Adapting agriculture to climate change

By Chris Stokes and Mark Howden

Key messages

- There is a national imperative to equip Australian agriculture to be prepared to adapt to climate change.
- Some agricultural communities, industries, or regions will have a greater capacity to adapt than others: understanding their constraints and incentives is important in ensuring that they do so successfully.
- An early part of adapting agriculture to climate change involves helping communities to understand why adaptation is a needed part of today's vision of the future and therefore of their management strategies.
- Successful adaptation to climate change will require flexible, risk-based approaches that deal with future uncertainty and provide strategies that are robust enough to cope with a range of possible local climate outcomes and variations.
- Many climate adaptation options for agriculture are similar to existing 'best practice' and good natural resource management, and do not require farmers to make radical changes to their operations and industries in the near term. These options can, and should be, prioritised as part of a 'no regrets' or win–win strategy for agriculture because they will provide immediate and ongoing benefits as well as preparing the sector for climate change.

There is a clear imperative for action to prepare agriculture to adapt to climate change. Worldwide, agriculture in general is highly sensitive to variations in climate, and in Australia especially so. The Australian climate is already changing and these changes have a measurable impact on primary production, as the drying of the Murray–Darling Basin and parts of the wheatbelt bear witness.[1] Early development of the technologies, skills, and policies that will allow adjustment to a changing climate is likely to provide significant national benefit.

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Adapting Australian agriculture

Australia's agricultural sector (including fishing and forestry) already has to cope with a harsh and highly variable environment, and primary producers have proved adept at continually adjusting management practices to deal with these and other challenges. However, there have also been tough lessons learned from inappropriate responses that have had negative impacts on enterprises and the land.[2] Climate change is likely to add a new dimension to these challenges, through projected negative impacts on the amount, quality, and reliability of our food and fibre production (as briefly outlined in Chapter 4).

However, besides the negative effects, potential benefits and fresh opportunities also arise from climate change. Higher temperatures may enhance production from horticulture and pastures in the continent's cool regions and the positive effects of higher levels of CO_2 on plant growth may partly offset the negative effects of higher evaporation or decreased rainfall.

Timely and effective adaptation will likely also bring opportunities and benefits. For example, as Figure 7.1 illustrates, adapting to the expected changes in climate and population-driven food demand could significantly offset declines in Australia's currently large wheat export surplus, reducing the risk of needing to import grain in some years.

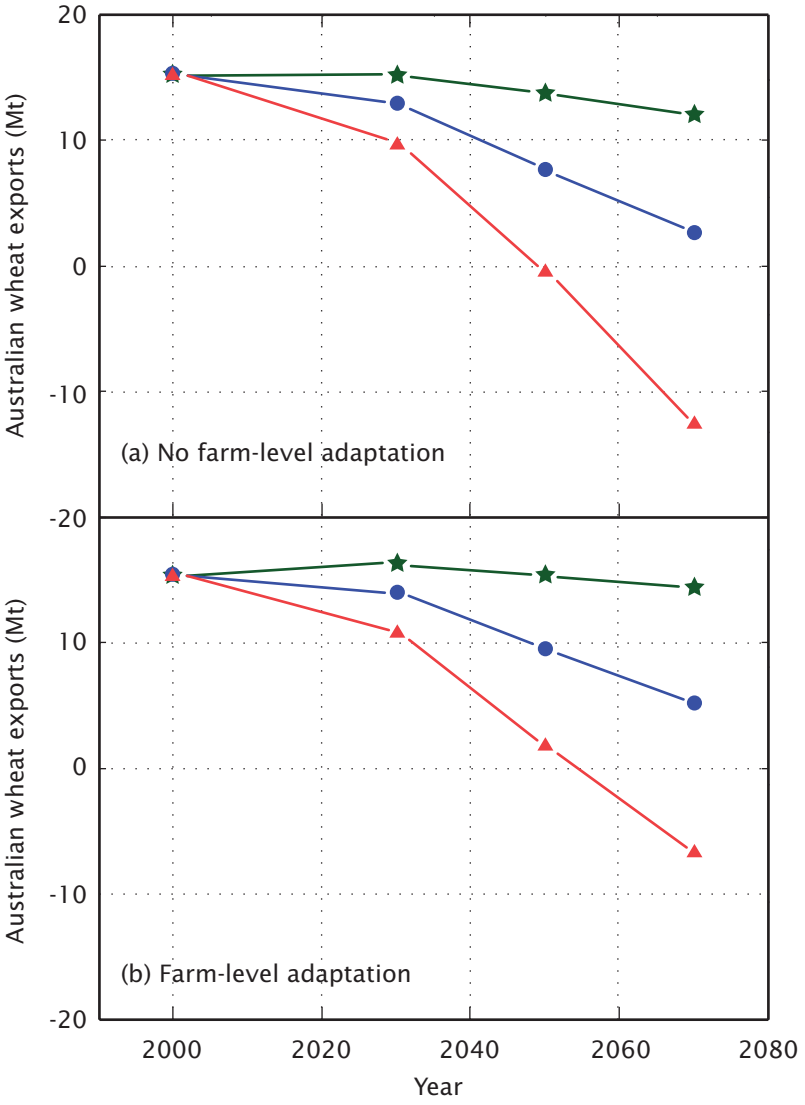
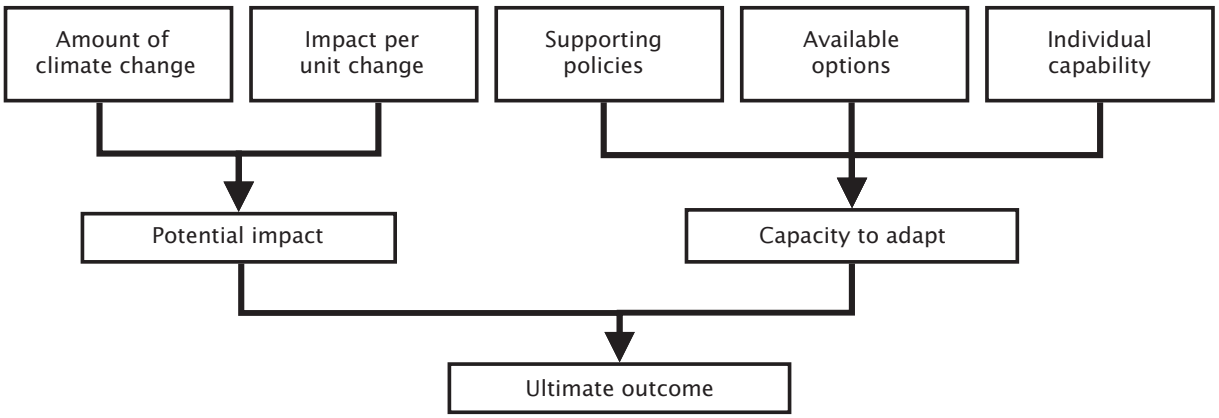


***Figure 7.1**: Estimated Australian wheat exports (Mt/year) for the years 2030, 2050, and 2070, with and without farm-level adaptation.[3] The lines indicate maximum, average, and minimum scenarios for each year. Values below the zero line mean that imports may be required.*

The impact of increased greenhouse gases on Australian agricultural activity depends on the magnitude of climate change locally (e.g. shifts in local temperature, rainfall patterns, and extreme events), how strongly each amount of change in the climate affects farm productivity, and lastly the actions taken in response to the climate changes (see Figure 7.2). The ultimate effect of climate change on farm enterprises and the rural economy therefore depends not only on how the climate affects farm production directly, but also on the way that individual farmers, communities, and whole industries respond to the changes.



▲ ***Figure 7.2**: Both climate and human factors determine ultimate outcomes.*[4]

Action at all scales

The performance of Australian agriculture in adapting to climate change and counteracting its negative effects will be influenced by three key drivers:

(1) the policies adopted by government at various levels and the signals they send to farmers and others in the food chain

(2) the development and availability of effective adaptation choices

(3) the capacity and motivation of individuals and industries to implement the appropriate adaptations and obtain support for doing so.

These factors make it clear that adaptation is not something that can be left to farmers, or indeed to governments, alone. Everyone involved in the food industry – including policy makers, research and development providers, and enterprise managers – can contribute to solutions by working in collaboration. Governments, for example, can ensure that water and drought policies accord with successful farm adaptation and do not impede it.[5] R&D providers, working with farmers, can help to ensure a choice of effective adaptation options and technologies – such as suitable crop varieties, water use efficiency measures, or new farming, forestry, or fishing methods – are available and delivered when needed. And farmers need the skills, the capital, access to the right information and advice, and suitable incentives to make the necessary changes. Successful adaptation is likely to be helped by considering the system-wide consequences of proposed adaptation measures at all social levels, at all points in the food chain, and in relation to other concurrent challenges (such as meeting the growing demand for food and fibre). Hence, there is likely to be increasing demand for strong science–policy linkages, analysis of alternative governance models, and stronger focus on the institutional arrangements to support adaptation in agriculture.[5–7]

A core issue confronting governments is that some communities, industries, or regions will have a greater capacity to adapt than others; understanding the constraints and incentives that bear on them is important in ensuring that they do so successfully. As climate impacts are often unpredictable, or may be perceived to be 'in the distant future', an early part of this task involves helping communities to understand why adaptation is a needed part of today's vision of the future, and therefore of their management strategies.

Coping with uncertainty

Successful adaptation to climate change will require flexible, risk-based approaches that deal with future uncertainty and provide strategies that are robust enough to cope with a range of possible local climate outcomes and variations.[8, 9]

Every strategy should derive from working with farmers, fishers, and foresters to develop a choice of alternative adaptations to suit the range of likely climates they may encounter, and building the skills to evaluate, choose, and implement these as required. This is preferable to trying to second-guess actual climate outcomes in particular places and times and trying to adapt to something that may turn out differently. It will be important for government policies in areas such as drought assistance, Landcare, and water provision to help hone this capacity in the farming community.

Successful adaptation requires both strategic preparation and tactical responses. These should initially be based on current 'best practices' for coping with adverse conditions such as drought. There are a wide range of actions, among individual farmers and across the whole of agriculture, that can help to promote adaptation (see box on page 90).

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Contributors to successful adaptation[10]

(1) confidence among farmers and others that the climate really is changing and that inaction is not an option

(2) the motivation to change, to avoid negative impacts, or seize opportunities

(3) wide communication and demonstration of the benefits of new climate adaptations

(4) support for farmers as they make the transition to new systems, new land uses, or new forms of livelihood

(5) building capacity in farming communities to take up and implement adaptation strategies

(6) a rapidly evolving transport, market, and financial infrastructure to support the most climate-efficient forms of agriculture

(7) an effective system for monitoring climate change impacts and human adaptive responses, so that policy and management can develop 'ahead of the game'.

Adaptation priorities and opportunities

Some adaptation priorities apply broadly across the whole agricultural sector. Among these is the need to improve and promote existing management strategies for dealing with climate variability. This will enhance farmers' capacity to plan for, and deal with, extreme events (droughts, floods, fire, hail, etc.) in the medium and longer term. Using climate forecasts at a range of time scales to make pre-emptive, tactical management adjustments will help to track the early stages of climate change, until the longer term trends and necessary adaptations in particular regions become clearer.

Examples of likely adaptations include:

- **Information delivery** to farmers from climate analyses can be enhanced by providing projections of management- and policy-relevant weather metrics (e.g. cold indices for stone fruit), providing climate information at scales relevant to the decisions being made, and combining information on both climate variability and trends in seasonal and medium-term (decadal) forecasts.
- **Biotechnology** and traditional plant and animal breeding have the potential to develop new 'climate-ready' varieties and new crops or pastures pre-adapted to future climates.
- **Plant nutrition** can be adjusted by measures such as precision fertiliser use, legume rotations, and varietal selection to maintain the quality of grain, fruit, fibre, and forage sources.

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- **Irrigation efficiency** will become critical as water resources become more constrained, particularly in southern Australia. This can be assisted by identifying less water-intensive production options, by developing better water delivery technologies, and by implementing water markets and water-sharing arrangements.
- **Soil and water conservation methods** and new systems become even more important as climates fluctuate more and extreme events become more frequent.
- **Biosecurity, quarantine, monitoring, and control measures** can be strengthened to control the spread of pests, weeds, and diseases under a warming climate.
- **Better models of agricultural systems** can assess climate change impacts and more reliably explore and improve adaptation options.
- **Monitoring and evaluation systems** are needed to track changes in climate, impacts on agriculture, and the effectiveness of adaptation measures, to help decide when to implement particular options and to refine them over time.
- **Policy and management decisions** require timely inclusion of climate information as it becomes available, as well as closer collaboration between policy makers, managers, researchers, extension agencies, and farmers.

It is important to note that many climate adaptation options are similar to existing 'best practice' and good natural resource management, and do not require farmers to make radical changes to their operations and industries in the near term. These options can, and should, be prioritised as part of a 'no regrets' or win–win strategy for agriculture because they will provide immediate and ongoing benefits, as well as preparing the sector for climate change.

At the time of writing, few adaptation options have been fully evaluated. Those that have been evaluated suggest that the benefits of adaptation are so significant that further systems analyses are warranted. For example, in the wheat industry alone, relatively straightforward adaptations to future climate change, such as the growing of new varieties, adjustment of planting times, and the practising of moisture conservation may be worth between AU$100 million to AU$500 million per annum at the farm gate.[11] Further benefits are likely if a wider range of adaptations is practised, but these remain to be assessed.

Preparing for step-changes in adaptation

The benefits obtained from each major type of adaptation are likely to plateau as more extreme climate changes come into play over future decades, as Figure 7.3 indicates. This means that there are likely to be limits to the effectiveness of incremental adaptations within a given farming system and that, at some point, a step-change or transformational adaptation will be called for. This has been found in both national and global studies.[3] Part of the cause for this is that initially positive impacts of climate change – of higher CO_2 on plant growth for example – may be outweighed by negative effects (such as higher temperatures or drought) as conditions become more extreme.

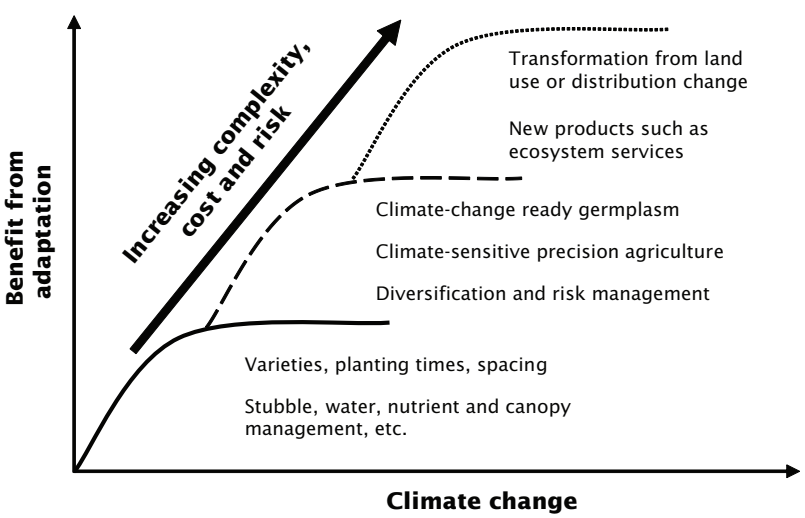

***Figure 7.3**: The potential benefit from different levels of adaptation with increasing climate change from incremental, within-system responses, to system-level changes to transformational changes. Greater levels of climate change would overwhelm the maximum potential of simple adaptation options, requiring additional strategies that involve increasing risk, cost, complexity, and time to develop and implement.[3]*

As incremental adaptations are rendered less effective by changing conditions, larger adaptations, such as changes in land use, the re-location of significant industries or diversification into new activities, such as carbon sequestration or farming for energy provision, may become desirable. Inevitably, as we move from incremental to transformational change, the complexity, cost, and risk of actions will also increase, and these must be planned well.

Areas of farming that are economically marginal today are among the most vulnerable to climate change; here, impacts are most likely to exceed the region's adaptive capacity, stressing their communities, farming systems, and natural resources. Such areas include outer wheatbelt zones subject to drying, warmer dairying or fruit growing areas, or irrigation communities whose water resources are in decline – all areas where quite small changes in climate can have quite large economic and social consequences. An early priority is to identify particular regions, and indeed industries, where climate change risks and opportunities require strong policy intervention (beyond simple incremental adjustments to existing agricultural practices) so that the affected communities can be appropriately supported through the transition.

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It is equally important to investigate the adaptive capacity of local farmers, communities, and industry groups region by region, so as to identify and rectify factors that may hinder successful adaptation.[7] This will enable policy makers to identify broad areas where action can be taken. Self-assessment of capacity to adapt is currently used for local evaluation and consequent improvement in adaptive capacity.[12] However, the scaling-back in state agricultural agencies and decline in support for activities such as Landcare over recent decades has made this task more difficult at regional and national scales, although the emergence of grower groups has partly offset this. Effectively, this means that there is less analytical capability in Australian agriculture and less advice and support available to farmers just at the time it is most needed.

Issues requiring urgent enhancement include all those factors most likely to limit (or accelerate) farmers' ability to take up and implement the necessary adaptations: their health, education, and skill profiles, their access to capital and knowledge, and whether or not the social structure of their community is conducive to far-reaching changes and the exploitation of new opportunities. This underlines the main point that responding to climate change is as much a social as a technical or policy challenge.

Past climate policy has focussed primarily on mitigation (reducing emissions) rather than considering adaptation (coping with changes that do occur). With delays in global action on mitigation, there is likely to be growing demand by both farming and policy communities for information on how to cope with emerging climate challenges and for approaches that consider adaptation and mitigation together. Importantly, this should ensure that adaptations do not increase GHG emissions, so making the underlying cause worse – and, similarly, that mitigation options do not undermine adaptation efforts.

Conclusion

As climate change unfolds through the early decades of the 21st century, adaptation will become the pivotal response by Australia to maintain its own food security and self-sufficiency, to retain vibrant rural communities, and to sustain globally important agricultural exports.

Much needs to be done to enable Australian society to adapt to conditions that are already changing, and to further change, which may now be largely unavoidable. Early preparation to adapt is both sound practice and likely to confer national benefit and competitive advantage under almost any likely climatic outcome. Furthermore, it is highly likely that many of the adaptations developed in Australia will have great value in helping other countries and societies to stabilise food production and to offset or avoid some of the more serious consequences of climate change. This is a role for which Australia's past contributions and current expertise equip it well to contribute solutions to this global challenge.

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Further reading

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