Agrifood Awareness AUSTRALIA Limited

Telephone 02 6273 9535
Fax 02 6273 3968
Email info@afaa.com.au
Web site http://www.afaa.com.au
Address PO Box E10, Kingston, ACT, 2604
ABN 49 103 817 296

## Information Paper 14

# GM crops and climate change

This fact sheet aims to explore the implications climate change may have on global agriculture and the role gene technology could play in contributing to climate change solutions.

Climate change and its current and potential impacts have an increasing profile globally. A growing number of countries are looking to implement policies and actions aimed at managing the impacts of climate change. In Australia, a new Commonwealth Department of Climate Change was established in 2007 to drive activities in this area.

**Climate change in Australia**

According to the Bureau of Meteorology (BOM), "Australia and the globe are experiencing rapid climate change. Since the middle of the 20th century, Australian temperatures have, on average, risen by about one degree celsius with an increase in the frequency of heatwaves and a decrease in the numbers of frosts and cold days. Rainfall patterns have also changed - the northwest has seen an increase in rainfall over the last 50 years while much of eastern Australia and the far southwest have experienced a decline."

**Man's contribution to climate change**

According to "Climate Change in Australia", a website maintained by CSIRO, the climate of earth changes continually on a range of timescales due to 'internal' and 'external' factors. Internal factors are natural and arise from complex interactions within the climate system. Some of the external factors are also natural and include such things as volcanic eruptions. Humans are also responsible for external factors which contribute to global warming, these factors include:

- Changes in atmospheric composition (for example in concentrations of ozone, and greenhouse gases: carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons.
- Release of atmospheric particulates (such as sulfate aerosols, black carbon).
- Modification of earth's ecosystems (including land clearing and agricultural practices).

**Climate change and agriculture**

Of relevance to agriculture, some of the impacts of climate change projected for the coming century include:

- More heatwaves which will impact livestock, damage crops, and lead to an increase in bushfires.
- Warmer conditions which will increase the likelihood of pests and diseases from tropical and sub-tropical Australia spreading southward. Some weeds may benefit from climate change due to reduced competition from native species and perhaps crops.
- Fewer cold and frosty days which could impact some industries such as stonefruit where chilling would be inadequate.
- More intense and sporadic rainfall (including from tropical cyclones) which would increase flooding and associated loss of life, property and productivity. It would also affect soil erosion and pollution of rivers and oceans.
- More frequent or intense droughts which would increase loss of crops, livestock, fisheries and wildlife, and decrease river flows and water quality.

In 2005, the Australian Greenhouse Office commissioned "The Climate Change Risk and Vulnerability" report. This report identified agriculture as one of the sectors most at vulnerable in Australia. The report noted that the impacts on individual sectors will vary depending on the sensitivity of the system and its adaptive capacity. It says that agricultural systems have shown considerable capacity to adapt to the climate changes in land management practices, crop and cultivar choice and selection of animal species and technologies to increase efficiency of water use.

The report identifies the agribusiness units most at risk as:

- those already stressed - economically or biophysically, as a result of land degradation, salination and loss of biodiversity;
- those at the edge of their climate tolerance; and,
- those where large and long lived investments have being made - such as in dedicated

irrigation systems, slow growing cultivars and processing facilities.

**Food security and climate change**

All aspects of food security will likely be affected by climate change according to the Food and Agriculture Organisation of the United Nations (FAO).

- **Food availability (production and trade) -** Climate change impacts on food production will be mixed and vary regionally (FAO, 2003b, 2005c). For instance, a reduction in the production potential of tropical developing countries, many of which are already faced with serious food insecurity, may add to the burden of these countries. Globally, the potential for food production is projected to increase with increases in local average temperature over a range of one to three degrees Celsius, but above this it is projected to decrease.
- **Food stability and access –** Food stability and access will be affected by changes in the patterns of extreme events, such as increased frequency and intensity of droughts and flooding. Food insecurity and loss of livelihood would be further exacerbated by the loss of cultivated land and nursery areas for fisheries through inundation and coastal erosion in low-lying areas.
- **Food utilisation** – The health consequences of climate change may also affect the way food is used in the future. For example, populations in water-scarce regions are likely to face decreased water availability, with implications for food processing and consumption; in coastal areas, the risk of flooding of human settlements may increase, from both sea level rise and increased heavy precipitation. This is likely to result in an increase in the number of people exposed to vector-borne diseases such as malaria and water-borne diseases such as cholera, thus lowering their capacity to utilise food effectively.

**Biotechnology, climate change and agriculture**

According to the UN Intergovernmental Panel on Climate Change Working Group II Report *Impacts, Adaptation and Vulnerability, "*Breakthroughs in molecular genetic mapping of the plant genome have led to the identification of bio-markers that are closely linked to known resistance genes, such that their isolation is clearly feasible in the future. Two forms of stress resistance especially relevant to climate change are to drought and temperature. A number of studies have demonstrated genetic modifications to major crop species (for example, corn and soybeans) that increased their water-deficit tolerance, although this may not extend to the wider range of crop plants. Similarly, there are possibilities for enhanced resistance to pests and diseases, salinity and waterlogging, or for opportunities such as change in flowering times or enhanced responses to elevated CO2."

Gene technology, more specifically, is allowing scientists to further develop the basic science of genetics through gene discovery, and improved understanding of gene functions and interactions. This sets the foundation for the use of genetic markers to speed up plant breeding, the control of gene activity, and the modification and transfer of genes.

According to CSIRO, gene technology can help Australia's agricultural industries beat pests, diseases and weeds; understand flowering and seed formation; discover and silence genes; improve the nutritional traits of plants; develop plants as biofactories; and improve how plants perform in hostile environments.

**Environmental benefits of GM crops**

In a report titled, "GM crops: the first ten years - global socio-economic and environmental impacts", UK-based PG Economics concluded that genetically modified (GM) crops had significantly reduced the release of greenhouse gas emissions from agricultural practices through less fuel use and additional soil carbon storage from reduced tillage associated with GM crops. In 2006, this was equivalent to removing 14.8 billion kilograms of carbon dioxide from the atmosphere or equal to removing nearly 6.6 million cars from the road for one year.

**GM crops and climate change in Australia**

As mentioned previously, climate change predictions for Australia are that much of the country may become hotter and drier. This means that farming practices in Australia's major cropping zones will need to adapt accordingly. Two particular research projects in Australia have the potential to help producers deal with the impacts of climate change. These projects involve drought tolerant wheat and water-efficient cotton.

1. **Drought tolerant wheat** – Developed by the Victorian Department of Primary Industries, field trials of the GM drought tolerant wheat have been approved by the Office of the Gene Technology Regulator (OGTR). The trials will take place near Horsham and Mildura in Victoria on a maximum total area of 0.4 hectares per year between June 2008 and March 2010. The trials aim to assess the

agronomic performance of the GM wheat under rain-fed, drought prone field conditions. In order to increase the drought tolerance of the wheat, it has been modified to contain one of fifteen genes originally isolated from the plants thale cress and maize, a moss and a yeast.

2. **Water-efficient cotton** – Field trials of water-efficient GM cotton have been approved by the OGTR. Developed by Monsanto Australia, each of the GM cotton lines contains one of 50 different genes derived from various plants, bacteria, yeast or fungi. The introduced genes are intended to confer enhanced water use efficiency. The trials will be undertaken in local government areas in NSW, Queensland and Western Australia will evaluate agronomic characteristics including the water use efficiency, yield and fibre quality of the GM cotton lines under both optimal and water stress conditions. Promising lines will be selected for possible future trials and commercial development. This is very early stage research, but due to the Australian cotton industry's focus on innovation including high adoption of GM varieties, Monsanto has commenced this global research in Australia, recognising the importance of an efficient water-use crop variety in the Australian environment.

Climate change presents challenges. Biotechnology and gene technology are tools which will contribute to climate change solutions. Australian agriculture will continue to adopt new technologies and innovations to ensure a sustainable and prosperous future.

**Further reading**


Bureau of Meteorology, www.bom.gov.au

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