The National Mission for Future Crop and Community Resilience

Australian National University

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This document has been prepared by The Australian National University, The University of Adelaide, The University of Queensland and The University of Western Australia. For printed copies of this document, please request from contacts listed on the back cover.

The document was created by staff from plant science, agriculture, computer science, technology, engineering, social sciences, economics and policy disciplines at The Australian National University, The University of Adelaide, The University of Queensland and The University of Western Australia in 2019–2021 and supported by an EY consultant. It incorporates elements of advice and insights from the set of stakeholders outlined in Appendix 1 gained through a consultancy process in 2020. This document can be cited as "The National Mission for Future Crop and Community Resilience" (2023) The Australian National University, The University of Adelaide, The University of Queensland and The University of Western Australia, doi: 10.26182/y1nv-5517.

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National Mission for

Future Crop and Community Resilience

Funding to be drawn from federal sources **$500 million matched by industry and other partnerships**

Delivery timeframe **10 years**

Estimated RD&E return on investment in Australia **$17 dollars for every $1 dollar**[1]

1 Petersen, E. and D. Vanzetti (2021). Estimation of the impact of the National Mission for Crop and Community Resilience on the Australian economy. Advanced Choice Economics, Pty Ltd

Annual yield growth required to meet demands of a growing global population[2]

Current projected annual growth in Australian major crop supply[3]

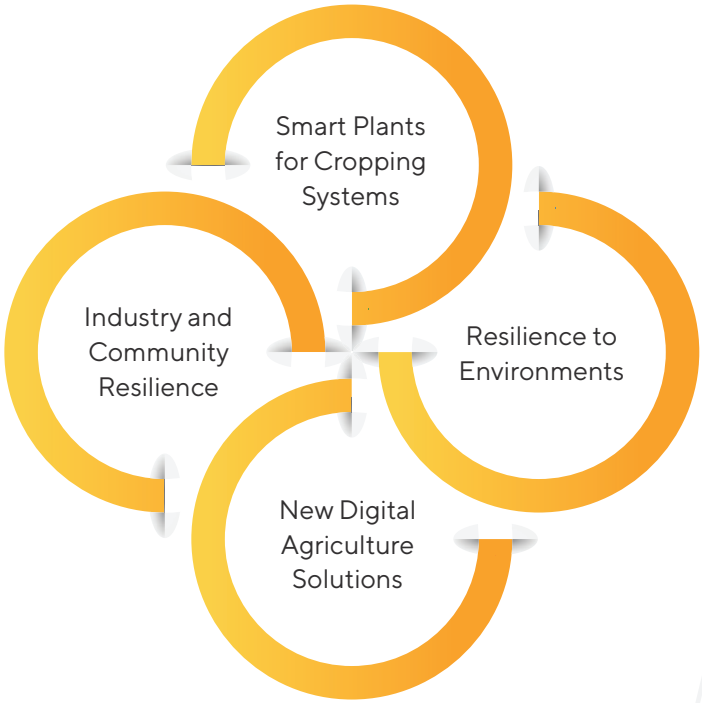
The *National Mission for Future Crop and Community Resilience* will respond to the urgent need for improved productivity, competitiveness, climate preparedness and resilience of rural and regional communities. It will support technologies never before implemented in Australia.

Water-saving, drought-tolerant crops that need only a fraction of the water used by today's varieties and technology which decreases fertilizer costs by 80% are examples of the transformational change required to improve crop productivity and resilience.

A National Mission will provide the strategic direction, resources, and industry collaboration needed to implement the over the horizon thinking that will build a future-ready industry.

Research Pillars of the National Mission

The National Mission will deliver change through four distinct and complementary research pillars.



Outcomes of the National Mission

Transformed productivity and resilience of the cropping sector

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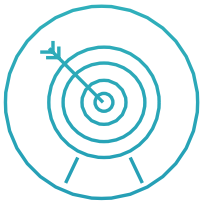

New competitiveness to service international and local demand

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Prosperity and resilience of rural communities

2 Deepak K. Ray, Nathaniel D. Mueller, Paul C. West, Jonathan A. Foley, "Yield trends are insufficient to double global crop production by 2050," PLoS One (2013) Accessed at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0066428

3 Rabobank, "The Australian Feed Grain Squeeze Report," (2019) Accessed at: https://research.rabobank.com/far/en/sectors/grains-oilseeds/the-australian-feed-grain-squeeze.html

01 Executive Summary

AUSTRALIA'S RURAL COMMUNITIES ARE FACING UNPRECEDENTED CHALLENGES, WITH MANY COMMUNITIES ALREADY EXPERIENCING DEPOPULATION, DECLINING PARTICIPATION IN AGRICULTURAL EDUCATION AND JOBS, POOR HEALTH OUTCOMES AND POOR RATES OF RETURN FOR THE MAJORITY OF FARM BUSINESSES.

They are also having to adjust to shifts in seasonal climate – shifts that are likely to become more acute in the coming decades. These challenges threaten the resilience, stability and growth of crop-growing communities.[4]

A cornerstone of Australia's agricultural R&D strategy are investments that target the profitability and sustainability of today's farmers. While these investments can, and do, target the near-term needs of industry, the requirement to return value to today's farmers means that there is limited ability to invest in long-term, transformational projects.

Similarly, the Federal Government's National Agricultural Innovation Agenda is focused on near-term projects that promote adoption, commercialisation and extension; achieving greater impact from the research knowledge that already exists, or will soon exist, is a key aspect of this agenda. This agenda does not target the long-term needs of future generations of Australian farmers.

Increased competition and productivity in the international market – combined with the impacts of changing climates on productivity growth and increased public concerns about novel agricultural methods - means that much higher levels of biological, technological and social innovation are needed if Australia is to secure the long-term future of the cropping sector. New forms of innovation are also needed to help agriculture meet the Australian Government's goal to achieve net zero emissions by 2050, and to increase our nation's annual agricultural output to $100 billion by 2030.

By developing a new approach to agricultural R&D - targeting intergenerational challenges – our children will have the tools needed to farm profitably and sustainably.

This document sets out the case for a National Mission for Future Crop and Community Resilience - an investment in R&D that addresses the needs of future generations of crop farmers and the communities in which they live.

The National Mission would be funded by the investment of up to $500 million drawn from federal funding and leveraged to attract matching funding from private partnerships over a 10-year timeframe.

4 KPMG, "A Sustainable Australian Grains Industry," (2019) Accessed at: https://www.graingrowers.com.au/wp-content/uploads/2019/09/Behind-Australian-Grain-insights-report-2019.pdf

The National Mission would complement the recently announced portfolio of CSIRO Missions, each of which are designed to create impact within five years. Coupling CSIRO's near-term investments to long-term goals of the National Mission will help to protect the livelihoods of future generations of crop farmers.

The National Mission would bring a return on investment of $17 for every $1 invested, with much of the benefit going to supporting – and ensuring the prosperity of – Australia's rural communities that rely on broadacre crops, and horticulture and managed pastures for their living. Benefits that include job creation, enhanced farm profitability, development of new commodities, and equipping of workers with the skills and higher order knowledge to boost innovation and productivity.

To achieve this return on investment – and ensure that future generations of farmers have the tools needed to farm profitably and sustainably – we need to act now.

Broadacre crops, horticultural crops and managed pastures – our plant-based industries – underpin Australia's rural and regional economies, accounting for more than half of the total value of production from agriculture, fisheries, and forestry.[5] Plant-based industries also sustain other industries such as livestock production, transport, manufacturing, and produce a variety of products such as plant-based protein, oil, carbohydrates, and fibre for both domestic and international markets. In the absence of significant adaptation to a changing climate, by 2060 crop farmers in many regions face a decline in productivity of more than 20 per cent below current levels. [6]

To secure a prosperous future for our regional and rural communities, productivity growth of our plant-based industries needs to increase by more than 20 per cent. A business as usual approach using existing R&D models will not deliver the outcomes required.

A step change is needed.

Business as usual approach to crop improvement using existing R&D models will not deliver the outcomes required.
A step change is needed.

Australia needs to transform the resilience and productivity of plant-based industries through a strategic, long-term approach that embraces the newest technologies, some of which are in their infancy and/or have not yet to be deployed in Australia, coupled to the full capabilities of research, development, and extension institutions across the nation.

Australian legislation is evolving to accommodate innovative agricultural products, such as gene edited crops, that are found to be safe and low risk.[7] As a result, there is a large opportunity for step changes in crop productivity improvement, which could position Australia as a global innovator and leader.

Australia has world-leading research, development, and technical capability to discover and develop new emerging digital and genetic technologies that will transform traditional agricultural industries and provide a step change across a wide range of crop plant species.

5 ABARES "Snapshot of Australian Agriculture," (2018) Accessed at: https://www.agriculture.gov.au/sites/default/files/abares/documents/snapshot-australian-agriculture.pdf 6 Climate Council of Australia "Feeding a Hungry Nation: Climate Change, Food and Farming in Australia" (2015) .

6 Climate Council of Australia "Feeding a Hungry Nation: Climate Change, Food and Farming in Australia" (2015) . Accessed at https://www.climatecouncil.org.au/uploads/7579c324216d1e76e8a50095aac45d66.pdf

7 Commonwealth of Australia, "The Third Review of the National Gene Technology Scheme, Final Report," (2018). The Scheme regulates gene technology using a risk-based approach, where higher risk activities involving GMOs are subject to greater regulatory oversight

Failure to make a significant additional investment in R&D to create this step change will lead to a future with fewer jobs in rural areas and a reduced ability for Australia to protect and expand its export markets.

Failure will place at risk the future of rural communities across Australia.

Drawing on their world leading and interdisciplinary expertise, The Australian National University (ANU), the University of Adelaide (UA), the University of Queensland (UQ) and The University of Western Australia (UWA) and have taken the initiative to bring together an ambitious research program designed to leverage the full intellectual capacity of Australia's agricultural innovation ecosystem across the country, both in capital cities and in regional centres, and across the diversity of crop production regions across Australia.

A set of stakeholders was consulted during the development of this National Mission, including a series of workshops held with more than 18 agriculture related entities. These include research institutions, rural research and development corporations, plant breeders, rural service providers, government and industry peak bodies. Their feedback, and subsequent broader consultation, has helped shape this proposal for a National Mission.

The National Mission will draw on the interdisciplinary strengths of Australia's universities, CSIRO, industry, state governments, RDCs and peak bodies, as well as leverage national infrastructure investments, including the NCRIS-funded Australian Plant Phenomics Facility and BioPlatforms Australia. It will include experts across Australia, from every state and territory, addressing the breadth and depth of the opportunities and challenges that the agrifood sector in Australia addresses given our national footprint embraces temperate, sub-tropical and tropical production environments.

The need for a National Mission for Future Crop and Community Resilience is real and urgent. Rural communities are under unprecedented environmental and economic pressure, and at the same time the opportunity for new technological solutions is burgeoning.

We urge the government, nation, and our rural communities to embrace the opportunity of this National Mission.

Courtesy of ARC CoE Plant Energy Biology

02

Outcomes of the National Mission

THE PROPOSED NATIONAL MISSION FOR FUTURE CROP AND COMMUNITY RESILIENCE IS INTENDED TO NOT ONLY INCREASE THE VALUE OF AUSTRALIA'S CROPPING AGRICULTURE, BUT ALSO TO TRANSLATE THAT VALUE TO BETTERING THE LIVES OF PEOPLE IN CROPPING COMMUNITIES.

Research shows that every dollar invested in agricultural research returns $12 on average to the economy, in addition to a suite of economic, environmental and social benefits.[8,9,10] Further, with investments targeting a combination of near-term and generational investments, our financially modelling shows that Commonwealth investment of $500 million over 10 years will bring a 17:1 return,[11] paying for itself many times over in terms of Treasury receipts and social good.

8 Terrance M. Hurley, Xudong Rao, Philip G. Pardey, "Re-examining the reported rates of return to food and agricultural research and development." American Journal of Agricultural Economics, 96, no. 5 (2014): 1492–1504. Accessed at: https://academic.oup.com/ajae/article-abstract/96/5/1492/2738767; and

9 Ernst and Young, "Agricultural Innovation - A National Approach to Grow Australia's Future," (2019). Accessed at: https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/agriculture-food/innovation/full-report-agricultural-innovation.PDF ; and

10 Yu Sheng, Emily M. Gray, John D. Mullen, Alistair Davidson, "Public investment in agricultural R&D and extension: an analysis of the static and dynamic effects on Australian broadacre productivity," ABARES Research Report 11.7, (2011). Accessed at: https://grdc.com.au/_data/assets/pdf_file/0013/142402/public-investment-inagricultural-rd-and-extension.pdf.pdf

11 Petersen, E. and D. Vanzetti (2021). Estimation of the impact of the National Mission for Crop and Community Resilience on the Australian economy. Advanced Choice Economics, Pty Ltd

The National Mission will be composed of the following aspects:

INPUTS

RESEARCH AND DEVELOPMENT OPPORTUNITIES

- Smart plants designed to align to future farming systems
- Novel tolerances to abiotic stress including drought, salinity, frost and heat
- New digital technology for crop monitoring and improvement
- Social, economic, and market considerations

CONNECTED AND COLLABORATIVE INDUSTRY AND ACADEMIA

- Government
- Breeders and growers
- Universities
- CSIRO
- Other research institutions
- NCRIS-funded infrastructure
- Rural service companies

OUTPUTS

- Step changes in productive, nutritious, higher yielding and stress tolerant crops
- Novel crop products, technologies and management strategies that meet market needs
- Reduced crop breeding timeframes
- Reduced use of crop fertilizers and associated carbon emissions
- Real-time decision support tools for cropping and livestock farmers that integrate data from satellite-enabled technologies with ground-based sensors and market information
- Detailed profiles of the needs of current and potential future consumer markets
- In-depth understanding of the social and economic impacts of emerging agri-technology on different regional communities, framing regional resilience plans and strategies
- Tailored training and skills development to enable deployment/extension
- Creation of new, highly-skilled jobs and equipping of rural workers with the skills and high-order knowledge to boost innovation and productivity

OUTCOMES

- Transformation of productivity and resilience of plant-based and associated live-stock industries
- Contribution to Australia's international commitments on net zero carbon emissions by 2050
- New competitiveness of plant-based industries to service international demand
- Spill over technology benefits for other sectors
- More resilient and prosperous rural communities

RETURN ON INVESTMENT:

- An expected Benefit Cost Ratio of 17:1 over 30 years
- Impact on the economy: an annualised benefit of $567M per year over 30 years
- Impact on employment: 14,000 full time new jobs; 76% in rural and regional areas.

03

The importance of plant crops to Australian agriculture

ANNUAL CROP PRODUCTION – FROM BROADACRE CROPPING TO HORTICULTURE TO MANAGED PASTURES – UNDERPIN AUSTRALIA'S RURAL AND REGIONAL ECONOMIES, SUSTAIN LIVESTOCK PRODUCTION, TRANSPORT, AND MANUFACTURING, AND PRODUCE PLANT-BASED PROTEIN, OIL, CARBOHYDRATES, AND FIBRE FOR BOTH DOMESTIC AND INTERNATIONAL MARKETS.

These crops range from wheat, barley, canola, cotton, rice and legumes to vegetables and fruits to pastures for livestock production. Broadacre crops alone cover 22 million hectares of farmland yielding 66 million tonnes per year. Improved pastures cover another 40 million hectares.[12] Together, they are the backbone of Australia's crop export and intensive livestock production sectors.

In many crops, production needs to increase annually in line with international demand to achieve the vision for Australia's annual farm gate output to exceed $100 billion by 2030[13], and to meet rising food demand in the decades thereafter.

Achieving this target is a significant challenge considering the stagnation of productivity growth in recent years.

For example, Australian cereal grain supply is only expected to increase by 0.4 per cent annually over the next 10 years, but needs to be 2–3 per cent, both for demand in international markets[14] and within Australia.[15]

This productivity gap is exacerbated by the effects of extreme and prolonged weather events, including water shortages and droughts. By 2060, predicted declines in rainfall – driven by global climate change – could reduce the productivity of grain growers by 50 per cent below the 2018 baseline levels. [16]

12 Australian Bureau of Statistics, "Agricultural Commodities, Australia - Statistics on the production of agricultural commodities including cereal and broadacre crops, fruit and vegetables and livestock on Australian farms," (2020). Accessed at: https://www.abs.gov.au/statistics/industry/agriculture/agricultural-commodities-australia/latest-release

13 Agrifutures, "A 100bn industry by 2030?" (2019). Accessed at: https://www.agrifutures.com.au/news/agriculture-a-100b-sector-by-2030/

14 Deepak K. Ray et al., "Yield trends are insufficient to double global crop production by 2050," PLoS One, (2013). Accessed at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0066428

15 Rabobank, "Livestock feed demand puts squeeze on Australian grain – industry report," (2019). Accessed at: https://www.rabobank.com.au/media-releases/2019/191011-livestock-feed-demand-puts-squeeze-on-australian-grain/

16 Commonwealth Bank of Australia, "CBA Annual Report 2019," (2019). Accessed at: https://www.commbank.com.au/about-us/investors/annual-reports.html

Disruption to these diverse cropping industries has a significant impact on intensive livestock production and rural communities. These industries also support employment in associated sectors such as food transport, manufacturing and commercial services. Because of this, crop industries form the economic foundation of many rural and regional communities.

Improved productivity and profitability can create flow-on benefits that support and sustain those communities. Environmentally responsible future productivity gains can occur by adopting the principles of sustainable intensification[17] and by offsetting the future impact of crops to ensure Australia meets carbon release reduction goals by 2050.[18]

Loss of their profitability – be it due to changes in the climate or the effects of unexpected shocks such as those caused by COVID-19 or geopolitical impacts on market access – has enormous knock-on negative effects for rural communities.

3.1. Achieving the $100 billion by 2030 target

Looking forward, the vision of the broader agricultural sector – led by the National Farmers Federation – is for annual farm gate output to increase from $60 billion (2018–19) to $100 billion by 2030.[19]

Achieving this target – and increasing productivity growth in the decades beyond 2030 – will require large increases in productivity growth. And importantly, growth that is environmentally sustainable. Yet, productivity growth in Australia has stagnated over the last 25 years (in part because of climate change), with increases in the price paid for commodities being responsible for 90 per cent of growth in farm gate output since 2010.[20]

In 2017, Australia's agricultural productivity growth rate was 1.4 per cent, significantly below the world average of 1.7 per cent.[21] This is despite Australian agriculture – including the crop industry – deploying radical changes in management systems, such as the: shift from ploughing to conservation agriculture; types of crops produced; use of genetics and the associated dramatic shift in marker assisted selection; whole genome breeding; and use of automation in harvesting and production.[22]

Achieving the **$100 billion target** cannot be at the expense of the environment or in ways that exacerbate carbon emissions. There is a simultaneous need to intensify (to reduce inputs) and to diversify (to produce higher quality products for high value markets). One example is in Northern Australia where Federal, State and Territory governments have identified the untapped production opportunities and proximity to rapidly expanding markets. For these opportunities to be realised, the technologies underpinning success in diverse environments need to be enhanced.

If major plant-based industries are to play their part in achieving the **$100 billion by 2030** target, they must focus on unlocking innovation through investing in R&D that addresses a combination of near-term and long-term goals that cannot be achieved through the existing agricultural innovation ecosystem. This will include investments in much-needed decision making tools that integrate pipelines of complex observational, management and trade scenario data. It will also include investments in powerful new genetic and digital technologies and new digital agriculture infrastructure, to deliver improved access to the newest science and accelerated productivity gains. [23]

17 Jules Pretty et al. (2018) "Global assessment of agricultural system redesign for sustainable intensification," Nature Sustainability 1. (2018): 441–446. Accessed at: https://doi.org/10.1038/s41893-018-0114-0

18 Australian Government Department of the Environment and Energy, "Australian greenhouse gas emissions projections 2019," (2019). Accessed at: https://www.industry.gov.au/sites/default/files/2020-12/australias-emissions-projections-2020.pdf

19 Robert Poole, Ben van Delden, Peter Liddel, "Talking 2030. Growing agriculture into a $100 billion industry," KPMG & National Farmers Federation, (2018). Accessed at: https://home.kpmg.com/au/en/home/insights/2018/03/talking-2030-growing-australian-agriculture-industry.html

20 Ernst and Young, "Agricultural Innovation - A National Approach to Grow Australia's Future," (2019). Accessed at: http://www.agriculture.gov.au/SiteCollectionDocuments/agriculture-food/innovation/summary-report-agricultural-innovation.PDF

21 KPMG, "Powering Growth: Realising the potential of AgTech for Australia," (2016). Accessed at: https://assets.kpmg/content/dam/kpmg/vn/pdf/consumer-market/vn-powering-growth-realising-potential-agtech-australia.pdf

22 Australian Academy of Science, "The Decadal Plan for Australian Agricultural Sciences 2017-2026," (2017). Accessed at: https://www.science.org.au/files/userfiles/support/reports-and-plans/2017/agricultural-decadal-plan-2017-26.pdf

23 Robert Poole, Ben van Delden, Peter Liddel, "Talking 2030. Growing agriculture into a $100 billion industry," KPMG & National Farmers Federation,

There is a lot at risk if we continue business as usual. Failure to invest in the National Mission and increase agricultural productivity growth from 0.4 to 2.4 per cent will mean Australia misses the opportunity to secure the socioeconomic future and health of rural communities.

Without improving productivity, growth in rural sector jobs will be forgone and it will be harder for Australia to protect and expand its export markets.

Investing in the National Mission now will help secure the future of rural and regional communities.

3.2 Increasing global and domestic demand

New R&D approaches are also needed to keep pace with global demands for food, which will double by the middle of this century.[24]

For example, to achieve a doubling of global production by 2050, grain yields need to increase by 2.4 per cent each year – a value far higher than global historical averages for other major grain crops such as maize (1.6 per cent), rice (1.0 per cent), wheat (0.9 per cent) and soybeans (1.3 per cent).[25] [26]

We also need to meet growing domestic demand for crops, driven by demand to feed livestock and domestic population growth. Under the current system, 0.4 per cent annual growth in major crop supply will not keep pace with the forecast domestic demand – driven in part by feed demands of livestock – of 2.3 percent annual growth over the next decade.[27]

The current 0.4 per cent annual growth in major crop supply will not keep pace with the forecast increase in international and domestic demand over the next decade. Rather, there is an urgent need to dramatically increase productivity growth of plant-based industries.

Achieving the $100 billion by 2030 target, and associated 2–3 per cent per year productivity goals, will not be achieved through the existing research, development and adoption strategies deployed across Australia. To achieve the required step change in productivity, and to provide farmers need to reduce carbon emissions, we need to greatly increase investment in new forms of innovative, industry-aligned R&D that focus above the current investment horizon to what is needed for the future.

Our ability to meet global demands, during both good and bad years, will enable us to secure existing markets and grow international trade. There are so many possibilities if we get this right.

24 Deepak K. Ray et al., "Yield trends are insufficient to double global crop production by 2050," PLoS One, (2013). Accessed at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0066428

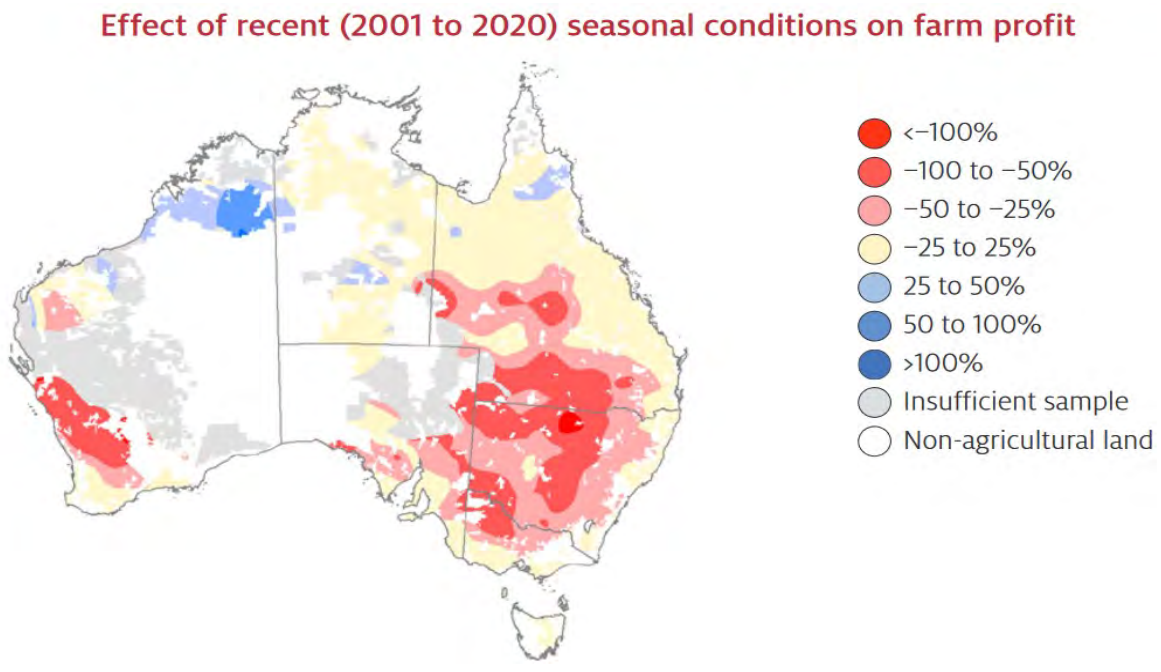
25 Mitchell C. Hunter, Richard G. Smith, Meagan E. Schipanski, Lesley W. Atwood, David A. Mortensen, "Agriculture in 2050: Recalibrating Targets for Sustainable Intensification," BioScience 67, no 4 (2017): 386-391. Accessed at: https://academic.oup.com/bioscience/article/67/4/386/3016049

26 Ortiz-Bobea, A., et al. (2021). "Anthropogenic climate change has slowed global agricultural productivity growth." Nature Climate Change 11(4): 306-312.

27 David Tilman, Christian Balzer, Jason Hill, Belinda L. Befort, "Global food demand and the sustainable intensification of agriculture," Proceedings of the National Academy of Sciences of the United States of America 108 no. 50 (2011): 20260-20264. Accessed at: https://www.pnas.org/content/108/50/20260

04

Challenges facing cropping industries



Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). https://www.agriculture.gov.au/abares/publications/citations

Figure 1 – Recent changes in climate have affected the profitability of Australian farms. Simulated broadacre farm profit with current (2016-2019) farms and commodity prices and recent (2001-2020) climate, relative to historical (1950-2000) climate. Source: Hughes, N., et al. (2021). Simulating the effects of climate change on the profitability of Australian farms. ABARES working paper. Canberra.

4.1 Changing climates

A MAJOR FACTOR CONTRIBUTING TO STAGNATION IN PRODUCTIVITY GROWTH OF CROP INDUSTRIES IS THE UNPRECEDENTED CHANGES IN CLIMATE IN RECENT DECADES, INCLUDING SHIFTS IN RAINFALL SEASONALITY AND MORE FREQUENT AND SEVERE DROUGHTS, ALL IN A BACKGROUND OF RISING TEMPERATURES.

A recent study shows that globally, farming productivity is 21% lower than it could have been in the absence of climate change – equivalent to losing seven years of productivity since the 1960's.[28]

In Australia, the climate has warmed by 1.4°C since 1910, with the warming being most pronounced in the last 70 years. Since 1970, winter season rainfall has decreased 20% and 12% in south-west and south-east Australia, respectively.[29] These changes in climate have reduced annual average farm profits by 23 per cent, with the most pronounced effects occurring in the south-west and south-east regions (Figure 1). [30]

Broadacre crops are particularly vulnerable to climate impacts (and associated biosecurity threats) compared to livestock- related enterprises and mixed cropping,[31] with a forecast productivity decline in the future of up to 50 per cent (below 2018 baseline levels) in some rural regions of Australia.

Climate has a significant effect on both the productivity and profitability of broadacre crop industries. Climate change since 2000 has reduced average annual profits of Australian cropping farms by as much as 35 per cent,[32] resulting in an average loss in gross value of production for the broadacre cropping industry of more than $1.1 billion per year.[33]

A similar pattern is seen for grain crops such as wheat, but with the effects of climate being larger, with climate between 2000–01 and 2014–15 having lowered national wheat yields by 12 per cent (16 per cent in Western Australia and 15 per cent in Victoria). [34]

Compared to other wheat-exporting countries, Australia has higher levels of yield variation between years,[35] reflecting the effect of year-to-year variation in climate, particularly drought. Similar trends are also apparent in other Australian broadacre crops.

Analysis of the effects of climate change on investment portfolios by the Commonwealth Bank of Australia shows that in some regions, broadacre crop productivity could drop by up to 50 per cent by 2060. Broader economic analysis shows that the impact of climate change could cost between 3 per cent and 8 per cent of annual global GDP depending on how delayed response action is.[36] This presents a serious challenge to Australia's competitiveness.

The capability of broadacre cropping and improved pasture industries to adapt to climatic change and to offset its effects will, therefore, be crucial to the future success of the sector, other agricultural industries (e.g. livestock) and the rural communities that rely on them.[37]

28 Rabobank, "Livestock feed demand puts squeeze on Australian grain – industry report," (2019). Accessed at: https://www.rabobank.com.au/media-releases/2019/191011-livestock-feed-demand-puts-squeeze-on-australian-grain/

29 CSIRO and BOM (2020). State of the Climate 2020. Commonwealth of Australia.

30 Hughes, N., et al. (2021). Simulating the effects of climate change on the profitability of Australian farms. ABARES working paper. Canberra, ABARES. https://www.agriculture.gov.au/sites/default/files/documents/abares-climate-change-working-paper.pdf

31 Neal Hughes, Kenton Lawson, Haydn Valle, "Farm performance and climate. Climate-adjusted productivity for broadacre cropping farms," ABARES, Australian Government, (2017). Accessed at: http://data.daff.gov.au/data/warehouse/9aas/2017/FarmPerformanceClimate/FarmPerformanceClimate_v1.0.0.pdf

32 Neal Hughes, Kenton Lawson, Haydn Valle, "Farm performance and climate. Climate-adjusted productivity for broadacre cropping farms," ABARES, Australian Government, (2017). Accessed at: http://data.daff.gov.au/data/warehouse/9aas/2017/FarmPerformanceClimate/FarmPerformanceClimate_v1.0.0.pdf

33 Neal Hughes, David Galeano, Steve Hattfield-Dodds, "The effects of drought and climate variability on Australian farms," ABARES, Australian Government (2019). Accessed at: http://doi.org/10.25814/5de84714f6e08

34 Neal Hughes, Kenton Lawson, Haydn Valle, "Farm performance and climate. Climate-adjusted productivity for broadacre cropping farms," ABARES, Australian Government, (2017). Accessed at: http://data.daff.gov.au/data/warehouse/9aas/2017/FarmPerformanceClimate/FarmPerformanceClimate_v1.0.0.pdf

35 Grains Research and Development Corporation, "Australian wheat international benchmarking," GroundCover 133, (2018). Accessed at: https://grdc.com.au/resources-and-publications/groundcover/groundcover-133-march-april-2018/australian-wheat-international-benchmarking

36 James Nixon, "The economic impact of global warming: an Oxford Economics White Paper," (2019). Accessed at: https://www.oxfordeconomics.com/my-oxford/publications/522177

37 Neal Hughes, Kenton Lawson, Haydn Valle, "Farm performance and climate. Climate-adjusted productivity for broadacre cropping farms," ABARES, Australian Government, (2017). Accessed at: http://data.daff.gov.au/data/warehouse/9aas/2017/FarmPerformanceClimate/FarmPerformanceClimate_v1.0.0.pdf

Other challenges and threats

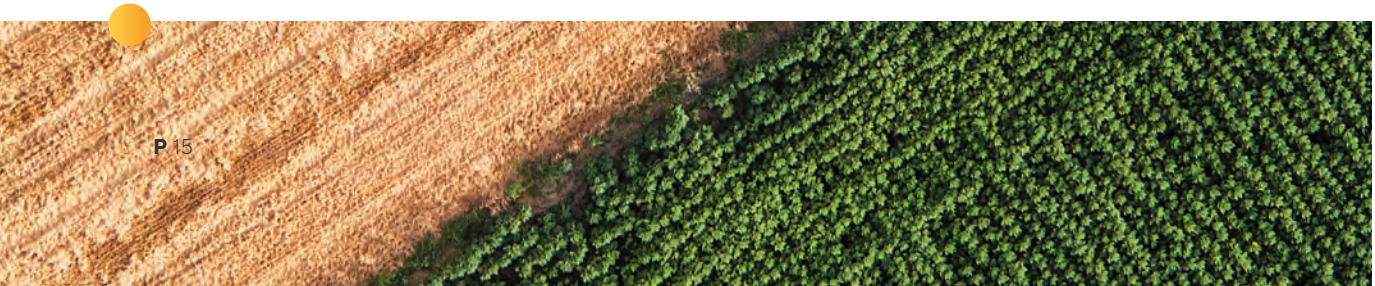
Further threats to come from diverse and interrelated factors, including:[38]

- Pressure to reduce net carbon emissions from plant-based industries
- Changes in the skill sets needed for many of the new jobs that will emerge
- An aging workforce, successional change on farms and depopulation
- Declining participation in agricultural education and jobs
- Poor mental and physical health outcomes in rural communities
- Growing trade protectionism in global markets creating commodity price fluctuations
- Increased competition and productivity in the international market
- Poor rates of return for the majority of farm businesses
- Access to digital connectivity infrastructure and services
- Slow uptake of disruptive technologies that improve productivity and sustainability
- Supply chain risks that disrupt production, transport and crop inputs
- Changing consumer attitudes/preferences
- Public acceptance of biotechnology applications and production processes/ products.

Associated with the progressive shift to automation is the increasing need for workers with skills in the processing and interpretation of data, both within rural communities and cities. As such, a challenge facing the crop industry will be the need for highly-trained workers with skills in IT, robotics and mechatronics. Successfully navigating this transition will provide significant opportunities for new jobs and workforce robustness.

In the face of mega shocks from climate change and COVID-19, combined with the above challenges, the crop industry's capacity to innovate at scale and in the necessary timeframe, is severely compromised.

38 CSIRO, "Australia 2030: Navigating our uncertain future," (2016). Accessed at: https://www.csiro.au/en/Do-business/Futures/Reports/Australia-2030



05

Business as usual is not enough – a step change is needed

GIVEN THAT THE CHALLENGES FACING AUSTRALIA'S PLANT-BASED INDUSTRIES WILL GROW IN SCALE AND COMPLEXITY, COMPOUND AND OCCUR MORE FREQUENTLY, THERE IS AN URGENT AND CRITICAL NEED TO MOVE BEYOND BUSINESS AS USUAL.

A cornerstone of Australia's agricultural R&D strategy is investment by industry and government in the 15 Rural RDCs, with a focus on increasing the profitability and sustainability of Australian farmers. While these investments can, and do, target the short- and medium-term needs of industry, the requirement to return value to today's levy payers means that RDCs can be limited in their ability to invest in long-term, transformational projects.

Similarly, the Federal Government's National Agricultural Innovation Agenda[39] has so far largely focused on shorter-term projects that promote adoption, commercialisation and extension; achieving greater impact from the research knowledge that already exists, or will soon exist, is a key aspect of this agenda.

The recently announced portfolio of CSIRO Missions [40]are also focused on near-term outcomes, with each mission designed to create impact within five years. This R&D investment strategy – while delivering plant varieties with increased yield potential and tools to improve farm management – is not capable of delivering the productivity growth (and associated climate resilience) needed for Australia to meet its $100 billion by 2030 and 2–3 per cent productivity goals. It will also not deliver the transformational tools that future generations of farmers will need to farm profitably and sustainably or provide tools that dramatically reduce reliance on fertilizer and water inputs.

To achieve the $100 billion by 2030 and productivity goals, year-on-year productivity of Australian plant-based industries needs to increase six-fold (i.e. 0.4 to 2.4 per cent). To achieve these goals, we need to invest in transformative projects that dramatically improve the yield potential and climate resilience of the major crops available to farmers.

There is also an urgent need for farmers to have greater control of plant- and crop-level inputs and outputs in response to seasonal variation in growing conditions and markets. And to urgently reduce carbon emissions

39 https://www.agriculture.gov.au/ag-farm-food/innovation/national-ag-innovation-agenda

40 CSIRO, "CSIRO sets sights on new 'Team Australia' missions program," (2020). Accessed at: https://www.csiro.au/en/News/News-releases/2020/CSIRO-sets-sights-on-new-team-australia-missions-program

from plant-based industries, such as through reduced use of inorganic fertilisers.

We also need to ensure that decision making platforms enable farmers to confidently make decisions at plant, crop, farm, and value chain levels based on reliable and interpretable data.

Finally, we need to build transformative readiness and capacity across the innovation ecosystem at the grower, farm, region, sector, and ecosystem levels.

Significant structural and cultural shifts are needed.

To transform the resilience and productivity of crops, Australia needs to adopt a strategic, long-term approach that addresses inter-generational challenges and that embraces the full capabilities of research, development and extension institutions across the nation, including temperate, sub-tropical and tropical production zones.

The scale of R&D targeting improvements in productivity will need to increase – markedly. Biological, technological and policy approaches in Australia will need to be integrated, along with a renewed focus on innovation, student training and capability building. [41]

Significant structural and cultural shifts in Australia's leading knowledge clusters will also be needed[42] – to break down discipline silos and create a culture of universities and other research providers using their full interdisciplinary capabilities to address complex industry and societal challenges, independent of traditional academic boundaries.

Solutions to problems faced by the sector need to be considered and prioritised using a co-innovation, co-design approach to define what communities most need and value, including both agricultural communities and Australia at large. In this context, solutions must also be mindful of:

- The interplay between technological change and consumer choices (including demand for products from genetically modified crops, noting that Australia regulations are increasingly accommodating products deemed to be low risk [43] and out of 20 surveyed countries, Australian's had the most positive attitude towards genetically modified foods). [44]
- Movement towards concentration, intensification and vertical coordination of the agricultural value-chain.
- Financing arrangements that support sustainable businesses through periods of fluctuating environment and market conditions.

When implemented across the nation, these changes will transform the productivity and resilience of cropping industries, our international competitiveness and ability to meet international demand, and the prosperity of rural communities that rely heavily on crop production.

41 Australian Academy of Science, "The Decadal Plan for Australian Agricultural Sciences 2017-2026," (2017). Accessed at: https://www.science.org.au/files/userfiles/support/reports-and-plans/2017/agricultural-decadal-plan-2017-26.pdf

42 Australian Academy of Science, "The Decadal Plan for Australian Agricultural Sciences 2017-2026," (2017). Accessed at: https://www.science.org.au/files/userfiles/support/reports-and-plans/2017/agricultural-decadal-plan-2017-26.pdf

43 2019 Amendments to Gene Technology Regulations 2001 of the Gene Technology Act 2000. Accessed at: https://www.legislation.gov.au/Details/F2019L00573

44 Pew Research Centre, "Science and Scientists Held in High Esteem Across Global Publics," Chapter 4, (2020). Accessed at: https://www.pewresearch.org/science/2020/09/29/publics-express-a-mix-of-views-on-ai-childhood-vaccines-food-and-space-issues/

06

Addressing the complex challenges facing cropping industries and communities

THE CHALLENGES FACING AUSTRALIA'S PLANT-BASED INDUSTRIES – AND THE RURAL COMMUNITIES THAT RELY ON THEIR PRODUCTION – ARE UNPRECEDENTED AND COMPLEX. EACH CHALLENGE VARIES WITH LOCATION, FARMING SYSTEM, FARM TYPE, ENTERPRISE MIX, AND THE SPECIFIC FINANCIAL CIRCUMSTANCES OF INDIVIDUAL BUSINESSES.

Because of this, we cannot rely on solutions that focus on a single part of the crop industry value chain or a single RDC investment strategy to meet one industry's immediate needs. Rather, we need to embrace a holistic, systems-based approach.[45, 46, 47]

6.1. The need for a holistic, systems-based approach

A system-based approach can reveal new opportunities, additional ways to create value, and new ways of creating benefits for the economy, community and environment.[48] Further, a systems approach is not limited to improving farm-gate productivity growth as the sole goal – rather, it focusses on *'growing the future benefit for and from Australia's rural industries'*[49] by broadening the focus to cover the wider elements of the agricultural value chain, which include use of national resources and biological processes to generate value through food, fibre and related products and services.

45 Ernst and Young, "Agricultural Innovation - A National Approach to Grow Australia's Future," (2019). Accessed at: http://www.agriculture.gov.au/SiteCollectionDocuments/agriculture-food/innovation/summary-report-agricultural-innovation.PDF

46 Rural Research and Development Corporations, "Vision 2050. New thinking about rural innovation in Australia," (2018). Accessed at: http://www.ruralrdc.com.au/news/council-releases-vision-2050-new-thinking-about-rural-innovation-in-australia/

47 World Economic Forum, "Innovation with a purpose: The role of technology innovation in accelerating food systems transformation," (2018). Accessed at: http://www3.weforum.org/docs/WEF_Innovation_with_a_Purpose_VF-reduced.pdf

48 Rural Research and Development Corporations, "Vision 2050. New thinking about rural innovation in Australia," (2018). Accessed at: http://www.ruralrdc.com.au/news/council-releases-vision-2050-new-thinking-about-rural-innovation-in-australia/

49 Rural Research and Development Corporations, "Vision 2050. New thinking about rural innovation in Australia," (2018). Accessed at: http://www.ruralrdc.com.au/news/council-releases-vision-2050-new-thinking-about-rural-innovation-in-australia/

Addressing the complex challenges facing the crop industries will require clear leadership and cohesion across the innovation ecosystem to set strategic priorities and drive a more coordinated and cross-cutting approach that integrates biological, technological and policy approaches.

Much of today's existing crop research in Australia is focused on short timeframes of three to four years, involving a small cross-section of the nation's capabilities, based around project investments by specific rural RDC's on specific crop species leading to important, but generally incremental, change.[50]

These investments rarely support the early development of ground-breaking digital and genetic technological improvements that could cut across crop systems that divide RDC structures.

In addition, the recently announced CSIRO Missions,[51] including one on Drought Resilience, are limited to a one to five year timeframe through investments designed to enhance on-farm productivity, regional water management and risk management tools.

What is missing is the ambition for longer-term (over 10 years) research at the scale needed to drive the transformational change required to address inter-generational challenges facing cropping sector, and to lift Australia beyond its $100 billion by 2030 goal.

This will require research and delivery of new genetic and digital technological solutions to rural communities and alignment of public and private funding and interests at a scale that has never been implemented in Australia.

6.2. Using mission approaches to address agricultural challenges

Recognising these challenges, through 2020 the Australian Government initiated significant changes to structurally reform the agricultural innovation ecosystem. Key to these reforms is the development of a new, mission-oriented National Agricultural Investment Priorities framework.[52]

The Government has proposed to use targeted, agriculture-focused missions to:[53]

- Align efforts to address shared national challenges
- Help Australian agriculture take advantage of strategic opportunities
- Ensure the Australia's agricultural innovation system increases its focus on transformational, cross-sectoral activities and research for the public good.

50 Ernst and Young, "Agricultural Innovation - A National Approach to Grow Australia's Future," (2019). Accessed at: http://www.agriculture.gov.au/SiteCollectionDocuments/agriculture-food/innovation/summary-report-agricultural-innovation.PDF

51 CSIRO, "CSIRO sets sights on new 'Team Australia' missions program," (2020). Accessed at: https://www.csiro.au/en/News/News-releases/2020/CSIRO-sets-sights-on-new-team-australia-missions-program

52 Australian Government Department of Agriculture, Water and the Environment, "National Agricultural Agenda," (2020). Accessed at: https://www.agriculture.gov.au/ag-farm-food/innovation/national-ag-innovation-agenda

53 Australian Government Department of Agriculture, Water and the Environment, "National Agricultural Agenda," (2020). Accessed at: https://www.agriculture.gov.au/ag-farm-food/innovation/national-ag-innovation-agenda

07

Embracing Missions to achieve breakthrough technological shifts

AS PART OF THIS APOLLO PROGRAM IN THE 1960'S, NASA USED A MISSION-ORIENTED INNOVATION APPROACH – A 'MOONSHOT' TO TAKE HUMANS SAFELY TO THE MOON FOR THE FIRST TIME.

Australia has a track record of national mission-style projects, from building the Snowy Mountains Scheme[54] to the global 30-year process of building and hosting components of the Square Kilometre Array.[55]

In 2018–19, the Australian Government initiated a 10-year Australian Genomics Health Futures Mission[56] with a budget of $500 million dedicated to improving Australian health through revolutionising the management of disease.

54 "Snowy Hydro Scheme – History," (2020). Accessed at: https://www.snowyhydro.com.au/about/history/

55 Australian Government Department of Industry, Science, Energy and Resources. "Co-hosting the Square Kilometre Array," (2020). Accessed at https://www.industry.gov.au/strategies-for-the-future/astronomy/co-hosting-the-square-kilometre-array

56 Australian Government Department of Health, "Genomics Health Futures Mission," (2020). Accessed at: https://www.health.gov.au/initiatives-and-programs/genomics-health-futures-mission

More recently, the Australian Government committed to a 10-year Future Drought Fund [57] that also displays the hallmarks of a mission-style initiative, albeit with a focus on short-term initiatives (mostly less than five years) to lift the agricultural industry.

A mission is a targeted industrial strategy to steer innovation in the direction of solving complex compounding challenges not for just a season, but for an entire generation. It provides the investment, resources, intent, collaborative framework, strategic vision and leadership needed to achieve transformational change in a sector. [58]

Missions provide an opportunity to invest in transformational R&D targeting not just today's challenges, but also those that the next generation are likely to face.

The core rationale for this intervention is that large-scale and breakthrough technological shifts are disruptive in nature and are rarely achieved without public intervention and long-term commitment.

This proposal advocates for the establishment of a National Mission to transform the productivity and resilience of Australia's crop industries – a 'moonshot' investment to create transformational change - and propel them to meet and exceed the goals outlined in the NFF 2030 Roadmap. [59]

57 Australian Government Department of Agriculture, Water and the Environment, "Future Drought Fund," (2020). Accessed at: https://www.agriculture.gov.au/ag-farm-food/drought/future-drought-fund

58 Klerkx, L. and S. Begemann (2020). "Supporting food systems transformation: The what, why, who, where and how of mission-oriented agricultural innovation systems." Agricultural Systems 184: 102901.

59 National Farmers Federation, "2030 Roadmap – Australian Agriculture's Plan for a $100 Billion Industry," (2020). Accessed at: https://nff.org.au/wp-content/uploads/2020/02/NFF_Roadmap_2030_FINAL.pdf

08

The need for a National Mission focusing on crops and communities

THE PROPOSED NATIONAL MISSION FOR FUTURE CROP AND COMMUNITY RESILIENCE IS A NATIONAL, CROSS-SECTORAL INITIATIVE TO ADDRESS THE EXTREME VULNERABILITY AND RISK EXPOSURE OF THE AUSTRALIAN CROPPING SECTORS TO CLIMATE CHANGE AND GEOPOLITICAL VOLATILITY IN THE WAKE OF COVID-19.

The mission structure will drive convergence of diverse technologies (synthetic biology, genetic engineering, big data, artificial intelligence, satellite imagery) together with socio-economic-environmental capabilities to ensure that R&D addresses the challenges facing different crop industries, and to ensure that rural communities benefit.

The mission will have knock on benefits across agriculture more broadly, both due to the foundational role of crop production and the future deployment of the same mission technologies to other agricultural production systems.

8.1. Relevance for Australia's innovation and mission agendas

The National Mission for Future Crop and Community Resilience is being framed around the key pillars of the National Agricultural Innovation Agenda[60] through:

- Setting a clear strategic vision to transform agricultural productivity, profitability and resilience
- Committing to co-innovation to ensure uptake of mission outcomes across the agri-system
- Collaboration across different sectors, using the entire research and innovation value chain, from fundamental research to applied research and cutting-edge innovation
- Supports long-term investments needed to achieve breakthrough gains in productivity

60 Australian Government Department of Agriculture, Water and the Environment, "National Agricultural Agenda," (2020). Accessed at: https://www.agriculture.gov.au/ag-farm-food/innovation/national-ag-innovation-agenda

- Capacity to deliver on both incremental and transformative innovation
- Partnerships with regional ecosystems to ground mission priorities, projects, outcomes and uptake
- Adoption of world-class innovation practices by working with entrepreneurs, start-ups and industry
- Building readiness to embrace innovation by scoping reforms in data/regulatory frameworks.

The National Mission for Future Crop and Community Resilience will drive a systemic change in the crop sector and trigger action to create the much-needed step change in productivity and climate resilience.

8.2. The need for scale and a long-term approach

Australia's existing R&D strategy focuses on increasing the profitability of today's farmers. It is not designed to tackle the complex, intergenerational challenges facing the nation – challenges that will require long-term investments to produce solutions that are beyond Australia's existing R&D ecosystem.

A cornerstone of Australia's agricultural R&D strategy is investment by industry and government in the 15 Rural RDCs, with a focus on increasing farm profitability and sustainability. While these investments can, and do, target the short- and medium-term needs of industry, the requirement to return value to today's levy payers means that RDCs can be limited in their ability to invest in long-term, transformational projects.

Similarly, the Federal Government's National Agricultural Innovation Agenda [61] is largely focused on shorter-term projects that promote adoption, commercialisation and extension; achieving greater impact from the research knowledge that already exists, or will soon exist, is a key aspect of this agenda. The CSIRO Missions [62] are another example of a near-term focus, with each Mission targeting impact within 5 years.

To protect the livelihoods of future generations of crop farmers, Australia needs to couple these existing, near-term strategies to a complementary program of longer-term investments that target transformational change in the productivity, resilience and sustainability of broad-acre crops, horticulture and pastures.

Knowing it takes time to extend research outcomes into programs for use by farmers, the sooner that the National Mission is commenced, the sooner the benefits can be realised for rural communities.

The National Mission for Future Crop and Community Resilience proposes a milestone-linked timeframe up to 10 years, at an investment level that matches the challenge to enable research to meet goals.

61 Australian Government Department of Agriculture, Water and the Environment, "National Agricultural Agenda," (2020). Accessed at: https://www.agriculture.gov.au/ag-farm-food/innovation/national-ag-innovation-agenda

62 CSIRO Missions. Accessed at: https://www.csiro.au/en/about/challenges-missions/missions

8.3. Goals of the National Mission for Future Crop and Community Resilience

The National Mission for Future Crop and Community Resilience will promote a culture of experimentation and risk taking not yet seen in Australian agricultural research by providing opportunities to 'think outside the box' and 'over the horizon' to come up with new solutions to address the mission goals.

It will also offer a new way to frame conversations on how basic and applied research – combined with new forms of collaboration - can be used to address complex industry and societal challenges.

The goals of this step change in R&D investment in crop industries need to:

- Support a six-fold increase in year-on-year productivity (i.e. from 0.4 to 2.4 per cent) through targeted investments that increase yield potential and climate resilience of major crops and pastures species
- Provide farmers with appropriate tools to manage crop system outputs in response to climate and market demand, including being able to switch crops to produce high value alternative commodities
- Ensure that decision making platforms enable farmers to confidently make decisions at plant, crop, farm and value-chain levels, based on reliable and interpretable data
- Build transformative readiness and capacity across the innovation ecosystem at the grower, farm, region, sector and ecosystem levels.

8.4. Achieving a competitive return

While the estimates for return on investment in agriculture vary, there is strong evidence that research in agriculture delivers very competitive returns. Research has shown that for every dollar the government invests in agricultural research, development and extension there is an average **$12 return on investment over a 10-year period**, in addition to a suite of economic, environmental and social benefits.[63, 64, 65]

Our financial modelling shows the National Mission can generate benefits earlier than has been experienced from agricultural research over previous decades.

It predicts an expected **Benefit: Cost Ratio for the National Mission of 17:1 over 30 years,** with:

- **Impact on the economy:** Annualised benefit (present value) = $567 million per year
- **Impact on the value of agricultural production:** An increase in value of primary production focussed on livestock ($2.0 billion over 30 years), fruit/vegetables/nuts ($1.8 billion), sugar cane ($1.8 billion) and wheat ($1.7 billion), and an increase in value of agricultural processing focussed on cattle and sheep meat products ($4.1 billion).
- **Impact on the value of agricultural exports:** An increase in value of primary production exports focussed on wheat ($1.3 billion over 30 years), fruit/vegetables/nuts ($1.1 billion) and wool ($0.86 billion), and an increase in value of agricultural processing exports almost in cattle and sheep meat products ($3.1 billion).

63 Terrance M. Hurley, Xudong Rao, Philip G. Pardey, "Re-examining the reported rates of return to food and agricultural research and development." *American Journal of Agricultural Economics*, 96, no. 5 (2014): 1492–1504. Accessed at: https://academic.oup.com/ajae/article-abstract/96/5/1492/2738767; and

64 Ernst and Young, "Agricultural Innovation - A National Approach to Grow Australia's Future," (2019). Accessed at: https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/agriculture-food/innovation/full-report-agricultural-innovation.PDF ; and

65 Yu Sheng, Emily M. Gray, John D. Mullen, Alistair Davidson, "Public investment in agricultural R&D and extension: an analysis of the static and dynamic effects on Australian broadacre productivity," ABARES Research Report 11.7, (2011). Accessed at: https://grdc.com.au/__data/assets/pdf_file/0013/142402/public-investment-in-agricultural-rd-and-extension.pdf.pdf

» **Impact on employment:** an annual increase in wages equivalent to 920 full time jobs, equivalent to 14,000 full time jobs new jobs from the National Mission, if wages are fixed, over the 30-year benefit period. These new jobs will be generated across Australia with 76% in rural and regional areas.

More broadly, investments through research in the agricultural sector can provide further economic benefits such as reduced production costs, increased productivity, diversification of revenue streams, economies of scale and scope, and new export revenue from advanced products and technology.

'Adaptive measures including breeding for improved tolerance to drought and heat could improve crop yields by up to 20 per cent by 2060 for certain crops. Genetic modification can markedly increase crops' climate resilience, with the potential to improve the yield of some crops by up to 40 per cent over the next 40 years.

Further developments in crop monitoring and management technology to maximise water efficiency and optimise activities are expected to boost productivity'.

CBA Annual Report 2019 [66]

66 Commonwealth Bank of Australia, "CBA Annual Report 2019," (2019). Accessed at: https://www.commbank.com.au/about-us/investors/annual-reports.html

Courtesy of ARC CoE Plant Energy Biology

09

A proposal from four of Australia's leading research universities

DRAWING ON THEIR INTERDISCIPLINARY EXPERTISE, THE AUSTRALIAN NATIONAL UNIVERSITY (ANU), UNIVERSITY OF ADELAIDE (UA), UNIVERSITY OF QUEENSLAND (UQ) AND UNIVERSITY OF WESTERN AUSTRALIA (UWA) AND HAVE TAKEN THE INITIATIVE TO DRAW TOGETHER AN AMBITIOUS RESEARCH PROGRAM DESIGNED TO LEVERAGE THE FULL INTELLECTUAL CAPACITY OF AUSTRALIA'S AGRICULTURAL INNOVATION ECOSYSTEM – AN ECOSYSTEM REPRESENTED ACROSS THE COUNTRY, BOTH IN CAPITAL CITIES AND IN REGIONAL CENTRES.

The National Mission for Future Crop and Community Resilience will deliver ground-breaking research and industry-aligned solutions to production challenges by drawing on the interdisciplinary strengths of Australia's research institutions (including CSIRO), NCRIS-funded infrastructure facilities (e.g. Australian Plant Phenomics Facility), industry, state governments, RDCs and peak bodies.

9.1 Structural and cultural change

ANU, UA, UQ and UWA are each implementing strategies that harness their world-leading research expertise to address the complex society and industry challenges. Examples include the Centre for Entrepreneurial Agri-Technology at ANU, inter-disciplinary expansion of the Waite Research Institute at UA, Queensland Alliance for Agriculture and Food Innovation at UQ, and the Institute of Agriculture and Public Policy Institute at UWA.

The four universities bring together a blend of geographies, regional partnerships, communities and climates in areas of direct relevance to the Australian cropping industry. Each have extensive national and international networks, as evidenced by the fact that 68 per cent (ANU & UQ), 72 per cent (UA), and 79 per cent (UWA) of papers published in the plant sciences included an international partner in 2020 – each well above the average for leading institutions in the USA (e.g. 56 per cent at Berkeley) and UK (66 per cent at Cambridge).

The University of Queensland AUSTRALIA — 72%

Australian National University — 68%

The University of Adelaide — 72%

The University of Western Australia — 79%

ANU, UA, UQ and UWA are also key partners of major international agriculture-related projects, including several multi-million dollar, Bill & Melinda Gates Foundation and International Wheat Yield Partnership projects. Common to these projects is how Australian discovery science is being used to create a step change in productivity of globally important crops such as rice and wheat.

The four universities also have long-established collaborations with a range of international food security institutes, including the pan-African Food and Natural Resources Policy Analysis Network (FANRPAN), International Centre for Crop Research in the Semi-Arid Tropics (ICRISAT) in India, International Rice Research Institute (IRRI) in the Philippines, and International Centre for Wheat and Maize Improvement (CIMMYT) in Mexico.

9.2 Partnerships linking researchers with industry

Partnerships with industry and non-university entities are a big part of the work done by the four universities. For publications in the plant/crop/agricultural science, pastures and agri-food areas, 37-51 per cent of papers published from ANU, UA, UQ and UWA have papers with a non-university partner (e.g. Melonek et al. 2021). [67] This includes CSIRO and state-level departments of primary industries/agriculture across Australia. It also includes numerous foreign government research agencies, including INTA (Argentina), EMBRAPA (Brazil), AgriFood (Canada), ICAR (India), ARO (Israel), Landcare (NZ), CSIC (Spain), and James Hutton, John Innes and Rothamsted Institutes (UK).

A key component of the cultural change that is increasing industry engagement by our researchers is the co-location of state and federal government entities (e.g. CSIRO, PIRSA-SARDI, DEWNR), industry peak bodies, companies (e.g. Australian Grain Technologies, PPB Technologies, Nourish Ingredients) and industry-owned organisations such as the Australian Wine Research Institute – on or adjacent to university campuses. University-located innovation hubs (e.g. ThincLab, Centre for Entrepreneurial Agri-Technology) and incubators are also providing increased opportunities for start-ups, researchers and students to collaborate and network.

Interdisciplinary research that addresses complex industry challenges is also being undertaken across the four universities. An example is a collaboration between the Canadian pharmaceutical company, Medicago Inc., and researchers at the ANU to create tools that non-invasively monitor plant-based production of vaccines.[68] The project has plant scientists, technology specialists, machine learning and artificial intelligence experts working collaboratively on projects that will help Medicago Inc. improve their production systems.

9.3 University research has impacts in the real world

Research at the four universities has greatly impacted the cropping sector in Australia.

Plant breeding by UA has led to the release of 17 new cereal crop varieties, with together produce $4.6 billion worth of grain from 2011 to 2016. This included new varieties of: barley with superior yield and quality that benefited domestic and international grain and malt buyers; and new varieties of Durum wheat used in pasta that thrive in southern Australia.

Another example is UQ's development of elite parent lines for licensing to the sorghum hybrid seed industry worldwide; this work has created benefits of over $220 million to Australia since 1997 through improvements in pest and disease resistance.

67 Melonek J, Duarte J, Martin J, Beuf L, Murigneux A, Varenne P, Comadran J, Specel S, Levadoux S, Bernath-Levin K, Torney F, Pichon JP, Perez P, Small I.Nat Commun. 2021 Feb 15;12(1):1036. doi: 10.1038/s41467-021-21225-0.

68 Plant Biology meets Computer Vision – interdisciplinary ANU research project reimagines plant phenotyping. Accessed at: https://ceat.org.au/plant-biology-meets-computer-vision-interdisciplinary-anu-research-project-reimagines-plant-phenotyping

Since 2004, identification of molecular markers by UWA in canola crossbreeding has resulted in the release and farmer adoption of 50 new canola varieties with higher yield, disease resistance and herbicide tolerance of weed control.

In the 1990's breakthrough carbon isotope analysis research at the ANU has led to development of Drysdale wheat that could grow in dry conditions. Drought tolerance is also being increased through work at ANU on the mechanisms that control water loss from crops.

Further evidence of research impact is the fact that in the last five years, over 125 lodged patents have cited agriculture-biological science papers from the four universities.

9.4 Partnership forged through decades of collaboration

The National Mission for Future Crop and Community Resilience builds on many years of collaborative research, expertise, and capability development at ANU, UA, UQ and UWA .

These universities lead – along with partners from the University of Sydney, Western Sydney University, La Trobe University, CSIRO and industry – three ARC Centres of Excellence (Translational Photosynthesis, Plant Energy Biology and Plant Success). The recently announced ARC Training Centre in Accelerated Future Crop Development is also being led by two of the universities (ANU and UA). UQ hosts the ARC Industrial Transformation Research Hub for Sustainable Crop Protection and the ARC Training Centre for Uniquely Australian Foods.

These centres are focused on improving the yield potential and climate resilience of crops through major advances in cell metabolism and signalling regulation, metabolic modelling, responses to changing environments, cellular transport, plant genomics and ecophysiology.

Through sustained investments from the ARC, industry and the university sector, each centre has built a range of world-leading biological and computational technology platforms that will contribute to – along with platforms at other Australian research institutions - the foundational capacities required for the proposed National Mission.

The universities also have expertise in machine learning, engineering, social sciences, legal and ethical frameworks, business and marketing analytics and agricultural economics.

Two of the three nodes of the current iteration of the NCRIS-funded Australian Plant Phenomics Facility (APPF) are hosted by the above universities (UA and ANU), with UQ and UWA likely to join an expanded APPF, should it be funded for the 2023-2028 period. The National Mission would provide the ideal industry-focused research program to optimise use of an expanded APPF.

The breadth and excellence of this capability is globally unique.

While Australia's research capability is world-leading in areas needed by crop industries, it is at risk due to decimation of research income arising from the recent COVID-19 financial crisis in the sector (and associated reduction in staff positions both for young and established researchers).

Without significant new investment that draws together our capabilities, Australia will lose its ability to be at the leading edge of true agricultural innovation.

9.5. Broadening who participates in the National Mission

A successful National Mission will bring together other capabilities from across the nation's innovation ecosystem to join the venture. Other universities based in capital cities and regional centres would be invited to help develop the National Mission for Future Crop and Community Resilience.

Key ecosystem players such as the CSIRO, Grains Research and Development Corporation (GRDC), Meat Livestock Association, AgriFutures Australia, other Rural RDCs, and Agricultural Innovation Australia would also be encouraged to contribute.

The National Mission for Future Crop and Community Resilience is being developed in consultation with relevant peak bodies/advocacy groups such as National Farmers Federation, Grain Growers, and Crop Life Australia. Other advocacy groups (e.g. Australian Agritech Association) and regional innovation ecosystems/initiatives (e.g. AgriPark, Bridge Hub, The Gate, CICADA Growlab, SproutX, COGGO, Grain Industry Association of Western Australia (GIWA), ThincLab, LOT14, Department of Primary Industries and Regions South Australia (PIRSA) Agtech Group), and the Queensland Department of Agriculture and Fisheries would also be invited to help design details of the Mission for Future Crop and Community Resilience.

A series of crop breeding companies have also already been consulted (Appendix 1) and continuing dialogue is defining potential partnerships in research, development and deployment of new digital and genetic technologies developed as part of the National Mission.

The Mission will bring together capabilities in every state and territory.

10 Components of the National Mission

10.1. Mission overview

THE NATIONAL MISSION FOR FUTURE CROP AND COMMUNITY RESILIENCE WILL DRAW TOGETHER THE INTERDISCIPLINARY STRENGTHS OF AUSTRALIA'S LEADING RESEARCH UNIVERSITIES WITH INDUSTRY, GOVERNMENT AGENCIES (E.G. CSIRO), RDCS AND PEAK AGRICULTURAL ENTITIES TO ADDRESS THE KEY CHALLENGES AFFECTING THE CURRENT AND FUTURE PRODUCTIVITY OF THE CROPPING SECTOR AND ASSOCIATED INDUSTRIES.

By investing a series of long-term, transformative projects, the National Mission will target over-the-horizon challenges facing future generations of farmers and the communities in which they will live. In doing so, it would address a crucial gap in Australia's existing agricultural R&D strategy, which is largely focused on increasing profitability and sustainability of today's farmers.

The National Mission would address this need via an ambitious, industry-facing research program that harnesses the full interdisciplinary capacity of Australia's universities and wider agricultural innovation ecosystem. It will focus on the needs of farmers and the communities by increasing research and development efforts in breakthrough technologies and by delivering the tools that better support farmers adapting to change.

Tangible solutions for farmers include, for example, new genetic technologies such as controllable plants, and machine learning research linked to phone apps that could allow farmers to predict crop variety yields based on weather data. This level of control and agility has the potential to be transformational for the cropping industry's profitability and community stability.

In order to future-proof the industry, the National Mission will look beyond traditional food and fibre uses for crops and will consider research requirements necessary to support emerging market segments such as biofuels, plant-based protein and novel fibre products. In doing so, and through investments in understanding the economic and social landscape of farming communities, the National Mission can contribute to greater regional and rural community resilience.

10.2. Investment strategies

The National Mission is framed around two forms of investment, both of which are designed to address the need to rapidly achieve a step change in productivity growth of major crops across Australia.

01 Turbo-charging investment into areas where technology either exists or will soon be available but are not being fully exploited in Australia's R&D portfolio due to lack of resources.

02 Investment into the development of tools that would revolutionise the cropping sector but which cannot be developed using business as usual approaches due to the scale of effort and investment risk profile necessary to realise their potential.

Both forms of investment require formation of interdisciplinary teams of researchers working together in new ways. This will include building teams with skills in digital and genetic disruptive technologies, including plant biology, synthetic biology, environmental science, data science, machine learning/artificial intelligence and engineering/robotics, alongside expertise in social science considerations, community development assessments, human choice analysis, marketing, business and economics.

Australian universities have the research and technology capability to position Australia as a leading innovator and exporter in this rapidly changing technology landscape.

Central to the two forms of investment is the need to augment traditional breeding approaches with new approaches that accelerate the progress of genetic selection, allowing multiple genes to be evaluated cost effectively. Current strategies mean that it can take 10-15 years for new varieties to be available to farmers. COVID-19 has shown us that it is possible - through changes in how we link R&D done at scale to regulatory processes – to dramatically shorten the time it takes to develop urgently needed vaccines.

The new approaches used by the National Mission will dramatically shorten the time it takes to deliver crop varieties to farmers. Such new approaches could include driving rapid deployment by whole genome selection, gene editing, or genetic engineering, providing improved translation of molecular physiology and biochemistry to the breeding system.

In addition to the mission being framed around two forms of new investment, it is critical that its products and services are fit for purpose. To achieve this, the mission will employ a co-innovation, co-design approach to define what users most need and value, and set priorities.

Ecowheat in Argentina

While the regulatory environment may not yet exist to allow on-farm use of smart plants, legislation is evolving in Australia to accommodate agricultural products that are considered safe and low risk.[69]

The Argentinian government recently approved farmers to grow genetically modified, drought-tolerant EcoWheat[70] that shows a 20 per cent yield improvement in drought conditions.

This shows that international regulations are moving to a wider acceptance of genetically modified crops, even cereal grains, when there is low risk and proven ability to benefit farmers, society and the environment.

The scale of Argentina's 2019 wheat export was equivalent to Australia's and is rising rapidly as a competitor in Australia's markets.

69 Australian Government Department of Health, "The Third Review of the National Gene Technology Scheme. Final Report," (2018). Accessed at: https://www1.health.gov.au/internet/main/publishing.nsf/Content/gene-technology-review

70 International Service for the Acquisition of Agri-biotech Applications, "Crop BioTech Update October 14 2020 – Argentina first in world to approve drought tolerant HB4® wheat," (2020). Accessed at: https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=18384

10.3. Developing disruptive technologies

The disruptive technologies that will underpin future agriculture productivity growth includes advances in the biological (e.g. climate resilient genes and synthetic biology), environmental (satellite imagining, climate data) and digital (automation, machine learning, artificial intelligence and robotics) sciences.

- Advances in **synthetic biology** and changes to the **regulatory environment** are making it possible for farmers to have access to 'smart crops' that will provide higher yields and increased resilience.[71,72,73] Smart crops would enable farmers to control at will the composition of crop products to those most suited to different weather conditions or market demands. Such crops will improve farm enterprise agility as it enables farmer to respond quickly to changed circumstances to maintain profits and environmental performance.

- Improved use of **environmental data and tools** combined with **new digital agriculture solutions** can enable farmers to optimise crop cultivation at a micro-climate level, and to maximise production. This includes use of climate forecasting, aerial platforms (e.g. drones and satellites) to document environmental variability, new sensors to assess plant performance and quality in the field and advanced farm machinery capable of precision planting, tilling, weeding and harvesting.[74]

- Advances in **engineering robotics** will allow automated vehicles and harvesting systems to play a major role in improving farmer quality of life, while also reshaping the sector's skills needs.[75]

Together, such technologies will make key aspects of future farming unrecognisable to today's practitioners. Under a National Mission these technologies can be advanced through industry aligned innovation and research and development, with the aim to provide farmers with greater control over crop production in good and bad years.

The full adoption of digital agricultural technologies alone is predicted to increase Australian annual farm gate output by $20.3 billion by 2050. Adoption will be more likely when the applications of the newest

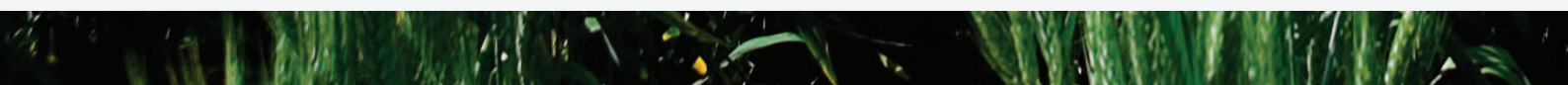
71 Bruce Donaldson Grieve et al., "The challenges posed by global broadacre crops in delivering smart agri-robotic solutions: A fundamental rethink is required," *Global Food Security,* 23, (2019): 116-124. Accessed at: https://www.sciencedirect.com/science/article/pii/S2211912419300100

72 "Technology Quarterly: The Future of Agriculture," The Economist, (2016). Accessed at: https://www.economist.com/technology-quarterly/2016-06-09/factory-fresh

73 Eleanore T. Wurtzel et al., "Revolutionizing agriculture with synthetic biology," *Nature Plants 5,* (2019): 1207-1210. Accessed at: https://www.nature.com/articles/s41477-019-0539-0.pdf

74 Bruce Donaldson Grieve et al., "The challenges posed by global broadacre crops in delivering smart agri-robotic solutions: A fundamental rethink is required," *Global Food Security,* 23, (2019): 116-124. Accessed at: https://www.sciencedirect.com/science/article/pii/S2211912419300100

75 Robert Poole, Ben van Delden, Peter Liddel, "Talking 2030. Growing agriculture into a $100 billion industry," KPMG & National Farmers Federation, (2018). Accessed at: https://home.kpmg.com/au/en/home/insights/2018/03/talking-2030-growing-australian-agriculture-industry.html



technologies are co-designed in partnership with the agricultural sector – through researchers listening and learning from industry to ensure they use technology to address real-world problems, and when the issues of community trust, social license and economic impacts are part of an iterative process underpinning the development of technological solutions.

10.4. Social commitment of the National Mission

The National Mission is committed to combine technological innovation in the cropping sector with social innovation in the Northern, Southern and Western growing regions with farmers and their communities through a co-innovation, co-design approach to define what communities most need and value, including both agricultural communities and Australia at large. Priority will be given to considering consumer and community attitudes and preferences. The National Mission will also develop new approaches to fostering public engagement in agricultural biotechnology and production processes that are necessary for solutions to be resilient and result in real change for the cropping sector and beyond.

through a co-design framework. It will build on initiatives from: the National Agricultural Innovation Agenda's[76] investment in eight Regional Resilience Adoption and Innovation Hubs[77] and precincts; the Grains Sustainability Framework[78]; regional work conducted by the Australian Resilience Centre[79]; state programs such as the NSW Department of Primary Industries Rural Resilience Program[80]; CSIRO's Responsible Innovation initiative[81]; and research expertise across the four universities in social innovation, regional development, socio-ecological resilience, rural health and wellbeing.

76 Australian Government Department of Agriculture, Water and the Environment, "National Agricultural Agenda," (2020). Accessed at: https://www.agriculture.gov.au/ag-farm-food/innovation/national-ag-innovation-agenda#national-agricultural-innovation-priorities

77 Australian Government Department of Agriculture, Water and the Environment. "Drought Resilience Research and Adoption Program," (2020) Accessed at: https://www.agriculture.gov.au/ag-farm-food/drought/future-drought-fund/research-adoption-program

78 Grain Growers. "A Grains Sustainability Framework – Behind Australian Grain," (2020). Accessed at: https://www.graingrowers.com.au/sustainability/grains-sustainability-framework/

79 "Australian Resilience Centre – Building Capacity for Positive Futures." Accessed at: https://www.ausresilience.com.au/

80 "NSW Department of Primary Industries Rural Resilience Program." Accessed at: https://www.dpi.nsw.gov.au/about-us/rural-support/rural-resilience-program

81 "CSIRO Responsible Innovation Future Science Platform." Accessed at: https://www.csiro.au/en/Research/LWF/Areas/FSPs/Responsible-Innovation

10.5. Pillars of the National Mission

Pillar 1 – Smart plants for new cropping systems

Development of higher yield and nutritious crops, combined with improved capture of environmental data to develop on-demand crop management tools. This will transform yields and provide farmers with the ability to switch production to high value alternative commodities such as oils and proteins in planted crops.

Examples of how our children would use smart plants to running Australia's farms, include:

- Plant crops that can be switch from producing grain starch to leaf oil – mid season – in response to changing climate conditions and/or market demand
- Plant crops with in-built air to fertilizer technologies, decreasing nitrogen fertilizer purchase and application costs by 80% (and associated carbon emissions) but still producing nutritious proteins.

Pillar 2 – Improved resilience to abiotic stress of future environments

Development of drought, heat, salinity and frost stress resilient crop varieties which yield well in good and bad years through biological means such as resilient gene selection and genetic enhancement of innate stress tolerance pathways. Combined with novel management approaches this will enable cropping to be productive and profitable even in harsh climates and soils.

Examples of how this step change will enable the next generation to farm profitably and sustainably in harsh climates and soils include:

- Water-saving, drought-tolerant broadacre crops that need only a fraction of the water used by today's varieties, and are able to produce a profitable yield in all but the driest of seasons or in semi-arid environments not currently used for cropping.
- Horticultural crops capable of delivering profitable yields under future, extreme heat wave conditions that would be lethal to today's crop varieties.
- New crops that can directly absorb and retain salt but still grow, enabling profitable yields even on land too saline for crop production today.

Pillar 3 – Next-generation digital agriculture solutions

Development and greater access to next-generation digital agriculture solutions both on-farm and in crop improvement. This will increase the speed at which improved crops are selected in environments for improved yields and resilience in response to changing climate and markets.

Examples of how our children will use next-generation digital solutions to revolutionize plant-based industries include using breakthroughs in satellite data analysis and automation to :

- Increase profitability of extensive livestock production by 15% through use of fully integrated decision-making platforms to improve live weight gain rate and stocking rates
- Raise horticultural production rates by 20% using precision fertilizer application/recycling and changing light quality rather than quantity to enable faster/more consistent flowering and growth.

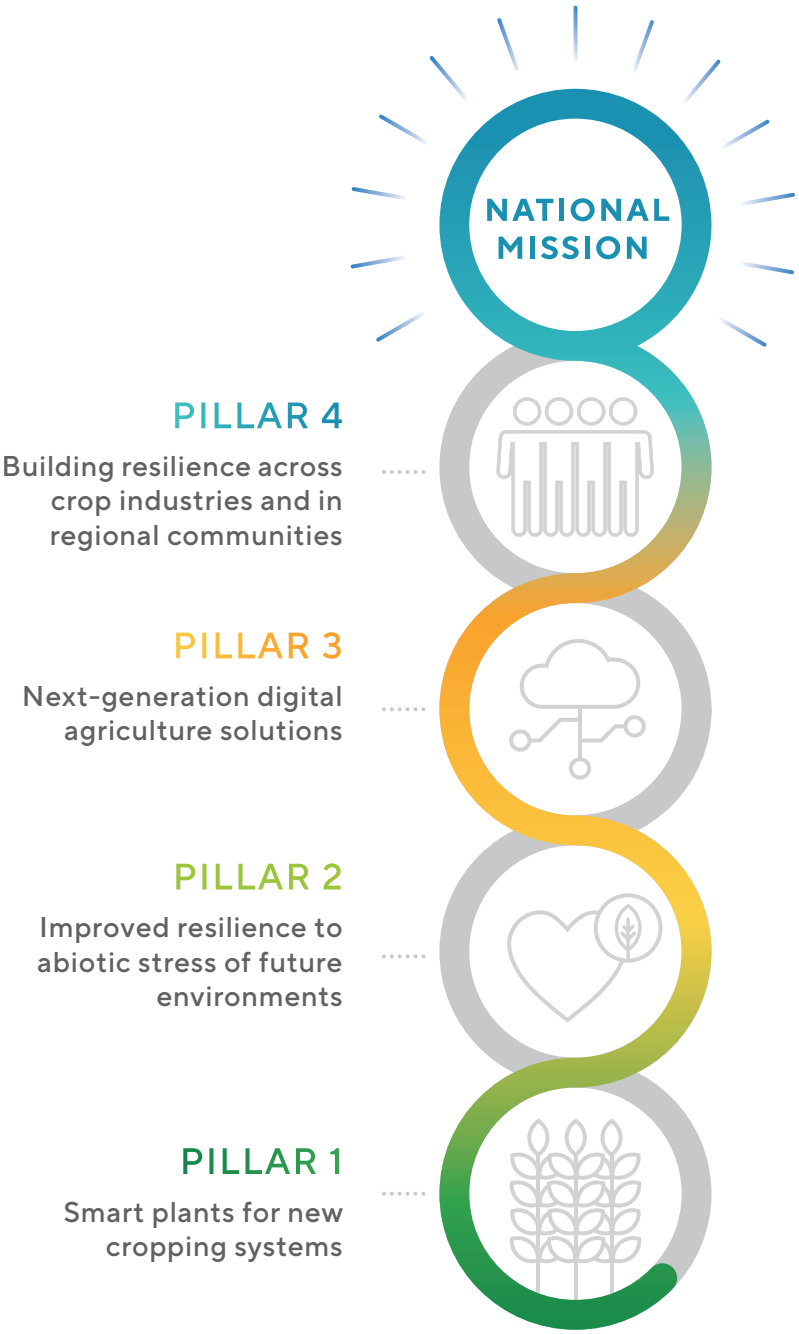
Pillar 4 – Building resilience across crop industries and in regional communities

Development of a region-specific resilience framework developed using a co-innovation, co-design approach. The framework will be founded on an understanding of stakeholder values and how they impact decision making, economic planning (with a focus on climate risk exposure of regional crop industries). This will also include development of the climate-smart agri-technology required to meet specific circumstances and needs. Other factors to be considered will be: economic and social

barriers to uptake and adoption of new technology and products; training and education requirements that address the needs of an emerging skilled workforce; and, the infrastructure and resource requirements needed to achieve community resilience and wellbeing.

Examples of how the next generation of farmers will design resilience into their communities include:

- Using fully integrated decision making platforms that use real-time high resolution satellite, on-farm and market information to optimise use of sunken investments and lower climate risk
- Increasing agricultural literacy for solutions providers from other sectors of the economy (business, finance and software services) to reduce barriers to enter the rural sector to offer robust and useful products that will drive productivity gains
- Providing training for new types of jobs within rural communities that combine skills in the use of satellite-based technology applications, robotic farm systems and mechatronic applications with detailed understanding of agronomy, biotechnology and crop management.



11 Governance

LONG-TERM SUCCESS OF HIGH RISK, HIGH RETURN VENTURES REQUIRES GOOD GOVERNANCE ON THE WAY AND RECOGNITION OF OPPORTUNITIES WHEN THEY APPEAR ON THE HORIZON. OUR GOVERNANCE MODEL WILL BE DEVELOPED IN CONSULTATION WITH GOVERNMENT, RESEARCHER PROVIDERS, RDCS, INDUSTRY REPRESENTATIVES AND PEAK BODIES TO ENSURE A PIPELINE FOR SUCCESS, TO CAPTURE BROAD PERSPECTIVES AND TO LEARN FROM PAST SUCCESSES AND MISTAKES.

To initiate discussions around governance, we propose that the National Mission be framed around an incorporated **Joint Venture (JV)** with an associated **JV Mandate**. In this proposed governance model, **JV members** would be made up of the Federal Government, universities, CSIRO, RDCs and those companies who co-invest at scale. To help ensure clear decision making around R&D investment, JV membership would be limited to those that have complementary areas of expertise.

The **JV Mandate** would guide how the National Mission operates and the nature of its investments. Key to the Mandate will be a focus on bringing together complementary expertise of the JV members to make investments in interdisciplinary, high-risk/high-reward projects that deliver long-term benefits to the cropping sector, and which cannot be reasonably achieved through the existing agricultural innovation ecosystem.

Stakeholders would be organizations with an interest in the outcomes of the NM and which are not members of the JV. This might include representative organizations such as the National Farmers Federation and associated peak industry organisations, companies, as well as a range of rural internet service providers, insurers and banks.

R&D providers would be any organisation that has the capacity to undertake research on behalf of the National Mission. It would include JV members with a capacity to deliver R&D. Other research organisations/ companies who are not JV members would also be able to become R&D providers. This would include research organisations who do not co-invest at scale for the duration of the National Mission but do have the capacity to co-invest in specific projects in particular time-lines.

The **Board** would be headed by an **Independent Chair** with **six other members**. The Board would have: three representatives from stakeholder organizations, appointed with consideration of the Board's skill matrix; and three JV member representatives with relevant industry, technology and science skills.

The Board would decide on the thematic areas that make up the National Mission investment portfolio, and deciding on which projects which should be funded. The Board will consult with industry stakeholders and their value chains to help identify priority themes and select the most exciting, high risk but high return projects.

Thematic Advisory Committees will be established to develop a portfolio of projects – using a co-design framework - within each theme.

The impact of projects on rural communities will be considered at each step in the investment decision-making process. Each project will identify deliverables consistent with the JV Mandate and socially acceptable pathways to achieve them.

The Board and Thematic Advisory Committees would receive support from an Executive Secretariat, headed by a Board-appointed CEO.

Photo by Lawrence Atkin

12

Extension and adoption

THE EXTENSION OF RESEARCH INTO COMMERCIAL ADOPTION HAS CONSISTENTLY BEEN IDENTIFIED AS A MAJOR AREA FOR IMPROVEMENT WITHIN THE AUSTRALIAN AGRICULTURAL ECOSYSTEM. FRAGMENTED AND LIMITED EXTENSION SERVICES REDUCE INNOVATION UPTAKE, HINDERS PRODUCTIVITY GAINS AND LIMITS VALUE ADDING.

We propose the National Mission have a clear approach to adoption and extension, to ensure the Mission's research agenda and investment is translated into uplift in the sectors productivity and resilience to changing climates and markets.

Building in part on the findings and recommendations from the recent Agricultural Innovation Report,[82] we propose the Mission address adoption and extension through:

- Early and thorough consideration of industry and regional communities needs through inclusion of industry members and regional development specialists in the co-design phase (Pillar 4) and subsequent Expert Advisory Panels responsible for setting research priorities.
- Utilisation of partnerships and matched funding to encourage industry buy-in and transfer of knowledge and skills.
- Early consideration of potential extension and adoption pathways and partnerships as part of the grants process.
- Consideration of diverse partnerships for the adoption and extension phase including state primary industry departments, RDCs, local farming groups, registered training organisations, rural service providers and regional innovation precincts.

82 Ernst and Young, "Agricultural Innovation - A National Approach to Grow Australia's Future," (2019). Accessed at: http://www.agriculture.gov.au/SiteCollectionDocuments/agriculture-food/innovation/summary-report-agricultural-innovation.PDF

13

Timeframes

WE PROPOSE INVESTMENT INTO THE NATIONAL MISSION BE DELIVERED OVER A 10-YEAR TIMEFRAME, TARGETING IMPACT OVER THE DECADE AND BEYOND. THIS IN LINE WITH THE MISSIONS THAT SIT UNDER THE MEDICAL RESEARCH FUTURE FUND, AND OTHER TRANSFORMATIONAL RESEARCH PROGRAMS.

A decadal timescale of investment is necessary to accommodate the length of plant system R&D and the ambitious nature of this research.

The Mission seeks to achieve a more rapid extension and application than business as usual, which is possible considering the rapid advances in science and the capability of Australia's agricultural innovation system.

A crucial goal of the Mission is to deliver long term, high impact research, development and extension that goes beyond the restrictive time horizon of current Australian agricultural research, which is typically limited to three to four years.

A crucial goal of the Mission is to deliver long term, high impact research, development and extension that goes beyond the restrictive time horizon of current Australian agricultural research, which is typically limited to three to four years.

While the timeframes to deliver this kind of transformative change are decadal and beyond, we propose the National Mission be milestone driven, and could include sprint-based innovation periods for appropriate elements and utilise early funding and delivery priorities to ensure early realisation of benefits for producers and communities.

The timeframe would then be spread across targeted short to longer term outcome periods such as 3, 6 and 10 years. These early funding and delivery priorities could be identified through the National Mission's Board's initial advice to the Minister.

Investment now will create jobs now. The National Mission is the kind of ambitious thinking that makes history, and the benefits will be realised for Australia throughout development and delivery.

14

Image by CoETP (Centre of Excellence for Translational Photosynthesis)

Next Steps

WE PROPOSE FOR THE AUSTRALIAN GOVERNMENT TO COMMIT TO FUNDING THE DEVELOPMENT AND IMPLEMENTATION OF A NATIONAL MISSION FOR FUTURE CROP AND COMMUNITY RESILIENCE.

IN THE DEVELOPMENT PHASE, A STEERING GROUP (TIME DELIMITED AND INCLUDING REPRESENTATION FROM RELEVANT COMMONWEALTH AGENCIES) WILL BE CONVENED EXPLICITLY TO DEVELOP AN OPERATIONAL PLAN FOR THE NATIONAL MISSION.

THE OPERATIONAL PLAN WILL DETAIL:

- Vision and scope the National Mission requires to drive solutions to the challenges facing the crop industry and associated rural communities
- Rationale, objectives, operating principles and policy context
- Appropriate governance solutions – based on the experience of existing missions with a co-innovation commitment
- Decision-making framework to guide project funding and the review process for ensuring transparent and effective research funding decisions
- Program logic to support investment decisions, program design and implementation
- Business case to support data and analytics capacity
- Monitoring, evaluation and risk framework
- Communication, stakeholder and community engagement frameworks
- Social, economic, environmental, ethical and regulatory frameworks

In the development phase, we propose that a set of co-design workshops be held with stakeholders in 2022 from across the crop industries and their value chains to refine the most pressing deliverables required from the proposed National Mission and socially acceptable pathways to achieve them.

Once operational, the specific research activities will be determined by the National Mission's Board and Thematic Advisory Committees in consultation with relevant RDCs, industry, plant breeders and regional development experts.

This will ensure research conducted under the Mission avoids duplication, meets industry needs and builds on the outcomes of previous investments.

POTENTIAL FUNDING SOURCES

Australian Government

Australian government funds in the form of grants and or partnership opportunities

State Government

State government provides funding in the form of grants, programs, loan and partnerships.

Private

Private sector provides funding in the form of sponsorships direct cash and or in kind donation.

Philanthropic

Philanthropic funding may be sought in the form of direct cash and or in kind contribution

Funding

THE NATIONAL MISSION IS PROJECTED TO REQUIRE THE COMMITMENT BY THE FEDERAL GOVERNMENT OF UP TO $50 MILLION PER ANNUM FOR TEN YEARS TO A TOTAL OF UP TO $500 MILLION. WE PROPOSE A COMPETITIVE LEVEL OF MATCHED FUNDING DERIVED FROM PARTNERSHIPS AS A SPECIFIC REQUIREMENT UNDER THE FUNDING PROCESS.

We recommend any Australian Government funding be drawn from new and emerging government funding sources such as the Future Drought Fund and the Prime Minister's Agriculture 2030 Plan rather than from reallocating or rationalising existing pools. This proposal is designed to undertake ambitious research beyond the profile of other R&D providers, not to replace them.

A detailed analysis of the Mission's alignment with the funding priorities under the Future Drought Fund and the purpose of the 2030 Agriculture Plan is provided at Appendix 2.

A holistic funding approach should be applied to the entirety of the four pillars, due to their interlocking and complementary nature. This approach will allow the National Mission to be best placed in delivering transformational benefits to agricultural communities and economies while catalysing new development opportunities across the wider agri-technological innovation landscape in Australia.

Courtesy of ARC CoE Plant Energy Biology

Appendices

APPENDIX 1:

Stakeholders consulted in drafting the Mission

Table 1 below provides a list of stakeholders who took part in consultation during the development of this National Mission document. A series of workshops were held in January to February 2020 with individuals from research institutions, rural research and development corporations, plant breeders, rural service providers, government and industry peak bodies. Participants were asked to broadly consider the value of a National Mission in this area. The feedback gained between the workshops and July 2020 has shaped this document.

ATTENDEE	ORGANISATION
Scott Ashby, Chief Executive Officer	Primary Industries and Regions South Australia
Chelsea Basset, Policy Officer	National Water Grid Authority
Katrina Kendall, Policy Officer	National Water Grid Authority
Jim Pratley, Secretary	Deans of Agriculture
Dr Anne-Sophie Dielen, Director Crop Biotech Policy	CropLife
Katherine Delbridge, Director Corporate Affairs	CropLife
Rohan Nelson, Agricultural Forecasts and Policy Lead	Australian Bureau of Agricultural and Resource Economics
Mark Allison, Chief Executive Officer	Elders Corp
Tress Walmsley, Chief Executive Officer	Intergrain
Dr Raj Bhula, Gene Technology Regulator	Office of Gene Tech Regulator
Peter Hayman, Principal Scientist, Climate Applications	South Australian Research and Development Institute
Caroline Rhodes, Chief Executive Officer	Grain Producers South Australia
Neil Comben, General Manager	Longreach Plant Breeders
Adrienne Ryan, General Manager Rural Affairs	National Farmers' Federation
Heidi Reid, General Manager Projects	National Farmers' Federation
Graham Bonnet, Lead, Advancing Agricultural Productivity and Environmental Health	Commonwealth Scientific and Industrial Research Organisation
Tim Lester, Executive Officer	Council of Rural Research and Development Corporations
Justin Crosby, Head of Industry and Government Relations	Grains Research and Development Corporation
Tristan Coram, Head of Science and Business Development	Australian Grain Technologies
Barry McGookin, General Manager Innovation, Capabilities and Skills	Food and Agribusiness Growth Centre

APPENDIX 2: *Alignment with funding opportunities*

Table 2 below details key Australian Government funding sources and their alignment with the strategic pillars and priorities of the National Mission.

PRIORITISED AUSTRALIAN GOVERNMENT FUNDING MODELS		
	FUTURE DROUGHT FUND	**FUNDING AMOUNT**
Funding option description	The Future Drought Fund is based around three strategic priorities listed below, which guide the design of its programs to build drought resilience Priority 1. Economic resilience for an innovative and profitable agriculture sector The focus of this priority is on enhancing drought resilience by growing self-reliance, productivity and profitability of the agricultural sector. Priority 2. Environmental resilience for sustainable farming landscapes The focus of this priority is on enhancing drought resilience through improving the natural resource management of agricultural landscapes. Priority 3. Social resilience for resourceful and adaptable communities The focus of this priority is on maintaining and improving the wellbeing and social fabric of rural and regional communities through drought resilience.	**$250 million over 10 years**
National Mission's alignment with Fund	**Pillar 1. Smart plants for cropping systems** Alignment: Priority 1 The development of higher yielding and more nutritious crops has the potential to materially increase the productivity and profitability of farmers. This will enhance their resilience towards drought conditions as improved profitability during non-drought years will build capital to carry through to low-income periods. **Pillar 2. Improved resilience to abiotic stress of future environments** Alignment: Overall Pillar 2 directly targets increasing the heat, drought, frost and salinity stress tolerance of crops through genome selection of tolerance traits. This pillar satisfies the overall goal of the Future Drought Fund in enhancing drought resilience. **Pillar 3. Next-generation digital agriculture solutions** Alignment: Priority 1 & 2 Digital technology-enabled solutions will not only accelerate production of high yielding technology, which satisfies Priority 1 of the Future Drought Fund, but also enables crop data collection and monitoring which informs natural resource management in line with Priority 2 of the Future Drought Fund. **Pillar 4. Building resilience across crop industries and in regional communities** Alignment: Priority 3 Pillar 4 will develop region-specific resilience frameworks co-designed with stakeholders, including programs associated with training and education for the needs of an emerging skilled workforce, and the infrastructure and resource requirements for community resilience and wellbeing.	

NATIONAL AGRICULTURAL INNOVATION AGENDA		FUNDING AMOUNT
Funding option description	We understand the Australian Government is further developing its National Agricultural Innovation Agenda as part of a strategy to meet the $100 billion by 2030 goal. The Agenda is likely to include additional funding for activities and/or programs.	**$250 million over 10 years**
National Mission's alignment	The activities under the proposed National Mission are essential to assisting industry to meet its ambitions in terms of increasing industry profitability and building resilience in the sector and the broader rural community. The National Mission will tackle barriers to growth and production in the cropping industry and has the potential to expand exports of agricultural products	

Photo by Lawrence Atkin

Notes:

The National Mission for Future Crop and Community Resilience

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Australian National University

THE UNIVERSITY of ADELAIDE

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

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