Australian Government

ANSTO

ANSTO Submission

Standing Committee on Agriculture and Water Resources - Inquiry into growing Australian agriculture to $100 billion by 2030

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Introduction

ANSTO (the Australian Nuclear Science and Technology Organisation) is pleased to make this submission to the Standing Committee on Agriculture and Water Resources.

ANSTO operates a large proportion of Australia's landmark research infrastructure, including the OPAL nuclear research reactor, the Australian Synchrotron and the Centre for Accelerator Science. This infrastructure places Australia at the forefront of research and innovation for the benefit of public health, industry and the environment, and is used by researchers and industry from around Australia and internationally.

A primary function of ANSTO, as mandated by the *Australian Nuclear Science and Technology Organisation Act 1987* (ANSTO Act) is to undertake research and development in relation to the production and use of radioisotopes and isotopic techniques for medicine, science, industry, commerce and agriculture.

ANSTO undertakes a wide range of research activities that relate to the aims of the current enquiry. Of particular relevance to the current inquiry is ANSTO's work in developing technologies that have the potential to expand the capabilities and improve the efficiency of the Australian agricultural sector.

ANSTO's facilities are used by a range of researchers and commercial users, including grain producers, aquaculture organisations, water resource managers and livestock organisations to conduct research that can directly affect their activities, including yield, financial savings and export market presence.

ANSTO also conducts research that investigates the underlying environmental challenges faced by Australian farmers as they seek to effectively manage scarce natural resources.

Primary Production Sectors

Australia's primary production sectors are comprised of, but not limited to: aquaculture and fishing, sheep, beef cattle and grain farming, other crop growing, dairy cattle farming, horticulture and fruit growing. This submission will outline the research ANSTO has undertaken across some of these areas, as well as the research it undertakes more broadly, which could be used to inform the future of the agricultural industry in Australia.

Aquaculture and Fishing

Feed Optimisation

Aquaculture is one of the fastest-growing food production sectors globally.[1] The aquaculture industry in Australia is relatively small compared to the global market, but has the potential to make large contributions to the economy. Whilst the aquaculture sector in Australia is also fast-growing, there are barriers to the continued growth and sustainability of this industry.

Currently, the cost of aquaculture production remains high, with feeding constituting a large majority of this cost.[2]

Isotopic and nuclear techniques at ANSTO, such as *Itrax* X-ray Fluorescence (XRF) scanning, ion beam analysis and neutron activation, have been deployed in agricultural research to assist in the identification of the right feed ingredients and quantities for fish in farmed conditions.

Accurate identification of the quantity of food being consumed by farmed fish can assist farmers in mitigating waste and over-feeding, leading to cost savings.

ANSTO can also determine if farmers are utilising the correct feed ingredients through the utilisation of isotopic techniques. These techniques enable ANSTO to determine if nutrients within feed material are absorbed and utilised in fish, or if they are simply discarded or excreted. This, similarly, can assist fish farmers in purchasing effective feed material to maximise the efficiency of their farming, and minimise the use of underutilised feedstock.

[1] FAO. 2018. *The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals.* Rome.
[2] Irvin S, Coman G, Musson D, Doshi A and Stokes C (2018) *Aquaculture viability. A technical report to the Australian Government from the CSIRO Northern Australia Water Resource Assessment, part of the National Water Infrastructure Development Fund: Water Resource Assessments*. CSIRO, Australia.

Case Study 1 – Feed Optimisation in Oysters and Finfish
In a joint research program with the NSW Department of Primary Industry (Fisheries), the University of New South Wales, the University of Tasmania and the Papua New Guinea National Fisheries Authority, ANSTO is optimising feeding in oyster and finfish farms by analysing feed and fish samples using *Itrax* X-ray fluorescence (XRF) scanning, ion beam analysis and neutron activation capabilities. ANSTO has demonstrated that through optimising feeding, product quality significantly improves – namely product colour and nutritional composition (Omega-3).

Seafood Provenance

Producing safe and high quality seafood is important to ensure consumer health and sustainable agribusiness.

Most of Australia's seafood is exported as high-value premium product. Approximately 70% of the edible seafood purchased domestically is imported largely from Asia, New Zealand and elsewhere.[3] The combination of domestic and imported products provides Australian consumers with access to high-quality Australian products, as well as a large choice of international products.

As Australian seafood is considered to be of high value,[4] the import and export of seafood has led to food fraud. This is a practice where a product is substituted with one of lower quality or value, or where product claimed to be Australian actually comes from another country, in order to increase profit margins.

Isotopic and nuclear techniques at ANSTO have been deployed to develop a technology that will enable seafood fraud to be detected. This will help to minimise the presence of fraudulent seafood products in the market, enabling Australian seafood to effectively compete both domestically and internationally.

Case Study 2 – Seafood Provenance
ANSTO is leading a project alongside the University of New South Wales, Macquarie University, the National Measurement Institute and the Sydney Fish Market that focuses on the novel application of nuclear techniques in seafood provenance and quality authentication. This project will lead to the development of a quick analytical tool that facilitates seafood authentication. ANSTO has investigated the use of this nuclear techniques in seafood provenance on two high-value seafood products, barramundi (*Lates calcarifer*) and giant tiger prawns (*Penaeus monodon*).

[3] Ruello, NV 2011, *A study of the composition, value and utilisation of imported seafood in Australia: project final report*, Ruello & Associates Pty Ltd for the Fisheries Research and Development Corporation, Canberra.
[4] Department of Agriculture 2015, *Australia's seafood trade*.

Case Study 2 – Seafood Provenance

The investigation concluded that ANSTO can effectively distinguish if seafood products are farmed or wild-caught, provide insights into the quality of the seafood, as well as the geographic location where the fish or prawns lived, with a high degree of accuracy (>90%). This scientifically validated method will help build consumer confidence in Australian premium products, nationally and internationally.

This technology can be applied to other terrestrial agricultural products such as fruit, various types of cattle, animal products (e.g. wool) for traceability, quality authentication, product branding and certification.

ANSTO is one of only a few organisations in the world that is pioneering the use of nuclear techniques to address questions of sustainable seafood production and seafood provenance to complement regulations, certification and traceability protocols.

The above projects present several opportunities to increase the value of Australia's agriculture industry over the next decade through improved production efficiency and quality assurance capabilities.

Grain Farming

Zinc in Wheat

Wheat is one of Australia's top 10 exports; however, there are challenges for this sector as our nation's agricultural soils are known to be deficient in zinc and other micronutrients critical to the growth of grain crops such as wheat.[5]

ANSTO is deploying nuclear techniques to determine ways to maximise the uptake of nutrients in fertilisers by tracing where zinc goes in the plant and how quickly it moves. Outcomes of this work can help develop new fertilisers that are more efficient at delivering essential nutrients to the plant, while minimising the impact on the environment from over-fertilising.

The increased efficiency in plant fertilisation will help farmers reduce costs associated with excess fertiliser, and enhance crop growth and yield.

Case Study 3 – Zinc Optimisation in Wheat

ANSTO and the Future Industries Institute at the University of South Australia are working on a project to determine what form of Zinc in fertilisers is the most efficient to provide a more sustained supply to broad-acre crops such as wheat. The study also involves determining the amount of fertiliser required to optimise growing conditions and mitigate excess fertiliser runoff.

[5] Alloway, Brian J. *Zinc in soils and crop nutrition*. Brussels, Belgium: International Zinc Association, 2008; https://www.theland.com.au/story/5459995/nuclear-science-boosts-understanding-of-fertiliser-effectiveness/.

Case Study 3 – Zinc Optimisation in Wheat

To do this, Zinc nanoparticle radiotracers are being irradiated in OPAL, ANSTO's multi-purpose reactor, to understand how zinc is transported through the crop and in what quantities. These crops are then imaged using autoradiography to identify the location of the tracer material. Gamma spectroscopy is also used to measure the concentration of Zinc taken up in the plant.

This study is still ongoing, but has already demonstrated that Zinc nanoparticle-based fertilisers are more effective at delivering Zinc nutrients to plants than conventional Zinc-based fertilisers.

This outcome presents an opportunity to develop evidence-based strategies to improve crop production through fertiliser optimisation, while mitigating the environmental impacts associated with the excess use of fertilisers.

Other Crop Farming

ANSTO's Australian Synchrotron has been heavily utilised by researchers to further understand plant and crop growth capabilities, as well as limitations and hindrances to maximising crop yield.

These findings have led to the development of new technologies which can help to improve the resistance of crops to diseases and unfavourable soil environments.

Case Study 4 – Growing Hardier Crops

ANSTO's Australian Synchrotron is a world class research facility that uses accelerator technology to produce a powerful source of light – x-rays and infrared radiation – many times brighter than the sun.

In very small quantities, Boron is essential for crop growth and development. However, soils with high concentrations of Boron affect crop yields, which results in significant revenue losses. Researchers from The University of Adelaide, in using the Australian Synchrotron, revealed how plants protect themselves from minerals such as boric acid. This has led to a better understanding of how to protect vulnerable vegetation to secure higher yields of edible crops and improve their nutritional properties.

Researchers from The University of Queensland have also used the Australian Synchrotron to improve plant resistance to fungal and microbial infections, making them less susceptible to pre-harvest diseases. These diseases can cause crop losses of up to 15% in a single season and affect a range of fruits and vegetables, including potatoes, tomatoes and kiwifruit.

Cotton

The Australian cotton industry strives for responsible management of nutrients through minimising any potential transfer of excess nutrients to the environment. These nutrients, when added to soil, can be dispersed from their intended primary use via losses to the atmosphere, rivers and aquifers.

Increased nutrient inputs to waterways can result in eutrophication and algal blooms, which are detrimental to the water quality of marine environments and can possibly contribute to coral decline. Therefore, the off-farm movement of nutrients may present an impediment to the ongoing sustainability of this sector, if not effectively managed.

Case Study 5 – Nitrogen Cycle in Cotton Irrigation

ANSTO, alongside the University of New South Wales and the Cotton Research & Development Corporation (CRDC) are investigating the irrigation sector's impact on the nitrogen cycle, and subsequent contributions the sector has made in releasing nutrients to the atmosphere, surface waterways and aquifers.

The areas of Murrumbidgee, Namoi and Nogoa River valleys are being investigated in this regard as they cover a diverse range of climatic, hydrogeological and farming practices in eastern Australia. ANSTO will utilise isotopic techniques to measure the concentration of nitrogen throughout the landscapes and compare them to Australian water quality guidelines.

Outcomes of this study will provide evidence that can be used to map the cotton industry's nitrogen cycle footprint, and can determine the impact of ongoing cotton irrigation practices. This independent research can help to inform policy decisions associated with sustainable irrigation in cotton farming.

This research can be applied to other irrigation and farming practices where independent advice on the impact of irrigation is required.

Other Livestock Farming

Meat Quality

ANSTO has collaborated with the Australian Meat Processing Association, universities and state agriculture departments in Victoria and New South Wales to validate and understand tests for meat tenderness and juiciness, and to correlate these qualities with feed, season and region.

These tests were developed and undertaken using the Australian Synchrotron. This line of testing enables livestock farmers to improve the efficiency of the feed they utilise, and the seasons they farm, to improve the quality of the meat they produce.

Studies such as this can assist Australia's meat industry in become increasingly competitive internationally and domestically.

Climate and the Environment

Improving Groundwater Sustainability

Water remains a scarce resource in Australia, and effective water management is central to good agricultural practice.

ANSTO researchers are utilising isotope hydrology to understand how freshwater resources are renewed, how they interact with ecosystems, and the effects of climate and human impact on these processes. Understanding the location, quality and quantity of groundwater resources in Australia is essential for future agricultural production.

This technique uses isotopic dating to measure and estimate the age, origins and the movement of water within the hydrological cycle.

This research has previously been, and continues to be undertaken in many locations of agricultural significance across Australia, including the Sydney Basin, Lockyer Valley, Gippsland Basin, Condamine River, Lower Namoi, the Darling River and areas of the Great Artesian Basin.

ANSTO also undertakes groundwater research outside of current agricultural regions to determine if additional water resource areas are capable of supporting an agricultural industry.

Case Study 6 – West Canning Basin Groundwater Assessment

ANSTO recently conducted a groundwater assessment of the West Canning Basin in the Pilbara region of Western Australia - an important water resource for regional development and agricultural development (namely livestock and cattle farming).

In utilising isotopic techniques, ANSTO was able to determine the rate of recharge of the West Canning Basin. This rate of recharge is used to identify the presence, reliability and availability of water in this basin into the future.

This research is important in identifying areas of groundwater sustainability and can assist with enabling increased agricultural production and substantial irrigation expansion for this remote arid zone region.

ANSTO's isotopic groundwater study techniques can be used to assist with the sustainable management of water resources and can be used to inform good agricultural and irrigation practices.

Rainfall Studies

Accurate and comprehensive rainfall records are an important planning tool for our agricultural sector, where ineffective planning can impact on crop and livestock sales.

Currently, Australia lacks reliable rainfall records beyond the instrumental record, especially in relation to variability.

ANSTO has undertaken studies to construct water history records dating back hundreds to thousands of years. This work enables researchers to understand variability in rainfall, and will help the agricultural sector to better plan for the future, particularly during periods where low rainfall is expected.

Case Study 7 – South-West Western Australia Climate Studies

On average, there is now 17 per cent less rainfall across Western Australia's south-western region than was recorded prior to 1970.[6] This rainfall reduction has implications for the region, particularly for the agricultural and other water-dependent industries.

There has been an urgent need to understand natural climate variability for this region. ANSTO has demonstrated that reconstructing past climates using climate-sensitive 'proxies' in cave stalagmites is an effective way to achieve this. ANSTO researchers have recently produced one of the longest cave monitoring datasets in Australia from Golgotha Cave stalagmites in south-west Western Australia. ANSTO is now constructing climate records, extending as far back as 8,000 years, in south-west Western Australia that are critically needed by researchers for testing climate models.

These models will lead to improved water resource and land management planning, which are critical to the ongoing sustainability of the agricultural sector in Australia.

ANSTO rainfall monitoring techniques are highly translatable and can be used to measure long-term rainfall trends across most Australian regions, and can help to inform farmers of future rainfall patterns.

[6] Hope, P., Timbal, B., & Fawcett, R. Associations between rainfall variability in the south-west and south-east of Australia and their evolution through time. (2010). *International Journal of Climatology*, 30(9), 1360-1371.

Further Information on Case Studies

Name	Link
Case Study 1 - Feed Optimisation	https://www.ansto.gov.au/news/progress-png
Case Study 2 - Seafood Provenance	https://www.ansto.gov.au/research/programs/health/seafood-provenance
Case Study 3 – Zinc Optimisation in Wheat	https://www.theland.com.au/story/5459995/nuclear-science-boosts-understanding-of-fertiliser-effectiveness/
Case Study 4 – Growing Hardier Crops	https://archive.synchrotron.org.au/images/AnnualReport_AustralianSynchrotron_2015-16.pdf
Case Study 5 – Nitrogen Cycle in Cotton Irrigation	https://www.ansto.gov.au/news/looking-deeply-nitrogen-cycling https://www.crdc.com.au/sites/default/files/pdf/Spotlight%20Spring%202018.pdf
Case Study 6 – West Canning Basin Groundwater Assessment	https://www.water.wa.gov.au/__data/assets/pdf_file/0017/5453/85453.pdf https://www.sciencedirect.com/science/article/pii/S0016703717305665
Case Study 7 – South West Western Australia Climate Studies	https://www.ansto.gov.au/news/reconstructing-a-history-of-palaeoclimate-south-eastern-australia