SUBMISSION

Submission to the Department of Agriculture, Fisheries and Forestry

# Submission on Complex Drought Challenges Facing Australian Agriculture

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**The Australian Academy of Technological Sciences and Engineering (ATSE) is a Learned Academy of independent, non-political experts helping Australians understand and use technology to solve complex problems. Bringing together Australia's leading thinkers in applied science, technology and engineering, ATSE provides impartial, practical and evidence-based advice on how to achieve sustainable solutions and advance prosperity.**

Droughts are becoming increasingly more frequent and more damaging, with Australia being one of the most severely affected countries in the world. The regions boasting some of Australia's largest agricultural sectors and communities are struggling to survive due to drought and climate change effects. Climate change is the leading cause of increased drought severity and frequency, in addition to the increase of flooding, severe storms, and bushfires, all highly damaging to Australian agriculture.

The Future Drought Fund can support research in critical areas to support climate change adaptation and resilience in the agricultural sector. ATSE proposes diversification of farming techniques and crops through greater investment in dryland and drought-tolerant crops in the Western Australian Wheatbelt and the Murray-Darling Basin. Additionally, the Future Drought Fund could boost innovation for sustainable production, including regenerative agriculture and agroforestry. Invaluable First Nations knowledge can be integrated and promoted in resilience planning and climate and drought management, through existing and novel frameworks and strategies. Collaboration between existing government, research institutions, and industry will assist in the implementation of new innovations, with a focus on encouraging international knowledge sharing. Upgrading high performance computing systems to support Australia's climate modelling and forecasting systems will also greatly assist in planning for the future of the agricultural sector.

ATSE makes the following recommendations:

**Recommendation 1:** Increase investment in dryland and drought-tolerant crops and techniques to promote diversification and reduce reliance on water-intensive farming, particularly in severely affected agricultural hubs.

**Recommendation 2:** Support the development of further governance surrounding water resource management and flexible distribution.

**Recommendation 3:** Use the Future Drought Fund to scale up investment in regenerative agriculture and agroforestry, which improve soil carbon storage, water retention, and long-term productivity.

**Recommendation 4:** Strengthen collaboration between government, research institutions, and industry, while encouraging proactive learnings from Traditional Knowledge, international knowledge-sharing and technology adaptation for Australia's benefit.

**Recommendation 5:** Upgrade high-performance computing to support improved climate modelling and forecasting systems

## Understanding Climate Risks to Australian Agricultural Regions

Large parts of Australia are experiencing the adverse effects of climate change. Since 2000, Australia has experienced several major droughts, including the 2006 – 2010 Millenium Drought in south-east Australia, 99% of NSW and 58% of QLD being affected by drought in 2018 (Steffen et al., 2018). Southeastern Australia and southwest Western Australia have been some of the worst regions affected by droughts, with an average 15% decrease in cool season rainfall since the mid-1990s (Steffen et al., 2018). These trends are expected to continue with cool season precipitation in Western Australia is projected to reduce by 50% (Delworth & Zeng, 2014). Adding to the challenges of drought is an increase in flooding, and extreme storms in close proximity to these droughts across Australia (Cresswell, Janke, and Johnston, 2021). Droughts can affect people beyond water availability with research showing increases in PTSD, depression and suicide rates in effected communities (Hanigan et al., 2012) (Brew et al., 2016). Regional farming communities face severe financial and social impacts from droughts and climate events, and foundational support if essential for resilience building. Preparing for and recovering from these conditions will require sustainable water management to prepare the agricultural sector and community for the effects of drought and climate change.

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Despite these challenges water is still being over-allocated and unsustainable agricultural practices are still occurring. (Hughes et al., 2015). The Western Australian Wheatbelt is experiencing significant detrimental effects due to climate change and drought, with reduced rainfall leading to soil degradation. This has impacted the production of key crops such as wheat, barley, and canola (Department of Primary Industries and Regional Development, 2022). Cereal crops and irrigated crops will be disproportionately affected, with particular concern being noted for perennial crops. These perennial crops have the potential to improve sustainable agricultural production through improving soil structure, carbon levels, and water retention (Gladek et al., 2017).

In addition to cropping concerns, reduction in rainfall frequency and amount has resulted in low river flows leading to increasing salinity, nutrient loading, and the risk of algae blooms, affecting irrigation and livestock health (Holland et al., 2023). The Murray-Darling Basin is home to 40% of all Australian farms and is therefore disproportionately affected due to its significant agricultural yield (Murray-Darling Basin Authority, 2024). ATSE advocates for a future-focused approach, as highlighted in their collection of essays, A thriving Murray-Darling Basin in 50 years. Long-term management policies, investment into diversifying crop portfolios, adopting conservation tillage practices, and utilising cover crops can assist in mitigating the effects of drought and climate change in the Basin. Additionally, incorporating Traditional Knowledge and consulting with Aboriginal and Torres Strait Islander communities who have managed and supported the Basin's health for centuries, is essential for long-term management. Water intensive crops such as almonds and rice place extreme pressure on the surrounding water resources (OECD, 2017). Investment in drought-resistant crop research is essential to supporting Australia's future of agricultural production without straining struggling water sources. Centres such as the International Centre of Crop and Digital Agriculture in NSW should be supported to find solutions and developments to support grain and perennial crop yields. Additionally, continuing to support existing initiatives such as the Murray-Darling Water and Environment Research Program will help ensure the Basin's agricultural future.

**Recommendation 1:** Increase investment in dryland and drought-tolerant crops and techniques to promote diversification and reduce reliance on water-intensive farming, particularly in severely affected agricultural regions.

## Enhancing Water Security and Sustainable Resource Management

Investment in and regulation of Australia's water security is vital for the agricultural industry to combat the growing threats of extreme weather events and droughts. Water management in Australia is highly fragmented, impacting future water security. To address this, it is essential to increase reliability and management of water governance, ensuring fairer distribution and long-term water security. A federal water governance structure such as a National Water Commission would bring together stakeholders' interests and enable clearer and more transparent governance and decision-making. Shifting water governance from a state and territory-based approach to a national-level perspective would facilitate better integration of proposed solutions, particularly those incorporating Traditional Knowledge and Aboriginal and Torres Strait Islander perspectives. Ensuring Aboriginal and Torres Strait Islander self-determination and engagement, including for cultural water, should be taken in water governance structures.

One of the most effective strategies to build resilience against the inevitable increase of droughts in Australia is to maximise the benefits of those years that receive higher rainfall. This includes prioritising investment in water storage solutions, as prolonged and severe droughts can affect hydro generation and dam storage (Willige, 2023). A National Water Commission would be empowered to consider sustainable resource management strategies, such as water recycling, desalination, and stormwater harvesting for agricultural use. A shift from rigid water allocation regulations to a dynamic, real-time water trading and forecasting system would further enhance the efficiency and flexibility of water distribution (Harris, 2025) (Dilling et al., 2023).

As climate change, soil degradation, water scarcity, and ecosystem breakdown increasingly stress agriculture, updating agricultural technologies and exploring new innovations could support reducing water usage and land degradation. Investment into urban-intensive food systems, such as cellular culture, aquaponics, hydroponics, and other indoor farming methods would reduce future water needs. These systems use 100% recycled nutrients and water and can save up to 95% of the land and water typically consumed by traditional farming systems (Chatterjee et al., 2025). These methods would reduce the demands of agriculture on the land, supporting restoration of ecosystems over time.

Applying agricultural technologies can also support the sector to reduce greenhouse gas emissions through the whole supply chain. For example, integrating renewable energy solutions and innovative farming practices can further boost agricultural productivity while reducing carbon emissions in agricultural practices. Renewable energy use in farms, such as solar panels arrayed in grazed paddocks, can maximise productive use of rural land (Clean Energy Council, 2023). Research conducted by Australia's Joint Venture Agroforestry Program in the early 2000s, has shown how agroforestry – the practice of planting trees on farms arrayed as windbreaks or in rows or scattered trees – improves productivity, biodiversity, and environmental outcomes, demonstrating greenhouse gas emission management through nature-based solutions (Castle et al., 2021) (Hassall, 2008). Developing and applying agroforestry applications could be a key component of an effective Future Drought Fund.

**Recommendation 2:** Support the development of further governance surrounding water resource management and flexible distribution.

**Recommendation 3:** Use the Future Drought Fund to scale up investment in regenerative agriculture and agroforestry, which improve soil carbon storage, water retention, and long-term productivity.

## Investing in Research, Innovation, and Policy Coordination

Droughts, water, and agricultural issues must be considered in the context of the needs and priorities of Aboriginal and Torres Strait Islander peoples. Further encouragement of Traditional Knowledge use into mainstream agricultural planning can assist the agricultural sector in adapting to a variable and changing climate. It is crucial to engage with and support Traditional Knowledge through frameworks like the CSIRO's Our Knowledge Our Way. Aboriginal and Torres Strait Islander Traditional Knowledge offers a far more comprehensive and longer-term picture beyond the 120 years of data the Bureau of Meteorology is operating on (Harris, 2022). Two-way learning and knowledge exchanges should be prioritised across the country to increase understanding of Australia's climate and drought history, in addition to preserving invaluable Traditional Knowledge. ATSE recommends scaling up existing tools that link technology and First Nations Knowledge in order to care for country, such as Indigital, an intermediatory service that partners with materials companies and communities to co-design social impact solutions.

A national review of agricultural training, education, and research – spanning all agencies, states, and industry partners – could help bridge this gap. The last significant review was conducted in the late 1980s (McColl, 1991), emphasising the need for an updated, comprehensive assessment. In addition to domestic assessment, international collaboration should be explored. Knowledge sharing between international partners can strengthen existing strategies. For example, the benefits of Anticipatory Action Plans (AAPs), which aim to shift disaster response efforts toward pre-crisis preparation, may be considered in a drought context. The Australian Government is currently funding four pilot AAPs in the Indo-Pacific, with growing evidence supporting their benefits (Australian Aid, 2023). Sharing the progress and research of international programs like AAPs could assist in tailoring domestic approaches for drought resilience in agricultural communities. Additionally, investing in research hubs that facilitate knowledge exchange could further enhance the country's drought resilience through technological innovations. Several technological innovations are being utilised or tested globally to improve water efficiency in agriculture. These include remote sensing for improved irrigation scheduling in cotton, biodegradable plastic films to reduce soil

evaporation in high-value horticulture, buried drop irrigation piping for wheat cropping, and drones for targeted chemical applications on drought-affected crops (Lakhiar et al., 2024) (Campanale et al., 2024) (Firouzabadi et al., 2021) (Hafeez et al., 2023). Expanding research into such technologies could significantly enhance climate adaptation strategies in Australian agriculture.

**Recommendation 4:** Strengthen collaboration between government, research institutions, and industry, while encouraging proactive learnings from Traditional Knowledge, international knowledge-sharing and technology adaptation for Australia's benefit.

## Improving Climate Modelling and Forecasting Systems

Beyond short-term forecasting, longer-term climate projections are equally important for agricultural planning. While Australia has advanced modelling capabilities, ongoing investment is needed to translate these complex climate models into practical insights for farmers. This requires further development in high-performance computing, artificial intelligence (AI), and machine learning applications, to enhance the accuracy and usability of long-range climate predictions. By prioritising these investments, Australia can build a more resilient agricultural sector that is equipped to withstand the increasing challenges of drought and climate change. Having shared and fit-for-purpose high performance computing facilities would be a key enabler for the research and application of innovations through the Future Drought Fund. Australia does not have a national strategy for high performance computing systems, despite their necessity for many crucial systems, including climate modelling and forecasting – essential for agricultural planning. ATSE recommends development of a national strategy as well as investment for existing high performance computing systems for climate modelling. Current investment in these systems is inadequate as the needs of national research grows, often not accounting for the significant data storage costs needed for climate services.

Climate mitigation tools are often fragmented, requiring greater consolidation for efficient use during drought and climate crises. Resources such as Geoscience Australia's Digital Earth Australia (DEA) can offer a national framework that can enhance decision making, including tracking changes in water presence, monitoring drought conditions, and improving inland water management. Investment in AI systems could enhance drought forecasting and risk mitigation, allowing for more proactive responses (Olawade, 2024). Collaboration with existing and emerging agencies, such as Environment Information Australia (EIA), can also greatly assist in drought management. Strengthening partnerships between research institutions, agencies, and policymakers will improve the accessibility and usability of climate-related data. Applying FAIR (Findable, Accessible, Interoperable, and Reusable) data principles to facilities and their outputs can assist in more efficient collaboration.

**Recommendation 5:** Upgrade high-performance computing to support improved climate modelling and forecasting systems.

*ATSE thanks the Department of Agriculture, Fisheries and Forestry for the opportunity to respond to the submission on Complex drought challenges facing Australian agriculture. For further information, please contact academypolicyteam@atse.org.au.*

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