

CLIMATE CHANGE AND AGRICULTURE PAPER

Climate change and agriculture: introductory editorial

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There seems to be little doubt that the global climate is changing, partly due to natural factors, and in part due to forcing by human activities. However, there are still uncertainties about the extent to which human activity (including agricultural activity) has contributed to the current changes and could influence the future climate.

Inevitably, climate and its variability, including the ongoing current changes at various spatial and temporal scales, must impact on agricultural activities. A major challenge for the agricultural industry worldwide is to feed the world population that has been projected to increase by 50% from 6 billion in 2000 to 9 billion in 2050. Most of the increase occurred in the less developed countries, where the current food production is often low. But, although the proportion of hungry people in the world is far below that of 1970, FAO's current estimate of the number of undernourished people in the world in 2008 was 915 million, the highest over the past 30–40 years (FAO 2009). History suggests that we can be optimistic about achieving appropriate increases in food production. Nevertheless, agriculture must adapt to a changing, and probably more variable, climate and simultaneously reduce emissions and other human impacts, which contribute to global warming. We need to develop and implement farming systems that produce more, from lower inputs, and that do not prejudice the future (i.e. are more sustainable) than the current systems.

A key focus of much current research around the world is to predict future changes in climate and to suggest how these changes will curtail current agricultural systems at individual locations. Thus, the *Journal of Agricultural Science, Cambridge* has

decided to inaugurate a 'special topic' of Climate Change and Agriculture. In this issue, we launch the series that will continue in future issues. The series will concentrate mainly on the effects of changing climate on agricultural activity but will also consider the impacts of agriculture on climate.

One group of papers deals with estimating climate change and documenting or predicting its effects on current agricultural systems, activity and outputs as well as estimating or predicting agricultural impacts from future climate change. The variability in climate, i.e. changing weather conditions from season to season, has a significant impact on agricultural productivity. There are several seasonal climate variations, such as the El Niño Southern Oscillation or the North Atlantic Oscillation, which are important in determining seasonal weather patterns and can impact on crop yields. Studying how current climatic variability influences crop yields is not only important in providing a baseline for estimation of future impacts, but it can also give insights into potentially useful crop prediction methods. Climate factors represent one of the main inputs for plant growth and have a direct effect on many plant physiological processes such as the onset and duration of phenological stages. Over the past decades, temperatures have been increasing and this has led to earlier start dates of crop stages and even shortening the duration of stages for certain species. This has implications for determining which crop varieties farmers can best grow at a certain location. Varieties developed or adapted to a certain location over the past 30 years may not be the best varieties to grow in the future. Integrating crop models with climate change scenarios can provide important information on whether farmers could or should replace the current crops or crop varieties with ones grown elsewhere in a region or continent, whether more research is needed to develop new varieties or

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whether to use crops from elsewhere in the world. Another important area of study is the altered impact of pests and diseases on crops in a changing climate. Climatic factors also alter many soil processes such as organic balances, nutrient cycling, soil erosion, leaching, salinization and others, leading to changing soil conditions that again can change the long-term yield potential for crops. Finally, climate or weather extremes can damage the realization of crop-yield potential and any change of frequency of extremes can increase agricultural production risks significantly. Adding these aspects to crop-modelling systems increases the demand for higher resolution data in the spatial and temporal scales.

A second group of papers concentrates on climate change with respect to the altered water availability and its use. Climate changes modify rainfall, evaporation, runoff and soil moisture storage, which in turn affect plant growth and development. The occurrence of insufficient moisture during flowering, pollination and grain-filling is harmful to most crops (e.g. grain, maize, soybean and wheat). Increased evaporation from the soil and increased transpiration from the plants cause drought stress, resulting in an increased need for crop varieties with greater drought tolerance. The demand for water for irrigation is projected to rise in a warmer climate, increasing the competition between agriculture and urban as well as industrial users of water. Falling water tables and the resulting increase in the energy needed to pump water makes the practice of irrigation more expensive, while more water will be required per unit area under drier conditions, all resulting in the generation of more greenhouse gas emissions. Peak irrigation demands are also likely to rise due to more severe heat waves. Additional investment for dams, reservoirs, canals, wells, pumps and piping may be needed to develop irrigation networks in new locations or to maintain the existing irrigation systems. Changes in soil water availability alter soil salinization processes in both irrigated and dry land cropping systems, with either beneficial or problematic outcomes depending on the system and climate changes. Altered patterns of rainfall lead to additional rainfall in other areas, producing higher rainfall intensities. This can lead to enhanced soil erosion and flooding. In addition, in very seasonal climates there is the possibility of improved water storage and water status of soils in currently drier areas. Increases in humidity may also change the incidence and severity of plant diseases and of pest occurrence.

A third group of papers considers our reactions to change, how we might mitigate the effects and how we might adapt to the possible future. Adaptation includes human activities, which adds some complexity to the challenge. In agriculture, significant differences in agricultural production conditions within regions or countries reflect differences in natural production resources, production risks and limitations as well as socio-economic conditions. Additionally, several levels of stakeholders can be identified, operating at different spatial regimes and scales from the policy level to the farm level. Adaptation to climate variability and change requires attention at different time scales, so as to develop measures for short-term (tactical) or long-term (strategic) responses. This makes it necessary to distinguish between spatial and temporal scales of adaptation studies in order to be of relevance for a particular challenge or stakeholder. Regional studies addressing local conditions are of special importance for local stakeholders or farmers, whereas studies that are carried out at larger spatial scales are more relevant for the policy level (e.g. to ensure food security). Thus, the research for developing the adaptation measures for agriculture is still at the starting point, and this series of papers would contribute to the knowledge fund.

Since 1905, the *Journal of Agricultural Science, Cambridge* has documented the research of 'agricultural' topics, which has involved utilizing a broad and ever-changing range of disciplines and research encompassing a range of scales. We believe that climate change and agriculture is an important topic that deserves wider appreciation and discussion. We also believe that the papers in this series (that will be published over a number of issues) can provide some evidence to help dispel the clouds of ignorance and misinformation that exists. Food production and security are vital activities (but in developed countries, all too often unrecognized) and climate change impacts on it. If agriculture is to continue the successes of the previous five decades in feeding the expanding world population in a sustainable way through into the next 50 years, then it is vital we (a) are aware of the current climate change impacts and likely future climate changes, (b) understand the impact of these likely changes on food production on a regional basis and (c) importantly, suggest the ways in which we can adapt ourselves, our agriculturally exploited species and our agricultural systems in order to secure our future food supply. This series aims to support that endeavour.

REFERENCE

FAO (2009). *The State of Food Insecurity in the World 2009*. Rome: FAO.