

RUN Research: regionally embedded, globally engaged



REGIONAL STRENGTH. NATIONAL SUCCESS.



The Regional Universities Network (RUN) is a group of six regionally-based Australian universities committed to delivering the research that matters most to regional and rural communities. Collectively, our institutions are characterised by their focussed, innovative, and socially-connected research agendas. Our strengths span a wide range of fields including agriculture, food security, environmental management as well as rural health and wellbeing.

Fast growing research capacity

RUN universities are increasing their research intensity to keep pace with the growing needs of regional Australia. Each year we continue to attract more external research funding, particularly from the Australian Research Council and from industries seeking to improve their productivity.

Growth in our competitive grants and industry funding has outpaced that in the Australian higher education sector as a whole. Between 2006 and 2013 income from

competitive grants and industry increased by 97 per cent and 126 per cent respectively at our universities. Research income from these sources across sector as a whole grew by 76 per cent and 48 per cent respectively over the same period.

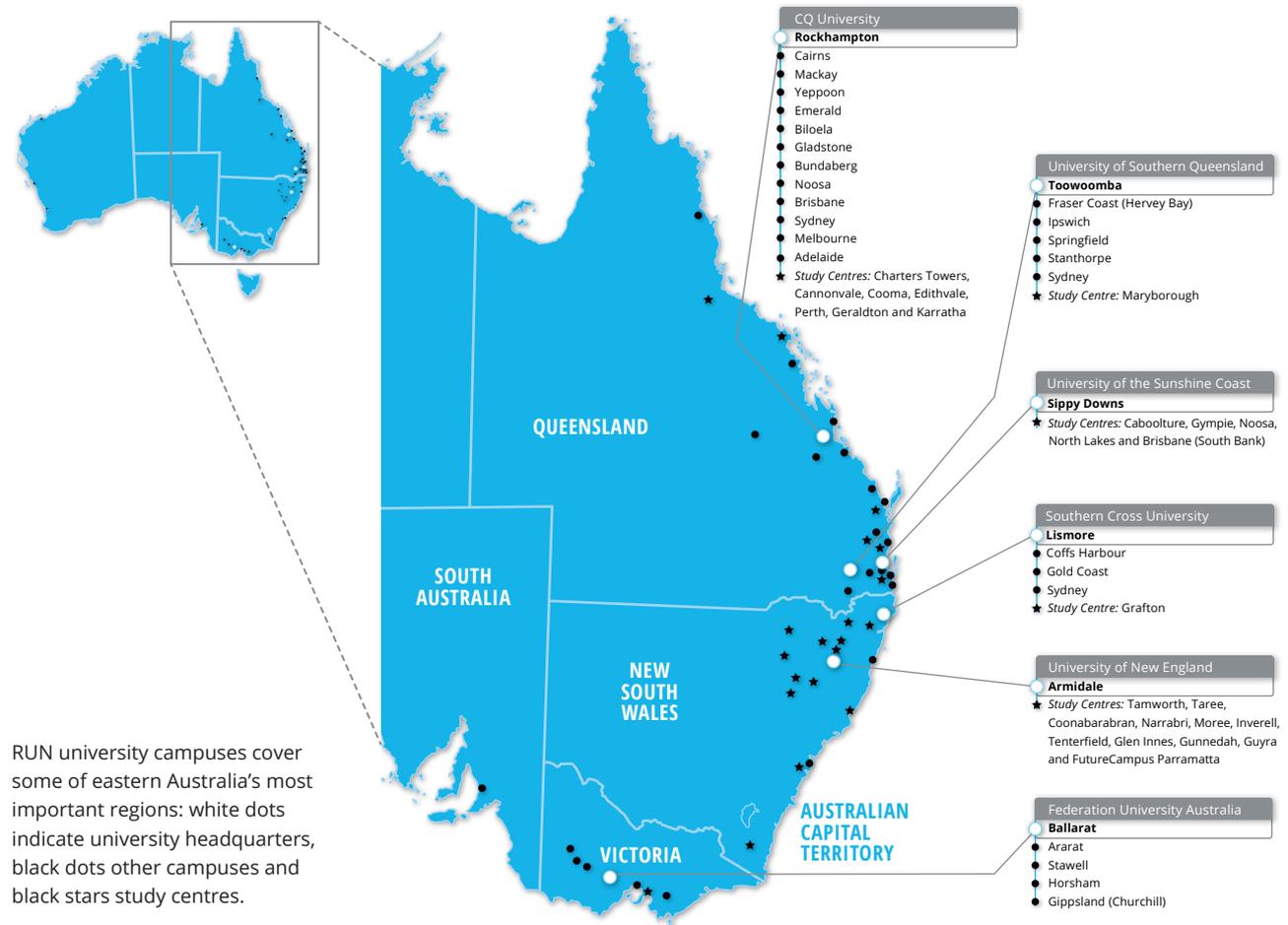
World-class research

The quality of our research is nationally recognised, with key disciplines ranked at the highest international standards in the Excellence in Research for Australia assessment¹, including:

- Agricultural sciences, including agriculture, land and farm management, crop and pasture production and forestry;
- Biological sciences, including zoology;
- Earth sciences, including geochemistry;
- Pure and applied mathematical sciences;
- Nursing and other medical and health sciences.

This expertise is reflected in the calibre of RUN researchers, and the many ways in which they are applying their talents to enhance their regional communities with internationally relevant research.

Here are some of their stories.



Selflessness of volunteer firefighters still a challenge



Professor Sally Ferguson

Better ways of protecting Australia's rural firefighters from their own dedication are needed, according to new research by CQUniversity.



Research into the fire conditions these volunteers endure during an outbreak shows firefighters can perform physically for extended periods of wakefulness, but their decision-making ability is impaired, as is their judgement of how much they are impaired.

"It's important for our agencies to know that while physically people are probably able to keep going, they probably shouldn't be making decisions out there. Somebody who's not tired should be looking out for them," said CQU sleep researcher, Professor Sally Ferguson.

Professor Ferguson said both she and the agencies were struggling with the challenge of how to help some 220,000 highly motivated and selfless volunteers look after themselves properly during the extended periods of wakefulness associated with 24-hour fire suppression campaigns.

"These are dedicated people fighting fires in their local communities and helping out their mates, so they are often not great at looking after themselves. Nobody wants to force volunteers to do anything. But how do you force them to stand down? People don't want to leave the place."

Firefighters work under extreme conditions and for extended periods. Local volunteers, many of whom are farmers, are often called out after they've already put in many hours of work in their usual jobs. As first strikers, they feel committed to stay until relief teams are able to be brought in from around Australia.

"In our regions we have about 220,000 volunteer emergency services personnel. They are around the periphery of cities, in the regions or rural areas. They are the ones who are called upon year around, not just for fires, but road crashes and increasingly other weather events such as storms.

"They are the ones who are on call. They are the ones whose pagers are going off whether they have been working 16 hours a day seeding or not. So the decisions that everybody makes, including their incident

management team, those individuals need to be informed," Professor Ferguson said.

The fatigue that is inevitable when people work at night has not been definitively linked to firefighter fatalities during fire outbreaks that can last days, even weeks such as the September 2014 outbreaks in Tasmania. However, both firefighters themselves and their incident managers talk about long hours and not enough sleep.

"Fatigue arises even if you've had heaps of sleep. If you are working at night then your fatigue likelihood is elevated because we don't work well at night. There's no eliminating fatigue, it's managing fatigue."

The number of very high and extreme fire weather days could increase by between four to 25 per cent by 2020, and 15 to 70 per cent by 2050 across parts of south eastern Australia, especially inland, according to CSIRO, Australian Bureau of Meteorology Bushfire and Cooperative Research Centre² research.

Professor Ferguson said the research on the operational readiness of firefighters was a collaborative effort

involving a colleague from Deakin University, peak fire agencies who were very concerned about the problem of managing first strike teams, and relief crews. They had come to recognise that fatigue can increase the likelihood of performance impairment, which can increase the risk of bad outcomes.

"We are talking about tanker-based firefighters in this scenario and obviously vigilance on a fire ground is pretty important," she said.

Professor Ferguson said she and others were still grappling with the challenge of how to reduce the length of the first shift. But, in the meantime, she was advising agencies to ensure that second wave relief crews were stood down and resting, not working.

"We need to look after these people because they are a valuable resource that is not replaceable in the regions. We can't just sign up more volunteers because of limited numbers. We are already losing them. They need to be looked after from the perspective of their health and wellbeing while they are doing these jobs. They are a critical resource."

²<http://www.bushfirecrc.com/news/news-item/weather-history-points-changing-bushfire-seasons>

Professionalisation of junior sports linked to injuries

Increasing numbers of rural and regional children who play sports are being admitted to hospitals or presenting to emergency departments for treatment of sports injuries, including fracture and concussion, new research from Federation University Australia shows.

The increasing professionalisation of junior sports, greater participation, and parents being more aware of the need to get their children checked at hospital to be on the safe side, is driving the trend.

The limited access to a full range of health services in rural and regional areas, especially on weekends, also means that hospitals are the preferred place for injury treatment. The trend is across all sports, not just football and netball, sports injury epidemiologist, Professor Caroline Finch said.

"We're seeing an increasing focus on professionalisation and competitiveness of junior sport. Kids who are talented want to play like professionals, so there's a faster speed to the game, greater competition. Parents also want their children to succeed. Unfortunately, these factors can increase the risk of injury," Professor Finch said.

"Fractured bones, joint dislocations, very serious muscle injuries, concussion and suspected concussion are the most common sports injuries treated at hospitals. In fact, sports injuries are the 'number one' reason why children and young people are admitted to hospital for injury treatment," she said.

The worrying trend in children and young people being hospitalised following increasingly competitive recreational sports is also reflected in recreational athletes among the 20 to 45 year old age group, again especially in rural and regional areas, and especially in popular sports like football and netball.

"Our research shows that the number of hospital treated sports injuries is higher in rural and regional communities per population than it is in the cities. Our most recent research shows that this problem has actually also been increasing over time," she said.

The major obstacles to better sports safety in regional Australia are poorly maintained playing fields that are hard, uneven and with cracked earth or without grass; a lack of pre-season training and preparation before sport; enthusiastic, long-serving but unqualified coaches; little access to rural general practitioners on weekends, no



Professor Caroline Finch (Jeremy Bannister)

sports medicine clinics, and few specialist sports injury doctors and physiotherapists.

Funds earmarked for safety at the peak body level are also not always finding their way down to local level sport in a way that can help where the vast majority of people play.

Professor Finch said it was very important that research of direct relevance to regional sport and communities continue. These sports injuries among rural and regional 20 to 45 year-olds can have serious 'knock-on' effects on surrounding family members, especially where the injured party is the sole breadwinner.

"If those people get a serious enough injury, they are not going to be able to work. They are going to lose income. They will have to pay medical bills. How will they cope with that? That's going to be really, really hard.

"In some rural families where the sole bread-winner is the father, he might be a labourer who plays football on the weekend to get fit. What if he gets an injury, and has to have surgery and is off for six months? Where's the income going to come for that family?"

Professor Finch is the Director of a sports injury prevention research centre that's just one of nine

accredited to the International Olympic Committee worldwide. She said her research had not just identified serious vulnerabilities in regional sports, but had also identified a series of solutions accessible by parents and weekend football warriors alike.

These included new information designed to help parents decide between local teams that stressed winning but risked greater injuries, or safer options including better training of volunteer coaches in the latest injury prevention knowledge. Another tool showed local people how to assess the safety of local sports grounds and to identify options to improve player safety.

One of the most important forms of prevention for sports where players have to change direction suddenly in pursuit of the ball is exercises that players can do themselves. These neuromuscular exercises are needed in pre-season training programs for all players. The exercises are designed to strengthen the muscles, ligaments and other structures around especially vulnerable knee and ankle joints.

Reducing overheads for farming families, and replenishing soils in developing countries

Southern Cross University researcher Terry Rose is working on ways to reduce expensive fertiliser costs for Australian farmers, research which also has the potential to stave off malnutrition in developing countries.

“Fertiliser prices have generally shown a continual upward trend, while rises in prices for bulk commodities such as wheat, barley, rice and canola, haven’t historically increased at the same rate, leading to narrower profit margins,” the SCU research fellow said.

Australian soils require inputs of nitrogen and phosphorus to achieve economical crop yields which are typically applied as inorganic fertilisers to paddocks.

Dr Rose is examining different fertiliser management strategies to increase crop uptake of fertiliser nitrogen, and breeding options to address phosphorous fertiliser issues.

“We focus on improving nitrogen uptake by crops, and minimising nitrogen losses, including leaching and gaseous losses. Nitrogen is not only required for plant growth, but it also determines grain protein levels - which is what grain farmers get paid for.”

Nitrogen losses can be as high as 50 per cent, and not only represent lost dollars for farmers but pose an environmental threat. Leaching of nitrogen contributes to eutrophication of waterways – responsible for algal blooms – and nitrous oxide gas losses contribute to global warming.

Phosphorus presents a different problem. Much of the world’s arable soil is already deficient in phosphate, so this fertiliser – essential for plant DNA, lipids and energy transfer processes – is required even for moderate crop yields.



Dr Terry Rose (NSW DPI)

“But unlike nitrogen, you don’t really want too much phosphorus in the grain because it is present as an organic form called phytate, which is considered to be an anti-nutrient,” he said.

Phytate binds iron, zinc and other essential elements, and cannot be digested by monogastric animals, including humans, meaning our urine and faeces are loaded with phosphorus. Much of the phosphorus applied as fertiliser is then removed from the paddocks in the harvested grain, driving the continuous need for fertiliser applications.

After spending years testing phosphorus in the grains of rice cultivars, Dr Rose and colleagues have identified promising lines that can be used in rice breeding programs.

“We have identified potential donor varieties in rice with lower grain phosphorous. We are now moving to the next stage of trying to identify what genes are involved,” he said.

Dr Rose said the work on both nitrogen and phosphorus was globally relevant. Political instability and migration in developing regions are often associated with impoverished populations and malnutrition brought on by the inability to afford or access fertilisers.

“The phosphorous project is probably more important for Africa than Australia. In Australia it will help farmers’ profit margins by reducing input costs. In Africa, it may mean the difference between food on the table or going hungry.”

Disaster survivors link to better mental health

The latest round of fires, droughts and flooding has resulted in increased rates of men taking their own lives in rural and regional Australia, with massive social change only likely to worsen the problem in future, according to University of New England researcher Myfanwy Maple.

Associate Professor Maple, a suicide prevention expert, said the problem needed to be much better understood since prevention strategies had made little difference to the toll of 2500 deaths by suicide across Australia each year.

These deaths were tragedy enough, but the need to create better interventions was even more significant as research had now established that those who are exposed to suicide are at greater risk of depression and suicide themselves, especially the second circle of acquaintances.

“We don’t know what that is. We don’t know why some people are more exposed to risk than others. But we do know some people are more resilient, and better understanding that is important to thinking about intervention,” she said.

Overall, depression and serious anxiety could be triggered both by genetics and situational crises, such as natural disasters, job loss associated with major plant closures,

relationship breakdown, and people experiencing a big life transition such as adolescence.

“There’s not really good evidence for whether or not rural Australians are more susceptible to mental ill health than their urban counterparts. But certainly we see that those pressure points are having a greater impact on more people within close knit communities,” she said.

Associate Professor Maple said we know enough about risk factors related to suicide, and what is really needed now is funding to look at how to help people build resilience, particularly in difficult or uncertain times.

“One of the things that helps us understand suicide really talks about our sense of belonging, being useful and contributing meaningfully. So if you lose your farm or you’re not able to contribute anymore or you’ve got financial pressures, then those things impact on how you are participating in the community.”

If these men begin to believe that they are becoming a burden rather than contributing, that is a predisposition to thinking about ending their lives.

But others were resilient and able to adapt to the same pressures.





Associate Professor Myfanwy Maple (simon scott photo)

“One of the things that we don’t appreciate enough when looking at suicide is what keeps people alive and healthy during periods of extreme stress. There are lots of people who have terrible, terrible things happen, but who are able to rebuild their lives and find new meaning in life.

“What is it about these people that we can learn from to better support people who are vulnerable? That’s just as important to understand,” she said.

Associate Professor Maple likened suicide death to “a pebble in a pond” with ripples going out in ever increasing circles, but with no-one knowing who is going to need support or when or what type of support they will need.

“That’s a prime area now that we need to move into in terms of prevention. For too long, those exposed to suicide death have been ignored in relation to their needs following the death by suicide of someone they know.”

Meanwhile, Associate Professor Maple’s work with suicide bereavement has gained international recognition for better understanding the adverse outcomes following exposure to suicide death, and she is now working on better identification of those most likely to experience harm following a suicide death to increase resilience following traumatic events.

Associate Professor Maple is applying the same principle of understanding resilience to helping understand the key components that underpin the successful rural youth intervention program BackTrack, which has won several awards for its work.

This work will enable other communities to develop local services for young people who are at risk of mental illness, substance abuse, criminal activity and lack of educational engagement.

She said flexible models aimed at helping young people to re-engage were key.

“Because we know that belonging and having aspirations for the future is the biggest change agent for somebody’s potential in his or her life.

“In terms of suicide prevention activities for the future, we must look beyond risk factors, and build individual and community resilience.”

People concerned about these issues can call MensLine Australia on 1300 78 99 78, or Kids Helpline on 1800 55 1800. Similarly, Lifeline offers 24 hour counselling on 13 11 14, while the Suicide Call Back Service operates seven days a week on 1300 659 467.

New drone technology nips problems in the bud to save crops

New drone and automatic recognition technology being trialled by University of Southern Queensland researcher, Dr Cheryl McCarthy, is set to help Australian farmers use less energy, water, herbicide and labour to grow more food and fibre.

High-tech management support tools like these are revolutionising agriculture, enabling farmers to have far greater control over production and creating a new class of data-centric agricultural careers for young people.

"This drone system has automatic recognition technology which is able to identify a diseased plant in the middle of a paddock, pinpoint it, raise an alarm to the grower, map the issue and tell them, 'here is a problem plant and you need to go out and have a look at this emerging problem'," Dr McCarthy said.

Weeds cost Australian farmers between \$2 billion to \$4 billion each year.

This automated, camera based technology is expected to reduce herbicide costs by 80 per cent, eliminate the labour costs of spot-spraying, and help identify problem pests, diseases and water shortages before they wipe out large areas of paddock. Farmers are already exploiting the power of drones to provide a bird's eye view of paddocks unavailable on the ground. However present drone systems are limited in that they require the farmer to manually inspect images of their crops and interpret data for very large areas of paddock.

"However, if the recognition of problem areas is happening automatically, you are down from the scale of looking at large groups of plants. You might be able to look down at a scale of what's happening at the individual plant level, and even what's happening on the individual leaf.

"So you can potentially identify problem areas at a much earlier stage as opposed to when it's starting to wipe out large areas of paddock," she said.



Dr Cheryl McCarthy (USQ Media Services)

In combination with ground-based sensing on tractors, the automatic recognition technology also has the ability to address the growing and expensive problem of herbicide resistance, as well as the need to reduce run-off in sensitive coastal areas adjacent to the Great Barrier Reef.

“There are problems with herbicide resistance. Industries and farmers have been relying too much on a particular herbicide and not putting on the correct application rate, which means that weeds are becoming resistant. But USQ’s tractor-based vision system is capable of automatically applying a different herbicide based upon whether the species is known to be resistant or not.”

Dr McCarthy said USQ was developing the technology to incorporate the sorts of observations and knowledge traditionally used by farmers to counter water stress in crops. For example, drone imagery is being combined with precision agriculture maps such as soil moisture, weather

information and yield from previous years.

“We’re hoping with this research to be able to diagnose all these different conditions which will then inform a prescription map for different chemicals or for water.”

The remote surveillance capabilities of automatic recognition technology are also being exploited to help ensure the continuing ability of wild bees to pollinate a third of Australian agriculture. The technology monitors pest traps at Australian cargo ports to help ensure the pollination services of wild bees don’t collapse, forcing hand pollination and other measures.

Dr McCarthy’s work is making a significant contribution to the broader development of intelligent farming systems led by USQ’s National Centre for Engineering in Agriculture/or Institute for Agriculture and the Environment.

Protecting livestock from disease, and reducing costs for Australian farmers



University of Sunshine Coast researcher Adam Polkinghorne is trialling a vaccine aimed at reducing overheads for Australian primary producers, including the live export industry, arresting the decline of the koala, and reducing antibiotics in the human food chain.

“I’m working on a disease caused by a bacterium, Chlamydia, which is a problem in humans, but it’s also a problem in sheep and cattle and koalas,” Associate Professor Polkinghorne said.

One of the biggest challenges facing Australian farmers is to continue to feed Australians, but also act on a global stage where they need to produce more food on less land at reduced cost. However, sheep and cattle farmers’ ability to be more productive is being degraded by the little understood Chlamydia infection.

“Another research group found that at least 40 per cent of Australian sheep are carrying the bacteria Chlamydia. What my work is doing is trying to understand that while 40 per cent are carrying it, only some of them go on to develop the disease, especially in central NSW.”

Associate Professor Polkinghorne and his fellow researchers believe Chlamydia arrived in Australia in the

cattle and sheep that accompanied colonial settlement. The descendants of these livestock, especially sheep, are increasingly needed for the live export trade but are being rejected by China and other countries on the dubious grounds of Chlamydia infection.

The research has also linked this livestock pathogen to infections in koalas where this same disease is causing localised extinctions in the iconic native species.

“Australia has a world-class agricultural system that sets a very high standard in maintaining the health of animals and the welfare of animals. We’re the envy of many other countries. But other countries that import our products also have high standards, and it’s a challenge for Australian producers to meet those standards,” he said.

The exact costs on Australia’s live sheep export trade are still to be completely assessed, but the impact is thought to be widespread across all Australian states, including for domestic producers.

“It’s something we’ve created and is not a threat to humans per se. But Chlamydia is a major cause of arthritis in lambs. That’s a problem especially for central NSW because that’s a prime production area for sheep meat. This disease means the animals arrive at the abattoir underweight and aren’t slaughtered, but are condemned.



Associate Professor Adam Polkinghorne

"So that's a cause of loss for those farmers. There's also the cost of production in terms of treating those animals throughout the year and using antibiotics, which we don't want to continue to put into the human food chain."

The two biggest threats to humans posed by infectious diseases in the 21st century are so-called zoonotic diseases jumping from wild animals to humans as the latter continue to encroach on native habitat, and rising antibiotic resistance.

"The main reason we have antibiotic resistance in Australia and across the world in our hospitals, is because of the antibiotics tipped into livestock around the world. So anything like a vaccine is going to be the preferred option for treating diseases to help reduce trends in antibiotic resistance in humans."

Associate Professor Polkinghorne and his collaborators want their vaccine to be effective in sheep, cattle and koalas. Koalas themselves represent an iconic Australia species valued at over \$1 billion in tourism per year. But the researchers say that such a vaccine is out of reach even with the considerable Australian Research Council grants they have won to date.

"It's going to require serious money from a range of stakeholders to assist with delivering a vaccine that has such widespread need."



Your partners in delivering regional solutions

If you would like to know more about our research programs or how you can partner with a RUN university, please contact the Regional Universities Network.

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