APPF
Australian Plant Phenomics Facility

Prospectus

A new National Research Infrastructure partnership transforming Australia's crop-based food systems and driving innovation in plant science

The next generation/evolution of the Australian Plant Phenomics Facility starts now.

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

Foreword

As a nation and global citizen, Australia is navigating major threats for sustainable, profitable food production. We share challenges such as climate change, degraded arable land, the mismatch between water supply and water needs, and the societal push for sustainable farming practices and novel, high-nutrition foods. COVID-19 has brought home the imperative for strong domestic supply of quality food, but we must also remain globally competitive, with 70% of Australian agricultural output being exported.

For more than a decade the Australian Plant Phenomics Facility (APPF) has supported high-quality research and innovation in plant science and cropping. We have been global pioneers in plant phenotyping (the characterisation, mapping and monitoring of crop/plant performance, as relates to genome, environment and management), bringing this capability and enabling technology to Australian and international researchers and innovators.

With the strong support of the Australian Government, our host organisations, and the APPF Board, we have embarked on an exciting process to determine what the next phase in the journey for this nationally significant research infrastructure should be.

We are rallying behind the National Farmers Federation's vision to make Australian agriculture an $100 billion industry by 2030. We recognise that to achieve this, game-changing advances in technology and farming practice will need to be underpinned by a coordinated and well-resourced national research effort.

Beyond agriculture, there are further exciting opportunities to build and support new and innovative industries such as plant-based medicines, and in the food-nutrition-health nexus.

With that in mind, we have consulted widely and listened carefully to researchers, innovators, growers, investors and policy makers around Australia and the world. With a dedicated coalition of the willing, we have conceived a new, expanded national research infrastructure that builds on our existing strong core. This prospectus outlines the opportunity for investment and partnership in that new infrastructure, and we invite you to discuss our vision for the future.

Yours sincerely

DR RON SANDLAND AM FTSE
Chair, Advisory Board

DR SUSIE ROBINSON
Executive Director

The APPF acknowledges and pays respect to the past, present and future Traditional Custodians and Elders of this nation and the continuation of cultural, spiritual and educational practices of Aboriginal and Torres Strait Islander peoples.

The opportunity

The APPF is one of 22 nationally significant research infrastructures, funded and enabled under the National Collaborative Research Infrastructure Strategy (NCRIS). Since its initiation in 2004-05, NCRIS has provided strategic funding for national-scale and world-class research infrastructure to bring economic, environmental, health and social benefits for Australia.

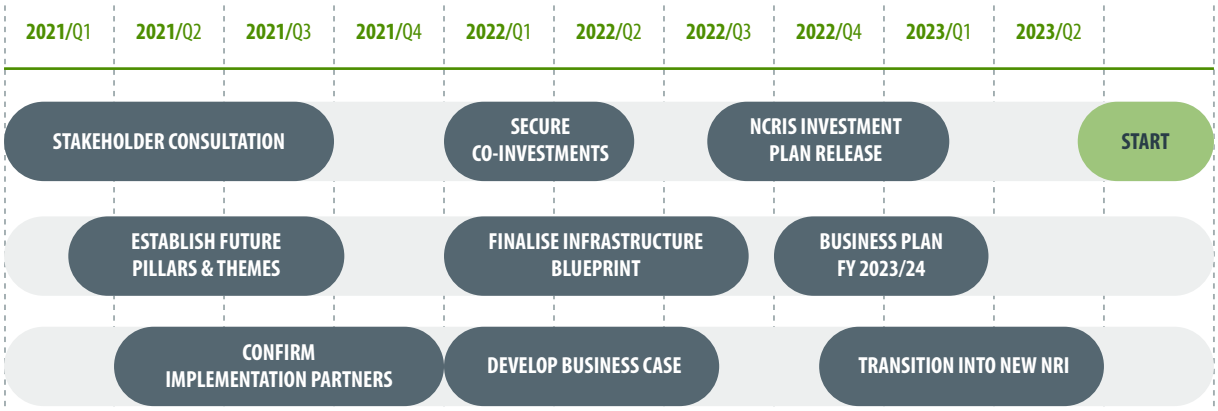
Every five years, the Australian Government consolidates and renews its policy approach to national research infrastructure investment by engaging the research community and its stakeholders. The latest National Research Infrastructure Roadmap, setting out Australia's research infrastructure priorities has just been released (April 2022) and will inform the Government's subsequent investment into publicly funded research infrastructure, through the Research Infrastructure Investment Plan (RIIP), anticipated to be released in late 2022.

The APPF is the only national research infrastructure wholly dedicated to serving the agricultural sector, and we have been advocating strongly for the Roadmap to reflect the significant and changing needs of food and agriculture.

Built on the compelling evidence we have gathered during our extensive research and consultation, this prospectus outlines the proposal we intend to put to the Australian Government for renewed and expanded investment into research infrastructure to support innovative plant science and the transformation of our Australian food systems.

Our case for NCRIS investment, and what we can ultimately achieve, will be made stronger by stakeholder endorsement, implementation partnership and co-investment from government, host-organisations and industry.

Timeframe for investment

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From challenge to opportunity –
why do we need new national research infrastructure?

Agriculture, one of the world's oldest industries, must transform to sustainably meet global demand for food in the face of a changing climate.

Australia must balance the need for sustainable food production that protects our scarce natural capital while ensuring the economic health and global competitiveness of our agriculture sector.

The kinds of crops we grow, and where we grow them will continue to be affected by climatic shifts, and we will need to produce much more with much less. We can achieve this through better crop breeding and genetics to increase yields, through more capital-intensive (rather than land-intensive) production systems, such as protected cropping and vertical farms, through robotics and automation, and by harnessing the power of artificial intelligence (AI) to enhance measuring and monitoring and provide real-time analytics and decision-making tools supporting better farming practices.

Australian agriculture feeds the nation but also exports to the world (70% of our agricultural output is exported). We are therefore heavily trade-exposed and our international competitiveness is critical. Beyond yield, climate adaptation and farming efficiency, we must compete on quality, novelty, provenance and traceability.

The COVID-19 crisis has further intensified other challenges that agriculture faces. Disrupted global supply chains have highlighted the importance of sovereign supply, and restrictions on human mobility have exposed our heavy reliance on affordable migrant manual labour, and our need for better digitisation and connectivity.

A snapshot below of the compelling challenges and opportunities that we face

UN predicts global population growth to 9.7bn by 2050[1]

Climate variability impact – ABARES finds a 23% climate-related loss in Australian farm-gate profit per year since 2001[2]

Environment protection – agriculture contributes 20% of all global greenhouse gas emmissions[3]

National Farmers Federation Roadmap target – to exceed $100 billion in farm gate output by 2030[4]

Functional foods and personalised nutrition worth $690-$770 billion globally by 2025[5]

The tropical economy is growing 20% faster than the rest of the world – Northern Australia opportunity[6]

Agriculture supports 250,000 Australian workers, with labour shortages[7]

Australian production of wheat and barley alone worth $8b p.a. gross in 2019/20[8]

This is not just about agriculture

The botanical and plant-derived drugs global market has the potential to grow by US $13.67 billion during 2020-2024[9]

Australia's legal cannabis market forecast to grow from US $52 million in 2018 to US $1.2 billion in 2027 (the 5th largest in the world)[10]

The global plant-based vaccines market is estimated to be valued at US $43.7 million in 2021 and is expected to surpass US $581 million by 2028[11]

Enabling technologies are key to unlocking our potential

Smart crop monitoring (connected sensor data and imagery analysis supporting location-specific and real-time management) is estimated to have a potential global value uplift of $130-$175 billion by 2030[12]

Farming by drone (remote surveillance and interventions via image analysis and connected sensors) is expected to generate $85-$115 billion in value by 2030[13]

Globally, AI in agriculture growth is expected at a compound annual growth rate of 24% by 2024, with the Asia Pacific predicted to be the fastest growth region[14]

Building on today's progress in hyperspectral, multispectral, X-ray CT, LiDAR and other sensing technologies, the next decade will see unparalleled advances underpinned by digital connectivity.

Novel tools to phenotype crops from the air, from space and below ground, combined with the latest machine learning techniques, artificial intelligence and crop modelling will revolutionise agricultural research, crop breeding and farming practices.

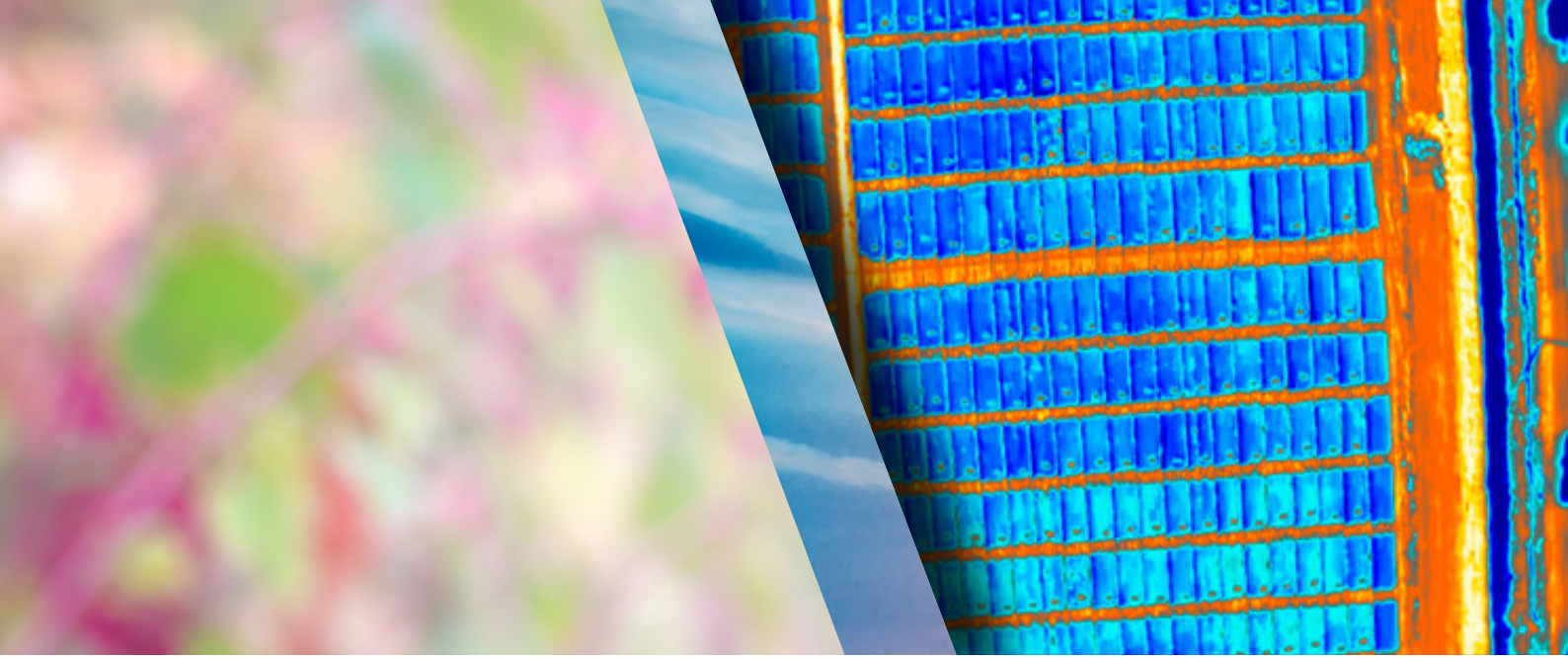
The integration of data from a range of critical resources will provide better insights and solutions into an array of problems from pest detection and management, to optimal harvest time, efficient use of water, development of new and improved crop varieties and increased post-farmgate value through detection of spoilage, provenance validation and creation of novel, high-nutrition and functional foods.

Our mission is to enable scientists, breeders, growers and innovators to address the major challenges facing sustainable agriculture, quality food supply, human nutrition and health. We will do this with a globally leading and interconnected network of plant and crop research infrastructure and supporting services in sensing, imaging and analytics, backed up by FAIR data practices, that foster scientific excellence.

An integrated National Research Infrastructure for agriculture and plant science innovation

Servicing agriculture in temperate, semi-arid and tropical environments with infrastructure located across urban, regional and remote settings.

- ✓ Provide expertise across plant science, engineering, robotics, AI and data analytics
- ✓ Enable excellence in individual scientific studies
- ✓ Deliver solutions for industry
- ✓ Drive nationally coordinated science missions
- ✓ Create nationally significant data assets
- ✓ Connect with, align to, and shape global excellence



We will invest in infrastructure for complex characterisation and manipulation of plants/crops, and coordinate nationally networked in-field testing and monitoring for crops and farmed environments. This will be delivered through:

Highly controlled environment facilities

- Specialist plant growth environments
- Robotics and automation - sensing, imaging and phenotyping
- Protected cropping and vertical farming

A national suite of coordinated phenotyping field sites

- Located in varied agro-ecological zones
- Uniform sensors and instrumentation
- Multi-site data linkage

Network of continental observation units

- Producing data streams servicing research and testing hot spots
- Delivering environmental, crop and soil data
- Supporting calibration and validation of satellite data

Lean, mobile, in-field phenotyping services

- Mobile phenotyping, imaging and sensing capability delivered on-demand at clients' own sites
- End to end data management

Collaborative data infrastructure

- Consistent end-to-end management of data from controlled and field environments
- National curation of high-value FAIR agricultural data assets
- Integrated hub for aggregation and analysis of plant phenotyping data, leveraging expertise in modelling and AI
- Data visualisation and modelling products using AR/VR

Emerging and frontier technology development and testing

- Proofing new-to-world and new-to-Australia technology for Australian conditions
- Novel sensors relating to yield, quality, disease, stress resistance and carbon capture
- Protected cropping and indoor farming technologies for Australian native species, high value-add crops and for plants in space

Investment and impact

Recently commissioned analysis by Lateral Economics to assess the positive impacts of NCRIS found that the direct benefit of investment in NCRIS was calculated to be above a $7 return for every $1 invested, with the published report concluding: "*Based on economic theory and evidence from the time of the GFC to present, we can think of few approaches to providing additional stimulus to the Australian economy that are more cost-effective than increasing investment in NCRIS.*"

The APPF has commissioned further cost-benefit analysis for this future NRI, looking at use cases addressing our contribution to economic growth in crop breeding, medicinal plants, protected cropping, improved crop protection product development, and the development of plant pathogen sensing systems. The analysis underlines that potentially large net benefits could flow from this investment.

For example, in medicinal agriculture, the analysis revealed that research and innovation enabled by this future NRI into medicinal cannabis alone, would result in economic benefit valued at a Net Present Value (NPV) of $57.4 million (5% discount rate), with a benefit to cost ratio of 3.6:1 (with the internal rate of return for the investment being 23.7%). The analysis further suggests that research supporting a number of key protected cropping industries, enabled by this proposed NRI, would result in economic benefits with a NPV of $74.7 million (5% discount rate) and a benefit to cost ratio of 16.9:1 (with the internal rate of return for the investment being 29.9%).

Overall, the analysis shows a benefit-cost ratio of 5.5:1, indicating that for every dollar invested, industry benefits of $5.50 could be expected, with the overall NPV for this investment therefore likely to be well in excess of $800M.

Impact

This future NRI will enable the following economic, environmental and social impact:

Reduced wastage and concomitant preservation of natural capital (water, soil, biodiversity)

Accelerating achievement of carbon-neutral agriculture & a competitive Australia in global carbon markets

Supporting food security and consumer shifts (dietary, health, environment & food safety considerations)

Increased grower profits through decreased production costs & better value-add

Export and domestic market expansion for agricultural and agri-tech products

Health and nutrition benefits flowing from high-nutrition and functional foods, and plant-based medicines

Improved standing of Australian science (attractive global collaboration partner)

Notes for prospective partners

In our commitment to support research excellence and industry impact, we will continue to partner and collaborate widely, and look to expand our partnerships to achieve our vision for the future. Internationally, we will maintain and grow our special relationship with the European Infrastructure for Plant Phenotyping, EMPHASIS, alongside cooperation with major international research efforts including the CGIAR centres, the global Wheat Initiative and others.

Expectations for investment

The success of NCRIS is dependent on co-investment from the Australian research and innovation community, alongside the Commonwealth Government's investment via the Research Infrastructure Investment Plan. Leading NCRIS facilities achieve a dollar of cash co-investment for every dollar invested by NCRIS, and we will engage with partners on that basis.

While the final proposed 'research infrastructure blueprint' and associated resourcing envelope are still to be finalised, and noting that the outcomes of the Australian Government Investment Plan will be unknown for some time, we are envisaging the value of this new national research infrastructure to be $150M+ (capital and operating) over five years.

A cohesive operating partnership

For this new NRI to flourish, we would expect partners to commit to some key shared principles. These reflect the mission of NCRIS, and the particular strategic intent of this infrastructure to achieve powerful outcomes through coordinated, integrated and interoperable activities, data and services. These principles include:

- Harmonised standards and protocols for data gathering and management to support data integration across platforms, sites and scales, and from individual research investigations into pooled national data assets where appropriate
- Adoption of the FAIR data principles, noting that any data where openness is restricted for commercial reasons should still be in a form that means they could readily be made open at a later date
- Principles for sharing and deriving value in an NCRIS context from intellectual property generated by the NRI
- Nationally coordinated and monitored resourcing and investment
- Transparent documented access and costing-charging protocols for users.

In the coming months, we will finalise arrangements with implementation partners for this future NRI. We intend to achieve a complementary network of controlled-environment facilities, fixed field sites and mobile offerings. There will be some minimum requirements and expectations around the fixed field sites in terms of land area, servicing and options for instrumentation. There will also be a need for local crews to enable the roll-out of our proposed mobile, in-field phenotyping services. We welcome ongoing discussion from interested parties across Australia who may be appropriate to host these installations and services.

We will work with prospective partners through a process of investment prioritisation, and determination of future governance and operating models. The final proposal submitted to the Australian Government will be approved by the APPF Advisory Board, having been shaped by a Steering Committee that is representative of all proposed implementation partners. We will continue to liaise closely with the NCRIS office in the Department of Education, Skills and Employment during this period, and our submission will also be guided by their feedback.

Partner benefits

Becoming an implementation partner in an NCRIS facility brings significant benefits:

- Part of a network that not only enables science and innovation now but shapes what science and innovation will be possible in the future, for Australia and beyond
- Significant local spillover benefits for host organisations, through ready access to equipment, capability and collaborations- all of this leverages funds that flow into the local operating environment, including by adding a competitive edge for applications to contested research grants, and through service levies arising from facility user fees
- Supports the establishment and operations of industry and start-up activities that can cluster around the NCRIS base, and gives a competitive edge to industry collaborators in their product and s ervice innovation
- Lifts research and innovation capability via highly skilled people, cutting edge research processes and access to vanguard technology.

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The APPF is enabled by NCRIS, the National Collaborative Research Infrastructure Strategy.

Current partners

NCRIS National Research Infrastructure for Australia An Australian Government Initiative

THE UNIVERSITY of ADELAIDE

CSIRO

Australian National University

Government of South Australia