



CAMA CLIM RESEARCH BRIEF



Global Climate Change and Cameroon's Agriculture

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A. BACKGROUND

This Issue briefly describes the theme of **Climate Change**. It puts into perspective the concept of global climate change--its potential relationship with agriculture and further highlights the effort of the international community in raising climate change on the totem pole of the international development agenda. The target audience for this brief is the members of the CAMA CLIM Research Team in Cameroon. As noted above, this is Issue Number 1, heralding the onset of periodic (quarterly) release by the CAMA CLIM Team members, in the entire lifetime of the research project. However, the CAMA CLIM research team will gladly disseminate its internal product and share with members of the respective country teams of the GEF/WB Global Climate Change and African Agriculture, governmental agencies, academics, NGOs and the civil society.

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1. What is climate change?

It is widely acknowledged that the amount of carbon dioxide and other so-called greenhouse gases [carbon dioxide, water vapour, methane, and nitrous oxide, chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF₆)], in the atmosphere are increasing. Carbon dioxide in particular has increased by 30% over the last 200 years, primarily as a result of the combustion of fossil fuels, such as coal, oil and natural gas (e.g. in automobiles, industry and electricity generation) and changes in land use (e.g. deforestation). If current trends continue, the amount of carbon dioxide in the atmosphere will double during the 21st century, with further increases thereafter. The amounts of other greenhouse gases will also increase during the 21st century due primarily to human activities.

The accumulation of carbon dioxide and other greenhouse gases in the atmosphere will change the climate by enhancing the greenhouse effect, leading to an increase in the Earth's average surface temperature. Currently, the best estimate is that the global average surface temperature will rise 1-3.5°C (about 2-6 ° F) by the year 2100 (relative to 1990), with continued increases thereafter. Because most greenhouse gases remain in the atmosphere for a long period of time, even if emissions from human activities were to stop immediately, the effect of accumulated past emissions would persist for centuries.

2. Why is it important for Agriculture?

It is frequently assumed that global change will bring higher temperatures, altered precipitation, and higher levels of atmospheric carbon dioxide. At the basis of any understanding of climate impacts on agriculture lies the biophysical sciences. The rates of most biophysical processes are highly dependent on climate variables such as radiation, temperature, and moisture, that vary regionally. For example, rates of plant photosynthesis depend on the amount of photosynthetically active radiation and levels of atmospheric carbon dioxide. Temperature is an important determinant of the rate at which a plant

progresses through various phenological stages towards maturity. The accumulation of biomass is constrained by the availability of moisture and nutrients to a growing plant. What might these changes mean for the biophysical response of agricultural crops?

2.1 Interactions with thermal regimes. Higher temperatures in general hasten plant maturity in annual species, thus shortening the growth stages during which pods, seeds or grains can absorb photosynthetic products. This is one reason yields are lower in the tropics. Because crop yield depends on both the rate of carbohydrate accumulation and the duration of the filling periods, the economic yields of both temperate and tropical crops grown in a warmer and carbon dioxide-enriched environment may not rise substantially above present levels, despite increases in net photosynthesis.

Both the mean and extreme temperatures that crops experience during the growing season will change in both temperate and tropical areas. Extreme temperatures are important because many crops have critical thresholds both above and below which crops are damaged. Prolonged hot spells can be especially damaging. Critical stages for high temperature injury include seedling emergence in most crops, silking and tasseling in corn, grain filling in wheat, and flowering in soybeans. In general, higher temperatures should decrease cold damage and increase heat damage. Agroclimatic zones are expected to shift poleward as lengthening and warming growing seasons allow new or enhanced crop production (soil resources permitting).

2.2 Changes in hydrological regimes. The hydrological regimes in which crops grow will surely change with global warming. While all Global Climate Models (GCMs) predict increases in mean global precipitation (because a warmer atmosphere can hold more water vapour), decreases are forecast in some regions and increases are not uniformly distributed. The crop water regime may further be affected by changes in seasonal precipitation, within-season pattern of precipitation, and interannual variation of precipitation. Increased convective rainfall is predicted to occur, particularly in the tropics, caused by stronger convection cells and more moisture in the air. Too much precipitation can cause disease infestation in crops, while too little can be detrimental to crop yields, especially if dry periods occur during critical development stages. For example, moisture stress during the flowering, pollination, and grain-filling stages is especially harmful to maize, soybean, wheat and sorghum.

The amount and availability of water stored in the soil, a crucial input to crop growth, will be affected by changes in both the precipitation and seasonal and annual evapotranspiration regimes. Global climate change is likely to exacerbate the demand for irrigation water. Higher temperatures, increased evaporation, and yield decreases contribute to this projection. However, supply of needed irrigation water under climate change is uncertain. Where water supplies are diminishing, extra demand might require that some land be withdrawn from irrigation.

2.3 Physiological effects of Carbon dioxide. The study of agricultural impacts of trace gas induced climate change is complicated by the fact that increasing atmospheric carbon dioxide has other effects on crop plants besides its alteration of their climate regime. These are often called "fertilising" effects, because of their perceived beneficial physiological nature. Carbon dioxide enrichment tends to close plant stomates, and by doing so, reduces transpiration per unit leaf area while still enhancing photosynthesis. Higher carbon dioxide may thus improve water-use efficiency, defined as the ratio between crop biomass accumulation or yield and the amount of water used in evapotranspiration.

Temperate crops may benefit more from increasing carbon dioxide than tropical crops. In crop species with the Carbon-3 pathway characteristic of non-tropical plants (e.g., wheat, soybean, cotton) carbon dioxide enrichment has been shown to decrease photorespiration, the rapid oxidation of recently formed sugars in the light, a process which lowers the efficiency of overall photosynthesis. Carbon-4 crops, which are particularly characteristic of tropical and warm arid regions (e.g., maize, sorghum, and millet), are more efficient photosynthetically under current carbon dioxide levels than carbon dioxide plants (because they fix carbon dioxide into malate in their mesophyll cells before delivering it to the RuBP enzyme in the bundle-sheath cells). Because of this carbon dioxide -concentrating and photorespiration-avoiding mechanism, experimental data show that Carbon-4 plants are less responsive to carbon dioxide enrichment.

The physiological effects of high levels of atmospheric carbon dioxide described above have been observed under controlled experimental conditions. In the open field, however, their magnitude and significance are still largely untested, and their importance relative to the predicted large-scale climatic effects uncertain.

2.4 Soils. Climate change will also have an impact on the soil, a vital element in agricultural ecosystems. Higher air temperatures will cause higher soil temperatures, which should generally increase solution chemical reaction rates and diffusion-controlled reactions. Solubility of solid and gaseous components may either increase or decrease, but the consequences of these changes may take many years to become significant. Furthermore, higher temperatures will accelerate the decay of soil organic matter, resulting in release of carbon dioxide to the atmosphere and decrease in carbon/nitrogen ratios, although these two effects should be offset somewhat by the greater root biomass and crop residues resulting from plant responses to higher carbon dioxide.

Sea level rise, another predicted effect of global warming, will cause increased flooding, salt-water intrusion, and rising water tables in agricultural soils located near coastlines. This is particularly crucial in tropical countries such as Bangladesh, with large agricultural regions and high rural population located near current sea level.

2.5 Pests. Pests affect agricultural plants and animals in ways considered unfavourable. They include

weeds, and certain insects, arthropods, nematodes, bacteria, fungi, and viruses. Because climate variables (especially temperature, wind and humidity) control the geographic distribution of pests, climate change is likely to alter their ranges. Pests and diseases from low latitude regions, where they are much more prevalent may be introduced at higher latitudes. As a consequence of pest increase, there may be a substantial rise in the use of agricultural chemicals in both temperate and tropical regions to control them.

3. What does this mean for Cameroon's Agriculture?

Agriculture is the basic activity by which humans live and survive on the earth in general and Cameroon in particular. Cameroon's economy is predominantly agrarian. Assessing the impacts of climate change on Cameroon's agriculture is a vital task. Nonetheless, in both developed and developing countries, the influence of climate on crops and livestock persists despite irrigation, improved plant and animal hybrids and the growing use of chemical fertilisers. The continued dependence of agricultural production on light, heat, water and other climatic factors, the dependence of much of the world's population on agricultural activities, and the significant magnitude and rapid rates of possible climate changes all combine to create the need for a comprehensive consideration of the potential impacts of climate on global agriculture.

Numerous studies have examined the impacts of past climatic variations on agriculture using case studies, statistical analyses and simulation models. Such studies have clearly demonstrated the sensitivity of both temperate and tropical agricultural systems and to climatic variations and changes.

As evidence of climate change and its possible anthropogenic origins rapidly accumulates, researchers are increasingly turning their attention to the costs and benefits of this change and their world-wide distribution. All other things being equal, it is reasonable to expect that industrialised countries are in a better position to adapt themselves to and absorb the impact of climate change. In developing countries such as Cameroon, however, much larger proportions of the population are much more directly exposed to the whims of climate, and the scope for protective investments (dikes, irrigation systems and transportation networks to name a few) is extremely limited. For this reason, a great deal of attention needs to be focused in the coming years on studying the impact of climate change on developing countries such as Cameroon.

4. What international efforts have been taken to address climate change?

Climate change was initially recognised as a serious problem meriting international attention at the First World Climate Conference in 1979. Greater understanding of the global climate and evidence of increasing concentrations of atmospheric carbon dioxide caused the United Nations Environmental Programme (UNEP) and the World Meteorological

Organisation to establish the Intergovernmental Panel on Climate Change (IPCC) in 1988.

The IPCC published its First Assessment Report on Climate Change in 1990. The Report affirmed the underlying scientific basis of climate change. Using the IPCC report as a starting point, the United Nations General Assembly established the Inter-governmental Negotiating Committee to begin negotiating a Framework Convention on Climate Change in 1990. The Second and Third Assessment reports were released in 1995 and 2001, respectively, presenting robust findings and evidence on global climate change.

4.1 The United Nations Framework Convention on Climate Change (UNFCCC)

At the 1992 United Nations Conference on Environment and Development (the so-called Rio Earth Summit), the United Nations Framework Convention on Climate Change (UNFCCC) was signed by 154 governments. The stated objective of the UNFCCC is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous, human-induced climate change. The Convention calls upon Parties to achieve that level in a time-frame which will allow ecosystems to adapt naturally to climate change, and to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner.

The Convention divides the world into two groups: industrialised (Annex I) countries who have been primarily responsible for human-induced greenhouse gas emissions; and developing (non-Annex I) countries, who in the future will contribute to an increasing proportion of human-induced emissions.

All Parties to the Convention are obligated to develop national inventories of greenhouse gas emissions by source and removals by sinks. They are also committed to developing national strategies for adapting to, and mitigating climate change, and to take climate change considerations into account in the social, economic, and environmental policies. Further, they must promote the sustainable management, conservation, and enhancement of sinks of greenhouse gases, including forests and all other terrestrial, coastal, and marine ecosystems.

The UNFCCC recognised the concept of 'Joint Implementation.' Under Joint Implementation, Parties acting under the auspices of the Convention voluntarily agree to undertake a project to reduce, avoid or sequester greenhouse gas emissions. In a subsequent meeting, a pilot phase was established to gain experience with Joint Implementation. The Parties also designated the Global Environmental Facility (GEF) as an interim financing mechanism.

In recognition of their historical, and therefore differentiated, responsibilities for the build-up of greenhouse gases in the atmosphere, developed nations committed under the UNFCCC to voluntarily reduce emissions to 1990 levels by the year 2000. Three years after this commitment was made,

emissions in most industrialised countries, were above 1990 levels and in some cases rising steadily.

At the first Conference of the Parties in 1995, Parties recognised that voluntary commitments were inadequate and agreed to the Berlin Mandate, which called for Parties to initiate a process for strengthening the commitments of Annex I Parties in the period beyond 2000. A separate subsidiary body, the Ad Hoc Group on the Berlin Mandate, was created to draft a protocol for adoption at the third Conference of Parties in 1997. The Berlin Mandate talks were given a significant push when the IPCC issued its Second Assessment Report in 1995 concluding, "the balance of evidence suggests a discernible human influence on the global climate."

4.2 The Kyoto Protocol

In December 1997, at the third Conference of the Parties to the UNFCCC, some 160 nations agreed to the Kyoto Protocol to the UNFCCC. The Protocol calls for the first ever legally binding commitments to reduce carbon dioxide and other greenhouse gas emissions. While individual country commitments vary, the Protocol calls for an overall reduction by five per cent from 1990 levels. Those countries with commitments are those Annex I Parties to the Convention. Developing (non-Annex I) countries have no commitments.

To accommodate national circumstances, each Annex I country agreed to a different greenhouse gas reduction target. For example, Japan committed to a six per cent reduction, USA to a seven per cent reduction, while the European Union, as a group, committed to an eight per cent reduction. Not all Annex I countries agreed to a reduction; Australia, for example, was allowed an eight per cent increase from their 1990 emission level. These reductions must be accomplished within a "commitment period" from 2008-2012. This five-year period was created to allow for increased flexibility in the timing of reductions. For example, Japan's emissions may be above the six per cent agreed reduction target in any given year during the commitment period, as long as the average over the five years is not. The Protocol requires inventories of the six major greenhouse gases.

To meet their Protocol commitments, Annex I countries have a number of options. They may:

- take domestic action to reduce emissions from their industrial sectors, such as replacing fossil fuel use with renewable energy sources
- take domestic action in the forest sector through a limited set of activities - afforestation and reforestation, that count as

reductions, and deforestation, that counts as an emission

- utilise three market-based mechanisms created by the Protocol. Two of these (emissions trading and project-based credit trading) allow Annex I countries to buy, sell, or trade greenhouse gas reductions and emission allowances from other Annex I countries. The third mechanism allows Annex I countries to buy or trade project-based credits from non-Annex I countries - the Clean Development Mechanism.

At the upcoming sixth Conference of the Parties to the UNFCCC (13-24 November 2000, The Hague, The Netherlands), Governments are expected to take decisions on how to operationalise several aspects of the Kyoto Protocol and how to enhance the capacity of developing countries to implement the Convention.

5. Conclusion

In the coming decades, agriculture faces the prospect of a changing climate, as well as the known challenge of continuing to feed teeming population in Cameroon and the rest of the world. Climate change could have far-reaching effects on patterns of trade among nations, development, and food security. To help prepare for this uncertain but challenging future, CAMACLIM examines the potential effects of climate change on Cameroon's agriculture. Effort is being put to integrate CAMACLIM research with the broader research activities of the World Bank via the *GEF/WB Climate Change Impacts on Agriculture in Africa* project.

C. News

The first workshop for the GEF/WB Project on *Climate Change Impacts on Agriculture in Africa* project takes place in Cape Town South Africa, 4-7th December, 2002. Three members of eight African teams are sponsored for the workshop by the GEF/WB Project—where the GEF/WB Project currently have funds to support their country studies. However, only the expenses of the team leaders of three other countries, including Cameroon—where the GEF/WB Project is yet to find funding for their studies—would be covered for the workshop. Notwithstanding, the GEF/WB Project is also funding the participation of other African and International experts. For regular updates and briefing, the CAMACLIM team leader has been in contact with Dr. James K.A. Benhin — the Technical Co-ordinator of the *GEF/WB Climate Change Impacts on Agriculture in Africa* project at the Centre for Environmental Economics and Policy in Africa (CEEPA), Faculty of Agriculture and Natural Sciences of the University of Pretoria, Pretoria, South Africa.

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"Agriculture is Life"