Adapting agriculture to climate change

Agriculture is one of Australia's most exposed industries to climate variability and extremes. Farmers have always managed for and adapted to a variable climate. This experience should benefit the industry in adapting to climate change.

Key Points

Agriculture, in its business-as-usual mode, is by nature very adaptive. Climate change presents both challenges (biosecurity threats, reduced productivity) and opportunities (business diversity, new crop types and varieties) for the industry.

Key needs to support future adaptation include:

- Education and extension – especially in the form of on-ground practitioner assistance - and maintenance of industry knowledge;
- Good science as a basis for policy-making, including more investment in social science research;
- Improved seasonal weather predictions, at a regional and district level, rather than further downscaling of climate model outputs for the far future; and
- Policy certainty and adaptability, including monitoring and evaluation feedback loops to assess policy outcomes.

In a changing climate, government has an ongoing role in technology, skill and awareness development, to create an information-rich industry through:

- Extension and education to ensure the best possible knowledge supports evidence-based decision making by farmers;
- Supporting networks to build industry-wide knowledge and skills; and,
- Maintaining corporate knowledge in the industry.

Information should be framed appropriately, for example in terms of business and profitability rather than climate change.

NCCARF's evidence-based Policy Guidance Briefs address key challenges to effectively adapting Australia to a variable and changing climate, providing high-level policy guidance designed for use by policy makers at Commonwealth and State levels. This Guidance Brief deals with adapting Australia's agriculture to climate change, especially broadacre farming, and is based mainly, but not exclusively, on experiences in southern South Australia.

1 Increasing atmospheric CO_2 and the climate context

Direct effects of CO_2: In theory, higher atmospheric concentrations of CO_2 should make plants grow bigger and faster. Although this is confirmed by laboratory experiments, in the field the effect becomes much less, and is likely to be overwhelmed by changes in temperature, rainfall and other atmospheric gases due to climate change. In 2005, the Royal Society in London concluded that the benefits of elevated CO_2 concentrations are "likely to be far lower than previously estimated".

Temperature: Average temperatures across Australia have increased by 0.75°C since 1910. Temperatures are expected to increase by 1°C (above 1990s temperatures) by 2030 with greater warming inland and less in coastal regions.

Rainfall: Patterns in 1997-2011, compared to the entire record since 1900, show:

- lower rainfall in SW Western Australia in the winter half-year;
- increased monsoonal rainfall in the north in spring and summer; and
- higher rainfall across the centre and decreased late autumn and winter rainfall across the south.

By 2030, rainfall is projected to decrease by 2 to 5% across Australia, except in northern Australia where little change is expected. Increased evaporation rates and possible changes to rainfall seasonality may affect sustainability of current agricultural practices.

Extreme weather: More frequent and hotter heat waves are likely. Drought frequency is expected to increase, particularly in southern and south-western Australia. There is less agreement amongst models about future trends in intense rainfall.

2 Current effects, impacts and issues

The agricultural sector is strongly influenced by biophysical factors, government policy and regulations, and market and economic drivers. Their interaction with climate change determines the ultimate impact.

Biophysical factors: Weather events, particularly extremes, are critical drivers of agricultural profitability. The most pervasive impact is drought, which disrupts cropping programs, reduces stock numbers, and erodes the productivity and resource base of farms, threatening long-term sustainability (see Figure 1).

Many of Australia's soils are ancient, weathered and infertile. Poor soils together with a highly variable climate create challenges to developing sustainable agricultural systems.

Outbreaks of pests, weeds and disease can come in climatically "good years", pushing the farmer beyond his/her financial capacity.

Market and economic factors: Market and global economic drivers are increasingly important in determining farm profitability and management. New technologies, new knowledge and farmer innovation have increased productivity in Australia over the past 30 years. These, together with the advent of efficient global transport and food storage, have permitted increasingly competitive pricing and reduced per unit area profitability. Rural debt is climbing ($66 billion in 2012, according to the Reserve Bank of Australia) with interest paid on debt increasing by 35% from 2006 to 2011. This burden can significantly affect capacity to invest and business decisions.

Social factors: Farming is becoming more mechanised and farms are becoming larger, partly to achieve economies of scale required by narrowing profit margins. Smaller labour requirements are leading to migration out of some smaller rural towns and expansion in some nearby regional centres.

Current effects, impacts and issues ... continued

Farming has an aging demographic, with a decline in uptake of the family business by the younger generation, especially on smaller (<1000 ha) farms and in beef and sheep farming. Younger farmers are to be found on larger farms, sometimes as managers for corporate owners, and in horticulture and dairy farming (PC, 2005). Many have considerable formal education and skills, embrace new technologies and understand the role of climatic factors and variability.

Market forces and a series of poor seasons (e.g. through drought) can put emotional and financial pressure on farming families and their communities.

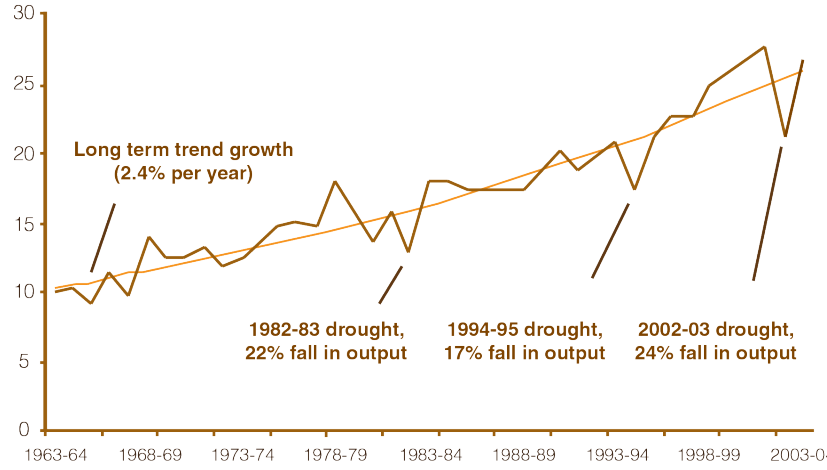


Figure 1: Growth in agriculture output, 1963-64 to 2003-04. Value added ($ billion, constant 2002-03 prices) (PC, 2005)

Government policy and regulations: All tiers of government support and impact on agriculture through policies and regulations targeting sectors from environmental conservation through to supply and markets. Water markets have been a significant driver of change in areas dependent on irrigation.

3

Future effects, impacts and issues

Climate change presents challenges and potential opportunities for agriculture, generally beyond historical experience.

Biophysical factors: Moderate warming may benefit some crops, provided they are not water stressed, and some colder locations. However, warmer temperatures together with more variable rainfall mean that soil moisture is likely to decline over much of southern Australia. Higher atmospheric CO_2 concentrations may enhance growth in some plants (including some weeds). Pests, weeds and diseases will change in abundance and distribution with some new or "sleeper" species likely to become invasive.

Without adaptation, the grazing industry is likely to experience declining pasture productivity and quality, livestock heat stress, changes to pests, weeds and diseases, and increased soil erosion, due to more frequent droughts and intense storms.

Without adaptation, changes to seasonality relative to growing season events can have impacts through, for example, reductions in pome fruit (e.g. apples and pears) yields due to changes in frost duration and timing, and lower wheat yields (up to 20%) when early heat stress coincides with flowering.

Overall, production levels are projected to decline over much of southern Australia as a result of climate change.

Market and economic factors: The interplay between yields and prices has always been central to decision making. New technologies and increased productivity mean that supply now outstrips demand, and this is likely to continue in the short-term future.

Agriculture can make a valuable contribution to lowering Australia's greenhouse gas emissions. The Carbon Farming Initiative (CFI) allows farmers and land managers to earn tradeable carbon credits for storing carbon or reducing greenhouse gas emissions on their land. Such initiatives will impact on financial decision-making.

Social factors and externalities: Farming changes will continue to impact on regional centres and communities. While new industries have potential to reinvigorate small communities, it seems more likely that the current trend of ageing and community loss will continue.

Externalities affecting farming include increasing competition for productive land, especially in peri-urban areas. Linked to this, a key future challenge is to increase productivity from ever-decreasing available land. An unresolved question is how close agriculture is to the ceiling of production per millimetre of rainfall.

Agriculture training in Australia has changed with greater focus now on new areas such as biotechnology to support agronomy.

4 Adaptation actions and policy

Adaptation to climate change in agriculture is likely to focus on the near future rather than a century ahead, and to address climate variability and climate change seamlessly.

Building resilience and reducing vulnerability. What contributes to resilience and high adaptive capacity?

- Scale: Scale of investment in machinery (and co-ownership across properties), scale of supplementation with external income, size of farm enterprise.
- A farmer's skills, flexibility, judgement and planning ability: Understanding of weather, and making successful break-of-season decisions around planting dates, can be critical in a changing climate. Thus, there will be increased need for education, extension activities and information provision (e.g. seasonal forecasts). Improved understanding of why some farmers learn and adapt could help these activities to succeed.

Adaptive strategies: changing business practice or location. To adapt to climate change, farm businesses may consider:

- Geographical relocation: Some relocation is already happening at farm level, particularly in response to drought or reduced rainfall. Farm businesses have purchased land in cooler and higher rainfall zones (e.g. Tasmania), however efforts to relocate to wetter northern locations have so far been unsuccessful.
- Changing or new enterprises:
  - o Marginal lands are becoming and will continue to become more marginal. While this may spell the end of traditional agricultural practices in some areas, it may provide new opportunities. Thus, Eyre Peninsula landholders have been encouraged to establish saltbush and other perennials to reduce erosion and provide forage.
  - o Carbon farming offers potential alternative business with co-benefits for biodiversity. The present price is unlikely to be a catalyst for change.
  - o Changing land use is likely to be tested on small scales and developed in an iterative process to minimise risk.

- Changing or new practices:
  - o Many emerging farming systems offer enhanced resilience, for example, no-till practices have effectively provided 30 years grace with respect to drying conditions by enhancing soil moisture capture. Looking forward, further efforts will be needed to improve water management and efficiencies.
  - o Technology and machinery have potential to increase precision-based agriculture and therefore offer adaptation benefits, but can increase financial risk and may have undesirable social and environmental outcomes.
  - o Advances in genetic modification and epigenetics may have capacity to increase or maximise production; this remains largely untested.
- Greater emphasis on sustainability: Climate change will affect natural resources. Farm management practices, as they adapt, will need to ensure sustainable use of these resources. Government policies and initiatives already exist to encourage sustainable practices, such as the Australian Government's Caring for our Country.
- Ceasing business: The Australian Government's Climate Change Adjustment Program offered retraining and re-establishment assistance up to $150,000 for farmers who chose to sell up.

Changing agricultural practices or industries carry the risk of perverse outcomes, for example land use change can increase fire risk. Monitoring and effective treatment of pests, weeds and diseases will be essential for optimal productivity, particularly in "good years".

5 Policy Implications

The context of adaptation policy for agriculture

Conflicting policy or policy discontinuity between levels of government and jurisdictions creates challenges for farming. Associated with this, the scale of decision-making may not match the scale of the problem: climate change is a national problem but decisions made at, for example, state level apply only within state boundaries.

Climate change, by its nature, constantly changes the policy development context. Benchmarks may have to shift. Failure to act at the right time may mean that inappropriate or non-existent policy creates uncertainty that becomes a barrier to action. Policy itself must embrace the concept of adaptability to enable an appropriate and timely response to new situations, information or data. It must be flexible and "no-regrets" – it should not lock farming into climate-inappropriate practices and sunk investment. Adaptation calls for policy-making that has regard for the long-term. It is likely to demand distinction between incremental changes, appropriate for the short-term, and transformational changes, required to address longer-term climate change; identification of the trigger points of climate change necessitating transition from one to the other; and policy instruments for ensuring that transformational change takes place when and where required.

Policy Implications ... continued

Role of government

Farmers make business decisions in a context of uncertainty, and a major source of uncertainty is climate variability. To what extent should government protect farmers from risks associated with these decisions? Equally, there is a risk that government assistance can bias on-farm decision-making and lead to market distortion. Is the role of government in a free market economy to be an information provider, with a restricted role for policy, or should it extend to policy interventions to, for example, support farmers through droughts?

Such debates around policy and the role of government have always existed, but are intensified when considering climate change adaptation.

Adaptation policy instruments for agriculture

Existing policies. Some existing policies have important implications for adaptation, e.g. around environmental management and conservation, water trading and drought relief and assistance. Policy around irrigation and groundwater management will be critical in future.

New policies to support climate change adaptation in agriculture will be needed for:

- Biosecurity. Existing biosecurity issues are likely to be exacerbated by climate change, with potential for species loss, invasions and shifts in boundaries. Management will require cross-boundary decision-making powers, resourcing, and capacity for rapid reaction.
- Infrastructure. Policy related to infrastructure will have important implications for agricultural adaptation, including telecommunications to support business to thrive (especially in good seasons), transport investment and energy pricing.
- Land stewardship. If farmers are to be environmental guardians under climate change, then policies will be required to lead them into that role, for example by placing a dollar value on the environment.
- Carbon sequestration is likely to provide farmers with additional income and so build resilience, although some land, especially sandy soils, yields little potential.
- Protection of prime agricultural land. With the squeeze on land from competing uses, there is a need for policy protection of prime agricultural land under climate change.
- Monitoring and evaluation to understand the performance and effects of policies to address climate change.

New policies for adaptation are likely to require investment. For example, land stewardship and carbon sequestration policies may need to compensate farmers for lost productivity.

Research and development

Policies to direct agricultural research and development under a changing climate should focus on:
productivity in a water-limited environment, including developing an informed understanding of whether there are limits to adaptation in a dry future; research to improve seasonal forecasting capability at regional and district levels, and forecasts of extreme events; and availability of spatially explicit information on historical weather data, land use, vegetation, soils and topography to underpin adaptation decision-making.

Extension and knowledge

The farming community is sceptical about the reality of climate change or, at very least, about the need for action now. Generally, education and extension work around adaptation does not engage in this debate. Rather, the message is about the need for actions that address climate variability and so improve resilience and reduce vulnerability to climate change. This is appropriate. While farmers question the science of climate change, many have been steadily adjusting through adopting no-till, planting winter crops earlier and selecting more resilient cultivars. However, in the longer term, management for variability rather than change may deliver inappropriate, even maladaptive, solutions.

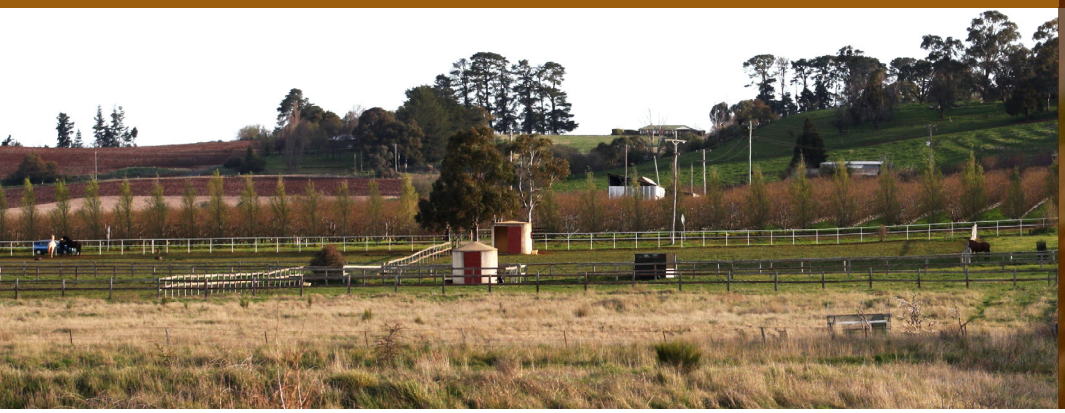
An ongoing role for government under climate change is in technology, skill and awareness development, to create an information-rich industry through:

- Extension and education. More and more farmers use scientific knowledge to build an edge in business, derived from diverse sources including the Internet, workshops and consultants. There is considerable benefit in ensuring the best possible knowledge supports this evidence-based decision-making.
- Supporting networks to build industry-wide knowledge and skills.
- Maintaining corporate knowledge in the industry.

Information must be framed appropriately, for example in terms of business and profitability rather than climate change.

Approach

The policy guidance in this brief was developed based on a workshop held in Adelaide, South Australia, and attended by farmers and industry groups from across Australia; representatives from local, state and federal government; a researcher from the University of Adelaide; a private consultant and NCCARF staff. The brief emerges from the evidence base of stakeholder experience and knowledge and NCCARF's research programs. NCCARF produces National Climate Change Adaptation Research Plans (NARPs) that identify research gaps to guide future research programs to support policy development. The NARP for Primary Industries is available from: www.nccarf.edu.au/content/narp-primary-industries



NCCARF is producing a portfolio of twelve Policy Guidance Briefs in 2012–13 on critical climate change adaptation topics. For a complete list of available Policy Guidance Briefs, please go to: www.nccarf.edu.au/publications/policy-guidance-briefs

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