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Bioscience Futures: Collaboration, Innovation, and Impact in Australia and the Asia-Pacific

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ABSTRACT

In an era defined by rapid technological change and interconnected global challenges, bioscience stands at the forefront of innovation with the potential to reshape enterprise ecosystems and drive sustainable wealth creation. This paper explores how collaborative models—spanning academia, industry, and government—are pushing the boundaries of discovery in bioscience research across Australia and the Asia-Pacific region, drawing on the work of Australian researchers and Fellows of the Australian Academy of Science. It examines the transformative role of artificial intelligence, high-performance computing and data, and shared international research infrastructure in enabling new breakthroughs. Australia's bioscience education landscape and the long-term vision outlined in the Academy's Bioscience 2030 report, emphasising how future-ready education and workforce development are essential to building resilient innovation ecosystems and Australia's broader research and development system, including the challenges of translating early-stage discovery into real-world impact are discussed. The Academy has an initiative to measure Australia's future national science capability, with synergies to the Philippines' *PAGTANAW 2050*. This presentation provides an Australian perspective on how collaborative foresight, investment in research infrastructure, and a shared commitment to bioscience excellence can help realise a thriving, innovation-led future for the Asia-Pacific.

Presented during the 47th Annual Scientific Meeting of the National Academy of Science and Technology Philippines on 9-10 July 2025

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Keywords: Bioscience, International collaboration, Science-policy interface, Sustainable development, Asia-Pacific, Research partnerships, Artificial intelligence, Science education, Climate change, Innovation and technology

Abbreviations: AASSA, Association of Academies and Societies in Asia; ACIAR, Australia Centre for International Agricultural Research; AI, Artifical Intelligence; CA, Conservation Agriculture; CSIRO, Commonwealth Scientific and Industrial Research Organisation; DOST, Department of Science and Technology; GDP, Gross Domestic Product IRRI, International Rice Research Institute; ISC, International Science Council; NAST PHL, National Academy of Science and Technology Philippines; NSW, New South Whales; PCAARRD, Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development; QUT, Queensland University of Technology; RFP-AP, Regional Focal Point for Asia-Pacific; UP, University of the Philippines; UK, United Kingdom; USA, United States of America; WISE, Women in Science and Engineering

Bioscience at A Turning Point

The world is navigating a period of profound transformation, marked by both unprecedented challenges and significant opportunities. In the Asia-Pacific region, these dynamics are especially pronounced. The accelerating impacts of climate change, biodiversity loss, demographic shifts, and the emergence of new diseases are placing increasing pressure on social, environmental, and economic systems. At the same time, rapid technological advances- including developments in artificial intelligence and synthetic biology- are reshaping the way we live, work, and interact.

Within this context, the role of bioscience is both critical and far-reaching. As a field that deepens our understanding of living systems, bioscience also provides the foundation for innovative responses to some of the most pressing issues of our time. From enhancing ecosystem resilience and securing food systems to improving public health and supporting inclusive economic development, bioscience has the potential to drive sustainable and equitable progress across the region.

Collaboration Unlocks the Potential of Bioscience

To fully unlock the potential of bioscience, collaboration is essential— not only across nations, but also across sectors and disciplines. The complexities of today's global challenges require integrated approaches that leverage diverse expertise and resources. Whether addressing the climate crisis, advancing healthcare solutions, or fostering sustainable economic development, no single country or field of study can provide all the answers.

In this regard, regional cooperation becomes especially important. Forums and platforms where scientists, policymakers, and stakeholders from various sectors and nations engage in open dialogue are crucial for aligning research priorities, sharing knowledge, and developing joint strategies. This collaboration is not just an ideal, but a necessity for ensuring that bioscience innovations are translated into tangible solutions for the collective benefit of societies and ecosystems.

The Australian Academy of Science and NAST PHL

Both the Australian Academy of Science and the National Academy of Science and Technology Philippines (NAST PHL) are active members of the Association of Academies and Societies of Sciences in Asia (AASSA). This regional network has provided valuable opportunities for collaboration, leadership, and engagement. The Academy's Foreign Secretary, Professor Frances Separovic—a renowned biophysical chemist—currently serves on AASSA's Advisory Committee and chairs its Women in Science and Engineering (WISE) committee,

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where NAST PHL is also represented by Professor Aura Matias.

The Australian Academy of Science was delighted to host a delegation from the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development of the Department of Science and Technology (DOST-PCAARRD) in May 2025, led by Executive Director, Dr. Reynaldo Ebora. This was a fruitful meeting, where discussions included the nature of international research partnerships and experiences with Australia, priority areas for the Philippines, how DOST-PCAARRD engages with Indigenous Knowledge systems and practices, and how both countries can strengthen research collaborations.

Regional Collaboration and Strengthening Science-Policy Links

The Australian Academy of Science hosts the International Science Council's Regional Focal Point for Asia-Pacific (ISC RFP-AP). Professor Gisela Concepcion served as a valued member of the Regional Focal Point's Advisory Committee from 2023 to 2025, and her leadership, insights, and commitment to advancing science across the region have been deeply appreciated.

Under the umbrella of the ISC RFP-AP, the Academy supports a new initiative called Seeds of Science Asia (https://aassrec.org/call-for-applications-for-seeds-of-science-asia-program). This program offers grants which are designed to strengthen the science-policy interface across the region, which is crucial for ensuring that our research informs the decisions that shape our societies and our future.

The goal of Seeds of Science Asia is simple but powerful: to support evidence-informed, adaptive, and forward-looking governance throughout our complex region. By building researchers' capacity to engage with policy processes, and likewise, by building policymakers' capacity to engage with scientists, it aims to ensure that the best available research is used to address the complex challenges our societies face. This is a small but significant step towards building a future where science and policy work hand-in-hand for the benefit of all.

In addition to this program, the Regional Focal Point supports a mentoring initiative to build the next generation of science leaders. In 2025, four outstanding early-career researchers from the Philippines have been selected for the Asia-Pacific Mentoring Program:

- Dr Chinee Padasas-Adalla, a biological scientist from Cavite State University;
- Dr John Andrew Albay of the University of Santo Tomas, whose research focus crosses chemical sciences and education;
- Dr Temmy Vales, a chemical scientist from Caraga State University; and
- Melinda Gagaza of De La Salle University-Manila, whose research spans mathematical sciences, technology, and education.

Through initiatives like these, we are laying the foundations for stronger, more resilient, and more just societies within our region– by ensuring that science is not only excellent, but also deeply connected to the decisions that shape our world.

Research Collaboration between Australia and the Philippines

Research collaboration between Australia and the Philippines has increased in the past 10 years as shown by the number of publications from 2015 to 2024 (Figure 1). Our greatest area of collaboration is biomedical and clinical sciences, followed by clinical sciences and then biological sciences (Figure 2). Biological science research between Australia and the Philippines commonly occurs in ecology, environmental science and genetics (Figure 3).

The top research organisations by number of publications are the following: International Rice Research Institute, Philippines; University of Queensland, Australia; University of the Philippines Manila, Philippines; University of the Philippines Los Baños, Philippines; and James Cook University, Australia.

The top funders for publications in biological sciences involving research institutions from both Australia and the Philippines are also shown in Table 1

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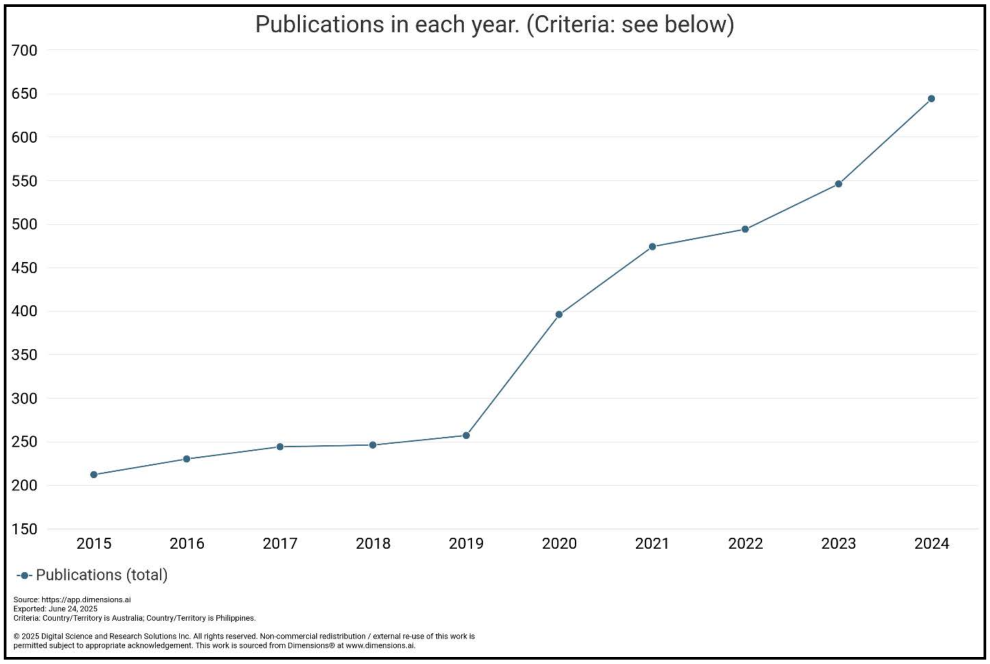

Figure 1. Publications involving both Australian and Philippine research institutions over time.

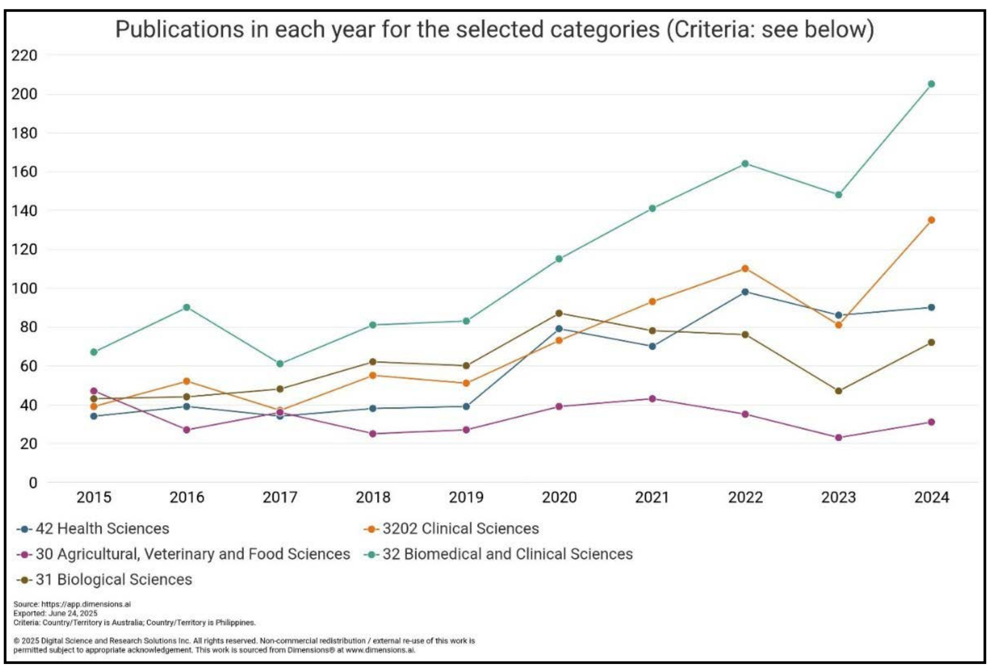

Figure 2. Top Field of Research codes by number of publications.

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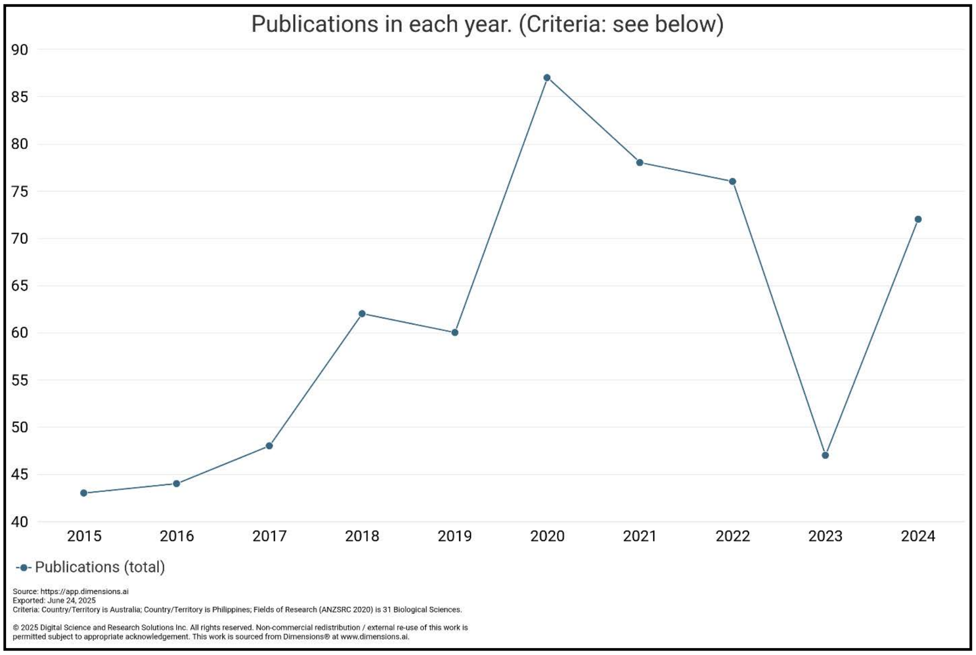

Figure 3. Research Collaborations in Biological Sciences of Australia and the Philippines over time.

Table 1. Top funding institutions for publications in Research Collaboration in Biological Sciences of Australia and the Philippines.

Organisation & country	Number of publications
Australian Research Council – Australia	95
European Commission – Belgium	88
Directorate for Biological Sciences – United States	76
Bill & Melinda Gates Foundation – United States	56
Wellcome Trust – United Kingdom	55

Case Studies of Successful Collaboration

Australia's experience in bioscience shows how collaborative models- bringing together academia, industry, government, and communities- can deliver real-world impact, and highlighted below are a few examples of Australian scientists who have advanced regional or global bioscience through strong collaborative partnerships.

Case study 1: Developing genetic solutions to enhance cereal crop resistance to fungal pathogens

Dr. Evans Lagudah, a Fellow of the Australian Academy of Science and Chief Research Scientist at CSIRO, leads a multidisciplinary team focused on developing genetic solutions to enhance cereal crop resistance to fungal pathogens (Figure 4). This initiative aims to reduce reliance on chemical treatments, thereby supporting both human and environmental health.

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Figure 4. Dr. Evans Lagudan at IRRI with the collaborating team.

Building upon their discovery of a rare, naturally occurring mutation in a wheat nutrient transporter gene conferring broad-spectrum resistance, Dr. Lagudah's team collaborated with scientists at the International Rice Research Institute (IRRI) in the Philippines. Together, they employed gene editing techniques to replicate similar mutations in rice, resulting in improved resistance to persistent fungal diseases.

This partnership extends beyond laboratory research. By integrating their findings into breeding programs, the collaboration aims to develop rice and wheat varieties that are more resilient to diseases, thereby enhancing food security in regions heavily affected by cereal crop pests. Such efforts are crucial for smallholder farmers who are often the most vulnerable to crop losses due to fungal diseases.

The collaboration includes capacity-building initiatives, such as training programs and workshops, to equip local scientists and farmers with the knowledge and tools necessary to implement these innovations effectively. This holistic approach ensures that the benefits of the research are accessible and sustainable, fostering long-term improvements in agricultural practices and livelihoods.

Case study 2: Development of plant-based omega-3 oils

An example of innovation through partnership is the work of Academy Fellow, Dr Surinder Singh and his team at CSIRO (Figure 5), who have collaborated across disciplines and sectors to address a global sustainability challenge.

To meet the rising global demand for omega-3 oils, which are essential for human health and aquaculture, Dr Singh's team worked with partners in crop science, biotechnology, and industry to develop a sustainable, plant-based source of these vital nutrients.

By using advanced genetic techniques, they enabled canola, a widely grown oilseed crop, to produce the key omega-3 fatty acids EPA and DHA, traditionally sourced from wild fish. This breakthrough was made possible through cross-sector collaboration, combining expertise in genetics, agriculture, and health to deliver a scalable, environmentally sustainable alternative to fish oil.

The result is a globally significant innovation that supports marine conservation, food security, and public health- and demonstrates how partnerships can accelerate solutions to shared challenges.

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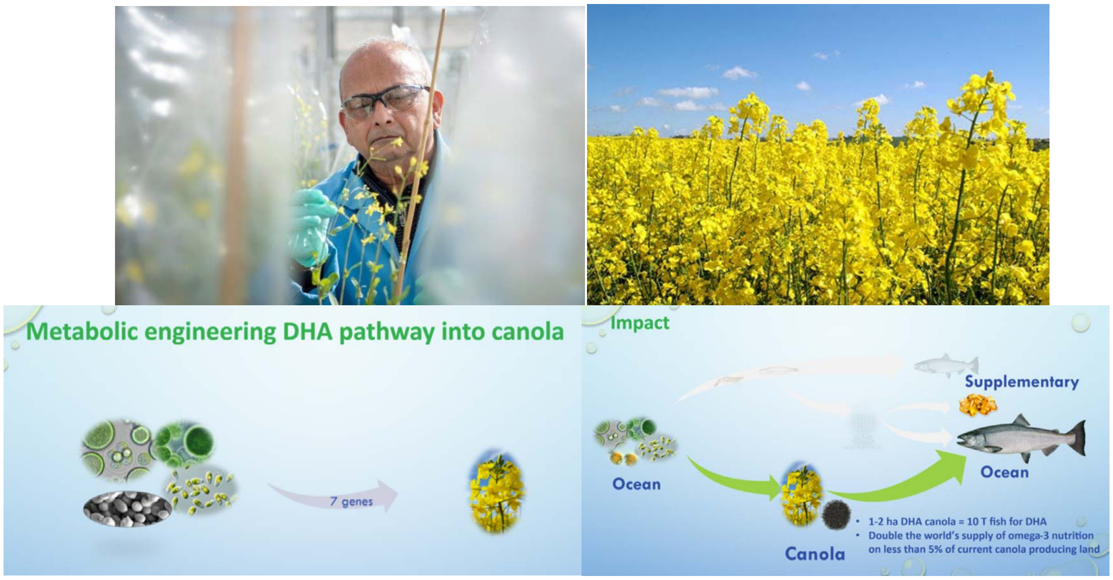

Figure 5. Dr Surinder Singh and his team successfully engineered the key omega-3 fatty acids pathway in canola

Case study 3: Combining expertise and resources to promote food security, sustainable agriculture, and improved livelihoods

A powerful example of international collaboration in agricultural biotechnology is the work of Academy Fellow, Dr TJ Higgins of CSIRO Australia.

Dr Higgins has led a long-standing partnership with Assam Agricultural University in India to develop insect-resistant chickpea varieties, targeting the pod borer (*Helicoverpa armigera*)- a major pest threatening yields and livelihoods in South Asia (Figure 6).

Supported by partners including the Indian Department of Biotechnology, ACIAR, the McKnight Foundation, and the Indo-Swiss Collaboration in Biotechnology, the collaboration has resulted in transgenic chickpeas expressing Bt genes (Cry1Ac and Cry2Aa). These innovations aim to reduce dependence on chemical pesticides and improve productivity, particularly for smallholder farmers.

Field trials and biosafety assessments in India- with further testing planned in Bangladesh- mark significant progress toward regional adoption.

This initiative demonstrates the real-world impact of cross-border scientific cooperation, combining expertise and resources to promote food security, sustainable agriculture, and improved livelihoods in vulnerable farming communities.

Case study 4: Philippines – Australia Research on coral larval restoration

Led by Professor Peter Harrison of the Southern Cross University and UP Marine Sciences Institute, Philippines, from 2015- 2025, this case is an exemplar of transdisciplinary collaboration in coral restoration research delivering huge benefits for both countries (Figure 7). The Philippines actively sought to be at the 'leading edge' of innovation and is substantially co-investing in the research. At the start, it was an uncertain concept, but science breakthroughs created a pathway for impact at scale that had not been previously seen.

The proof of concept that larval restoration techniques can be made practical, resulting in restored reefs spawning after just three years, is now being rolled out at multiple sites in Australia, the Philippines, the Maldives, and soon, Indonesia. Robotics innovation by Queensland University of Technology (QUT) is a key part of this scale-out. Parallel research on the drivers of policy change by the University of Technology Sydney has opened the door for major policy impact in the Philippines, influencing their soon-to-be-released National Coral Reef Program.

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Figure 6. Dr TJ Higgins of CSIRO Australia, with collaborators in India.

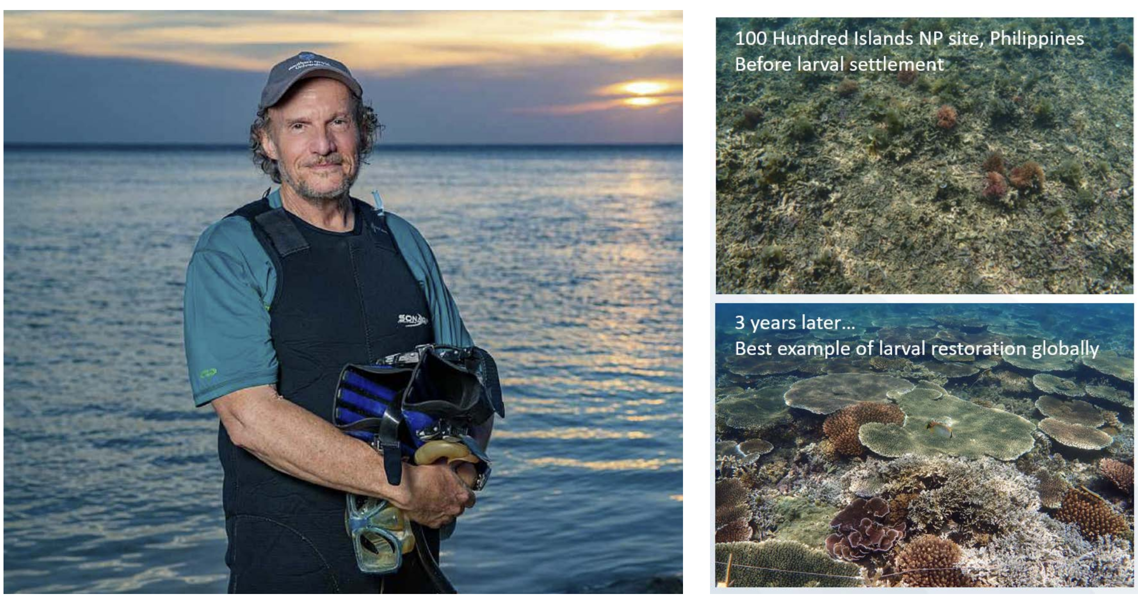

Figure 7. Professor Peter Harrison of Southern Cross University, collaborated with the UP Marine Sciences Institute, Philippines, from 2015- 2025

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Case study 5: China – Australia research on conservation agriculture (CA)

Over 10 years, from 1993- 2003, Dr. Jeff Tullberg, the University of Queensland and China Agricultural University identified equipment and residue treatment methods and economically and socially viable conservation agriculture (CA)—a systems suitable for wheat and maize in north-western China (Figure 8).

Before the early 1990s, most Chinese agricultural scientists considered that conservation agriculture technologies had little relevance for dryland farming in China. This was at a time when Australia was beginning to scale out these technologies in grain farming. Research collaboration over ten years aimed to see if a similar pathway might be possible and relevant in China.

The research collaboration lasted until 2003, but it did not end there. China Agricultural University, working with industry, drove a massive scaling up of the potential, resulting in massive benefits for productivity, reduced greenhouse gas emissions, and soil health. The China Institute for Conservation Agriculture formed on the back of these developments, still remembers the origins of these impacts and looks to work with Australia trilaterally to expand the benefits to other countries in the region.

Case study 6: Vietnam – Australia research on oyster industry development

This case is about how science collaboration between Australia and Vietnam resulted in the development of a very large oyster industry from scratch. Led by Professor Wayne O'Connor, NSW Fisheries and Research Institute for Aquaculture 1 and industry, Vietnam, from 2005-2019 (Figure 9).

Innovations in hatchery and grow-out technology linked to long-term approach to supporting all facets of industry development – from regulation and management, through to grow-out and selective breeding

In the early 2000s, oysters were consumed in small quantities in coastal communities, but the seed supply

Figure 8. Collaboration of Dr Jeff Tullberg, University of Queensland, and China Agricultural University on conservation agriculture.

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Figure 9. Professor Wayne O'Connor and NSW Fisheries and Research Institute for Aquaculture 1 and Vietnamese industry collaboration from 2005-2019.

was limited. A review of opportunities identified that the development of bivalve hatchery production capacity was a key gap that needed some basic research before industry development could proceed.

The subsequent research developed the basic understanding needed to underpin the development of bivalve hatcheries. The collaboration also built essential skills needed to support oyster industry development (e.g., Specialist molluscan veterinary skill, Biosecurity skills, Food Quality Assurance skills). The result was a massive scale-out of the industry from scratch to become 1.5 times greater than the industry in Australia by 2019, at the end of the ten years of research.

Each of these examples underscores a central truth: bioscience breakthroughs rarely happen in isolation. They are born from networks of cooperation that transcend borders.

As a region, we have immense shared strengths-rich biodiversity, vibrant research communities, and complementary capabilities. Our task is to weave these together, creating a fabric of innovation that is resilient, inclusive, and future-facing.

AI, Data, and Shared Infrastructure

At the heart of this transformation lies technology. Artificial intelligence, high-performance computing, and advanced data analytics are revolutionising bioscience. These tools enable us to model living systems in unprecedented detail, process vast datasets across genomics, ecology, and health, and accelerate the pace of discovery.

Yet this progress depends on a powerful and often invisible backbone: research computing infrastructure. From genome centres to synchrotrons and biofoundries, to the supercomputers that power modelling and simulation, these systems are now essential scientific instruments.

Australia's scientific community, led by the Academy and others, is calling for greater investment in next-generation computing capacity. This includes a vision for shared regional access to exascale computing—systems capable of performing a billion billion calculations per second. Hosting such capability in the Asia-Pacific would be transformative, opening up new possibilities in bioscience, climate modelling, medicine, and more.

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As a nation, Australia is committed to working with partners to ensure that these technologies- whether hardware or data- are not only world-class, but also ethical, inclusive, and designed for the common good.

Future-ready Bioscience Education

The recent explosion in AI and related technology advancements has forced the discipline to question how and what we value in a bioscience curriculum. The Australian Academy of Science's Bioscience 2030 report explored how Australia can build a bioscience education system that is truly future-ready. The report's message is clear: we must equip our graduates not only with foundational knowledge, but with skills such as:

- How to think critically and use sound judgement - in the age of unparalleled access to "facts and content" and mis and disinformation - the ability to judge what is correct and appropriate is paramount.
- The role of communication and advocacy of bioscience to diverse audiences and contexts
- Data literacy and a deep understanding of data
- Adaptability, resilience and embracing uncertainty
- How to flourish in digital and hybrid learning environments.

The pandemic taught us valuable lessons in this regard. We learned that hybrid education models- blending in-person and online learning- can provide flexibility, resilience, and new forms of engagement—while still achieving the appropriate learning outcomes. We also saw how technologies like AI, virtual reality and augmented realities and new digital media can complement and enrich the learning experience.

But challenges remain

The report identified a disconnect between academia and industry, a limited public awareness and understanding of biosciences, and ongoing funding uncertainties. If we want bioscience to deliver its full potential, we must address these gaps- strengthening links between universities and the private sector, engaging communities, and advocating for sustained investment.

National Foresight, Australian Science, Australia's Future: Science 2035

The Academy's work extends beyond bioscience to the broader science system. In 2024, the Academy began work on an initiative called Australian Science, Australia's Future: Science 2035. **The primary aim of this initiative is to assess whether Australia has the balance right when it comes to its science capability—does it fit what we need? And is the system fit for purpose for the challenges that lie ahead?**

For a long time, the Academy has been calling on the government to undertake a root and branch review of the science system that could do just that. In the 2024 federal budget, the Strategic Examination of R&D was announced and is now well underway. As part of the Academy's contributions to this Strategic Examination, **it designed Science 2035 to analyse Australia's preparedness to respond to its national challenges.**

The Australian Government 2023 Intergenerational Report (https://treasury.gov.au/publication/2023-intergenerational-report) was of particular importance in the literature review phase. This is a report that provides analysis and projections of the key drivers of economic growth to help inform and improve public policy settings to better position Australia for the next 40 years. Not just a single budget year or election cycle, but a look at those forces that will shape our economy for decades to come.

<u>The intergenerational report lists the five biggest forces shaping the Australian economy over the coming decades as</u>:

- Population ageing
- Technological and digital transformation
- Climate change and net zero transition
- Rising demand for care and support services
- Geopolitical risk and fragmentation.

We also looked at federal and state government reports to assess the forces shaping our economy in the long term and took a stocktake of the different science and research priorities that exist across the government, including in Defence, CSIRO missions, and many others.

Through national and international consultations—including with our colleagues in the Philippines—we have identified where our science system is strong, where it must grow, and how we can work together to build capability - work that has a lot of parallels with the Philippines initiative PAGTANAW 2050 (https://www.nast.dost.gov.ph/index.php/pagtanaw-2050/595-pagtanaw-2050-the-philippine-foresight-key-descriptions).

A vital part of this work is engaging with Aboriginal and Torres Strait Islander communities, ensuring that our vision for science is inclusive, respectful, and enriched by the deep knowledge systems of Australia's First Peoples.

It is about creating a science system that is fit for the future—for Australia and for our region.

At the end of the process, we had identified three major challenges Australia would need to address by 2035:

- Technological transformation;
- Demographic change; and
- Climate change, decarbonisation and the environment.

These major challenges are underpinned by two cross-cutting challenges: The first is our national capability—we know that Australia lacks industrial diversity, making it susceptible to external shocks like trade disputes, extreme weather events, pandemics, and military conflicts. The second is the role of education and science literacy in ensuring the Australian public is equipped to make informed choices in a rapidly changing world.

The need for the public awareness of science and appropriate levels of community science literacy are an age-old challenge, however, the current explosion in social media, generative AI, deep fakes and the subsequent opportunities for the spread of mis and disinformation are a clarion call for new initiatives in this area - what does an informed and well-equipped citizenry look like - and more significantly - what can we do to work towards such goals?

A Vision for Australia in 2035

Once we had identified the challenges, we then needed a vision, a goal to measure progress against: ***By 2035, Australia will have built the capacity to provide its people with an enviable quality of life while contributing as a responsible global citizen.***

For this we drew from the Measuring What Matters framework (https://treasury.gov.au/policy-topics/measuring-what-matters), a framework developed by the Australian Government's Treasury to track themes and indicators of wellbeing, to understand, measure and improve what matters to Australians. This has cross-cutting themes of inclusion, equity, and fairness. Drawing on this philosophy, success is not based solely on GDP growth, but on a broader suite of indicators—healthy environment, cohesive society, prosperous economy, and thriving people.

We started to break apart the problem and tried to find a method for measuring science capability into the future. We wanted to be specific with asks or recommendations to reinforce this science capability, but gaps in information existed, particularly around the demand side of science- figuring out what we would need more of and how much more- and predicting how our workforce will look into the future.

Once we had these gaps, we moved into the data gathering phase. We took the three major challenges facing Australia and compiled data dashboards to present information on the science capability that will help respond to these challenges. These dashboards helped give us an idea of the current state of Australian science and helped us to look at different patterns over the past decades. This data is a compilation of public data and data that we have collated or requested to fill gaps in knowledge about science capability.

Based on all the data we collated, we determined the top 10 science capability areas Australia would need to meet the three major challenges:

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- Data science
- Statistics
- Modelling
- Artificial intelligence
- Climate science
- Agricultural science
- Biotechnology
- Geoscience
- Epidemiology; and
- Materials science.

Whole of System Findings

Some of the key findings included:

1. Australia's international collaboration is heavily reliant on our top three collaborators: the USA, China, and the UK – but the strengths and reliance on those collaborations are poorly understood on a system level.

2. High-Performance Computing capabilities are urgently needed to deliver essential data science, statistics, and modelling capabilities, e.g., for genomic analysis and drug synthesis in current and future scientific fields – but we have no long-term planning or investment in this capability. One of our national facilities will reach the end of its life span this year, and there is no plan to replace it.

3. Faster, reliable telecommunications infrastructure is essential, both to do science and to deliver services, including rural and remote health services.

4. Advancing multi-disciplinary approaches for problem-solving and systems thinking is essential. Reflecting on various knowledges, including Traditional Knowledges and humanities and social science disciplines, will help address the challenges facing Australia.

5. Science communication is needed broadly to demonstrate the value of science to society and to build trust in science by addressing disinformation.

6. Workforce: focus on investing in and supporting people in our science system and creating a strategic approach to science capabilities and skills.

7. Structures and systems needed to accelerate science into solutions, e.g., medical research into clinical practice.

8. STEM education to be further examined and understood, to address:

- How higher education can adapt to the demands of future careers and technologies
- Declining domestic PhD enrolments in many areas of science
- Restricted mobility of the research workforce, e.g., between academia and industry
- STEM workforce diversity
- Vocational training for specialist areas, e.g., electricians for decarbonisation, plumbers for supercomputing infrastructure.

What's Next?

This is where our work comes full circle. The Academy's analysis has shown—disciplined by data and informed by foresight—where Australia's science capability is insufficient to meet our 2035 challenges. But identifying the gaps is only the first step; we now need to fill them.

We are examining Australia's gaps in scientific capability in this way for the very first time. We are using what we have found to inform the Australian Government's Strategic Examination of R&D, and in September 2025, we will publish various outputs, including the report and method, and progressing the recommendations at our 2025 Symposium as part of our annual flagship event, Science at the Shine Dome.

We are excited to share what we've found and to begin to chart a path forward that builds the science capability Australia will need to confront the challenges of our future.

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Building an Innovation-led Future Together

In closing, let's return to where this discussion began, with Bioscience.

Bioscience offers our region extraordinary opportunities— to drive innovation, build sustainable economies, and improve health and wellbeing. But to realise these opportunities, we must do three key things:

1. Collaborate across borders and sectors;
2. Invest in education, technology, and infrastructure; and
3. Strengthen the links between science, policy, and society.

By working together as partners in science and innovation, we can build a future that is not only prosperous, but sustainable, inclusive, and resilient. Let us continue to share knowledge, build partnerships, and create solutions that serve both current and future generations.

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