Australia's National
Science Agency

Ag2050 Scenarios Report

Executive summary

2024

Authorship

This report was lead authored (in alphabetical order) by Philippa Clegg, James Deverell, Micheala Kuen, Kate McMahon, Yasmin Morgan, Rohini Poonyth and Katherine Wynn with input from over 100 participants across different organisations from government, industry and research leaders.

CSIRO Futures

At CSIRO Futures, we bring together science, technology and economics to help you develop transformative strategies that tackle your biggest challenges. As the strategic and economic advisory arm of Australia's national science agency, we are uniquely positioned to transform complexity into clarity, uncertainty into opportunity and insights into action.

CSIRO Agriculture and Food

CSIRO's work in agriculture and food is solving the greatest challenges through innovative science and technology to build a profitable, productive, trusted and sustainable agrifood and fibre sector for the future. Working with CSIRO provides access to world-class multidisciplinary science, technology and facilities, relevant intellectual property and global networks across the value chain (from gene to the plate). Our people and partnerships span Australia and 25 countries, fostering a shared vision to create measurable economic, environmental and social impact, and delivering new pathways and new technologies for the future.

Accessibility

CSIRO is committed to providing web-accessible content wherever possible. If you are having difficulties with accessing this document, please contact csiro.au/contact

Acknowledgement

CSIRO acknowledges the Traditional Owners of the land, sea and waters, of the areas that we live and work on across Australia. We acknowledge their continuing connection to culture and we pay our respects to their Elders, past and present.

The project team is grateful to the many stakeholders who generously gave their time to provide input to this project through consultations, workshops, reviews and feedback. In particular, we would like to acknowledge Aaron Quigley, Anton Wasson, Brad Pfeffer, Brent Henderson, Cara Stitzlein, Carmel Pollino, Cathryn O'Sullivan, Claire Naughtin, Dave Henry, David Beatty, Frank Sperling, Jen Taylor, Katrina Szetey, Maja Arsic, Margaret Jewell, Navinda Kottege, Nina Welti, Rick Llewellyn, Rose Roche, Steve Swain, Stuart Whitten and Zaynel Sushil for providing significant reviews.

We thank the members of the project's Steering Committee, including representatives from the Department of Agriculture, Fisheries and Forestry, the Australian Farming Institute and CSIRO

Project partnership

The Ag2050 Scenarios Report project was led by CSIRO with financial and in-kind support from the Australian Government Department of Agriculture, Fisheries and Forestry. CSIRO would like to acknowledge the contributions of DAFF as advocates of co-design and connecting with industry to ensure their involvement and for bringing policy insights to the co-design process.

Copyright

Executive summary

The Ag2050 Scenarios Report explores a range of significant trends, risks and opportunities to identify key shifts and actions needed to support Australian farming systems into the future. This report aims to motivate discussions and actions around plausible futures and seeks to answer the question: what does a productive, resilient and sustainable future look like for Australian farming systems by 2050?

Why agriculture?

As of early 2024, agriculture in Australia has seen several years of high yield and profitability through continuous adaptation and leading innovation. However, there are several key threats to farm productivity, resilience, and sustainability that are already impacting farming systems, fisheries and forestry. These growing threats include climate change, emissions reduction targets, supply chain disruptions, workforce access, changing consumer preferences, market access, and innovation timelines.

Why now?

The last two decades have shown long-term reductions in farm profit, with projections estimating that these growing threats could cause profitability decline in some areas by up to 50% by 2050.[1] Australian agriculture has an active innovation system focussed mainly on short to medium-term deliverables (5–10 years) and commodity groups within existing farming systems. Australia will need to accelerate the transformation of its current farming systems to respond to these complex and whole-of-sector challenges and deliver against the sustainability, productivity and profitability needs of 2050. As such, there is a need for whole-of-system planning that provides the agricultural innovation system with achievable stepping stones towards long-term transformative system change.

Why future scenarios?

The goal of this report is to motivate discussions between industry, researchers and policy makers on the strategy and coordination needed for the Australian agriculture innovation system to productively address cross-sectoral challenges and opportunities. By exploring four plausible, alternative futures for Australian farming, this report aims to expand the scope and urgency of collaborative and whole-of-sector strategic thinking for decision makers at all levels across the agriculture sector.

This work combines research by CSIRO and input from leaders and organisations across the Australian agriculture industry, research and government sectors to develop a set of four plausible and evidence-based scenarios for 2050. It was developed through a highly collaborative approach over 6 months that combined input from **over 100 participants across 54 organisations** in a co-design workshop series.

1 Hughes N, Gooday P (2021) Climate change impacts and adaptation on Australian farms. ABARES, DAFF. <https://daff.ent.sirsidynix.net.au/client/en_AU/search/asset/1032401/0> (accessed 31 January 2024).

How to read this summary

Immerse yourself in the four contrasting future scenarios below. These scenarios are evidence-based and plausible explorations of what Australian farming systems could look like by 2050. While some may have more desirable elements than others, it is important to note that there is no one preferred future scenario and every scenario presents trade-offs.

What is possible for Australian farming if the agriculture innovation system achieves its full potential?

- Scenario 1 – Regional Ag capitals
- Scenario 2 – Landscape stewardship

What can be achieved with incremental innovation and proactive climate adaptation?

- Scenario 3 – Climate survival

What if agriculture fails to effectively respond to the challenges and needs of 2050?

- Scenario 4 – System decline

Each scenario contains a set of key signposts. Signposts are the unique trends, events or signals that could indicate the sector is on a pathway to the future described in the scenarios.

Next, explore the five fundamental shifts Australia needs to make to identify and pursue the future it wants for its farming systems.

Five shifts: climate adaptation, land and water, industry, regions and whole-of-system change were developed drawing on insights from the co-design workshops and CSIRO's research. A set of action areas were defined for each fundamental shift. These action areas are not exhaustive, but help to articulate the initial changes, assumptions testing, and initiatives required. Ultimately, achieving the most optimistic future is plausible for Australian agriculture. However, it will require significant effort, collaboration and action across the public and private sectors.

Methodology

Through a rigorous literature review and extensive consultation with stakeholders, 14 drivers of change were identified. These drivers will shape the direction and speed of change across Australian farming systems to 2050. For each driver, two contrasting and alternative outcomes were developed. In a series of co-design workshops, these driver outcomes were logically grouped to form the foundation of the four future scenarios in this report.

Over the next few years, the CSIRO Ag2050 program will continue to iterate these initial future scenarios through modelling and consultation to inform the policy and R&D actions required by industry and government to facilitate a preferable future.

It is important to note that the four future scenarios included in this report cover a wide range of plausible outcomes, however they are not mutually exclusive, nor exhaustive of the future possibilities. Additionally, while these scenarios will have implications across broader agrifood value chains, the scope of this report is pre-farm gate.

Regional Ag capitals

Large multinational corporations have consolidated and seamlessly integrated much of Australia's agriculture value chains. By leveraging transformative technologies, increased levels of productivity have been unlocked. New workforce opportunities have emerged, concentrated in a select few regional cities where multiple sectors are experiencing growth.

How do we know we are heading here?

- ↑ **industry investment in novel climate adaptation strategies**
- ↑ **industry-led collaboration and R&D investments**
- ↑ **rates of industry and supply chain consolidation**
- ↑ **investment in novel food and fibre production**
- ↑ **concentration of investment in select regional centres.**

What does the agriculture sector look like in 2050?

- **Increasing yields and productivity gains**
- **Food and fibre focus through new and intensified production systems**
- **Decreasing emission intensity and plateaued absolute emissions**
- **Improvements to the health of ecosystem services**
- **Skilled and diverse workforce in select growing regional cities**
- **Step-change investment and uptake of disruptive agritech**
- **Evidence-based and Australian-led trade frameworks**

Landscape stewardship

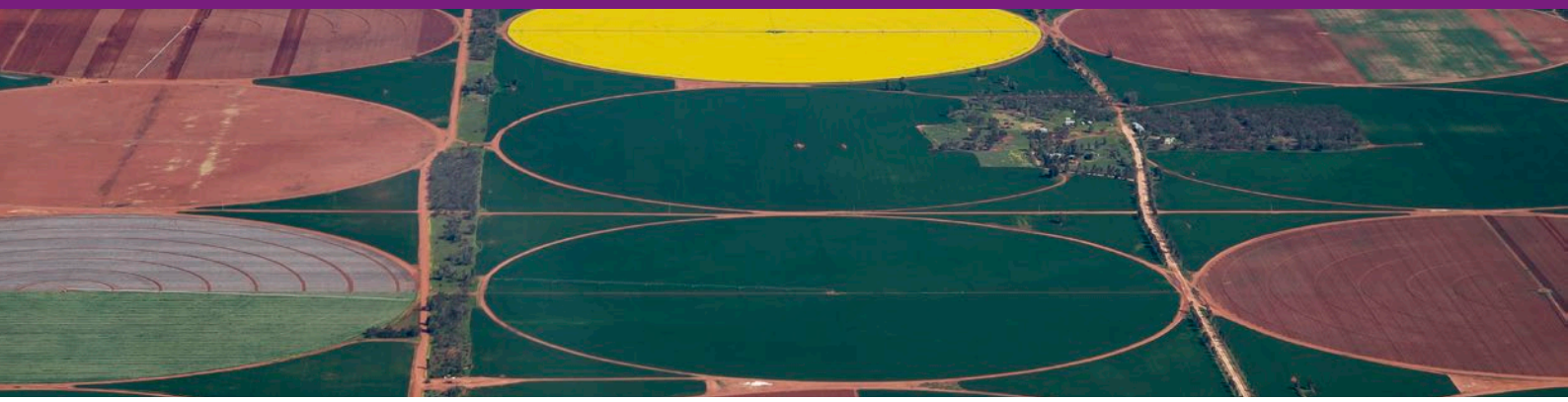
Using the land to support the energy transition through carbon capture and the restoration of the environment is a national priority. Farming systems are resilient and productive because producers have taken advantage of a range of diverse income streams, blurring the lines between farming, biodiversity, carbon sequestration, and energy and fuel production.

How do we know we are heading here?

- ↑ **investment in novel climate adaptation strategies**
- ↑ **R&D investments across industries and sectors**
- ↑ **strength of governance and guidance across land uses**
- ↑ **application of novel cross-sector and diversified business models**
- → **growth in food and fibre production.**

What does the agriculture sector look like in 2050?

- **Increasing productivity gains and resilience**
- **Diversified into innovative new market opportunities**
- **Decreasing absolute emissions and increasing carbon sequestration**
- **Active improvement to biodiversity and ecosystem services**
- **Skilled and diverse workforce attracted to the sector**
- **Step-change investment and uptake of disruptive agritech**
- **Strong Australian brand for high-value goods**



Climate survival

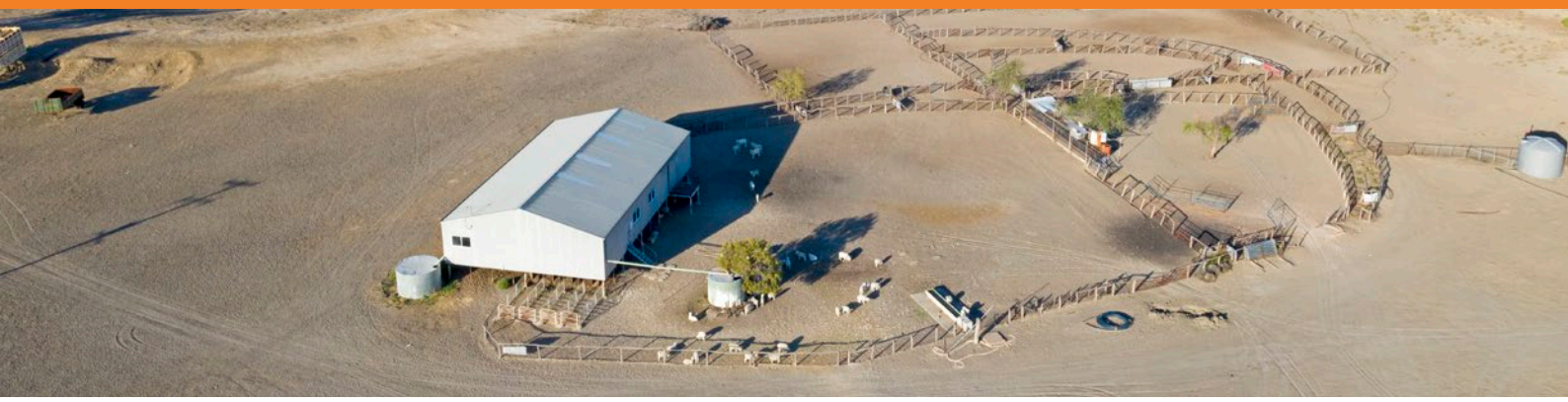
Without transformative change, the agriculture sector is forced to focus on surviving rather than thriving. Producers relocate and incrementally adapt and diversify their farming systems to offset the impacts of climate change. However, they remain uncertain about the long-term viability of their businesses.

How do we know we are heading here?

- ↑ **adoption of compounding of incremental climate change adaptation strategies**
- → **agriculture R&D investments**
- ↑ **application of diverse land management practices**
- ↓ **collaboration between industry and government**
- ↓ **trust in Australian agriculture brand.**

What does the agriculture sector look like in 2050?

- **Plateauing productivity and efficiency gains**
- **Diversified land management practices and products**
- **Some reduction in emissions intensities while lagging national net zero targets**
- **Slow deterioration of biological biodiversity and ecosystem services**
- **Some talent attraction and retention**
- **Incremental investment and uptake of low-risk technologies**
- **Diverse relationships to maintain an export market**



System decline

The Australian agriculture sector has reached a tipping point. Delayed and fragmented decision-making has left producers facing the economic and environmental consequences of extreme weather events and biosecurity outbreaks. With only incremental advances in agritech, many farm businesses are struggling to maintain profit.

How do we know we are heading here?

- ↓ **collaboration on climate change adaptation strategies**
- ↑ **short-term and reactionary focus of R&D system**
- ↑ **on-farm production intensity**
- ↑ **rates of biodiversity loss**
- ↑ **regional marginalisation.**

What does the agriculture sector look like in 2050?

- **Declining yields and productivity gains**
- **Food and fibre focus with traditional intensified production systems**
- **Lagging reduction in emission intensities and failing emissions reduction targets**
- **Declining biodiversity and ecosystem services health**
- **Shrinking workforce and increasing number of farmers exiting the sector**
- **Incremental investment and uptake of low-risk technologies**
- **Export focus to low price markets**

Considerations for policy and R&D actions

How Australia responds to trends and challenges will determine, in large part, its future outcomes. The four future scenarios describe plausible alternative futures for Australian agriculture each with benefits and challenges. This section outlines five initial shifts that Australian agriculture will need to make to identify the future it wants for its farming systems.

The shifts listed below do not offer all the solutions. Instead they present the types of changes, assumptions tests, and initiatives required. They draw on the insights developed during the co-design workshops and CSIRO's research and reflect existing aspirations for Australian agriculture. Significant effort and actions are required from Australia's agriculture innovation system to turn these aspirations into strong long-term sector plans for achieving the more desirable future outcomes and avoiding the less desirable ones for Australian farming systems by 2050.

Climate adaptation

A climate adaptation shift will support Australian food and fibre production to pursue growth in profitability and productivity within the context of a changing climate.

Increase research into climate change impacts – understand and forecast the impacts of climate change and offset strategies on ecosystem services and agriculture production at a regional level.

Increase research on adaptation approaches – identify adaptation approaches through continued research and strengthening international cross-collaboration.

Test for likely success of adaptation activities – test and demonstrate that adaptation strategies are adequate measures under a variety of global conditions, what social and policy measures are needed in regions, and how to monitor adaption action in the sector.

Land and seas

A land and sea shift will create a profitable and sustainable mix of food, fibre, and energy production and provide opportunities in carbon markets.

Improve understanding of on-farm emissions reduction including technology adoption challenges and incentives – model trade-offs between emission reduction and productivity under different global settings, incentivise the adoption of emission reduction through solving for process and technology challenges.

Model further land and sea use options and impacts – models to optimise alternative land and sea uses in regions, maps and tracking of land and sea use changes, monitoring impact on nearby ecosystems, and identifying repurposing of non-arable land.

Deepen understanding of carbon sequestration and ecosystem services opportunities – identity incentives for long-term sustainable practises, carbon sequestration opportunities, and in new technologies such as biotech and synthetic ecosystem services.

Foster sustainable agricultural practices through Indigenous-led research and Indigenous-led co-design – use co-design and two-way learning approaches to respectfully develop new knowledge bases for agricultural R&D that integrate Indigenous and scientific knowledge systems.

Industry

An industry shift will enable a productive and resilient agricultural sector and economy and provide new opportunities for exports and income streams.

Build support for skills and human capital – identify and communicate the skills and jobs required in the future, barriers and incentives to education and career pathways in regions, potential trade-offs and co-benefits of automation, and establish strategic partnerships to build education and talent pipelines for regional locations.

Broaden Australia's agriculture export focus – model the impacts of consolidation and diversification on exports, design policies that balance IP protection with knowledge sharing and collaboration, promote Australian sustainability and biosecurity credentials that can be evidenced by producers with minimal cost and effort.

Establish support from finance and diversified income streams – understand the settings needed from finance and insurance industries to support farm viability and resilience under various climate change and geopolitical scenarios.

Recommended areas for policy and R&D

Ultimately, achieving the most optimistic future is plausible if significant action is taken by Australian agriculture. This will require long-term strategic planning across the fundamental shifts: climate adaptation, land and seas, industry, and regions.

The expertise, experience and energy needed to achieve the more positive outcomes described in this report extend beyond any single organisation. Effective and urgent collaborative effort is needed from both public and private sector organisations.

Over the next few years, the Ag2050 program will continue to iterate these initial future scenarios through modelling and consultation to inform the policy and research and development (R&D) actions required by industry and government to facilitate a preferable future.

Regions

A regional shift will enable well-connected and vibrant regional communities that offer quality jobs, lifestyle amenities, education, and other services.

Target investment in infrastructure – map and assess regional centres to identify potential for growth and investment from agriculture and other sectors, to support other centres that are at risk of marginalisation and find new ways to connect and engage city-based communities better with agriculture.

Leverage mixed land use opportunities – harness land use mixes that leverage the energy transition and allow for more diverse income streams and quality jobs in regional areas, adopting relevant best practice from overseas around good planning and investment decisions.

Whole-of-system

A whole-of-system shift will mean the agricultural system has the planning and investment to achieve step changes towards long-term transformation.

Renew strategy guidelines – build on available strategic planning and forsighting tools, such as the future scenarios contained in this report, to enable industry, research organisations and government to develop effective strategy and standard evaluation frameworks in response to transformational and cross-commodity priorities.

Restructuring the agricultural R&D system – identify, evaluate and implement the strategy, structures, interactions, funding models, roles and responsibilities across Australian agriculture innovation needed for effective responses to cross-sector challenges and opportunities.

Strengthen relationships and dialogue with Aboriginal and Torres Strait Islander partners – incorporate Indigenous led co-design and research into the development of opportunities and re-engage with traditional methods to advance sustainable farming practices.

Productive, resilient and sustainable farming systems in 2050

As Australia's national science agency, CSIRO is solving the greatest challenges through innovative science and technology.

CSIRO. Creating a better future for everyone.

Contact us
1300 363 400
+61 3 9545 2176
csiro.au/contact
csiro.au

For further information
CSIRO Futures
Katherine Wynn
katherine.wynn@csiro.au
csiro.au/futures

B&M | 24-00100 ES