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Irrigated cropping in a changing climate: staying ahead of the game

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Introduction

The high natural variability of Australia's climate is well known. However, evidence continues to emerge that our climate has changed over the last 50 years as a consequence of the enhanced greenhouse effect as well as natural variability. Average temperature has risen by 0.7 °C since 1910, with most of the rise occurring post-1950. Mean annual minimum and maximum temperatures have increased by 0.12 °C/decade and 0.06 °C/decade, respectively. Since the 1970s there is a general trend for droughts to be hotter, and rainfall has decreased in southwest and southeast Australia since the mid 1970s and 1990s, respectively. Recent analyses of oceanic observations and climate modelling experiments suggest that a warming of 0.6 °C over the next 100 years is already locked in without any further increase in greenhouse gas emissions.

By 2030 annual average temperatures may rise by at least 0.4 to 2.0 °C, with similar changes in mean and maximum temperatures. Rainfall patterns are likely to change, with decreases in the southeast and southwest. The frequency and intensity of droughts and storm events are likely to increase. These changes will have far reaching impacts on our water resources, agriculture, built infrastructure, forestry, biodiversity, health, social structures, and regional and national economies.

The remainder of this paper provides background on some of the key uncertainties in climate change science and impact assessments that are most relevant to farmers. It also outlines a pragmatic strategy for preparing for climate change.

Key Uncertainties

Climate modelling – Although the performances of global climate models continue to improve, there is still uncertainty about the future behaviour of ENSO and continental summer rainfall projections vary substantially from model to model.

Abrupt climate change – There has been strong debate about whether the greenhouse gas emission scenarios used in climate change studies are overstated. Recent observations of widespread melting of permafrost, rapid melting of the Arctic ice cap, surface melting of the Greenland Ice Sheet, freshening of the high North Atlantic and the Antarctic-Australia basin, glacial retreat, and changes in atmospheric circulation in mid to high latitudes are causing some scientists to hypothesise that current climate change scenarios may underestimate the upper end of the range of possibilities.

Water resources – There is still only limited knowledge about the impacts of climate change and their implications into the future. Previous research efforts have focused on changes in water yield from surface water catchments. Information about impacts on groundwater resources, water quality and aquatic ecosystems is scant both nationally and globally. There are no recent and definitive impact studies for the Murrumbidgee and Lachlan Basins.

Effect of carbon dioxide – The effect of elevated carbon dioxide on plant growth, particularly in combination with increased temperatures and changes in rainfall, is not fully understood.

Impact on agriculture – Past impact assessments are piecemeal in terms of crop types and regions examined, and are poorly integrated. Most of the research effort to date has focused on implications for wheat yield.

Impact on pests, diseases and weeds – Knowledge is limited because only a few experimental or modelling studies have been carried out. However, biosecurity threats to agriculture, ecosystems and human health in southern Australia are likely to increase.

Impact on biodiversity – Knowledge about climatic thresholds and autonomous adaptation rates for individual species as well as ecosystems is limited. Many species are well-adapted to climate variability at interannual to decadal scales, but not long-term shifts in mean climate. Many species are already restricted in geographic and climatic range, and are thus predisposed to risk from human-induced climate change.

Adaptation and risk management – Development of strategies for adapting to and managing the impacts of climate change is still in an embryonic stage. This is because of an incomplete understanding of potential impacts and their interactions, and the lack of integrated assessments that address socio-economic as well as biophysical implications across multiple sectors at regional, national and international scales.

The Way Forward

Given the extent of the uncertainties listed above, it is tempting to wait until the point of full (or near full) scientific certainty is reached. However, it must be recognised that this may never come due to the complexity of the natural and human systems involved, and that the challenge of adapting to a changing climate will become harder the longer we wait. Therefore, it is important to manage the risk posed by climate change amongst the multiple stressors that face the irrigation industry. A pragmatic approach is as follows.

Staying Informed

The first step in adapting to future climate change is to stay up to date with the latest developments in the science and impact assessments. This can be achieved in three ways.

First, climate change scenarios are updated every five to six years through the Intergovernmental Panel on Climate Change (IPCC) process (see e.g. www.dar.csiro.au/impacts/future.html). It must be emphasised that a scenario is a sequence of events that takes us from the present to a plausible future: it is not forecast or prediction! The Fourth Assessment of the IPCC will be released in September 2007. It will consist of three volumes: (1) the physical science basis; (2) impacts, adaptation and vulnerability; and (3) mitigation of climate change. Both the first and second volumes will contain material specific to the southern regions of Australia.

Second, the newly announced South Eastern Australian Climate Initiative will provide a wealth of new climate-related information on the southeast corner of the Murray-Darling Basin. The Initiative has three research themes: (1) characterisation and attribution of current climate; (2) high-resolution climate projections and impacts; and (3) seasonal forecasts. The first theme will address issues such as: has the regional climate changed; what is the current climate baseline; and what is the short-term prognosis? The second will examine how climate and water availability are likely to change over the next 25 to 65 years, and whether levels of uncertainty can be reduced by improving regional projection methods. The third theme will develop new techniques for forecasting climate 2 to 12 months ahead. These methods will be used to forecast streamflow and crop yield, and their ability to provide greater predictive skill and longer lead times will be tested. Workshops in which the latest research findings are presented and discussed will be a regular feature of the Initiative over the next three years.

Third, Australian climate scientists hold regular meetings such as the ANZ Climate Forum and CSIRO's annual climate science meeting. The successful Greenhouse 2005 conference will be followed by the Greenhouse 2007 conference to be held in Sydney in October 2007. These meetings are used by scientists to exchange the latest information on climate variability and climate change, and are frequently open to members of the public.

Building Flexibility and Resilience

The development of effective and efficient adaptation strategies to the potential effects of climate change will necessitate the use of a portfolio approach. For example:

- Using efficient irrigation systems – effective scheduling, application and transfer of water.
- Planting water-efficient, heat- and drought-tolerant crops and changing planting dates in response to changes in seasonality.
- Diverting available water to high-value crops.

- Using crop management practices that lower climatic risk – zero-tillage, minimum disturbance techniques, widening row spacing and lowering plant populations.
- Integrated and region-wide management of pests and diseases.
- Managing soil erosion – this will become more important if rainfall intensity increases in time.
- Managing the carbon balance – improves the physical and chemical properties of soils, and positions enterprises for any future incentives for carbon sequestration.
- Monitoring farm performance in relation to trends in climate variables – provides background information that enables more effective adaptive management.
- Investment in agricultural systems research that compares the feasibility and effectiveness of adaptation options, and plant breeding programs.

Concluding Remarks

Australia's climate has changed in the past, is changing now, and will continue to change into the future. There is growing scientific evidence that human activity is the main cause of increasing globally averaged temperatures over the last 50 years. Current projections indicate a warmer climate and reduced water availability in the Murrumbidgee-Lachlan region in the 21st century. A prudent approach to farm management is to adopt an adaptive and cost-effective approach sooner rather than wait and be forced to adopt costly crash measures later. This will lead to better risk management and the prospect of improved immediate and long term returns on investment.