

# FOOD AND AGRIBUSINESS RESEARCH ROADMAP

Guiding research with impact for resilient regional communities



THE UNIVERSITY OF  
**NEWCASTLE**  
AUSTRALIA

**nier**

SOLUTIONS FOR GLOBAL CHALLENGES  
ENERGY RESOURCES FOOD WATER

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# INTRODUCTION

Food producers, manufacturers and farmers are under increasing pressure to reconcile a number of complex and competing challenges around quality and efficiency, health and environmental sustainability and food security.

At the same time, food and agribusiness is increasingly becoming a focal point for regional innovation and development, changing the economic and social role of food production, processing, distribution and food services more generally.

This Roadmap identifies and defines priority actions necessary to position the University of Newcastle as a major enabler of innovation, delivering scientific and technological advances to improve productivity, efficiency and ultimately competitiveness for the food and agribusiness sector.

This Research Roadmap:

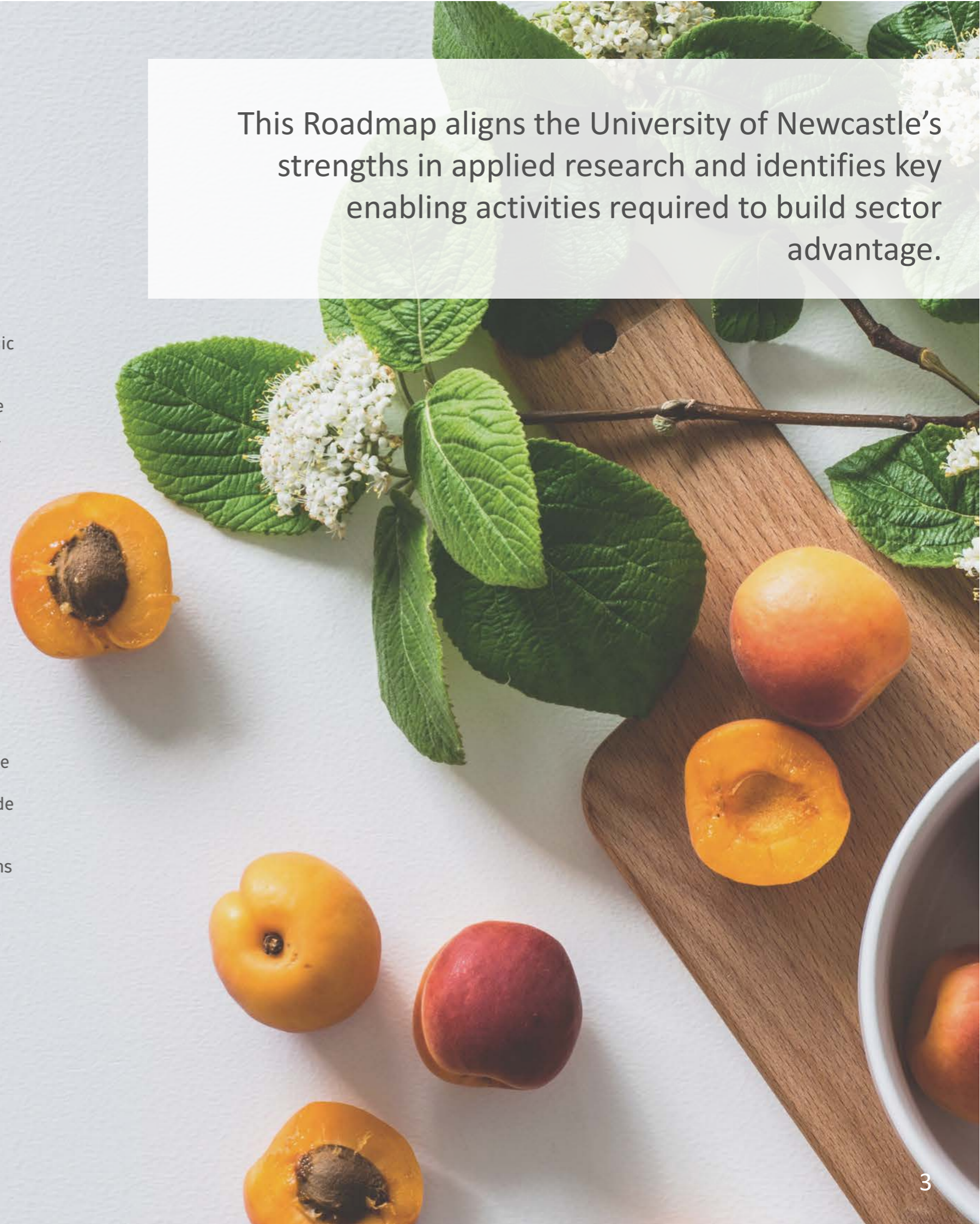
- Offers a strategic direction to guide capacity building to support industry and regional communities
- Provides a framework from which researchers and business can align and coordinate their efforts to increase impact
- Focuses workforce needs and priorities to enhance career pathways for graduates and postgraduates

Through the 'Looking Ahead' Strategic Plan 2020-2025, our University is focused on delivering applied research through Newcastle Institute for Energy and Resources (NIER), an enabling platform for the delivery of multidisciplinary collaboration and partnerships:

- Research and innovation to support superior products and services
- Growth, resilience and greater productivity
- Opportunities for scaling for export growth
- Social and environmental benefits

This Roadmap articulates our University's vision to leverage its core capabilities to benefit Australian industry. This research plan will guide activity to support a vibrant sector, dedicated to achieving environmentally sustainable solutions while fostering a highly skilled workforce through knowledge networks and infrastructure support.

This Roadmap aligns the University of Newcastle's strengths in applied research and identifies key enabling activities required to build sector advantage.



# SECTOR SNAPSHOT

Over the coming years a number of challenges and opportunities will shape the food and agribusiness sector and the communities they serve.

## POPULATION GROWTH AND INCREASED DEMAND

It is expected the world's population will surpass 9.5 billion people by 2050, dramatically shifting the demand for food. High quality foods and varying food sources such as trends towards high protein products are expected. Further, by 2030, roughly 175 to 220 million hectares of additional cropland will be needed to meet projected food, feed, and fuel demand. In contrast almost 800 million people worldwide will have insufficient food, with over 2 billion suffering from micronutrient deficiencies.

## CLIMATE CHANGE

Food and agricultural systems will continue to be challenged by the impacts of climate change. As rising temperatures, shifting rainfall patterns and extreme weather events put increased pressure on production systems, greater responsiveness will be required to adapt to new threats and food, water and energy security issues. Sustainable solutions maximising the efficient use of limited resources, technologies to maintain food quality and safety, and increased sustainability measures through circular economy approaches will be needed to satisfy consumer demand into the future.

The University will work actively to accelerate major scientific outcomes for increased productivity, enhanced biosecurity, resource sustainability, quality products and market opportunities.

## CONSUMER CHOICE AND HIGH VALUE, QUALITY GOODS

The way consumers are seeking to engage with premium offerings will continue to change, with convenience and sensory experiences in growing demand. Coupled with continuing and intensifying competition in global commodity markets, an inability to compete on price means local businesses may have little option but to target premium and high quality global markets.

## BIOSECURITY

The complexity of the food supply chain and the introduction of new technologies in food processing will increase food safety risk. Guaranteeing the safety and integrity of Australia's supply chain and protecting food from microbiological contamination, disease and pests will be ongoing challenges.

# GUIDING PRINCIPLES

Through our Strategic Plan 'Looking Ahead', the University is committed to the provision of quality research and research education to deliver increased competitiveness to the food and agribusiness sector.

This Roadmap demonstrates the University's commitment to support research translation to deliver new and improved Australian products and services in domestic and international markets. We will focus the delivery of capacity building initiatives in accordance with the following principles:

## ESTABLISH PRIORITY SETTING CYCLES

Priority setting that keeps pace with the rate of change in the sector, and which complements government policy and investment will build opportunity for public-private sector partnerships. This will encourage stability to undertake large scale endeavours as well as incremental step change at an SME level. Attention will also be given to addressing gaps in the innovation system that present barriers to the uptake of new processes as well as reinforcing and strengthening current systems.

## LEAD ACADEMIC, GOVERNMENT AND INDUSTRY SECTOR PARTNERSHIPS

Targeted enterprise engagement programs will provide exposure to career pathways and mentoring. Opportunities for advancement through doctoral training will provide mechanisms to fast-track solutions for industry and better support early career researchers and industry professionals.

## DRIVE OPPORTUNITIES FOR RESEARCH COMMUNITY THROUGH REGIONAL DEVELOPMENT INITIATIVES

Strategic activities that enhance regional capability and harness UON's collective capacity will deliver opportunities for research to drive innovation and build equitable prosperity, social cohesion and healthy communities.

## BUILD HUMAN CAPACITY THROUGH KNOWLEDGE TRANSFER AND SKILL DEVELOPMENT

Strategies aligned to workforce needs will enhance career pathways for graduate and postgraduate students and deliver regionally relevant programs. Novel delivery methods will be explored to enhance research training opportunities.

# STRATEGIC ELEMENTS

In consultation with major stakeholders, the University seeks to support sector competitiveness by closely aligning its research and education programs to meet industry needs. In achieving this goal, our approach will focus on delivering five core strategic elements which are seen as critical to building capacity and sector strength. These common elements will be reflected in plans developed by the University to drive focused activity.

## REGIONAL ENGAGEMENT

Enhance collaboration to better deliver outcomes to stakeholders by building skills and networks that support increased knowledge transfer and R&D adoption. Support resource intensive regions through collaboration, strategic partnerships and leadership aimed at economic diversification with the creation of new opportunities and innovations.

## INTERNATIONAL COLLABORATION

Tackle global challenges collaboratively via an interdisciplinary network of researchers, students, industry partners and other stakeholders.

## POSTGRADUATE TRAINING

Foster an enterprise culture and develop industry ready graduates through access to specialist research facilities and industry-focused, collaborative research partnerships.

## TECHNOLOGY TRANSFER

Establish innovative platforms that give SMEs the resources, knowledge, networks and infrastructure to transform ideas into enterprise. Build critical mass to deliver R&D outcomes for businesses.

## KNOWLEDGE MOBILISATION

Contribute to knowledge creation and transfer through the delivery of doctoral courses targeted to industry needs, and support accreditation pathways and funding avenues to upskill future work forces.



# DEVELOPMENT ACTIVITIES

## DRIVING APPLIED RESEARCH THROUGH DEDICATED RESEARCH CENTRES

In concert with the University's Strategic Plan, through NIER, targeted industry-led research will be undertaken across the following research focus areas:

- Product Science
- Climate Resilience and Sustainability
- Advanced Technology
- Market Access

These focus areas align to state and federal government policy, national sector competitiveness plans and reflect international and national sector trends.

Strategic activities will support the needs of industry by concentrating interdisciplinary expertise within dedicated research centres.

## BUILDING COLLABORATIVE PARTNERSHIPS

Modelled on the successful flagship institute, NIER, partner networks will be leveraged regionally, nationally and internationally to deliver tailored activities that support the research objectives of SMEs to benefit the sector as a whole.

The University will work closely with relevant government and industry peak bodies to develop strategic initiatives that respond to the needs of the food and agribusiness sector, supporting regional development and jobs growth.

## ENABLING INDUSTRY READY APPLICATION THROUGH THE PROVISION OF SPECIALISED FACILITIES

Investment in programs will support the 'living lab' model of collaboration. Existing research facilities will be made to ensure infrastructure such as open access laboratories, testing facilities and demonstration plants support the development of industry ready applications.

Collaboration spaces and associated support programs will also be available and highly visible to potential investors, partners and governments.

## ESTABLISHING A DOCTORAL TRAINING CENTRE

A Doctoral Training Centre (DTC) dedicated to food innovation and agribusiness will be established. The DTC will bring postgraduate students and researchers together with industry, business and government partners to inspire new ideas, new ways of working and smarter solutions to industry challenges.

As a collaborative initiative, the DTC will provide industry partners with unprecedented access to a pool of knowledge for targeted projects while supporting students to gain industry ready skills.

## COORDINATING ACTIVITY THROUGH ESTABLISHED REGIONAL NODES

Activity will be focused in regional nodes in the Upper Hunter, Central Coast and Pacific region. These regional nodes will leverage each other to solve shared challenges, boost sustainable regional development, promote economic diversification and improve social and health outcomes.

# RESEARCH FOCUS AREAS

The food and agribusiness sector is faced with a number of challenges and opportunities that will shape its evolution over the next 5 to 10 years.

In meeting future demands, the University will leverage its existing expertise in applied research and build capacity to develop opportunities across four key areas:

- **PRODUCT SCIENCE**
- **CLIMATE RESILIENCE & SUSTAINABILITY**
- **ADVANCED TECHNOLOGY**
- **MARKET ACCESS**





# PRODUCT SCIENCE

*Optimising food and agriculture production to deliver economic, environmental and health benefits.*

Challenges to the environment are predicted to place increased stress on production yields resulting in shorter growing seasons, increased heat stress and exacerbating water and food security issues.

Coupled with issues related to diet and associated health diseases, greater attention is needed on healthy consumption, lifestyle choices and overcoming challenges related to an ageing population.

The University integrates knowledge across a wide range of contributing disciplines encompassing plant, marine, food and health sciences to tackle these challenges and improve environmental and health outcomes.

## THE UNIVERSITY AT A GLANCE

- Microbiology, genetics, genomic engineering and biotechnological approaches to generate plant lines resistant to environmental stress
- Soil health, amendments, delivery mechanisms and precision management solutions
- Soil moisture, water quality and hydrology, weathering and degradation
- Nutrient dynamics for crop productivity
- Optimised resource allocation for maximising food, fibre and fuel productivity
- Development of novel biomarkers for plant, human and animal health
- Advanced aquaculture methodologies
- Molecular nutrition and health science
- Nutrigenomics, nutraceuticals for human health
- Microbiome and digestive health
- Clinical nutrition, diet quality, metabolic markers, stress responses in humans and animals

- Reproduction, biotechnology and advanced breeding
- Pharmaceuticals, disease control and smart supplements
- Bioactive compounds derived from natural materials

## MAJOR INDUSTRY R&D PRIORITIES

- Health and wellness
- Soil health and land management
- Animal feed additives and health
- Biopesticides and microbial fertilisers
- Advanced breeding and fertilisation



# CASE STUDY

## THE CENTRAL COAST FOOD INNOVATION REGION INITIATIVE

Building on a formal partnership between Regional Development Australia Central Coast and Central Coast Industry Connect, UON is leveraging the NSW Central Coast's existing strengths to grow the local food industry and boost economic and social outcomes.

The Central Coast Food Innovation Region Initiative is a catalyst project to grow jobs and, build regional business competitiveness through innovation, education and research.

Partners are working to foster greater industry, academic and government collaboration that will:

- Concentrate expertise in specific fields across food industry disciplines, working towards making discoveries, strengthening capability and delivering holistic solutions
- Build a partner network supporting research objectives and broader strategic initiatives for the benefit of many
- Expand existing research facilities including laboratories, testing services, industrial scale workshops and large-scale demonstration plants enabling industry-ready applications
- Build a cohort of industry-ready graduates through access to specialised research facilities and industry-focused
- Develop collaborative research partnerships and innovation platforms giving SME's the resources, knowledge, networks and infrastructure to transform ideas into enterprise
- Grow a central hub of related food activity on the NSW Central Coast.

# CLIMATE RESILIENCE AND SUSTAINABILITY

Providing sustainable solutions to environmental challenges.

The challenges posed by climate change and population growth will place increased pressure on limited natural resources, affecting the productivity and reliability of existing production systems. The University's world-renowned engineering and science expertise is focused on the development of new technologies to optimise resource sustainability and efficiency.

The University's Water Research Roadmap complements capacity in climate resilience and sustainability for the food and agribusiness sector, focusing on priority areas of regional water security, water management and resilience, water utilisation and water recovery.

## THE UNIVERSITY AT A GLANCE

- Climatology and vulnerability modelling
- Hydrodynamics, water management and water efficiency technologies
- Isotopic testing, tracers, GIS modelling and remote sensing for water and land management
- Beneficial utilisation of waste resources, solid waste minimisation and food waste conversion
- Low emission energy systems and advanced energy technologies (biofuels, biogasification, fermentation, mini smart grids)
- Energy efficiency (innovative processes for food preservation, advanced vapour compression drying, reduction in refrigeration use during storage and transport by controlled atmosphere)
- Advanced materials for sustainable packaging and waste utilisation
- Circular economy, waste to resources and waste to energy
- Water management technologies including micro-irrigation, off-grid desalination and sprayable polymers

- Climate change induced social and health impacts, food security, community displacement and resettlement
- Enabling technologies and handling solutions for waste management
- Efficient transport and logistics solutions
- Food safety testing and pathogen control

## MAJOR INDUSTRY R&D PRIORITIES

- Energy smart food
- Energy efficient food production processes
- Food waste reduction and extraction
- Reducing food packaging waste
- Micro irrigation and water efficiency technologies

# CASE STUDY

## THE UON CENTRE FOR WATER, CLIMATE AND LAND

A dedicated Centre for Water, Climate and Land (CWCL) focuses on understanding and dealing with the impacts of climate variability and change in the Asia-Pacific Region. Specifically, the CWCL conducts work on:

- Hydrological extremes and how these may change in the future
- Characterising impacts of climate variability and change
- Seasonal and interannual hydroclimate forecasting
- Quantify current and future risk of climate extremes (e.g. flood, drought, bushfire, storms, cyclones, East Coast Low's)
- Hydrological and stochastic modelling
- Climate-smart agriculture
- Climate risk, resilience and adaptation
- Land use and landscape rehabilitation
- Geographic Information Systems (GIS) and Remote Sensing
- Water-energy-food security

CWCL has been involved in a wide range of projects where insights into the impacts of climate variability and change are used to enable stakeholders in the agriculture sector to better assess their climate related risks and opportunities to develop more informed climate adaptation and mitigation strategies.

In a recent study of the impact of climate on growing grains in Australia, CWCL researchers explored Australia's climate variability in the context of a changing climate. The project demonstrated the importance of taking into account the impacts of natural climate variability and anthropogenic climate change when growing grains in Australia.

The study illustrated the historical variability associated with several climate products that are important to the Australian agriculture sector. This allowed:

- Assessment of vulnerability to negative climate impacts
- Identification of opportunities associated with positive climate impacts
- Existing climate risk management strategies to be evaluated and, where necessary, improved
- Projected impacts of anthropogenic climate change to be put into context and planned for.



# ADVANCED TECHNOLOGY

Applying advanced technology to deliver efficiency and productivity.

A new wave of innovation is being triggered by the unification of information derived from data analysis and the deployment of key technologies related to robotics, autonomous systems and remote sensing.

The University is committed to working alongside business to develop technologies to support solutions for efficient resource allocation in farming systems to optimise supply chains and manufacturing processes.

## THE UNIVERSITY AT A GLANCE

- Separation science extraction of bioactive and functional ingredients
- Encapsulation, prevention of oxidation, and sensory foods
- Novel food preservatives
- Cyanobacteria as biofertilisers and soil remediators
- Algal metabolites as fish and poultry feed stocks
- Food dehydration, food product development, natural bioactive compound utilisation in functional foods, edible coatings for extended shelf-life
- On-farm productivity including precision agriculture, mechatronics, robotics, automation and sensor technologies
- Seafood postharvest technologies, handling and storage of seafood products

- Data monitoring for marine ecosystems and rehabilitation and remediation of coastal areas
- Food engineering, food processing, membrane technology, packaging, product and process development

## MAJOR INDUSTRY R&D PRIORITIES

- Agriculture cybernetics
- Sensors and sensor networks
- Precision agriculture and big data
- Agricultural biotechnology
- Product reformulation
- Functional food and food fortification
- Technology transfer support services



# CASE STUDY

## PERFORMANCE OPTIMISATION FOR THE SUGAR INDUSTRY

Smart systems in process industries, nanotechnology, signal and image processing, and biomedicine can improve performance and reduce pollution through improved efficiency.

A team of University of Newcastle researchers is focused on researching complex systems to improve productivity and efficiency such as:

- energy generation and distribution
- health delivery
- safety and security systems
- telecommunications and transportation networks
- manufacturing processes

A recent study is looking at control techniques to improve the operation of steam boilers in Australia's sugar industry. Sugar plants throughout the world burn sugar cane residue, known as bagasse, in boiler units to generate energy that powers the sugar factory and exports electricity to the grid.

While it is a source of renewable energy, it is a challenging material to burn and it is difficult to keep the boiler unit regulated. By developing new control methods, researchers hope to improve the sugar production and electricity cogeneration capabilities of the sugar industry.

Sugar mills are difficult to regulate as the boiler units have highly variable loads operating at inconsistent times, which severely hinders production. Stabilising the process will provide significant benefits to sugar manufacturing and biofuel energy generation in Australia more broadly.



# MARKET ACCESS

Delivering quality and optimising market access through integrated supply chains and value-add.

Consumer preference is an increasingly important driver of food and agriculture production. Market signals impact product development, food standards, nutritional value, product presentation and sustainability measures. A driving force behind this is the recognition that improving nutritional value is critical for global food security and human health. The increasing demand for food combined with the use of data analytics and more sophisticated e-commerce platforms will also push the development of leaner, faster, more agile production with lower waste value chains.

## THE UNIVERSITY AT A GLANCE

- Food safety, integrity and traceability, biosecurity, DNA testing, isotopic analysis, advanced packaging, high pressure processing, biosensing and pathogen control
- Consumer behaviour, nutrition information and food labelling
- Innovative packaging solutions
- Optimising food intake behaviours and diet related health across life stages and health conditions
- Nutrition education tools, augmented reality for portion size, diet quality assessments, online personalized nutrition, food addiction, fortified foods, personalised nutrition, “free from” and natural foods,
- Supply chain, statistics and inventory and production planning optimisation, scheduling, shelf life, product service flows
- Manual handling and safe work practices
- Sensors, data analytics and artificial intelligence
- E-commerce for perishable products
- Materials handling, mathematical modelling and logistics
- Performance optimisation through automated digital and complex systems
- Portion innovation and functional packaging
- Biomarkers, sensory technologies and nanocomposite films
- Waste process optimisation

## MAJOR INDUSTRY R&D PRIORITIES

- Traceability and control
- Food safety and food fraud
- Logistics and shared mobility
- Supply chain transformation
- Warehouse operations
- Freight transportation
- Personalised nutrition

# CASE STUDY

## THE UNIVERSITY OF NEWCASTLE AND NSW DEPARTMENT OF PRIMARY INDUSTRIES WORKING PARTNERSHIP

The NSW Department of Primary Industries (NSW DPI) is one of the largest research providers supporting primary industries in Australia with a research portfolio across more than 50 disciplines. The Department seeks to improve the productivity, sustainability and biosecurity of the NSW primary industries and enters into strategic partnerships where appropriate to facilitate these outcomes.

University academics in nutrition, food, health and marine science work closely with NSW DPI through an institutional strategic collaboration to develop and implement science-based technologies. The NSW DPI's Centre of Excellence for Market Access and Greenhouse Horticulture is located on the University of Newcastle's Ourimbah campus and teams collaborate on a number of joint projects.

In addition, NSW DPI researchers conduct applied industry focused research in postharvest, supply chains and market access to provide innovative solutions to practical industry problems and have strong and active collaborations with University researchers including joint supervision of higher degree research students.

There is opportunity to build on this foundation and explore areas of further collaboration across food and agriculture more broadly.

Current projects and active areas of research include:

- Product quality and postharvest quality maintenance through the supply chain of a range of horticultural and agricultural products
- Reducing energy costs through the optimised use of refrigeration in the supply chain,
- Research to maintain and improve market access for a range of horticultural commodities
- Collaborative research to facilitate the cost effective utilisation of waste
- Improving the efficiency of low-medium technology greenhouse vegetable production in Australia
- The nutrition of leafy vegetables including Asian vegetables in hydroponics
- Improving the cultivation of indigenous vegetables
- Improving the nitrate nutrition of Australian grown green tea
- Medicinal cannabis
- Development of organic transistor based biosensors for food-borne pathogens
- Circular economy and balanced land use promoting economic diversification



# ENGAGE WITH US

For more information visit the Newcastle Institute for Energy and Resources website.



[newcastle.edu.au/nier](http://newcastle.edu.au/nier)



+61 2 4033 9000



[nier@newcastle.edu.au](mailto:nier@newcastle.edu.au)