The National Mission for Future Crop and Community Resilience

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Australian National University

THE UNIVERSITY of ADELAIDE

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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 and The University of Western Australia in 2019–2020 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.
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Contents

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
$12 dollars for every $1 dollar[1]

1 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/articleabstract/96/5/1492/2738767; and

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

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

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

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

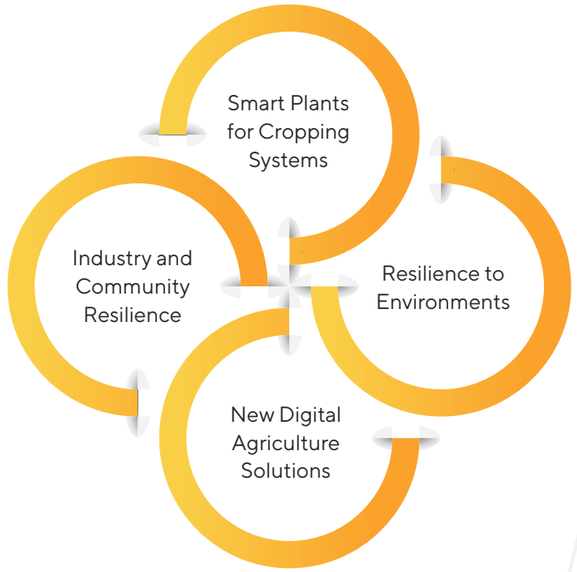
The *National Mission for Future Crop and Community Resilience* aims to respond to the urgent need for improved productivity, competitiveness, and resilience of rural and regional communities. This will be addressed through research, development, and application of new crop-based products and supporting technologies never before implemented in Australia.

Transformational change is required to improve crop productivity and resilience over and above what the current system provides.

A National Mission will provide the strategic direction, resources, and industry collaboration that is 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

+

New competitiveness to service international and local demand

=

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

THE AUSTRALIAN GOVERNMENT'S GOAL TO INCREASE OUR NATION'S ANNUAL AGRICULTURAL OUTPUT TO $100 BILLION BY 2030 IS THE KIND OF AMBITIOUS STRATEGIC THINKING THAT CREATES HISTORY.

Just as every success has many authors, the pathway to $100 billion will necessarily incorporate gains in productivity of biology, land, labour and technology – all working together to improve annual output.

However, the current trajectory of Australian agricultural research is insufficient to reach the $100 billion target.

This document sets out the case for a decade-long National Mission for Future Crop and Community Resilience. We propose the Mission 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.

This proposal comes at a time when 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.[4]

We must act now to deliver near- and long-term resilience, stability, and growth for these communities by increasing the productivity and sustainability of their foundational products. Increased competition and productivity in the international market, against a backdrop of lagging productivity in Australia, means that much higher levels of innovation are needed to achieve this, now more than ever.

Broadacre, horticultural crops and managed pastures underpin Australia's rural and regional economies, accounting for more than half of the total value of production from agriculture, fisheries, and forestry.[5] Crops also sustain other industries such as livestock production, transport, and 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 drop in productivity of more than 20 per cent below current levels.[6]

To secure a prosperous future for our regional and rural communities, crop productivity growth needs to increase by more than 20 per cent. A business as usual approach to crop improvement using existing R&D models – will not deliver the outcomes required. **A step change is needed.**

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

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) . Accessed at https://www.climatecouncil.org.au/uploads/7579c324216d1e76e8a50095aac45d66.pdf

A 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 crops through a strategic, long-term approach that embraces the newest technologies, not employed in Australia to date, coupled to the full capabilities of research, development, and extension institutions across the nation.

Australian legislation is evolving to accommodate innovative agricultural products 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.

Failure to invest 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.

Drawing on their world leading and interdisciplinary expertise, The Australian National University (ANU), the University of Adelaide (UA) and The University of Western Australia (UWA) 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.

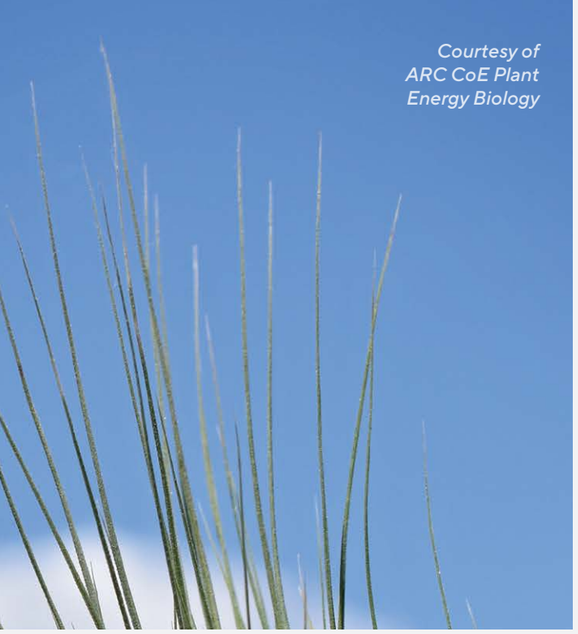
A set of stakeholders was consulted during the development of this National Mission, including a series of workshops held with more than 18 agriculture related entities in January to February 2020. These include research institutions, rural research and development corporations, plant breeders, rural service providers, government and industry peak bodies. Their feedback 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. It will include experts across Australia, from every state and territory.

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.

Australia has world-leading research, development and technical capability to discover and develop the new emerging technologies needed to transform Australian agriculture and deliver a step change in crop productivity.

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.



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 to the economy, in addition to a suite of economic, environmental and social benefits.[8] We can confidently anticipate that a Commonwealth investment of $500 million over 10 years will pay 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
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
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

The National Mission will be composed of the following aspects:

INPUTS

RESEARCH AND DEVELOPMENT OPPORTUNITIES

- Smart plants designed to align to future cropping systems
- Novel tolerances to abiotic stress including 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
- Rural service companies

OUTPUTS

- Step changes in productive, nutritious, higher yielding and stress tolerant crops
- Development of novel crop products, technologies and management strategies
- Reduced crop breeding timeframes
- 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

OUTCOMES

- Transformation of productivity and resilience of the cropping sector
- New competitiveness of the cropping sector to service international demand
- Spill over technology benefits for other sectors
- More resilient and prosperous rural communities

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.[9] 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.[10]

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[11] and within Australia.[12]

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 could reduce the productivity of grain growers by 50 per cent below the 2018 baseline levels. [13]

9 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

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

11 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

12 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/

13 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[14] and by offsetting the future impact of crops to ensure Australia meets carbon release reduction goals.[15]

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.[16]

Achieving this target will require large increases in productivity growth – and importantly, growth that is environmentally sustainable.

Yet, productivity growth 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.[17]

In 2017, Australia's agricultural productivity growth rate was 1.4 per cent, significantly below the world average of 1.7 per cent.[18] 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.[19]

If major cropping 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 in powerful new genetic and digital technologies and new digital agriculture infrastructure, to deliver improved access to the newest science and accelerated productivity gains. [20]

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.

14 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

15 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/2020-07/australias-emissions-projections-2019-report.pdf

16 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

17 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

18 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

19 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

20 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

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.[21]

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).[22] [23]

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.[24]

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

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, 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.

21 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

22 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

23 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

24 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/

04

Challenges facing cropping industries

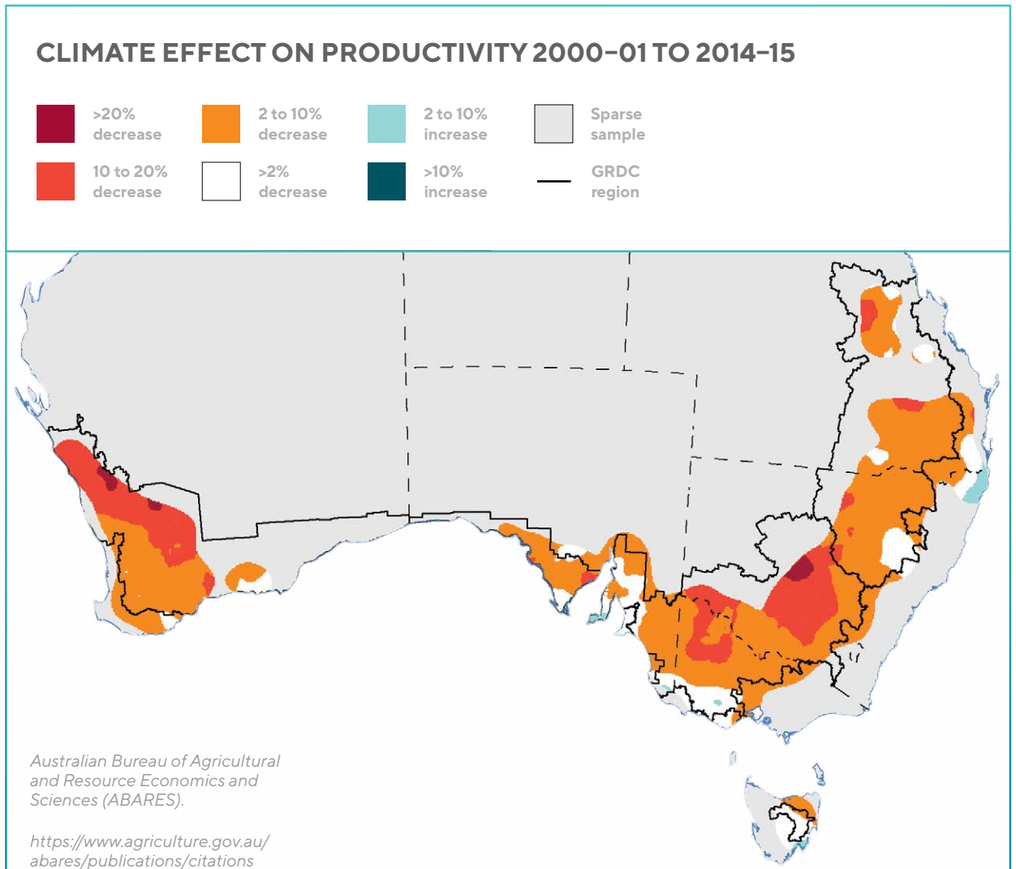


Figure 1. Map of average climate effect on productivity levels of Australian cropping farms 2000-01 to 2014-2015 (relative to average conditions in the period from 1914-15). Hughes et al. 2017, "Farm performance and climate. Climate-adjusted productivity for broadacre cropping farms," (ABARES, Australian Government, 2017).

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.

Broadacre crops are particularly vulnerable to climate impacts (and associated biosecurity threats) compared to livestock-related enterprises and mixed cropping,[25] with a forecast productivity decline of up to 50 per cent below 2018 baseline levels in some rural regions.

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,[26] resulting in an average loss in gross value of production for the broadacre cropping industry of more than $1.1 billion per year.[27]

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).[28]

Compared to other wheat-exporting countries, Australia has higher levels of yield variation between years,[29] 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.[30] 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.[31]

25 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

26 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

27 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

28 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

29 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

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

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

4.2. Other challenges and threats

Further threats to come from diverse and interrelated factors, including:[32]

- 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.

32 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 CROPPING 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.

Australia's existing crop 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.

To achieve the $100 billion by 2030 and productivity goals, year-on-year productivity of the Australian crop industries need to increase six-fold (i.e. from 0.4 to 2.4 per cent). To achieve these goals, we need to 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.

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 embraces the full capabilities of research, development and extension institutions across the nation.

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.[33]

Significant structural and cultural shifts in Australia's leading knowledge clusters will also be needed[34] – 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 must be framed around the needs of rural communities and 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[35] and out of 20 surveyed countries, Australian's had the most positive attitude towards genetically modified foods).[36]
- 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.

33 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

34 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

35 2019 Amendments to Gene Technology Regulations 2001 of the Gene Technology Act 2000. Accessed at: https://www.legislation.gov.au/Details/F2019L00573

36 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

The complex challenges facing cropping industries and communities

THE CHALLENGES FACING AUSTRALIA'S CROPPING 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.[37]

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.[38] 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'*[39] 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.

37 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

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/

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

38 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/

39 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.[40]

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,[41] 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 lift Australia towards its $100 billion goal all the way to 2030. 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.[42]

The Government has proposed to use targeted, agriculture-focused missions to:[43]

- 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.

40 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

41 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

42 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

43 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

AUSTRALIA HAS A TRACK RECORD OF NATIONAL MISSION-STYLE PROJECTS, FROM BUILDING THE SNOWY MOUNTAINS SCHEME TO THE GLOBAL 30-YEAR PROCESS OF BUILDING AND HOSTING COMPONENTS OF THE SQUARE KILOMETRE ARRAY.

In 2018–19, the Australian Government initiated a 10-year Australian Genomics Health Futures Mission[44] with a budget of $500 million dedicated to improving Australian health through revolutionising the management of disease.

More recently, the Australian Government committed to a 10-year Future Drought Fund [45] 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.

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 – and propel them to meet and exceed the goals outlined in the NFF 2030 Roadmap. [46]

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

45 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

46 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[47] through:

- Setting a clear strategic vision with ecosystem leaders to transform the productivity, profitability and resilience of the agriculture sector
- Committing to co-innovation approaches to ensure the uptake of mission innovation processes and outcomes for the cropping sectors and across the wider agri-system
- Collaboration across and among different sectors, using the entire research and innovation value chain, from fundamental research to applied research and cutting-edge innovation
- Funding – and an investment model – predicated on public/private commitment with appetite for the longer-term time frames needed to achieve breakthrough gains in productivity
- Capacity to deliver on both incremental and transformative innovation
- Partnerships with regional innovation ecosystems to ground mission priorities, projects, outcomes and uptake of innovation
- Adoption of world-class innovation practices through working with entrepreneurs, start-ups and industry
- Building transformational readiness of the cropping sector to embrace next generation innovation platforms by scoping reforms and evolution in data and 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

It takes time to extend research outcomes into breeding and adoption programs for use by farmers. The sooner that the National Mission is commenced, the sooner the benefits can be realised for rural communities.

The existing research and development community in Australia is insufficiently resourced and has a focus on a research timeframe that is typically two to five years.

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

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 between basic and applied research and to galvanise new forms of collaboration.

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 crop and pasture 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.

47 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

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 a **$12 return on investment over a 10-year period**, in addition to a suite of economic, environmental and social benefits.[48]

More broadly, investments through research in the agricultural sector can provide economic benefits such as reduced production costs, increased productivity, diversification of revenue streams, economies of scale and scope, and increased export revenue from 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 [49]

Photo by Lawrence Atkin

48 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
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
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

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

09

A proposal from three leading research universities

DRAWING ON THEIR INTERDISCIPLINARY EXPERTISE, THE AUSTRALIAN NATIONAL UNIVERSITY (ANU), THE UNIVERSITY OF ADELAIDE (UA) AND THE UNIVERSITY OF WESTERN AUSTRALIA (UWA) 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 groundbreaking research and industry-aligned solutions to production challenges by drawing on the interdisciplinary strengths of Australia's research institutions (including CSIRO), industry, state governments, RDCs and peak bodies.

Structural and cultural change

ANU, UA 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, and the interdisciplinary expansion of the Waite Research Institute at UA and the Institute of Agriculture and the Public Policy Institute at UWA.

The three 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), 72 per cent (UA), and 79 per cent (UWA) of papers published in the plant sciences included an international partner in 2020, well above the average for leading institutions in the USA (e.g. 56 per cent at Berkeley) and UK (66 per cent at Cambridge).

Australian National University — 68%

THE UNIVERSITY of ADELAIDE — 72%

THE UNIVERSITY OF WESTERN AUSTRALIA — 79%

ANU, UA 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.

9.2. 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 and UWA. These universities lead – along with partners from the University of Queensland, University of Sydney, Western Sydney University, La Trobe University, CSIRO and industry – two ARC Centres of Excellence (Translational Photosynthesis and Plant Energy Biology).

Both 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 form the foundation 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.

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.

9.3. 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 all capital cities, and regional centres across Australia, would be invited to help develop the National Mission for Future Crop and Community Resilience, as would key ecosystem players such as the CSIRO, Grains Research and Development Corporation (GRDC), AgriFutures Australia, other Rural RDCs, and Agricultural Innovation Australia (recently formed to bring together individual RDCs to facilitate joint investment/collaboration in cross-industry agricultural issues).

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) 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.

Photo by Lawrence Atkin

Courtesy of ARC CoE Plant Energy Biology

Photo by ANU image library

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, RDCS AND PEAK AGRICULTURAL ENTITIES TO ADDRESS THE KEY CHALLENGES AFFECTING THE CURRENT AND FUTURE PRODUCTIVITY OF THE CROPPING SECTOR AND ASSOCIATED INDUSTRIES.

The National Mission 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. For example, moving from traditional breeding approaches to new approaches that accelerate the progress of genetic selection, allowing multiple genes to be evaluated cost effectively. 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.

02 Investment into the development of tools that could be beneficial but don't exist yet. For example, smart plants that can be programmed to sense the environment or farmer-provided triggers in order to switch to different productions outputs (e.g. oil for biofuels instead of grains).

Both forms of investment require formation of interdisciplinary teams of researchers working together in new ways – 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.

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

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.[50]

The Argentinian government recently approved farmers to grow genetically modified, drought-tolerant EcoWheat[51] 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.

50 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

51 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.[52,53,54] 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.[55]
- 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.[56]

52 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

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

54 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

55 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

56 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

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 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-design framework. It will build on initiatives from: the National Agricultural Innovation Agenda's[57] investment in eight Regional Resilience Adoption and Innovation Hubs[58] and precincts; the Grains Sustainability Framework[59]; regional work conducted by the Australian Resilience Centre[60]; state programs such as the NSW Department of Primary Industries Rural Resilience Program[61]; CSIRO's Responsible Innovation initiative[62]; and research expertise across the three universities in social innovation, regional development, socio-ecological resilience, rural health and wellbeing.

57 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

58 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

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

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

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

62 "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.

Pillar 2 – Improved resilience to abiotic stress of future environments

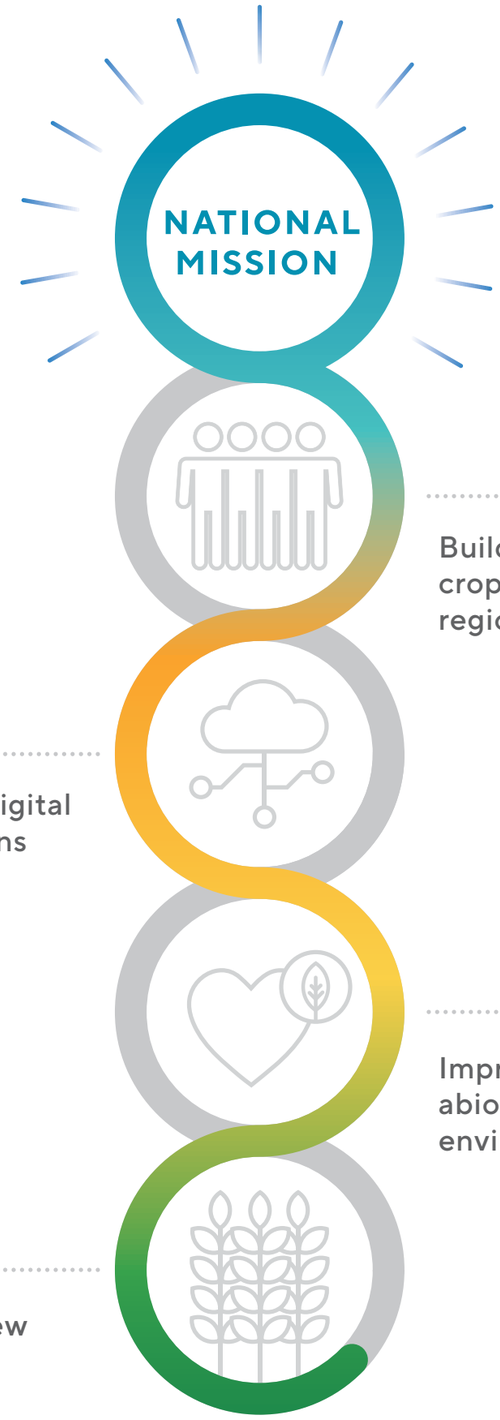
Development of drought, heat, salinity and frost stress resilient crop varieties which yield well in good and bad years through biological means such as resilient gene selection and genetic enhancement of innate stress tolerance pathways. Combined with novel management approaches this will enable cropping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

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.

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

Development of a region-specific resilience framework, founded on an understanding of stakeholder values and how they impact decision making and 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, 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 determining infrastructure and resource requirements needed to achieve community resilience and wellbeing.



11

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 specific focus on 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,[63] 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.

63 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

12

Timeframes

WE PROPOSE INVESTMENT INTO THE NATIONAL MISSION BE DELIVERED OVER 10 YEARS, IN LINE WITH THE MISSIONS THAT SIT UNDER THE MEDICAL RESEARCH FUTURE FUND, AND OTHER TRANSFORMATIONAL RESEARCH PROGRAMS.

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

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.

While the timeframes to deliver this kind of transformative change are decadal, 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 Mission's Expert Advisory Panel'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.

13

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 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 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 2021 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 Mission's Independent Expert Advisory Panel 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

14

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.	
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.	**$250 million over 10 years**

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:

FOR FURTHER INFORMATION CONTACT:

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Australian National University

THE UNIVERSITY of ADELAIDE

THE UNIVERSITY OF WESTERN AUSTRALIA