Please note: the substantive content of the 2026 NRI Roadmap Survey begins at Question 20 (with prior questions dealing with administrative and other information).

As such all submissions that are published include the responses submitted from Question 20 onwards only.

Q20.

Part 2: Research themes

2.1 NRI comprises the assets, facilities and associated expertise to support leading-edge research and innovation in Australia and is accessible to publicly and privately funded users across Australia and internationally. We are seeking your input on possible directions for future national-level investment - i.e., where the requirements are of such scale and importance that national-level collaboration and coordination are essential.

The 2021 Roadmap used a challenge framework to support NRI planning and investment. With this in mind, consider likely future research trends in the next 5 - 10 years, and with respect to one or more of the 8 challenge areas identified in the 2021 Roadmap as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or not at sufficient scale and
- describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities.

Q21.

Resources Technology and Critical Minerals Processing

Not applicable.

Q22.

Food and Beverage

The Australian Wine Research Institute (AWRI) is one of the world's leading grape and wine R&D organisations providing world-class research, practical solutions and knowledge transfer. The AWRI represents significant investments by Industry and State and Commonwealth Governments towards capability building and addressing industry issues, in support of approximately 2,500 commercial Australian wine producers and 8,000 wine grape growers. The AWRI undertakes a range of fundamental and applied research programs and provides targeted extension and commercial services as well as a range of fee-for-service activities. The latter is provided through the AWRI's commercial arm, Affinity Labs, with support from Bioplatforms Australia-led infrastructure including Metabolomics Australia, AGRF and Ramaciotti Centre. Looking ahead to the next 5-10 years, key research priority areas for the Australian wine industry will require enhanced national infrastructure to support: Climate Resilience and Adaptation • New breeding technologies and plant based synthetic biology for the development of unique grapevine varieties and rootstocks, requiring expanded genomics, metabolomics and phenotyping capabilities. • Biological alternatives to established agrochemicals and for pest control, for example through development of RNAi technologies and biofilms of bioprotectant microorganisms, supporting food biosecurity for plants, and pest and disease managements. Production Excellence • Next-generation fermentation technologies and down-stream processing requiring infrastructure investments together with improved sensing and process control, and data management and bioinformatics support. • Wine quality enhancement through process innovation, leveraging multi-omics approaches through community of practice approaches. • Sustainable production systems and valorisation of side-streams requiring analytical capabilities for environmental monitoring. New product development, Diversification and Optimisation of resource utilisation • Value-added product development and diversification into alternative fermentation systems and production technologies requiring translation capabilities for innovation in food manufacturing. Technology Integration • Precision agriculture systems supported by the Australian Plant Phenomics Network • Advanced sensing and monitoring technologies requiring national-level data infrastructure • Digital solutions for environmental monitoring and production optimisation

Q23.

Medical Products

Not applicable.

Q24.

Defence

There are considerable opportunities and synergies from co-development and R&D towards dual-use applications in sensing and autonomous and population sampling between Defence (esp. for Chemical and Biological Risk monitoring and large-scale surveillance), Agriculture (biomarkers for detection of biosecurity risks, emerging pest and disease issues, unintentional environmental contaminations) and Environmental Monitoring (invasive species, PFAS and other ubiquitous contaminations, biomarkers for the verification of environmental sustainability credentials and monitoring of remediation efforts). R&D themes and capability requirements over the next 5 to 10 years include: Continuous access to remote sensing data with high spatial resolution; field-deployable low cost sensors and sampling systems available in sufficient numbers as required for national- and regional-scale monitoring with mobilisation and agility for rapid response; facilities and capabilities for rapid ground-truthing (whole genome sequencing; automatised bioinformatics pipelines and data infrastructure; biological phenotyping; generic GIS systems for mapping of biological populations); and advanced data analytics for detection and interpretation of variations in metabolomics-based biomarker signals.

Q25.

Recycling and Clean Energy

Not applicable.

Q26.

Space

Not applicable.

Q27.

Environment and Climate

To tackle challenges from a changing climate and extreme weather events, investments are required towards new technologies for accelerated breeding and phenotyping through the Australian Plant Phenomics Network and synthetic biology tools for plant breeding and microbial strain development. There is a convincing case to strengthen environmental monitoring of biosecurity risks, invasive species, and PFAS and other ubiquitous contaminations, together with establishing and monitoring biomarkers for the verification of environmental sustainability credentials. This will require enhanced metabolomics capabilities through Bioplatforms Australia and Metabolomics Australia networks, along with improved sampling and data management infrastructure and bioinformatics to support multi-omics approaches. Emerging research directions will require enhanced analytical capabilities with sufficient scalability and agility to respond to environmental and potential biosecurity challenges. National infrastructure providing integrated omics to service pathways will be essential for supporting industry needs in monitoring and adaptation. The translation of research findings into practical applications will require coordinated efforts across a community of practice involving both state government resources and national facilities.

Q28.

Frontier Technologies and Modern Manufacturing

At the AWRI, AI tools are already available and regularly used in bioinformatics analysis of genomics and proteomics data of complex biological systems. However, data fusion of genomics data with chemical phenotyping and metabolomics data is in its infancy and sovereign infrastructure for data warehousing of foundational datasets - combining complex biology and environmental meta data - is lacking. Specifically, AI tools are lacking for the efficient and effective interpretation of large-scale data sets obtained by non-targeted analysis of small molecules across different biologies, multiple timepoints, regions and populations. This represents a critical gap in the data infrastructure needed to support multi-omics approaches through Bioplatforms Australia and the Metabolomics Australia network. Data-driven omics-to-service approaches will facilitate and fast-track breeding, strain selection and new product development in fields such as precision fermentation, biomanufacturing of functional materials and polymers from renewables, and the sustainable production of high-value ingredients and bioactive compounds (nutraceuticals, pharmaceuticals, probiotics, biologicals for pest control). These developments will require enhanced analytical capabilities and translation pathways from research to application. Pertinent to this are the development and growth of a highly skilled on-shore workforce in data science, mathematics, data engineering and bioinformatics, across technology-centric domains. Training the next generation of scientists and supporting a community of practice around Australian-made solutions will be essential for innovation in food manufacturing and related industries.

Q29.

2.2 The 2024 statement of National Science and Research Priorities (NSRPs) includes outcomes linked to each priority to assist in identifying critical research needed in the next 5 to 10 years.
Consider the priority statements and, with respect to one or more of the 5 priority areas as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or
- not at sufficient scale and describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities, and where relevant, refer to the underpinning outcomes and research identified in the NSRPs document.

Q30.

Transitioning to a net zero future

Not applicable.

Q31.

Supporting healthy and thriving communities

Not applicable.

Q32.

Elevating Aboriginal and Torres Strait Islanders knowledge systems

Not applicable.

Q33.

Protecting and restoring Australia’s environment

The AWRI manages Sustainable Winegrowing Australia, which now encompasses 1,820 members representing 85% of Australia's vineyards. This experience has highlighted critical infrastructure gaps for environmental protection across agricultural sectors. Over the next 5-10 years, three essential research directions require enhanced national infrastructure: Agricultural Sustainability Monitoring: Precise quantification of soil carbon sequestration requires advanced metabolomics capabilities beyond current capacity. Reducing fertiliser inputs needs improved soil multi-omics platforms connecting Metabolomics Australia networks with the Australian Plant Phenomics Network. Biodiversity assessments in agricultural landscapes, as well as defining and promoting healthy soils at national level, demand integrated genomic surveillance tools with data infrastructure for species identification and metabolomics tools for functional assessments. Biosecurity and Endemic Pest Management: Early detection systems for invasive species require sampling and mobilisation capabilities in combination with analytical capabilities for species and strain verification that can rapidly deploy across regions. Bioplatforms Australia resources need expanded capacity for environmental diagnostics and biomarker translation to service field applications. Integration of sequencing platforms with environmental sensors would enable continuous monitoring and complement point-in-time sampling. Environmental Contamination: PFAS and emerging contaminant detection and assessment in agricultural systems require expanded screening tools and metabolomics tools to trace biodegradation and establish biomarkers in support of remediation efforts. Tracing environmental impacts from industries requires scalability in sampling and analysis beyond current capabilities. Current environmental monitoring infrastructure often lacks integration with data analysis platforms, limiting innovation in predictive modelling. Strengthening cross-sector communities of practice between agriculture, conservation, and environmental monitoring would maximise infrastructure value while training the next generation in environmental sciences that serve both industry and conservation needs.

Q34.

Building a secure and resilient nation

Not applicable.

Q35.

2.3 The case for a new NRI capability, or enhancements to existing capabilities, typically emerges through advocacy from research communities clustering around rigorously identified needs and goals. Such a concept could respond to a requirement for novel or expanded capacity within a domain, or across domains, and must be such that it could only be made available with national-level investment.
If you have identified such a requirement, briefly describe the need, the proposed infrastructure capability, the medium-term goals, impacted research communities, and the timeframe over which you advocate its establishment. Your response can include links to relevant existing reports.

A case for enhanced or new NRI capability: Modular fermentation facilities to bridge the gap between laboratory-based systems for R&D and large scale production facilities. Background: Fermentation is a green manufacturing technology that uses yeast and other microorganisms to produce a range of valuable products, from pharmaceuticals and foods to biofuels, enzymes and fine chemicals. While some companies have been manufacturing fermentation-based products for over three decades, in recent years, 'precision fermentation' has attracted global attention and investment in the production of food ingredients used in vegan dairy and meat alternatives, aroma compounds, lipids and proteins. The biomass fermentation industry has seen a rapid diversification in microbial species, production methods and consumer products. From 2013 to 2022, the average global investment in fermentation-derived products tripled, and the number of commercially producing companies increased from seven to 136. To support translation of research and realise long-term growth, contract manufacturing organisations (CMOs) and innovation in technical capabilities play a crucial role in alleviating manufacturing capacity constraints, especially for early-stage companies working with precision or liquid-biomass fermentation. However, the limited availability of CMOs and fermenter capacity across all stages of development remains a challenge. To address this gap, there is a case for creating modular fermentation facilities, together with ready access to down-stream processing technologies, to bridge the gap between laboratory-based systems for R&D and large scale production facilities. These would connect with existing Bioplatforms Australia and Metabolomics Australia capabilities to enable monitoring of fermentation processes and products. In addition, brownfield development and retrofitting existing equipment have the potential to reduce up-front capital expenditure by more than 70 percent and significantly shorten construction lead times. However, no blueprints are available for retrofitting the equipment involved, especially fermenters traditionally used for anaerobic wine production. In this context it's worth noting that a large volume of fermentation capacity across Australian wineries is currently underutilised, proving an opportunity for developing diversified fermentation infrastructure and capability.

Q36.

Part 3: Industry perspectives

This section is seeking input specifically from industry-based respondents. Other respondents can skip this section.

Recommendation 6 of the 2021 Roadmap related to improvements in industry engagement with NRI. To complement work on this topic that has occurred since then, we are seeking additional advice on NRI requirements as perceived by current or potential industry-based users.

Q37.

3.1 Have you (or your organisation) interreacted with or used Australia's NRI?

- (●) Yes
- ( ) No

Q38.

3.2 If so, please briefly outline the NRI capabilities you (or your organisation) have interacted with or used. Do not limit your response to NCRIS capabilities.

The AWRI and its subsidiary, Affinity Labs, regularly uses services, access to equipment, specialised staff and training provided by BPA's facilities, including Metabolomics Australia for bespoke chemical analysis, and the Ramaciotti Center, SAGC and AGRF for genomics and bioinformatics support services. We also utilise Pawsey for high-performance computing of population-size data sets needed for pattern recognition in support of developing novel analytical capabilities. These partnerships are essential for multi-omics approaches and building foundational data in support of our work serving industry through analytical services and translation of research findings. Other NRI facilities AWRI interacts with from time to time for specific project needs include: The Atlas of Living Australia, Australian Plant Phenomics Network (APPN) and Microscopy Australia.

Q39.

3.3 Please indicate your (one or more) primary reasons for interacting with NRI:

- [x] For expertise or advice
- [ ] Access to research resources or products
- [x] Access to equipment for research
- [x] Access to equipment for operational reasons
- [x] Help in translating research
- [ ] Access to data

- [ ] Support for clinical trials
- [ ] Other (please specify)

Q40.

3.4 If you answered no, please indicate your (one or more) primary reasons:

This question was not displayed to the respondent.

Q41.

Part 4: Other comments

4.1 Please elaborate on any of your above responses or add any other comments relevant to the development of the 2026 Roadmap. Your response can include reference or links to existing reports that you recommend be considered during the 2026 Roadmap development process.