SECTION 1

The Assessment of Effects of Climatic Variations on Agriculture: Aims, Methods and Summary of Results

Martin Parry and Timothy Carter

1.1. Introduction

There is growing evidence that increasing concentrations of carbon dioxide (CO_2) and of other radiatively active trace gases in the atmosphere may be having a long-term effect on our climate. The earth is at present experiencing a long timescale climatic warming, with global mean temperatures increasing by 0.3–0.7 °C over the last 100 years (WMO, 1986). Five of the nine warmest years in the entire 134-year global temperature record occurred after 1978, the three warmest being 1980, 1981 and 1983 (Jones *et al.*, 1986). Although this observed increase cannot yet be ascribed in a statistically rigorous manner to the increasing concentration of CO_2 and other trace gases, its direction and magnitude lie within the predicted range of their effects. Recent assessments suggest that increases in global mean temperatures in the range of 1.5–5.5 °C are likely to occur as a result of increases in CO_2 and other trace gases equivalent to a doubling of the atmospheric CO_2 concentration, which will probably occur between 2050 and 2100 (Bolin *et. al.*, 1986).

The magnitude of these climatic changes could be sufficient to bring about long-term changes in agricultural potential, but it is not yet clear whether these changes in potential would be reflected in spatial shifts of cropping patterns and regional changes in agricultural output. However, preliminary estimates are that in the mid- to high-latitude cereal growing zones, shifts of several hundred kilometers per °C change are possible, assuming unchanged technology and economic constraints.

In addition to potentially large-scale and long-term changes in temperature, short-term anomalies of climate continue to cause severe shocks to economies

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and communities around the world. In 1982 and 1983 the most pronounced El Niño event ever recorded was associated with major floods in Ecuador and Peru, persistent drought in Northeast Brazil and widespread forest fires in Australia. At the same time there occurred persistent drought in southern and eastern Africa, and in north-central India.

Droughts have also recently affected the southeastern United States (in 1986) and the US Corn Belt (in 1983). Each of these short-term events has had a substantial effect on agriculture at the regional level. The 1983 drought in the US Corn Belt, for example, reduced average US maize (corn) yields by 29% relative to the year before (Parry *et al.*, 1985). This, combined, with a 29% reduction in planted area promoted by the US government to reduce over-production, resulted in a 50% fall in US maize production in 1983 in comparison with the previous year.

Short-term variations in temperature can also affect agricultural output, especially in northern countries where the growing season is limited by spring and autumn frosts. In Japan, for example, a cold winter in 1982–1983 was followed by a late spring and cool summer in 1983. As a result, average rice yields in the northernmost district, Hokkaido, were about 21% below normal and there was extensive damage by weather to wheat and barley both in terms of the area affected and the quantity of production lost. Details are given in the Japanese case study in Part VI of this volume.

These brief examples have, of course, greatly over-simplified the connection between climatic variations and fluctuations in agricultural output. Many other (non-climatic) factors are also at work, and it is not a simple task to unravel them. However the indications are, firstly, that short-term climatic anomalies will continue to cause short-term perturbations in output and, secondly, that future long-term changes in climate may alter the long-term agricultural potential of different regions of the earth. Taken together, these are sufficiently compelling reasons for attempting to extend our understanding of the effects of climatic variations on agriculture.

1.2. Aims

This volume considers, firstly, the range of effects that both short-term and long-term changes of climate may have on agriculture and, secondly, the array of adjustments available to mitigate or exploit these effects. The core of the volume is a number of case studies of cool temperate and cold regions in the northern hemisphere. A companion volume reports results of similar case studies in semi-arid regions (Parry *et al.*, 1988).

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