricultural chemicals, and runoff that holds livestock nutrients and waste into water bodies [5]. It is predicted that the projected fluctuations in temperature, precipitation, and ambient carbon content and severe events would have dramatic effects on plant growth and yields, seeds, nutrients, insects, pests, pathogens, livestock and water supply in Africa. Scientists say that the predicted impacts in dryland areas involve rainfall loss, temperature rise and enhanced variation in rainfall. Several irrigated areas like Mali, Mauritania and Niger might get even higher rainfall levels.

The Impact model for Estimation:

At the beginning of the 1990s, IFPRI created the "International Model for Policy Analysis of In acknowledgement of the absence of the a long-term strategy and consensus between policymakers and researchers regarding the steps needed to feed, mitigate hunger and protect the natural resources has been identified. by Agricultural resources and trade. The Effect concept covers countries and regions as well as the world's major agricultural resources. In order to analyse baseline and alternative scenarias for worldwide food intake, access, work, occupations, and populace, the IMPACT uses a technique of food consumption and production parameters as a partial balance model for agriculture output, growth and trade. Mechanisms of demand and supply introduce elasticity of supply and demand to represent the fundamental mechanisms of output and consumption. Each year, world agricultural crop prices are set at rates that open foreign markets. Nation and national sub-models of agricultural products are related through exchange. The production, demand, and prices for agricultural commodities are calculated within every nation or national sub-model [13].

The initial IMPACT model believed “normal” climate conditions, so it did not reflect the effects of yearly climate fluctuations on demand, food production and trade. The Water Simulation Module (WSM) allows IMPACT model the effect of the availability of water and delivery on food production and consumption, its yearly variations and the groundwater competition among sectors of the economy. WSM forecasts water demand for large water uses industries within the model, integrate water supply, using intersectoral and intrasectoral water through seasonal reservoir management and water distribution on river basin scales. In addition to volatility, lifelong patterns of water supply and use in multiple areas are expected to include exogenous factors such as income growth and population, better water use techniques, and new waterways.

Geographic region analyses have recently been strengthened for natural river basins and the global economic zones. It now employs 261 "food production units" (FPU), which constitute the spatial junction of 118 economic regions with thirty-seven fluvial basins. FPU level simulations of climate and crop growth, when food demand and trade projections of agricultural goods take place at national or economic scale. The breakdown of the space unit reinforces model ability to represent agrarian economies' spatial complexity and, more generally, water usage abundance [14].

Recent climate change success has increased trust in human-induced global warming, with major consequences for socio-economic and agriculture processes. To evaluate the impacts of environmental change on regional and ecological food systems, particularly climate change, and also to formulate appropriate action measures, the IMPACT model has been expanded to include elements of climate change like the altered hydrological cycles, yield effects of CO_2 fertilization and changes in temperature, and adjustments in water supply and water demand (irrigation). The global hydrology model is capable of translating projected climate forecasts from GCM simulations into hydrological elements, like evapotranspiration, precipitation, and soil moisture, used in this paper. For the baseline forecasts up to 2040, researchers use the intermediate growth B2 scenario1 from the SRES scenario unit. Temperature and CO_2 fertilisation impacts on crop yields are based on IMAGE model simulations. Recent results of the research indicate that the crop yield enhancement observed in the global “Free Air Carbon Enrichment Facilities” (FACE) experiments dropped way below (about half) the chamber value expected [15].

In order to understand the impact on quantity and temporary and geographic distribution of pluvial and river runoff, climate change will likely impact on the composition and frequency of individuals under stress conditions and on the effectiveness of the world agriculture systems. In the future, this will influence the occurrence and circulation of people underneath stress conditions. Researchers using climate data from the B2 scenario run HadCM3, which was systematically downscaled to global grid of 0.6 degrees latitude / longitude using the Climate Research Unit's trend scaling tool. The model forecasts the proportion and amount of undernourished preschool children (0-4 years old) in developed countries to investigate the impact of food deprivation. A malnourished infant is a kid with more than two normal weight-for-age variations below the U.S. weight-for-age norm. “Global Health Information Centre / World Health Organisation”. In developing countries, an under-nourished number of pre-school children is estimated based on calories per capita, the percentage of women and men at birth, overall female enrolment in secondary education as a proportion of women in the provincial secondary education legislation. The number of under-nursing children is calculated [16].

Conclusion

This paper uncovered a wealth of information regarding a variety of initiatives that can help the developed worlds' agriculture sector becoming more responsive to climate vulnerabilities. Several initiatives are applied at farm level to minimize exposure to climate change. These involve, in general, risk diversification approaches such as crop diversification, adjustments in development volume, nutrient and pest control systems, insurance policies, food storage, climate knowledge monitoring and distribution, and temporary relocation in pursuit of opportunities for off-farm jobs. Although they are immediately effective, however, they are probable to be inadequate in the longer term to cope with climate change threats. Accordingly, a wide variety of strategies to reduce long-term vulnerability need to be pursued as well. The number of options in this regard involves changing the crop mix, enhancing water management, adopting and using emerging technologies and continuously migrating away from unviable areas of agriculture. The literature also indicates that factors which lead to vulnerability, irrespective of the temporal aspect of climate change, need to be resolved. In addition, low per capita income, high reliance on natural resources and subsistence agriculture, poor governmental and institutional capability, prevalence of preventable and inevitable diseases, high frequency of violent conflict and dependency on assistance were described as challenges for economic growth and development.

References

1. Intergovernmental Panel on Climate Change and Intergovernmental Panel on Climate Change, "Agriculture, Forestry and Other Land Use (AFOLU)," in Climate Change 2014 Mitigation of Climate Change, 2015.

2. R. Lal, "Climate Change and Agriculture," in Climate Change: Observed Impacts on Planet Earth: Second Edition, 2016.

A. Dinar, R. Hassan, R. Mendelsohn, J. Benhin, and et al, Climate Change and Agriculture in Africa. 2012.

3. M. Jolánkai, M. Birkás, Á. Tarnawa, and K. M. Kassai, "Agriculture and Climate Change," in International Climate Protection, 2019, pp. 65–71.

4. S. Kumari, T. P. Singh, and S. Prasad, "Climate Smart Agriculture and Climate Change," Int. J. Curr. Microbiol. Appl. Sci., vol. 8, no. 03, pp. 1112–1137, 2019.

5. R. Pilgeram, "Climate change and sustainable agriculture," in Emergent Possibilities for Global Sustainability, 2018, pp. 127–137.

6. L. Lipper et al., "Climate-smart agriculture for food security," Nature Climate Change. 2014.

7. S. Manandhar, V. P. Pandey, F. Kazama, and S. Kazama, "Economics of climate change," in Climate Change and Water Resources, 2014.

8. S. Weart, R. Cicerone, P. Gleick, and N. Oreskes, "Climate change," Proc. Natl. Acad. Sci. U. S. A., 2014.

9. S. J. Scherr, S. Shames, and R. Friedman, "From climate-smart agriculture to climate-smart landscapes," Agriculture and Food Security. 2012.

10. P. Newell and O. Taylor, "Contested landscapes: the global political economy of climate-smart agriculture," J. Peasant Stud., vol. 45, no. 1, pp. 108–129, 2018.

11. World Bank, CATIE, and CIAT, "Climate-Smart Agriculture in Peru.," CSA Ctry. Profiles Lat. Am. Ser., pp. 1–12, 2014.

12. S. Robinson et al., "The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Model Description for Version 3," SSRN Electron. J., 2016.

13. M. Rosegrant and T. I. development Team, "International model for policy analysis of agricultural commodities and trade (IMPACT): model description. International Food Policy Research Institute," Int. Food Policy Res. Inst. (IFPRI), Washington, D.C., 2012.

14. C. Octaviano, S. Paltsev, and A. C. Gurgel, "Climate change policy in Brazil and Mexico: Results from the MIT EPPA model," Energy Econ., 2014.

A. Calzadilla, T. Zhu, K. Rehdanz, R. S. J. Tol, and C. Ringler, "Climate change and agriculture: Impacts and adaptation options in South Africa," Water Resour. Econ., 2014.