

Agriculture and Aquaculture at JCU

Contents

James Cook University	1
Agriculture and Aquaculture at James Cook University	1
Resource management	
Soil Health	3
Water Resources	4
Biodiversity Stewardship	5
Biological Invasions	6
Integrated approaches to pest management and pollination in tropical crops	7
Biofertilisers	8
Production	
Climate impacts on food production	10
Animal Production	11
Tropical Rangeland Production	12
Veterinary Tropical Diseases and Food Biosecurity	13
Fertility in Adverse Environments	14
Aquatic Animal Health and Disease Group	15
Physiology, Nutrition and Post-Harvest Technology	16
Aquaculture Production – Barramundi	17
Aquaculture Genetics	18
Macroalgae	19
Marine Ornamental Breeding	20
Fisheries Science	21
Sharks and rays	22
Advanced Chemical solutions	23
Green production of commodity chemicals from biomass	24
Social Dimensions	
Human and Social Dimensions	26
Regional Development – policy, governance, behaviour change, social science and rural leadership	27
Applied Economics and Business systems	28
Digital Innovation	
Remotely Piloted Aircraft Systems	30
Information Technology, Innovation and digital technology	31
Solar Technologies for Aqua- and Agriculture Applications	32
Digital Homestead: Precision Agriculture for on farm profitability, security and sustainability	33
Automatic image recognition systems	34
Wind and Wave loading analysis	35
World Class Research Facilities	36
Research Centres at JCU	37
Find out more	40

James Cook University

James Cook University (JCU) is a world class, research-intensive institution with a strategic intent focused on discoveries and graduates that make a difference in the tropics worldwide. JCU is defined by its tropical locations. Our three tropical campuses (Townsville, Cairns and Singapore) are complemented and extended by regional and remote study centres and research stations. The University has a range of facilities to support research and development activity. Research at JCU is focused on providing knowledge which ensure sustainable communities, industries and livelihoods into the future.

Agriculture and Aquaculture at James Cook University

Tropical regions of the world face unprecedented challenges due to increasing population growth and an associated demand for high quality agriculture and seafood production. The world's demand for food is estimated to increase by 50% in volume and 77% in monetary value by 2050. However, agricultural productivity growth has slowed globally since the 1990's.

What happens in the Tropics in coming decades will have profound implications for the world. Sustainable development is critical and will have a particular character in the tropics. JCU specialises in the sustainable use of tropical aquatic species and is Australia's leading university in Fisheries Science. JCU also has an extensive history in

agricultural research, especially veterinary science, working to ensure sustainable development in tropical landscapes.

Our research is world-class, as evidenced by the Excellence in Research for Australia evaluations, where JCU was the highest ranked Australian university, receiving rankings of research "well above" and "above world average" in Fisheries Science and Environmental Management. Our internationally renowned experts partner with industry, non-government organisations, and government to tackle challenges associated with the sustainable production of agriculture and seafood.





Resource management



Soil Health

Agriculture is expanding and intensifying globally, especially in the tropics. In many places poor agricultural practices have degraded the soil, as well as downstream aquatic ecosystems, due to poor runoff water quality, and the atmosphere through greenhouse gas emissions. The Food and Agriculture Organisation estimates that around 33% of our land globally is degraded. In the tropics, soil is particularly susceptible to erosion, nutrient leaching, acidification and loss of organic matter, the main mechanisms by which soil biological health and ecosystem functions are degraded. It is critical for future human welfare that food production enhances rather than degrades the environment. Our research is about understanding the effects of agricultural management on soil and ecosystem health, and devising management practices that sustain them.

Facilities

Most of our research is carried out on farms in northern Australia, South East Asia and the Pacific. Our field equipment includes numerous cutting-edge systems for measuring soil biological activity, the composition of soil minerals, water and gases, and the physical condition of the soil. Our laboratories operate a large range of equipment for characterising the elemental, isotopic, molecular and biological characteristics of soil and its components.

Research and Development

Our research focuses on developing innovative approaches and tools for improving sustainability and productivity. Soil is the habitat for the most diverse ecosystems on earth and soil ecology is critical for determining plant productivity and resistance to diseases. For example, we are assessing the soil conditions that influence

the soil-borne fungal disease of bananas known as the Panama disease. Inputs of organic matter are the main drivers of many soil functions and we are studying ways to improve the organic matter content and biological activity of soils in sugarcane and other cropping systems. Nutrient cycling and management are also critical, and we are assessing the effects of applied and living mulches, compost, food-processing wastes, biochar and enhanced efficiency fertilisers on soil fertility, greenhouse gas emissions and runoff water quality in a wide range of tropical cropping systems. Monitoring of soil condition and processes, and predicting the effects of changed management, are crucial for sustainability. However, doing so in a timely and cost-effective manner is challenging. We are therefore developing practical tools for doing so, based on sophisticated crop system models.

We collaborate closely with plant scientists,

ecologists, hydrologists, chemists, modellers and social scientists to better understand agroecosystem processes and to identify farming innovations and ways those innovations may be used more widely.

Industry Engagement

Our main industry partners in Australia and the region include individual and corporate farmers, their industry organisations, government departments responsible for science, agriculture and natural resources, CSIRO, and the Natural Resource Management Boards of northern Australia, especially Terrain NRM, Northern Gulf Resource Management Group and NQ Dry Tropics.

Research team

This research area is supported by six senior research academics and over 10 research focused post-graduate students.



Water Resources

Water availability in Australia is highly variable from region to region and year to year. However, water quality and quantity is key to agricultural success Australia wide. TropWATER has over 25 years successful operational experience working on management of aquatic resources in the major irrigation districts of northern Australia – e.g. Burdekin, Mareeba-Dimbulah, Wet Tropics and the Mackay district. In established irrigation areas, TropWATER has many projects covering the management of freshwater, estuarine, coastal and marine habitats. This includes the full range of projects from working with farmers on their properties to improve the quality of runoff water and reduce soil loss, the management of flow regimes, wetlands and aquatic habitats within irrigation districts and understanding and limiting impacts of farming upon the Great Barrier Reef. In addition to established agricultural districts, TropWATER have undertaken numerous pre-development studies for a variety of new and proposed irrigation developments.

Facilities

TropWATER's Water Quality Laboratory provides a water quality assessment service for James Cook University's research and consulting projects and a commercial analytical service to government agencies and industry. Whilst our focus is on the analysis of water, wastewater and related samples, staff expertise also includes experience in many facets of water quality research. This includes providing support for studies which examine freshwater streams, rivers, wetlands and reservoirs, ground waters and marine waters.

Research and Development

With a specialised focus on achieving sustainable use of water resource systems and water ecosystems, TropWATER has a national reputation for conducting highly

recognised and influential research in fields related to water science, resource management and the ecology of water ecosystems. This group has extensive skill sets in the design, analysis, presentation, reporting and publication of this research to both stakeholders and interested groups. Examples of this research include sediment and runoff from farmed and grazed upper catchment areas to the Great Barrier Reef, monitoring water quality in flow plumes and identifying pesticides.

Industry Engagement

TropWATER has collaborated extensively with stakeholders in Australia, including state and territory governments, Natural Resource Management boards, local government authorities, the CSIRO, and Non-Government Organisations. TropWATER has a long history of combining research

with contract work and consultancies to ensure that its work is of practical relevance to community, government and industry. TropWATER's catchment to reef research group has projects which are conducted jointly with many government, research and industry partners and include working on the ground with farmers in direct trials to reduce.

Research team

TropWATER is an amalgamation of aquatic expertise from across James Cook University that brings together over 130 research and support staff into one cohesive research group. TropWATER provides a unique opportunity for multidisciplinary research activities, which covers expertise from ecology, water quality, hydrology, engineering, physics, oceanography, modelling and resource economics.



Biodiversity Stewardship

Recent agricultural strategic plans emphasise the need for improved stewardship and sustainability of agricultural land. An important aspect of stewardship and sustainability is the maintenance of biodiversity, including its application to the control of pests and weeds. James Cook University is internationally renowned for research on tropical ecology and biodiversity, including industry-relevant applications of these fields to the use and maintenance of biodiversity in terrestrial agricultural systems. For example, JCU scientists have found that maintaining or increasing the diversity of pest-consuming organisms can dramatically improve natural pest control, without costly chemical inputs, and that improving pollinator habitat can improve yields and vertebrate biodiversity on Australian farms.

Research and Development

James Cook University has been a worldleader in tropical biodiversity research for more than 15 years and over this period has been a primary international source of high-quality research in this area. The institution is a recognised leader in ecology and biodiversity research including the application of ecological principles to pest control, biodiversity assessment, and biodiversity management on agricultural land.

Industry Engagement

JCU is engaged with the Meat and Livestock, QDAF as well as the cropping industries in Australia through both direct partnerships with peak bodies and research conducted on-farm. Such research is yielding new insights into ways of applying ecological knowledge to pest control and to methods and benefits of biodiversity maximisation on agriculturally managed land.

Research team

Five profile academic staff and eight PhD level research students provide the highest level of professional excellence and expertise in applying cutting-edge ecological understanding and modelling techniques to any emerging agricultural issues.



Biological Invasions

JCU expertise in biological invasions research spans many disciplines and taxa, and uses innovative approaches. Species invasions can cause many problems in agriculture and aquaculture and their prevention, control, and mitigation of their impacts can be costly. Researchers at JCU are at the forefront of developing and implementing innovative methods for detecting and controlling pest species. In addition, multiple disciplines across the university offer training in subjects relevant to biological invasions research.

Facilities

We have access to, and regularly utilize, the Australian Tropical Herbarium, Daintree Rainforest Observatory, shade houses, insect flight cages, light and temperature-controlled facilities (aquatic and terrestrial), boats and PC2 laboratories.

Research and Development

JCU is at the forefront of developing multiple novel methods for the detection and control of invasive species. Several researchers are developing eDNA as a tool for detecting invasive species such as tilapia in waterways. Senior research staff have developed an image recognition system to detect noxious weeds in the agricultural landscape and combine it with an automated system for herbicide delivery. Preliminary results of

research to train honey bees to find elusive invaders such as ants are promising. JCU researchers have also partnered with a Melbourne company to devise innovative trapping and control solutions for vertebrate pests. JCU researchers also lead multiple projects to assess and mitigate impacts of invasive species in their unique environments.

Industry Engagement

We are engaged with a broad spectrum of industry partners and stakeholders and community groups. These include local, state, and federal governments, local farmers, local beekeepers, the mining industry, Wet Tropics Management Authority, Terrain NRM, Powerlink Queensland, Queensland Transport and Main Roads department, Queensland Department of Environment and Heritage, and Trees for the Evelyn and

Atherton Tablelands. The research has resulted in the production of multiple reports for use by our industry partners together with theses and academic publications. Our industry partners have provided funding and capacity through involvement of personnel. We also have projects to increase public education around the identification and reporting of pest species and their spread. We welcome further partnerships and working relationships.

Research team

Over a dozen profile academic staff conduct research on the detection, effects, or control of biological invasions. Academic staff are supported by senior and other research staff. Numerous HDR students are currently undertaking research on biological invasions.

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Integrated approaches to pest management and pollination in tropical crops

Recent research documenting unintended consequences of pest management strategies on pollinator populations and pesticide runoff have led to calls for more creative solutions to pest management. At James Cook University there is a diverse community of researchers with expertise in identifying methods to improve pollination services provided by honey bees and wild insects as well as the evaluation of biological, chemical, and cultural methods of controlling crop pests. In particular biological control expertise ranges from pest suppression by arthropod predators, entomopathogens, and vertebrate predators such as birds, bats and reptiles. The researchers generally take multi-disciplinary approaches with collaboration regularly occurring among people in the physical, ecological and social sciences.

Facilities

Shade houses, climate-controlled glasshouses and plant and animal growth chambers, insect flight cages, field plots, advanced genetics laboratories, PC2 laboratories.

Research and Development

Australia, and tropical Australia in particular, is well known for high biodiversity. While this biodiversity is often considered at risk from agriculture, it also provides a pathway to improve pollination and natural pest control services. Thus JCU expertise is especially strong in identifying key roles animals have in improving agricultural yields through

pollination and pest control and identifying methods of maximising the benefits of these species. Success stories involve improving pollinator habitat to dramatically improve yields in fruit crops using native ants to control pests and evaluation of methods to reduce honey bee disease. Therefore the diverse team of researchers at James Cook University are strategically located and skilled to improve agricultura.

Industry Engagement

JCU researchers work closely with industry partners to identify and address key limitations to industries such as agriculture, forestry, and natural resources management in Australia and internationally. For example,

we have HDR students funded and coadvised by scientists within the agricultural industry. We find this co-mentoring of new students is critical to develop the next generation of scientists with the skills and knowledge to promote innovation in Australian industry.

Staff

JCU has several profile academic staff members that conduct research on the effects of interactions on invasive species. These academic staff members are supported by diverse teams of senior and other research staff and currently advise multiple HDR students with projects related to pollination and/or pest management.



Biofertilisers

Unprecedented population growth challenges food, energy and freshwater security. Maintaining crop productivity on tropical soils requires extensive fertilisation. In the context of food security and building sustainable tropical communities, the potential of nitrogen-fixing cyanobacteria as biofertilisers and soil conditioners is important in assisting agri-industry in developing fertilisation regimes based on soil nitrogen and phosphate budgets. Large amounts of agricultural organic waste offers the potential to unlock stored energy and nutrients using anaerobic digestion. We characterise microbial consortia for optimisation of energy – and biofertiliser recovery from organic waste. These two approaches also provide potential for the cultivation of microalgae with nutraceutical and feed potential in aquaculture. Microalgae are fundamental components of aquatic food webs and the backbone of the aquaculture industry. The integration of the above processes provide the foundation for building economical and environmentally sustainable, energy – and water smart innovative tropical communities.

Facilities

Specialist research infrastructure for microbial strain identification, isolation, domestication and cultivation has been established at JCU since 2004, through extensive external research funding. Our research also uses specialist infrastructure for microbial genomic fingerprinting of soil microbial consortia at the MEEL facilities and at the Advanced Analytical Centre at JCU for characterising the potential for bio-fertiliser, bio-energy and co-product applications.

Research and Development

This research group is internationally recognised for innovative microbial

approaches for waste management, biofertiliser and co-product creation. We investigate soil microbial responses to biofertilisation and impacts on soil health, the principal driver for agricultural productivity. Such data are used to build techno-economic models and in-life cycle assessments of the processes to ensure outcomes are environmentally suitable for maintaining vital ecosystem.

Industry Engagement

The research into energy and water smart microbial bio-fertiliser and bioenergy solutions for tropical agricultural communities engages with Bioenergy

Australia and affiliated international energy agency focus groups. In particular Bioenergy Australia provides a strategic platform for information dissipation and discussions with industry, government and other research providers, thereby facilitating cross-discipline and cross-institutional/industry research and development.

Research team

The microbial bio-fertiliser for soil health and food security group led by Heimann consists of 13 PhD students conducting research into suitable nitrogen-fixing cyanobacteria and soil microbial consortia for soil health and ecosystem services, respectively.



Production



Climate impacts on food production

Our nationally and internationally recognised team has extensive experience in enhancing the sustainability of agricultural systems to benefit the environment, industries and societies in the Tropics. This research team helps industries become more robust to extremes in weather and climate with particular focus on crop forecasting to help manage the risks of year to year climate variability. This team is also focused on finding sugarcane production solutions for increased efficiency in water use and nutrient uptake, development of new varieties and yield forecasting. We aim to increase productivity and sustainability through better understanding risks and informed best management practices.

Research and Development

Our research and development seeks solutions that will enhance industry decision making by effectively linking a number of major disciplines. These disciplines include mathematics, statistics, data science, climate science and agricultural modelling. For example, by injecting climate predictions into an agricultural model we can produce forecasts of crop production. Crop production forecasts allow industry to implement better management strategies that can lead to a number of environmental and economic benefits.

Industry Engagement

Our research engages heavily with industry partners from Australia and overseas so that our research outputs are adopted and applied in practice. Our research allows for applied solutions for industry by integrating the use of different technologies such as cropping systems simulators, climate science and datamining. This group has worked extensively with the Australian Sugar industry and Department of Environment and Heritage.

Research team

Our highly multidisciplinary team consists of two senior academic staff and three PhD students. Our team has a range of skills and experience in climate impacts, climate prediction, data science, agricultural science, crop modelling and outreach.



Animal Production

Agricultural production and services contribute 3% to Australia's total gross domestic product with the gross value of Australian agriculture in 2011–12 being \$46.7 billion. Agricultural production plays a vital role in alleviating poverty, sustaining the health of human populations and in socioeconomic development. Our research group is focused on improving the efficiency and productivity of both national and international agricultural sectors with a particular emphasis on tropical regions.

Facilities

Facilities for our research include the James Cook Tropical Veterinary Research station, pathology and microbiology laboratories, facilities for the housing of a range of domestic animals, assay of hormones and cell populations and semen analysis which are located within the Discipline of Veterinary Science. Further access to facilities is also available through collaborative arrangements with the CSIRO and Department of Primary Industries.

Research and Development

Our current research areas include improving artificial breeding technologies and synchronisation of oestrus, reproductive physiology, methods of contraception in cattle, understanding processes involved in natural resistance to cattle ticks, meat science, genetics and pathology associated with diseases affecting agricultural and aquatic animals. We are also conducting studies within the goat industry to improve productivity within this agricultural sector.

Industry Engagement

Current research projects are funded through Meat and Livestock Australia, Agrimix and

Ausaid. Members also contribute to a range of professional organisations, outreach activities and publications to disseminate knowledge on improving agricultural production.

Research team

Our current research team comprises a diverse range of skills and experiences which are currently contributing to projects which enhance agricultural production within tropical regions. In this team there are 12 key research staff and post graduate students working in areas of animal production.



Tropical Rangeland Production

The dry tropical rangelands of northern Australia cover almost a quarter of continental Australia and account for nearly 70% of the Australian beef industry. The Australian Dept. of Environment describes them as “characterised by vast tracts of eucalypt savanna and native grasslands, small areas of cleared land and scattered settlements, and the rivers and wetlands that sustain ecosystems”. Our research interests are designed to promote sustainable animal production systems and protect catchments and marine environments associated with tropical rangelands through the management of the quality and quantity of plant biomass in these environments.

Facilities

- Plant propagation unit
- Animal house and metabolism units;
- Access to ruminally fistulated small and large ruminants,
- Laboratories equipped for wet chemical analyses of forages and other animal feeds;
- Access to dedicated research and commercial grazing properties through collaborative arrangements within JCU, private landholders, the CSIRO and Department of Primary Industries.

Research and Development

Our current research interests include:

- Identification, propagation and

commercialisation of tropical rangeland adapted legumes

- Use of NIR technologies to characterise the nutritional value of novel and newer tropical legumes suited to rangeland environments
- The use of enclosures to manage grazing pressure and productivity from tropical rangeland pasture systems
- Validation of the metabolisable protein and energy systems to predict productivity of meat from goats fed tropical grasses, legumes

Industry Engagement

Current research projects are funded through Meat and Livestock Australia, Agrimix Pty Ltd

and Commonwealth Government, Australian Awards Scholarship (formerly AusAID) as well as contributions from a range of professional organisations, outreach activities and publications to disseminate knowledge on improving agricultural production.

Research team

Our current research team comprises a diverse range of skills and experiences which are currently contributing to projects which enhance agricultural production within tropical regions. Current staff include two key senior researchers with extensive research experiences and two post graduate students working on productivity in large and small ruminants.

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Veterinary Tropical Diseases and Food Biosecurity

Our group conducts research in Veterinary Tropical Diseases and Food Biosecurity. We are a multidisciplinary, multi-institutional and multinational group with unique expertise in tropical veterinary science, epidemiology, microbiology and public health and are ideally positioned to work in tropical regions of the world.

Facilities

All our research is conducted in tropical regions of the world and a large portion of this is in developing countries. Supporting this research are the modern microbiology laboratories housed within the Discipline of Veterinary Science.

Research and Development

Our group has successfully been engaged in biosecurity issues in the Pacific Island region and Southern Africa and have developed syndromic surveillance platforms in Papua New Guinea and Zambia. Using expertise in social networking and market chain analysis, food security platforms have been mapped out in Fiji, Solomon Islands, Vanuatu, Papua New Guinea and Zambia. In Africa we have looked at issues related to the effect of global

warming on vector movement in subtropical regions and sociological factors that play

a role in disease surveillance. We have also been studying the role native and non-native rodents in the wet tropical rainforests of Northern Queensland play as reservoirs of disease for human and domestic animals.

The group is also currently working on an industry funded project on the environmental persistence of *Mycobacterium avium subsp. paratuberculosis* in Northern Queensland. It is the cause of Johne's disease in cattle, sheep and goats. This disease presents a threat to the export of live cattle from this region.

Another focal area of research for our group has been the study of tropical diseases of horses which has become of increasing importance for public health with the emergence of viral equine diseases. The role horses play in the epidemiology of these diseases has not been well studied. We have equine projects running in Australia and South Africa.

Industry Engagement

Our projects are usually run in partnership with government veterinary services of the host countries, other academic institutions and private veterinarians. Imbedded into some of these projects have been training workshops to build capacity in animal health and disease surveillance.

Research team

The core JCU staff include eight academic research specialists in Epidemiology, Equine Medicine, Veterinary Bacteriology, Veterinary Virologist, Veterinary Public Health, Veterinary Parasitologist, Cattle Medicine and Herd Health. In addition we have three PhD and three Masters Students servicing the group and co-workers in all the countries mentioned.



Fertility in Adverse Environments

Animal production industries are critical to circumvent world-wide food shortages. However the fertility of animals in these industries is directly at risk from the impacts of adverse environmental conditions such as heat stress, social stress, disease, malnutrition, maternal age, and even *in vitro* embryo production. Our group uses *in vivo*/*in vitro* fertilization systems coupled with gamete and molecular biology techniques to investigate the underlying mechanisms that affect gamete quality and embryo survival in terrestrial and aquatic animals. Moreover we actively develop mitigation strategies that will ultimately improve reproductive performance in these species.

Facilities

The Gamete and Embryo Laboratory (GAME Lab; Discipline of Biomedicine) has temperature controlled equipment for the sterile culture and microscopic evaluation of animal germplasm and embryos. We house one of only six Computer Assisted Sperm Analysis Systems in Australia for the evaluation of sperm motility. The Molecular Biology Laboratory (Biomedicine) permits quantitative real-time PCR analysis and protein immunofluorescent labelling techniques. Additional access to FACS facilities (Biomedicine/Medicine) permit the evaluation of sperm DNA damage. Domestic animals are housed in purpose-built large animal and experimental hot-room facilities on-site. Through collaborators, we also have access to fin-fish aquaculture and frog breeding facilities at JCU as well as captive and field sites for wild mammals in Southern Africa.

Research and Development

Current research in our group includes the impact of heat stress on semen quality and embryo survival in pigs; effect of IVF and mare-age on embryo development in horses; correlating sperm quality with fecundity in barramundi; influence of season and social dominance on fertility in male African wild dogs, and the impact of chytrid fungus infection on gamete and embryo viability in frogs. Moreover we undertake trials using nutritional supplements and novel pheromones to mitigate adverse effects on fertility in several of these species.

Industry Engagement

Our work is funded through AusAID, Morris Animal Foundation, various zoological institutions and internal grants. Through our PhD and Research Masters programs we deliver specialist training and knowledge transfer activities to students from regional

developing countries in the tropics. Our results aim to inform best-practice in animal production via industry bodies such as Australian Pork Limited and Mainstream Aquaculture (Australia) as well as improve wildlife conservation and translocation practices via the Wild dog Advisory Group (South Africa).

Research team

Core JCU staff, who work in this research area include eight academic staff with the addition of four PhD and two Honours Students undertaking projects in our group.



Aquatic Animal Health and Disease Group

James Cook University has long standing R&D expertise in aquatic animal health and diagnosis that integrates viral, bacterial and parasite diagnostics with practical, applied research. Over 30 years of supervision of research degrees has also created a ripple effect in this field with graduates working in both Australia and the Asia-Pacific.

Teaching and Training

JCU delivers specialist subjects in Aquatic Animal Health at both undergraduate and postgraduate level. Master Classes such as Disease in Tropical Aquatic Animals are also offered to both university students and industry. These subjects focus on disease and how to diagnosis them particularly as they are relevant to tropical aquaculture systems. Aquatic animal health concepts are also taught in the Veterinary Science degree thereby preparing future veterinarians for a role in this field.

Facilities

Secure infection facilities for aquatic animals enable research involving infection trials with pathogenic organisms with state-of-the-art disinfection facilities with either fresh or saltwater for both fish and crustaceans. A 5,000L recirculating seawater system for parasite cultures is also available as well as state-of-the art laboratories to securely and efficiently culture and investigate disease

causing agents. In addition Australia's largest tertiary aquarium research infrastructure is available at JCU if required to undertake larger-scale industry-relevant R&D for non-infectious agents and treatment. Recently JCU also opened the doors to the custom built facility for studying turtle health.

Research and Development

JCU continues to support industry with research into current disease problems in aquaculture which may range from bacterial, parasitic and viral pathogens in both crustacean and finfish aquaculture. Resident experts provide the capability and capacity to provide industry with a rapid response for disease investigations. Current topics of research include physiology and control of parasites, phage-therapy against antibiotic resistant bacteria, the application of cutting edge technology including RNAi and recombinantly expressed proteins to manage diseases in aquaculture.

Industry Engagement

Research conducted by JCU scientists enables fisheries, aquaculture and Biosecurity Australia to make informed decisions in regards to stock structure, disease management and import regulations. This marriage of pure and applied research has led to the development of unique and strong partnerships between industry, academia and government agencies. This has resulted in numerous grants and collaborations.

Research team

James Cook University has eight senior academic experts in Disease and Animal Health (Aquatic Pathobiology, Epidemiology and Control) which bring capacity in Aquatic animal health, Aquatic virology, Aquatic parasitology, diagnosis and detection of viral pathogens, Bacteriophage therapy, treatment of fish diseases, Animal health, welfare and ethics and Molecular techniques for detecting pathogens. Currently a combination of HDR students are researching Aquatic Animal Health topics within this group.

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Physiology, Nutrition and Post-Harvest Technology

James Cook University is internationally renowned for their work in aquaculture physiology, nutrition and post-harvest technology. The Physiology, Nutrition and Post-Harvest Technology Group has been influential in developing and implementing applied solutions across these fields for several important tropical species, including barramundi, grouper, tilapia, freshwater crayfish, tiger prawn and sea cucumbers. The university also boasts a world-leading comprehensive teaching program in aquaculture physiology, nutrition, and propagation with specific applications to commercial aquaculture and hands-on training in up-to-date relevant production techniques.

Facilities

Aquaculture@JCU comprises one of the largest aquaculture tertiary teaching and research groups in Australia. The Physiology, Nutrition and Post-Harvest Technology Group accesses a purpose-built modern research and development facility on-campus. More specifically, the facility consists of several large dedicated temperature and environmental controlled freshwater and saltwater recirculation systems. These systems are specifically designed for working with live aquaculture species at a pilot scale commercial production level. This is also coupled with purpose built systems for the measurement and analysis of animal energetics, gas exchange and metabolism, and complimented by the state-of-the-art molecular biology facilities to enable nutritional and physiological research.

Research and Development

Aquaculture@JCU is a leader in aquaculture research and development in the areas of physiology, nutrition and post-harvest technology. We combine whole animal

studies with relevance to commercial culture conditions; this includes work on both new and well-established aquaculture species, particularly marine and freshwater finfish. The group is recognised as being at the forefront of R&D in these respective areas and provides a full complement of expertise including methods for determining nutritional requirements of species, evaluating the use of sustainable-plant based ingredients to replace marine ingredients as well as of novel and functional dietary ingredients to improve intestinal health, molecular characterisation of the physiological response to dietary and environmental changes, resolving the drivers of egg and larval quality, and measurement of metabolism and energetics in aquaculture species.

Industry Engagement

Aquaculture@JCU is heavily engaged with aquaculture industries in Australia and internationally through research partnerships and training based on-campus and on-farms. As examples of some of these partnerships

we currently or have recently worked with barramundi (Australian Barramundi Farmers Association, Ridley Aquafeeds, Skretting, Coral Coast Fisheries), redclaw crayfish (Australian Redclaw Farmers Association, Rural Industries Research and Development Corporation), tilapia (Australian Centre for International Agricultural Research; Secretariat of the Pacific Community), grouper (US Soybean Export Council), and sea cucumbers (Australian Institute of Marine Science, Australian Centre for International Agricultural Research). Although the group works with a wide variety of species and countries, it has a particular focus on important, or developing aquaculture species in tropical Australia and Asia.

Research team

Three academic and 11 research staff and postgraduate students provide the highest level of professional excellence and expertise across the group and contribute to an industry focused teaching and research platform. Key senior personnel include Dr Igor Pirozzi, Dr Waldo Nuez and A/Prof Jan Strugnell.



Aquaculture Production – Barramundi

James Cook University is internationally renowned for its barramundi industry-relevant training programs and outcome driven Research and Development. Barramundi has been the model species for education, training and research at James Cook University for 15 years, with the institution responsible for development of the core knowledge base leading to the productive and profitable aquaculture of barramundi.

Facilities

Aquaculture@JCU comprises the largest aquaculture tertiary teaching and research group in Australia which is centred around world-class infrastructure on-campus specifically designed for finfish training and industry research and development, including a commercial-scale barramundi hatchery.

Research and Development

Aquaculture@JCU has been a world-leader in barramundi research and development for more than 15 years and over this period has been the primary international source of high-quality research for the species. The institution is a recognised leader in biology and production research, including hatchery

production, genetic stock improvement, fish health, adaptation to climate change, post-harvest quality, organoleptic properties, nutrition and feed development, reproductive control, and the bioremediation of barramundi farm waste water.

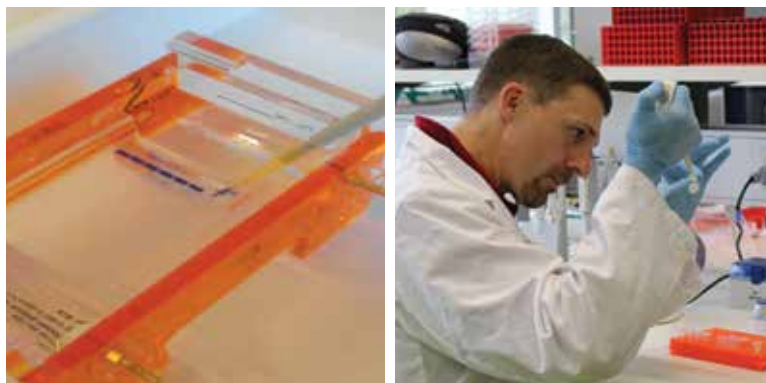
Industry Engagement

Aquaculture@JCU is engaged with the barramundi industry in Australia and internationally through direct partnerships and research and training based on-campus and on-farms. As an example of an industry partnership, James Cook University and a commercial company Mainstream Aquaculture (Pty Ltd) have collaborated to build and operate a barramundi hatchery on-campus that is used for teaching and

research purposes.

Research team

Eleven profile academic staff and 12 senior research staff (PhD) combine to provide the highest level of professional excellence and expertise in aquaculture and contribute to an industry focused teaching and research platform.



Aquaculture Genetics

James Cook University is internationally renowned for their work in aquaculture genetics and hosts the largest research team in the southern hemisphere that is solely focused on developing the knowledge and tools required by the aquaculture industry to understand genetic processes affecting culture success and in the conduct of efficient selective breeding programs. With over 15 year's expertise delivering services to the global aquaculture industry, James Cook University has been instrumental in the design and conduct of breeding programs for many important tropical species, including barramundi, marine shrimps, pearl oysters and freshwater crayfish. In fact for many species like barramundi, marine shrimp and pearl oysters, the majority of genetic tools and know-how needed to conduct effective breeding programs out in the public domain were developed in-house by James Cook University researchers. The university also has a comprehensive teaching program in genetics and biotechnology as applied to aquaculture.

Facilities

James Cook University has a fully-equipped, modern genetics laboratory, including an Illumina Mi-Seq sequencer, flow cytometers, robotics, quantitative PCR and high throughput PCR capabilities. Given its strengths in quantitative statistics and genomics, it also has the high-performance computing capability necessary to link phenotypes with the genome and develop genomic selection algorithms. JCU also has the largest tertiary aquaculture aquaria research infrastructure in Australia for the conduct of genetic related experiments and training.

Research and Development

James Cook University is a global leader in the area of aquaculture genetics and provides a full complement of expertise relevant to genetic improvement of aquatic organisms,

including development of molecular markers for new species, DNA pedigreeing, genetic audits of broodstock, estimation of genetic parameters for commercial traits, molecular early prediction of growth performance, transcriptomic, nutrigenomic, advanced genomic applications, breeding program design and genomic selection approaches. The team has the capability to start fresh with new species, or to integrate current knowledge to aid industry in their aspirations to breed faster growing and disease tolerant strains.

Industry Engagement

The aquaculture genetics team works directly with the aquaculture industry to develop the tools and knowledge required for them to commence selective breeding programs. As examples of some of these partnerships we currently work with global

companies involved in breeding programs for marine shrimp (Global Gen Inc, Seafarms Ltd), barramundi (Mainstream Aquaculture), tilapia (Worldfish), redclaw crayfish (NQFA), pearl oyster (Atlas South Sea Pearl) and abalone. There is a particular focus on improvement of important aquaculture species in Australia and Asia.

Research team

The aquaculture genetics team comprises eight senior researchers and 13 graduate students with skills in quantitative genetics, DNA pedigreeing, gene expression, genomics and project management. Key senior personnel include Prof Dean Jerry (Group Leader), A/Prof Kyall Zenger, A/Prof Jan Strugnell, Dr Jose Domingos, Dr David Jones, Dr Roger Huerlimann, Dr Andrew Foote, Dr Carolyn Smith-Keune.



Macroalgae

James Cook University is internationally renowned for its innovative industry and outcome driven Research and Development in macroalgae. The integrated production and application of macroalgae has been a focus of research at James Cook University for 14 years, with the institution responsible for development of the core knowledge base leading to the productive and profitable aquaculture of freshwater and marine macroalgae (seaweed).

Facilities

Research on macroalgae is centred around a purpose-built modern, world-class research and development facility on-campus. The facility is specifically designed for industry research and development and includes pilot-scale commercial production for marine and freshwater macroalgae.

Research and Development

James Cook University has been a world leader in the research and development of macroalgae for more than 14 years and over this period has been a leading international source of high-quality research for the

integrated production of macroalgae for the bioremediation of wastewaters. The institution is a recognised leader in biology, chemistry and production research, including the use of biomass in products ranging from human food and food ingredients (phycocolloids) through to nutraceuticals, animal feeds, fertilisers, biochar and bioenergy.

Industry Engagement

James Cook University is heavily engaged with the aquaculture and wastewater treatment industries in Australia and internationally through direct partnerships and research and training based on-campus

and on-farms. The exemplar of this industry engagement is MBD Energy, a long-term partnership with substantial and ongoing collaboration in the development and implementation of the bioremediation of wastewaters, and the profitable use of the end-product biomass.

Research team

A senior academic, seven research staff (PhD), seven technical staff and postgraduate students provide the highest level of professional excellence and expertise in production and end-use of macroalgae and contribute to an industry focused teaching and research platform.



Marine Ornamental Breeding

The aquarium trade is a multi-billion dollar industry, and it is growing at a rapid pace. However, unlike freshwater ornamentals, of which 98% are captive bred, it is estimated that over 95% of all marine specimens are still collected directly from the wild, mainly from coral reefs.

In order to be sustainable highly sought-after aquarium species must be bred locally to allow them to be traded and to further expand the industry. The Marine Ornamentals Captive Breeding Group are developing captive breeding techniques for dozens of popular marine ornamentals, including crustaceans and fish. The Group have so far successfully bred more than 20 species, several of which are world firsts and work on multiple species is ongoing.

Facilities

The Marine Ornamentals Captive Breeding Group uses a purpose-built modern research and development facility on-campus consisting of several large dedicated temperature and environment controlled freshwater and saltwater recirculation systems. These systems are specifically designed to conduct experiments to improve culture techniques for marine ornamentals focusing primarily on key aspects such as reproductive biology, optimisation of larval feeding regime and designing species-specific culture systems to reduce mortality.

Research and Development

Aquaculture@JCU is a world-leader for the development of successful intensive aquaculture methods for tropical copepods, as well as captive breeding techniques for various marine ornamental fish and crustaceans. These data are being used to improve the economic and environmental sustainability capacity of the multi-billion dollar marine ornamental trade industry.

Industry Engagement

Aquaculture@JCU is engaged with the marine aquarium industry in Australia through both local aquarium shops and

nationally wholesalers (e.g. Aquarium Industries Pty Ltd in Victoria, one of the biggest aquarium wholesalers in Australia) to form direct partnerships on marine ornamental captive breeding.

Research team

Collaborated with other aquaculture academics on their respective expertise areas, the research team includes a core senior academic, two visiting scholars and five postgraduate students that combine to provide high level of professional excellence and expertise in this field of research and development.



Fisheries Science

James Cook University is globally recognised for its research strength in Fisheries Science. This research strength translates into excellent teaching opportunities by providing students with access to leaders in the field and opportunities to learn applied skills through interactions with the fishing industry and fisheries management agencies. JCU staff and students work closely with the fishing industry and management agencies to provide relevant science-based advice on improving the management of fisheries in the tropical world.

Facilities

High calibre facilities, including field (Orpheus Island Research Station, research vessels), laboratory and computing infrastructure, support research and teaching efforts.

Research and Development

JCU is a global leader in fisheries research, especially in relation to tropical systems such as coral reefs. Research is conducted not only in Australia, but throughout much of Southeast Asia and globally and is designed to inform improved management. Research

includes biology of fished species, ecosystem effects of fishing, fisheries assessment, stock assessment, ecological risk assessment and socio-economic assessment and monitoring. JCU's research strength is recognised by its ranking as Well-Above World Standard or Above World Standard in recent Excellence in Research for Australia exercises.

Industry Engagement

JCU researchers work closely with commercial, recreational, charter and indigenous fishers and provide advice on management of fished resources to relevant

management agencies locally, nationally and internationally. JCU staff hold key positions on national and international advisory panels and management bodies actively advising policy and management. JCU's location provides for close links with world leading marine and fisheries research and management agencies, and with fishing industry centres.

Research team

Five profile staff, numerous research staff and several active adjunct staff have active Fisheries Science research programs.



Sharks and rays

James Cook University is globally recognised for its research strength in sharks and rays, and its teaching in marine biology, fisheries science and management and environmental science. This allows students of all levels to engage with leaders in the discipline to learn about sharks and rays, and their management and conservation. The adjacent Great Barrier Reef World Heritage Area provides students with ready access to field research sites and exposure to a diverse range of management and conservation issues.

Facilities

JCU has world class facilities that allows the study of sharks and rays in the field including the Orpheus Island Research Station, and a fleet of smaller vessels. Access to field and laboratory infrastructure for telemetry, life history, genetics and stable isotope studies is also available.

Research and Development

JCU is a global leader in shark and ray research, being the top ranked university for publications in the last five years.

Research is especially designed to inform the management and conservation of sharks and rays on a local, national and international scale. This includes work on the spatial ecology of sharks, stock structure and connectivity, population status, life history, fisheries interactions and post-release effects, and novel survey techniques.

Industry Engagement

JCU researchers work closely with commercial, recreational and indigenous fishers and provide advice on management and conservation of sharks to relevant

management agencies locally, nationally and internationally. JCU staff hold key positions on national and international advisory panels and management bodies such as the IUCN Shark Specialist Group and government reference groups, actively advising policy and management.

Research team

Two profile staff, six research staff and several active adjunct staff have active research programs on sharks and rays in the Great Barrier Reef, across Australia, and in the Indo-Pacific region.



Advanced Chemical solutions

Our nationally and internationally recognised group are experts in the development of characterisation solutions that are vital to addressing a broad range of practical issues in agriculture and aquaculture. We have developed a range of novel methodologies and sensor technologies for measuring trace species in waters, studying nutrient cycling in soils and the characterisation of biological processes in production systems including bioactive compounds.

Facilities

The Advanced Characterisation Group at JCU run a number of instruments including Ion Chromatography, High Pressure Liquid Chromatography, Gas Chromatography, Mass spectroscopy, UV-Vis and Electrochemistry. We are regular users of the Australian Synchrotron facility in Melbourne.

Research and Development

Natural systems are amongst the most challenging to characterise chemically. Our research and development program works to develop practical solutions to enhance industry decision making. The focus in the R&D program is on developing cost effective ways of providing the core data needed

to run quantitative chemical models of production systems. Better models are the key to stock management and control of nutrient flows. For example, we have worked with new fertilizer products to better understand mechanisms of bioavailability of these products in natural systems. Our team works to develop novel chemical characterisation solutions for a broad range of practical issues in the tropical agriculture (grazing, cropping) and aquaculture domains.

Industry Engagement

We have a number of ongoing collaborations including with Rhone-Poulenc in advanced pesticide monitoring. We have been working with the Department of Agriculture and Horticultural Innovation Australia to describe

soils important for growing bananas. In the past we have contributed vital expertise projects in mining to improve production and separation, waste management and in food production to establish point of difference in agricultural products.

Research team

Four Senior Academic Staff and five PhD students are involved in our Advanced Characterisation Group. We have developed a range of novel analytical methodologies to address a broad range of practical problems for studying the transformation of nutrients in soils, following the fate of trace metals in water and tracking organic pesticides in waterways.

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Green production of commodity chemicals from biomass

Will it be good enough in the future to continue to base our economy on raw materials? Value adding or processing of agricultural by-products or biomass has the potential to increase profitability and to access new markets. Green chemistry has been at the forefront of sustainable technologies but has traditionally focused on the reduction or elimination of hazardous substances in the manufacturing process. These processes remain energy intensive and concerns remain over emissions resulting from them. Meanwhile our plant species have harnessed solar radiation for growth for millennia and is the ultimate green energy source. Can the Sun's energy be used to drive chemical processes to add value to our agricultural industry?

Facilities

The group will move to dedicated research laboratories in the new Science Place in 2017. Newly acquired instrumentation include NMR spectrometers, LCMS and ICs, coupled with access to the advanced analytical centre (AAC) allows rapid quantification of experimental results. The group currently operates several solar thermal reactors.

Research and Development

Flow chemistry is an exciting recent branch of chemistry where streams of reagent are continuously pumped through reactors. These reagent streams can either be continuously cycled through the reactor or processed a single time with control over the flow rate dictating the reaction time. Use of a solar reactor and using solar power to drive the pumps would allow this process to be possibly off-grid. Our unique

position in the tropics also allows us to take advantage of high solar irradiation rates. So far our research team have started exploring the conversion of sugars to commodity chemicals such as 5-hydroxyfurfural and levulinic acid.

Research team

The team consists of one academic and honours student with a number of graduate students.



Social Dimensions



Human and Social Dimensions

Implementing change and enhancing sustainability of agriculture, aquaculture and fishery industries requires an understanding of the role of people in achieving these goals. Social and behavioural scientists at JCU are here to provide expertise on how to facilitate the adoption of new technologies, systems and strategies by stakeholders and how these people and communities may be impacted by these changes.

Facilities

Across behavioural and social science disciplines, there is broad engagement with major tropical population hubs, not just on the domestic campuses but also on the JCU Singapore campus. These facilities enable researchers to devise, develop and consult upon projects not just for Australian populations but for our closest Asian neighbours.

Research and Development

Social and behavioural scientists at JCU have a depth of expertise which has been

demonstrated in the implementation of research projects including but not limited to -exploring agriculture's contribution to regional development; workforce development in aquaculture industries; technology engagement in the beef industry; biosecurity practices by producers in the beef industry; the integration of new technologies in the beef industry; and the assessment of adaptive capacity in the fishing industry.

Industry Engagement

Critical engagement in research projects involves strategic partnerships with both government and industry groups and takes

place across the region. Past relationships have involved the prawn and barramundi sector, peak bodies in both the beef and fishing industry, Natural Resource Management, regional development groups and Queensland Health.

Research team

Our team consists of a network of researchers from disciplines such as psychology, business and information technology. Our network has the capacity to recruit and provide research expertise for the multiplicity of challenges that agriculture and aquaculture face in the coming decades.

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Regional Development – policy, governance, behaviour change, social science and rural leadership

The tropics are a location of profound social, environmental and economic change. With the ability to draw on multiple disciplines in the social sciences and humanities – and with considerable track record in agriculture, fisheries and extractive industries – JCU researchers are uniquely placed to work with the people of northern Australia, the Pacific and South East Asia to promote sustainable social and economic development. Central to this is the ability to work across scales, complementing research into community-based natural resource management with spatial planning, policy evaluation, institutional analyses, and working with stakeholders at all levels.

Research and Development

JCU is committed to understanding and informing the critical processes of transformation that will shape future wellbeing in the tropics. However, making a difference requires more than good intentions. Research at JCU brings research from multiple disciplinary perspectives into dialogue with policy-makers, communities and other stakeholders. Key research themes include:

- Governance, institution building and policy
- Natural resource management and planning

- Sustainable livelihoods and community development
- Indigenous land tenure and use
- Social impact assessment
- Disaster planning and resilience
- Sustainable supply chain organisation
- Social marketing and behavioural change.

Industry Engagement

Much of the research undertaken within these themes is undertaken in direct partnership with the communities and industries impacted by social, economic and environmental change. JCU has formal

agreements to collaborate with Aboriginal and Torres Strait Islander organisations, government agencies, industry groups and others across the region. The staff contribute to many more organisations as members and advisors.

Research team

Relevant staff and HDR students are located across several organisational units including the Division of Tropical Environments and Societies, the Centre of Excellence for Coral Reef Studies and The Cairns Institute – a hub for regional collaboration, capacity building and leadership.

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Applied Economics and Business systems

James Cook University is globally recognised for research in Tropical Ecosystems and Environment, Industries and Economies in the Tropics, Peoples and Societies in the Tropics and Tropical Health, Medicine and Biosecurity. The College of Business, Law and Governance (CBLG) contributes significantly to this agenda, covering a wide range of disciplines, with a strong focus on trans-disciplinary research across not only the disciplines within CBLG, but also other Colleges such as the College of Marine and Environmental Sciences and the Centre for Tropical Water & Aquatic Ecosystem Research.

Research and Development

Business@JCU has a cluster of five projects that connect directly with JCU's tropical research strategy. Three of these projects are currently being conducted in Lao PDR and examine a range of interconnected factors that impact positively on agricultural change and smallholder farming livelihoods. This first focuses on Government of Lao extension agencies and how results-based management can improve staff performance and production outcomes. The second focuses on farmers themselves, and how they form organisations to set their own agendas within a top-down socio political context, and finally the third examines the nexus between research and extension, seeking improvements to smallholder farmer adoption of agricultural research outcomes and innovations. Moving closer to home, a fourth CBLG research project investigates how rural women in Queensland Australia think about and make decisions with regard to rural digital technology, and

how these factors affect their personal career path, family business, and family aspirations. The fifth project harnesses the science of social marketing and is also being engaged to critically investigate how water quality programs are being marketed to land managers. It is hoped the gathered information will help government improve the way it relates and works with land managers.

Our multi-campus locations and world-class academics bring an international perspective to our teaching and research. Leading-edge postgraduate study areas reflect global industry needs and include international business, sustainable practice, creativity and innovation, political science, and information technology.

Industry Engagement

James Cook University researchers work closely with a range of stakeholders including groups of land managers, local and state government and industry to understand

attitudes beliefs and behaviours and to overcome problems and improve production practices and minimise environmental impacts.

Research Project Leaders

Peter Case – Enhancing district delivery and management of agricultural extension in Lao PDR.

Peter Case – Critical factors for self-sustaining farmer organisations in Lao PDR.

Peter Case – Smallholder farmer decision-making and technology adoption in southern Laos: opportunities and constraints (2015-2019).

Natalie Stoeckl – Harnessing the science of social marketing & behaviour change for improved water quality in the Great Barrier Reef: An action research project (2016-2018).


Rachel Hay – The engagement of women and technology in agriculture.

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Digital Innovation



Remotely Piloted Aircraft Systems

Remotely Piloted Aircraft Systems (RPAS; also known as UAVs or drones) provide low-cost, high resolution data for environmental mapping, monitoring and management. JCU researchers, working closely with industry partners, use these systems to improve the understanding of marine and terrestrial environments by complimenting traditional fieldwork and satellite data with information collected using drones.

Using a range of aircraft and sensors including hyperspectral, thermal and photogrammetric cameras with LIDAR and sonar, JCU researchers are mapping and monitoring:

- terrestrial and marine habitats and biodiversity;
- invasive species such as weeds, feral animals and other agricultural pests;
- vegetation health and biomass;
- crop yields and growth; and
- post disaster impacts and recovery (e.g., cyclone or flood).

Facilities

Multirotor and fixed winged aircraft with a range of sensors; JCU's Tropical Data Hub and High Performance Compute facilities for data storage and processing.

Research and Development

Research and Development in this area is

focused on integration of novel sensors into existing RPAS platforms and the data management/analytics/transformation of the data collection. Current research is looking at how hyperspectral, thermal and photogrammetric cameras with LIDAR and sonar can be used to:

- locate and quantify weeds, feral animals and other agricultural pests across landscapes as well as locating prawns for fisheries,
- evaluate quantity and condition of feed (grass) for cattle, and water quality in aquaculture ponds; and
- evaluate the condition of crops such as mangoes and sugar cane.

The R&D further looks at the algorithms required to analyse and transform the vast amounts of data collected into knowledge and presented in dashboards to inform management of these systems.

Industry Engagement

We work closely with several agricultural growers, aquaculture (barramundi and prawns), and the cattle industry, all of which provide support for collaborative research (knowledge, research income, data, resources and access to farm and equipment). One such company is Beef & Reef Ltd for which we are addressing issues with weeds, feral animals and cattle on large properties, as well as locating and quantifying prawns for their fishing operations.

Research team

The RPAS research team is a truly interdisciplinary team spanning GIS specialists, electrical engineers, social scientists, IT programmers, data analysts and industry representatives across the divisions of Tropical Environments and Societies and Research and Innovation. This team is supplemented by more than 15 fully licenced Remote Pilots in these divisions.



Information Technology, Innovation and Digital Technology

JCU is implementing a wide range of new innovative technologies and big data analytics to address challenges for agriculture and aquaculture. We are increasing the quality, quantity, sustainability and cost effectiveness of agricultural/aquacultural production in spite of increasing challenges (e.g., droughts and extreme events) through R&D in remote sensing (satellite, aircraft and RPAS, and on-ground sensors), automation and robotics, and data analytics.

Facilities

MARF, Fletcherview, Tropical Data Hub, ICT High Performance Computing Facility.

Research and Development

In this area, there are a wide range of projects including:

- Automated detection of weeds and feral animals for management. This is both within crops (robotic automation) and across broad landscapes using UAVs
- Remote sensing of water quantity and quality over cattle properties and in aquaculture systems using in pond sensors and RPAS
- Near real-time conditions monitored in crops and cattle pastures using low-cost, low power sensors
- Machine learning and artificial intelligence

for oyster and aquaculture image processing

- Digital dashboards that transform data from a wide variety of sources into pertinent information

Industry Engagement

- Australian Wine and Grape Authority funded PhD student to develop end-to-end system for monitoring on-ground conditions for grapes.
- CommBeef Ltd – industry-lead funding for monitoring condition and health of cattle from paddock to plate, together with CSIRO.
- Several other agricultural growers to monitor crop conditions
- Townsville city Council – Integrated Sustainability funding remote monitoring of water quantity and quality

Across all of these, we offer typically one day 'sprint' events in which the industry partners and general public are invited to work with us to address issues pertinent to the industry partner. This often results in sensor development, deployment and data visualizations informed by knowledge of all involved.

Research team

eResearch Centre has four key academic staff, three post docs, two research staff, six professional staff, five PhD students and four thesis students involved in this research capacity. A further eight academic staff from the College of Science and Engineering, and College of Business, Law and Governance (Discipline of IT) also collaborate in this research.

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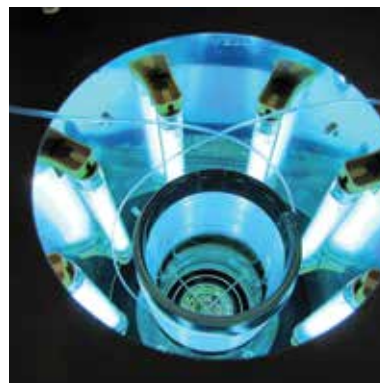
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Solar Technologies for Aqua- and Agriculture Applications

The essential oil, aquaculture, agriculture and cattle industries are of significant economic importance to Northern Australia. All four industries are currently facing severe commercial challenges. Cost pressures from cheap imports have forced the essential oil industry to seek competitive advantage through quality of product, vertical integration and product diversification. A major concern of the aquaculture industry is biosecurity and pathogenic microorganisms have been linked to food poisoning and mass mortality of aquaculture stock. Agriculture naturally produces vast amounts of bio-waste that are currently used as inefficient heating or fertilizer materials. Run-off water from cattle farms contains high levels of residual veterinary pharmaceuticals that threaten the aquatic environment and contribute to drug resistance formation. Natural sunlight and sustainable chemical processes can provide powerful solutions to these challenges. Essential oils can be converted into a range of high-value products such as repellents, fragrances, flavours or pharmaceuticals, taking advantage of existing technologies within the industry. Likewise, agricultural bio-waste represents a sustainable resource for biochar fertilizers, biofuels, cosmetics, dietary supplement products and pharmaceuticals. Furthermore, advanced oxidation processes can be integrated as climate-smart water treatment methods into aquaculture or animal farms.

Facilities

The group occupies new and fully equipped laboratory facilities within the Science Place with state-of-the-art office and research space. It also operates a range of small to technical-scale reactors for experiments with artificial and solar light. The group has all the instrumentation to conduct research in sustainable and applied chemical processes including chemical conversions, solar chemistry, waste management and water treatment. The group also operates modern chemical analysis equipment and has access to advanced analytical instrumentation within the discipline, college, Advanced Analytical Centre and various research centres.

Research and Development

This research group is known internationally for its research on green and applied

photochemistry. Their activities range from the development of miniaturized early drug discovery tools to the solar production of commodity chemicals from biomass, photostability testing and light-induced degradation of organic and microbiological pollutants. The research is truly multidisciplinary, spans across the entire spectrum of chemical research, supports the environmental, biological and marine sciences and aligns seamlessly with JCU's motto 'Crescente Luce – light ever increasing'.

Industry Engagement

- Current projects on Eradicating Insect-Borne Diseases with Sunlight funded by Far North Queensland Hospital Foundation, the Clinton Health Access Initiative and Fonds Pacifique.
- Current industry project on photochemical

steroid synthesis.

- Current project with the Townsville Hospital on treatment of medical waste.
- Co-development of advanced photochemical reactors with Vapourtec Ltd., UK.
- Past projects on sustainable water treatment with Northern Ireland Waters, Enva Technologies and Astellas Pharmaceuticals.

Research team

The group currently consists of seven PhD students, two Honours students and one Research Assistant is supported by three MSc, BSc and Internship students. Exchange agreements are also in place with various institutions in Europe and Japan. This international environment has shaped a creative and lively team that is recognised globally for its research outputs.



Digital Homestead: Precision Agriculture for on farm profitability, security and sustainability

The Digital Homestead is a partnership with CSIRO and JCU. Modern Information and Communication Technologies (ICT) tools such as wireless sensor networks (WSN's), data analytics and rural connectivity are used to support greater profitability for the Northern beef industry. Adding to this is information collected from remote sensing platforms (satellite and manned/UAV aircraft).

A browser-based data dashboard presents a single access point, combining on-farm sensors, remotely sensed data and external data sources including weather forecasts, market pricing, live weather monitoring, tank levels and aspects of a producer's herd such as cattle location, activity and weight. Information is the data, transformed in such a way to act as a decision support tool, enabling better informed management of homesteads.

Facilities

Fletcher View Station (potentially), CSIRO Lansdown, Q-DAFF Spyglass station; UAV (drone) Facilities JCU; eResearch Tropical Data Hub data storage infrastructure.

Research and Development

Current R&D efforts are focused on three new areas:

- Long-range, low-cost robust data networks for dealing with the vast distances of northern properties and new types of low-cost sensors including walk-over-weighing platforms
- Tracing and tracking beef from paddock to plate to build secure supply chains and increase consumer confidence and prices to producers
- Scale up and commercialisation.

Industry Engagement

- Mr Daniel Whipp has commenced a PhD (CSTE) with a scholarship and support

from the Australian Wine and Grape Authority.

- Mr Simon Igoli is being supported but TCC and MBD Energy.
- Industry funding from CommBeef Ltd
- A certificate III program in digital agriculture is being discussed for school students as part of the next phase of the Digital Homestead program

Research team

The eResearch Centre has three Researchers, two research staff and one research staff and four students from other colleges which collaborate.



Automatic image recognition systems

James Cook University's Engineering, Maths and Physics disciplines support projects that require modern image recognition methods for applications to agriculture and industry. The improvements in the mathematical methods of image recognition and the power of small computers have resulted in a large number of opportunities to develop intelligent machines for robotic and other autonomous applications.

Research and Development

The main project that is applied to agriculture is the development of image recognition algorithms to detect noxious weeds for application to weed killing robotic systems. An automated system has been developed, and is now being trialled, which is mounted on a towable trailer with eight cameras and herbicide sprayers.

The image recognition system detects the weed Lantana and a short spray is activated to kill only the weed leaving other foliage untouched. No human input is required.

Although the system is presently working on Lantana, the image recognition system being

developed can be applied to other plants and other applications. There is no doubt that this technology will soon become common place in agriculture but challenges still exist to make systems robust and reliable in different agricultural environments.

Other projects developing intelligent image recognition systems have applications to industry but give an indication of what is now possible for agriculture. One project is the use of an advanced image recognition system together with laser holographic optics to measure internal wear in paste pipes in mines with far more accuracy than is presently available.

Industry Engagement

We are trialling our robotic weed killing system on a local cattle property. Until now most of our engagement has been with the mining industry.

Research team

Under the guidance of Peter Ridd, three staff members, two PhD students and one Engineering Thesis student work in this research capacity.



Wind and Wave loading analysis

The Cyclone Testing Station (CTS) at James Cook University is the pre-eminent independent authority on the performance of buildings in severe wind events. CTS is located at the Townsville campus. Our focus is primarily on the performance of houses and other low rise buildings, including agricultural buildings, in Australia and the surrounding region. Activities include investigations after wind events as well as research, testing and community education, aimed at ensuring that buildings designed to resist severe wind events are safe, economical and sustainable.

Facilities

CTS has the Wind driven debris simulator, Air box testing (an open topped pressure chamber) and the Structural Testing Laboratory (testing machines with varying capacities are available for testing of structural components and connections) as well as the Boundary Layer Wind Tunnel.

Research and Development

- Improving the Performance of Crop Protection Enclosures to Resist Wind Loads <https://cyclonetestingstation.com.au/publications/content/technical-reports/technical-report->

ts846/view

- Assessment of forces on orchards and plantations as well as amelioration methods with DPI
- Wind and wave impacts on coastal areas
- Assessment of wind accelerating and shielding effects from terrain
- Assisted Timber Queensland with Best Practice Guide for Timber Plantations in Cyclonic Areas.
- Environmental monitoring and wind field sensor deployment

Industry Engagement

The Cyclone Testing Station has strong

engagement with local and state government and industry. We are able to provide technical advice, research tools and experience to assist partners as noted in examples above.

CTS has contributed to industry seminars and workshops for NGIQ and DPI.

Research team

CTS currently has two Academics with one Research Fellow, as well as one Senior Engineer and two Technical Engineers which enable the research at the CTS. These academics also mentor three PhD Students and one Masters Student.

World Class Research Facilities



Fletcher View

Fletcher View is a 1960 hectare working cattle station located 98 km southwest of Townsville. This station is used for beef cattle production and reproduction research and development by JCU researchers.

This property is situated in open savanna woodland habitat combined with areas of dry rainforest or 'vine thicket'. The station incorporates laboratory facilities and accommodation and provides extensive opportunities for the real world undertaking of agricultural related research.

While JCU's Australian Institute of Tropical Veterinary and Animal Science predominantly make use of its facilities. Fletcher View is also visited by field biology, earth and environmental researchers. Regional high schools stop by for field trips and local beef cattle producers meet here for discussion days and workshops.



MARFU (Marine and Aquaculture Research Facility)

The JCU Marine and Aquaculture Research Facilities is situated within the Townsville campus on an 11,500m² site. The facility is the largest in an Australian university and consists of eight large recirculating marine water systems supplying outdoor, undercover and indoor lab areas.

The facility has 21 indoor temperature controlled research labs. Eleven of these labs also have their own dedicated recirculating life support systems for high resolution or specifically modified research projects.

All the recirculating life support systems, research labs and MARF operating systems are controlled by an automated PLC system networked throughout the facility. At any one time MARF supports a variety of aquaculture, fisheries and marine biology projects involving various species of fish, crustaceans, bivalves, other aquatic invertebrates (ie corals), and algae.



Orpheus Island Research Station

Orpheus Island Research Station facility provides researchers and students with outstanding access to a variety of marine environments. This research station has accommodation, boats, dive facilities, a lecture theatre, extensive laboratory facilities, wet labs and a versatile saltwater aquarium system. The Island is located on the Great Barrier Reef and is situated 120km North of Townsville and 220km south of Cairns.

Research Centres at JCU



The Cairns Institute

In 2009 James Cook University established an institute for advanced studies in sustainable industries, economies, people and societies in the tropics. The Institute is dedicated to providing innovative, solution-orientated research with local, national and global tropical application. The Institute brings together the expertise and intellectual resources of more than 20 academic disciplines, creating a uniquely robust and relevant research, consulting, training and teaching hub for Northern Australia, South and South-East Asia and the Pacific.

Its location in North Queensland provides a real-world context and tropical research opportunities unparalleled in Australia.

The Institute undertakes research in the humanities and social sciences that addresses critical points of social and environmental transformation in the tropics. As a repository of regional knowledge and research capacity, it is perfectly positioned to make a significant contribution to the development of a sustainable quality of life for tropical communities.

To find out more visit:
jcu.edu.au/the-cairns-institute



Centre for Sustainable Tropical Fisheries and Aquaculture

The Centre for Sustainable Tropical Fisheries and Aquaculture aims to provide knowledge to underpin aquatic food security for Australia, the tropics and globally.

With aquatic food resources already under pressure and declining it is essential to gather data related to wild fisheries to ensure their long-term sustainability, as well as to develop sustainable aquaculture products to supplement that coming from wild fisheries. Both sources of seafood have to be produced in a sustainable, socially and economically viable fashion to improve aquatic food security. This will come about not only by improved biological understanding, but also through examination of the human systems that produce and consume aquatic food resources and by restoring already degraded systems to re-establish their production potential.

The Centre brings together a multi-disciplinary team organised into three main Research Themes: Aquatic food security and safety, novel aquatic products and applications, and human dimensions of aquatic resources and production.

To find out more visit:
research.jcu.edu.au/cstfa



TropWATER

The Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER) is an amalgamation of aquatic expertise from across James Cook University. It brings together over 150 research and supporting staff and over 100 post-graduate students into one cohesive research group. TropWATER provides a unique opportunity for multidisciplinary research activities by integrating JCU's aquatic expertise into one unit which covers the full spectrum of freshwater, estuarine and marine waters, with expertise from ecology, water quality, hydrology, engineering, physics, oceanography, modelling and resource economics.

TropWATER aims to conduct highly recognised and influential research in fields related to water science, resource management and the ecology of water ecosystems, with a special focus on achieving sustainable use of water resource systems and water ecosystems. Our overall goal is to secure the future of water ecosystems and maintain their critical functional processes. The Centre has a strong but not exclusive focus on tropical water systems both in Australia and internationally. It is concerned with major issues in water science including water resources, water quality and aquatic biodiversity, in relation to economic, social and environmental needs, constraints and change.

To find out more visit:
research.jcu.edu.au/tropwater



Centre for Tropical Biodiversity and Climate Change

The aim of the Centre for Tropical Biodiversity and Climate Change is to understand the patterns and processes underlying tropical biodiversity, the impact that global change will have on the natural environment, and provide knowledge for the natural resource policy and management within Australia and Internationally.

The CTBCC takes a socio-ecological-landscape approach to understanding major drivers of Tropical Biodiversity and Climate Change and how to manage the processes. We strive to achieve this through diverse pure and applied research initiatives, including linkages and coordination with other research organizations within and outside Australia, government, public and private stake-holders.

To find out more visit:

research.jcu.edu.au/ctbcc

ARC Hub for Advanced Prawn Breeding

The Australian Research Council Industrial Transformation Research Hub (ARC ITRH) for Advanced Prawn Breeding is a consortium involving researchers and industry from James Cook University, CSIRO, Australian Genome Research Facility, University of Sydney, Vlaams Instituut voor Biotechnologie and Seafarms Group.

The goal of the Hub for Advanced Prawn Breeding is to develop and transfer to the farmed black tiger prawn industry the capacity to benefit from advanced genomic-informed breeding programs. It will achieve this through:

- developing comprehensive genomic resources for the black tiger prawn including a draft genome;
- acquiring necessary quantitative genetic information for traits along with the development of industrial-scale disease testing and phenotypic data collection processes; and
- developing genetic algorithms to allow a multi-trait genomic selection approach to be practised in breeding programs.

To find out more visit:

research.jcu.edu.au/itrh-apb

MACRO

Macroalgae are an exceptional resource for the supply of biomass feedstock for a diversity of bio-products. Both marine and freshwater macroalgae are bio-resources that can be produced using non-arable land, and therefore this process does not compete at any level for food production.

Biomass-derived fuels also reduce the reliance on petroleum for combustion as carbon is captured during the production process by photosynthesis. Macroalgae are therefore an attractive and sustainable feedstock for carbon capture, bioremediation of wastewater, and the recycling of carbon into biofuel production and other bioproducts.

Our R&D includes the assessment of valuable bioproducts and biotechnology based on the unique biochemistry and properties of algae and the co-location of algal production with existing industries for bioremediation (treating waste streams) utilising the broad distributions of both marine and freshwater macroalgae and the ability of some species to grow in industrial waste water. Our ultimate goal is to develop and commercialise marine and freshwater macroalgae for fuel, feed and fertiliser applications.



Advanced Analytical Centre

The Advanced Analytical Centre (AAC) is a central analytical facility that supports research and industry providing a wide range of analytical instrumentation backed by experienced and professional staff.

The AAC provides access to a range of techniques covering the fields of microscopy and microanalysis, inorganic and organic chemical analysis, mineralogy/crystallography and genetic analysis. The centre provides a full range of services from sample preparation through to final analysis and reporting as well as specific hands-on training in instrument use. It is also a Linked Laboratory to the Australian Microscopy and Microanalysis Research Facility (AMMRF).

To find out more visit:
jcu.edu.au/advanced-analytical-centre



Centre for Tropical Environmental and Sustainability Science

The mission of TESS is to promote cutting-edge ecological and environmental research in the tropics, and the wise management, conservation and sustainable use of tropical terrestrial and coastal ecosystems in Australia and internationally.

Tropical Australia is resource-rich, ecologically fragile and infrastructure-poor and is undergoing unprecedented growth and development. It is a national priority to develop growth strategies that are ecologically, socially and economically sustainable. TESS is taking a leading role in developing, implementing and exporting solutions for the environmental and sustainability issues faced by Australia and the rapidly developing tropical world.

To find out more visit:
research.jcu.edu.au/tess



Centre for Biosecurity and Tropical Infectious Diseases

The Centre for Biosecurity and Tropical Infectious aims to expand our knowledge and understanding of tropical infectious diseases and translate this into new tools to manage diseases and control their transmission, at both individual animal and population levels.

Infectious disease agents impose major costs on human and animal health and are constantly threatening to undermine biosecurity. The world's tropical regions have special significance since several infectious diseases, many of which are zoonotic, have either been newly identified or have re-emerged there over recent decades. Detection and control of tropical infectious diseases is a major global challenge.

The Centre brings together a spectrum of researchers whose interests span human and animal diseases. This new alignment will lead to improvements, conceptual and practical, in the study and prevention of infectious diseases.



Find out more

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This brochure is published by James Cook University, March 2017. This publication is intended as a general guide. Information is correct at the time of printing. The University reserves the right to alter any information included in this publication without prior notice.

CRICOS PROVIDER CODE 00117J

