Regional Universities Network

REGIONAL STRENGTH. NATIONAL SUCCESS.

RUN Women in Science, Technology and Engineering in Regional Australia

The Regional Universities Network (RUN) is delighted to share these inspiring stories[1] of women in science, technology and engineering who are studying, or have studied, at one of the network's seven regionally-headquartered universities.

Inspired by the desire to help their communities and to teach others, and supported by their families and universities, the women's contributions are at the cutting edge of research.

Their research includes: using micro-technology in sports science; improving the mental health of people working in aged care; protecting human and animal health; helping people with disability stay mobile; enticing young people to careers in agriculture; analysing the use of autonomous vehicles; developing stronger and lighter steel; searching for exoplanets; combating disease in plants and animals; investigating ocean pollution; and supporting the management of the Murray-Darling Basin.

The stories of these impressive women are just a few examples of the important and rewarding contributions that women in science, technology, engineering and mathematics (STEM) careers are making in regional communities. However, women only make up around 16 per cent of the STEM workforce in Australia.
We need more women to study and pursue careers in STEM for the nation's prosperity.

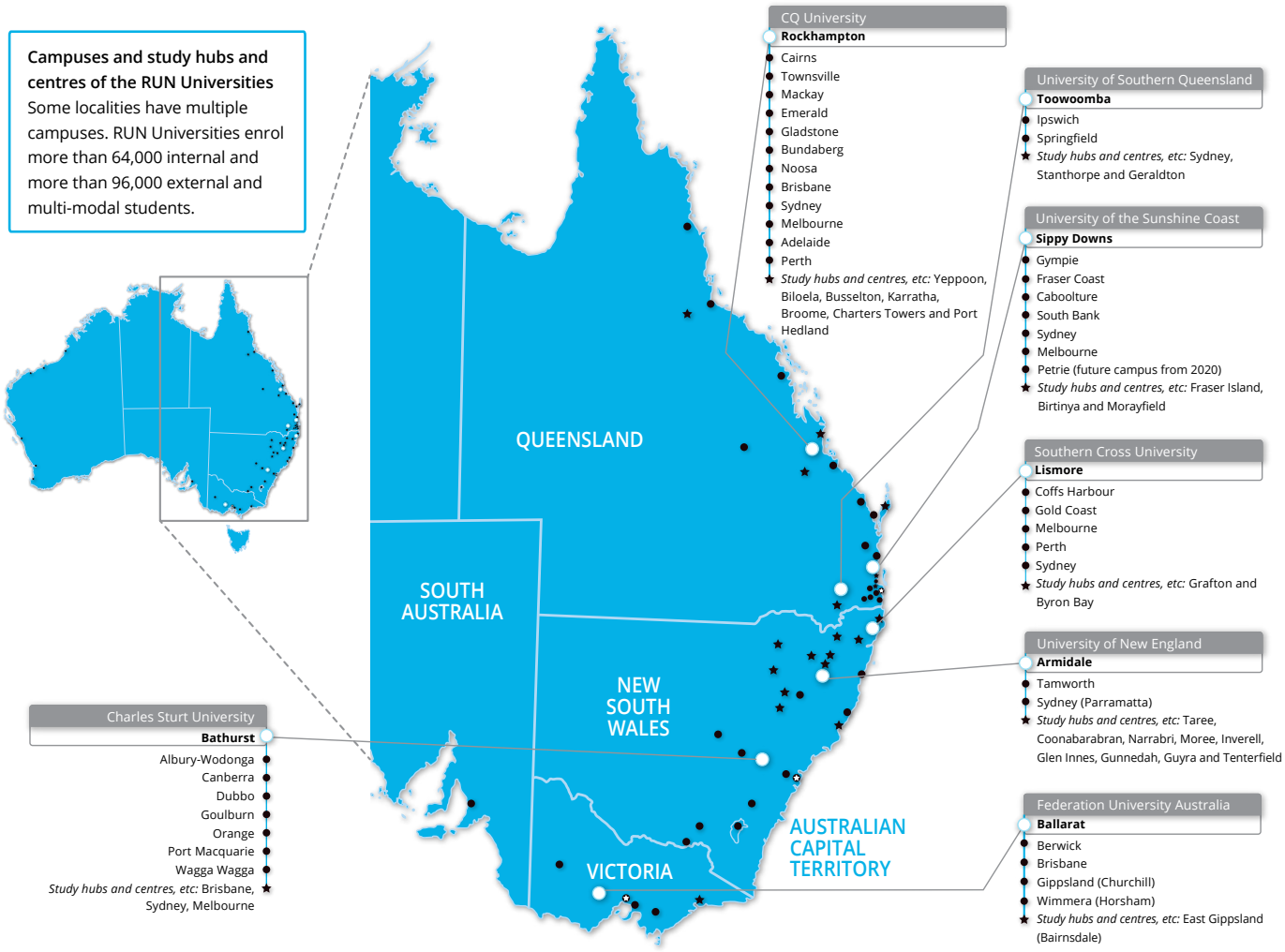
RUN, a group of seven regionally-based Australian universities that include Charles Sturt University, CQUniversity, Federation University Australia, Southern Cross University, University of New England, University of Southern Queensland and University of the Sunshine Coast, has published these stories as part of our work to champion the Women in STEM Decadal Plan.

The plan, developed by the Australian Academy of Science and the Australian Academy of Technology and Engineering, with the support of the Australian Government, offers a vision and opportunities for organisations, like RUN, to lead the significant changes needed to enable greater representation of women in STEM.

Our country needs more highly skilled, university-trained professionals to work in regional Australia. So, attracting more women and girls to STEM and providing an environment for them to thrive and progress is an important part of RUN's work. It is also encouraging that seven out of ten of the network's graduates go on to work in regional Australia, compared to the national average of two out of ten.

[1] *Written by Guy Healy*

Campuses and study hubs and centres of the RUN Universities
Some localities have multiple campuses. RUN Universities enrol more than 64,000 internal and more than 96,000 external and multi-modal students.



CQ University
Rockhampton
- Cairns
- Townsville
- Mackay
- Emerald
- Gladstone
- Bundaberg
- Noosa
- Brisbane
- Sydney
- Melbourne
- Adelaide
- Perth
- ★ *Study hubs and centres, etc:* Yeppoon, Biloela, Busselton, Karratha, Broome, Charters Towers and Port Hedland

University of Southern Queensland
Toowoomba
- Ipswich
- Springfield
- ★ *Study hubs and centres, etc:* Sydney, Stanthorpe and Geraldton

University of the Sunshine Coast
Sippy Downs
- Gympie
- Fraser Coast
- Caboolture
- South Bank
- Sydney
- Melbourne
- Petrie (future campus from 2020)
- ★ *Study hubs and centres, etc:* Fraser Island, Birtinya and Morayfield

Southern Cross University
Lismore
- Coffs Harbour
- Gold Coast
- Melbourne
- Perth
- Sydney
- ★ *Study hubs and centres, etc:* Grafton and Byron Bay

University of New England
Armidale
- Tamworth
- Sydney (Parramatta)
- ★ *Study hubs and centres, etc:* Taree, Coonabarabran, Narrabri, Moree, Inverell, Glen Innes, Gunnedah, Guyra and Tenterfield

Federation University Australia
Ballarat
- Berwick
- Brisbane
- Gippsland (Churchill)
- Wimmera (Horsham)
- ★ *Study hubs and centres, etc:* East Gippsland (Bairnsdale)

Charles Sturt University
Bathurst
- Albury-Wodonga
- Canberra
- Dubbo
- Goulburn
- Orange
- Port Macquarie
- Wagga Wagga
- ★ *Study hubs and centres, etc:* Brisbane, Sydney, Melbourne

Charles Sturt University
CQUniversity Australia
Federation University
Southern Cross University
une University of New England
University of Southern Queensland
USC

Best minds fighting to protect one of Australia's oldest and most valuable crops: wine grapes

Charles Sturt University (Charles Sturt) and National Wine and Grape Industry Centre researcher Sandra Savocchia is a veteran in the generation to generation struggle to better protect one of the most valuable agricultural crops in the world, the grapes in Australia's vineyards.

Having survived the aphid-like insect, phylloxera, which destroyed the vines of most countries in the 19th Century, Australia has some of the oldest grapevines in the world, with some dating back to the mid-1800s.

Australia also has some of the oldest and most varied soils types on Earth, which Wine Australia says creates superior and distinctive terroirs, and thus the production of unique wine styles.

Needing regular pruning, the distinctive T-shaped vines are vulnerable to a range of pests and diseases, many dating from the first vine plantings from Europe and America.

Grape-growing, wine-making and wine-related tourism in Australia's 65 wine regions were employing over 172,000 people, mostly in regional Australia, and generating AU$40 billion annually in 2016, according to Wine Australia in The Weekly Times.

Sandra – whose expertise in grapevine pathology was formed at The University of Adelaide – says better understanding these diseases of grapevines is important for the longevity of the wine industry.

'We all expect to see vines surviving 100 years or more in some instances. But we have cases where we're seeing vines as young as five years old, or 12-year-old vines that have been severely impacted by grapevine wood diseases.'

'Generally, the older the vines get, the better wine that you're able to make from them. So having vines last longer than 10 to 12 years is very important, not just for that wine quality aspect, but also for vineyard productivity. No-one wants to be pulling out and replanting a vineyard or undertaking extensive management techniques after that kind of time because it's very costly.'

Sandra is motivated by the difference that the field trials and associated workshops she conducts can make to the industry, and a passion for teaching:

'We go out and deliver workshops to industry, the growers in the field. They are always really well-received because we do presentations where we'll talk to them about the issue and how to manage it. Then we'll take the growers out to a vineyard, to a site where we know there's a problem, and do hands-on workshops around what to look for and how to manage the problem.'

In addition to a war of attrition against pests and diseases that affect viticulture in different ways worldwide, Australian growers face a dynamic range of challenges. The international wine production industry led by Europe, South America and the United States is regarded as fiercely competitive, and recently produced a bumper grape harvest and thus increased global wine inventory. However, lower income growth and greater uncertainty for the discretionary purchase of wine, for which Asian markets are increasingly paying over $18 per litre, can adversely affect demand.

Grape yields, with the 2019 vintage already estimated to be the smallest since 2013-2014, are forecast to be significantly reduced due to a combination of shortages of irrigation water, spring frosts and heatwaves, according to Wine Australia.

Growers have a range of control strategies to protect grapevines from pests and diseases. But Sandra is overseeing trials of remedial surgery to rejuvenate vines from debilitating wood diseases, and reducing costly post-infection re-plantings.

This results in the production from these vines being delayed for up to three years while growers wait for the 'cordons', or arms of the grapevine which carry the fruiting grapes, to regrow; the spurs to reform; and bunches to emerge. This is still better than replacing the whole vine.

'We have two vineyard sites where we've cut back the trunks and we've removed the infection from the vines. We're training some new shoots which will eventually form cordons, and we're monitoring them over the long-term to see whether we can get them back to the level of production observed prior to infection.'

Protecting these vines from re-infection by not pruning in the rain, and applying wound protectants from pruning are important ongoing disease management strategies, she says.

The Australian Research Council, the wine industry, Wine Australia and Charles Sturt have funded her research over the years.

Sandra expects her research on dieback – where trees begin to decline - to be applicable to other fruit and nut industries.

Charles Sturt University

Translating the science on Murray-Darling water to promote community buy-in

Beneath media headlines about tragic fish kills, water stealing, a complex water trading system and prolonged drought, is another quieter but no less important story: the slow, steady work of environmental scientists turned mediators and communicators, and the continuing rise of participatory science.

The Murray-Darling Basin is Australia's largest and most complex river system, serving millions with drinking water, hosting the nation's food bowl, as well as many wetlands and species of international significance.

But with conditions in 2019-20 dry to very dry, the main focus of environmental watering priorities this year is to avoid irreversible impacts on species, vegetation and important sites, says the multi-state Murray-Darling Basin Authority.

Charles Sturt University Professor Robyn Watts says there are four levels of complexity of the Murray-Darling Basin: geographic, institutional, social and ecological, and there are many different perspectives on who to best manage the system.

Despite this, Robyn – who lives and works in the Central Murray – says there has been a decade-long effort by different agencies, community groups, irrigator groups, environmental groups and scientists to work together.

'Collaboration and engagement takes time, and improvements in the river system are gradual and tend to not make news headlines.'

Robyn is an expert in the adaptive management of environmental water: the water releases that maintain and improve the health of rivers and floodplains, and are aimed at protecting the plants, animals and landscapes that underpin healthy communities.

Robyn synthesises the results of environmental flow trials to better engage a range of perspectives among stakeholders. Her research has evolved from being strongly biophysically focused, working with ecologists, hydrologists and geomorphologists, to a transdisciplinary approach involving the community and social scientists. For example, they interview landholders and managers about their perceptions of environmental flows.

In terms of women in science, Robyn says she has been struck by the effectiveness that female scientists have played in increasing the participation of different stakeholders, including Indigenous, irrigator and recreational angler groups:

'Quite a few of the scientists involved in engagement are women, and are leading this work. By using a participatory approach working with people from different parts of the community, it is possible to make changes that are beneficial for the environment and the community. It is about looking for win-win opportunities and being there for the long haul.'

'I love working in STEM. Through good science we can improve knowledge, and through engagement with managers and the community we can use the science to improve decision-making for healthy river ecosystems.'

Robyn said the story of the Murray-Darling Basin was a tale of two basins. The climate, biophysical environment, water licenses and the management of water are different in the southern and northern basins.

> *'At any given time, the people and the river ecosystem in different parts of the basin may be experiencing very different circumstances. One area can be in extreme drought while at the same time another part of the basin has received average rainfall.'*

This affects the way that water is managed and also influences people's perceptions of water management. This highlights the essential role of community advisory groups that provide an opportunity for different perspectives to be heard.

'There are some great examples where community representatives have been working collaboratively at adaptive management for many, many years now.'

One of her latest presentations about flow trials was to the Edward-Wakool Environmental Water Advisory Group. The group developed a trial for running environmental water through the system in a way that was different to the normal operating rules.

'The flow trial was outside the box. The advisory group worked together to see if it could be done and came up with a plan that wasn't going to inconvenience landholders' practices or flood infrastructure.'

Indigenous, angling and community groups are increasingly involved in the monitoring of turtles, fish and water quality as part of a current Australian Government funded project that she leads.

'It's a two-way collaboration. We are incorporating community knowledge and experience to improve the science and tweak the monitoring design to make sure we get the best design and outcomes.'

Robyn's Edward-Wakool work is funded by the Commonwealth Environmental Water Office and the Department of Environment and Energy.

Charles Sturt University

Australian agriculture is on a recruitment drive for the problem-solvers of the future

CQUniversity researcher Dr Amy Cosby is embedded in an agribusiness on her property in rural Victoria, fulfilling her dream of primary producing, but also to better understand the needs of her fellow farmers and rural communities.

Amy is most struck by the disturbing mismatch of perception about job prospects and opportunities in agriculture across Australia, which are very strong, versus the increasingly negative narrative city folk receive about the industry.

Over recent years, people would have seen devastating scenes of intense floods and heat-waves, record low rainfall and prolonged drought across many parts of Australia; they would have heard about farmers not getting paid enough for their produce, or doing back-breaking work; they would have seen news reports of farm invasions by animal activists, and heard about the contribution of national livestock herds to greenhouse emissions, she said.

'Our team is working hard at changing the negative perception of the agricultural industry and showing that many agricultural practices can improve the condition of the environment. Also, that Australia has some of the highest animal welfare standards in the world.'

Amy said that living in Gippsland and working for a regionally-based university meant she could better satisfy her motivation to make a difference in rural communities and to access firsthand the challenges faced by farmers and others working in agriculture.

'As a farmer doing agricultural research, my peers are not just the people that I work with at the university, but those that surround me working in a range of agricultural roles.'

Through her Women in Agri-tech project, Amy has concluded she is a living example of the type of good career that young women could enjoy for themselves in rural Australia: with women making up just 30 per cent of the agriculture workforce, 14 per cent of people in leadership or management positions, and only eight per cent on boards, young women were the 'untapped resource' of the sector.

An especially important part of Amy's work is to better educate young people that being a farmer is not the only career in agriculture. There are about four jobs available for every person who graduates with an agriculture degree, with about 1.6 million people currently employed in the industry. Fifty per cent of those employed live in capital cities, with the balance working in regional areas across the agricultural supply chain from production to manufacturing to retail.

'We also need scientists, data analysts, consultants, people working in the business sector or banking, sales and marketing. In particular, there are a lot of opportunities for scientists as the agriculture sector is working hard to address the many challenges farmers and the supply chain are facing.'

Australia risked falling behind the rest of the world if the country did not recruit the best and brightest minds to the industry. People were needed by the sector with the skills, interest and motivation to feed and clothe a growing population, she said.

'Everybody eats and wears clothes. So, everybody is already involved in agriculture whether they know it or not. We now need them to realise and appreciate the importance of the sector.'

Amy has co-developed the interactive 'GPS Cows' program to help entice young people into Australian agriculture. The initiative – which has been rolled out to hundreds of NSW schools – uses livestock tracking technology to better understand animal movement and behaviour, and their interaction with the landscape, to develop more efficient management practices.

'By using programs like GPS Cows, we can teach kids who don't know anything about agriculture, all about the science, technology, engineering and mathematics that's used in the industry. So, if they're interested in technology, data or science, they could end up in a career in agriculture, which is important as we need those people.'

Amy's assessment of job prospects in agri-business is backed by a 2014 report from Deloitte's, *Building the Lucky Country: Positioning for Prosperity*, that nominated agribusiness as one of the 'fantastic five' industry sectors with the potential to take over from mining as a key driver of growth in the Australian economy.

The Women in Agri-tech project is funded by the Department of Industry, Innovation and Science, New South Wales Department of Education, Queensland Department of Agriculture and Fisheries, and Cotton Australia. The GPS Cows project is funded by the New South Wales Department of Education.

CQUniversity AUSTRALIA

Safer roads and better buses for mobility scooters please!

CQUniversity researcher Carolyn Unsworth has been working to keep people driving as long as safely possible, or using mobility scooters, so they can continue to enjoy their communities, avoid premature entry to nursing homes, and live longer healthier lives.

Carolyn – an occupational therapist – says there is an 'invisible community' of millions of older and disabled Australians across the country who are no longer able to drive, and don't have access to the transport known to be so vital to social lives and healthcare.

She had been working for 10 years in the area of the neurological rehabilitation of people who had experienced strokes, when she had a motivating revelation.

'The big systems don't always provide the right support to help people manage as well as they could. Community transport mobility was affecting all of these people, and others across all age groups. All people with a variety of disabilities needed to access the community, but they weren't getting the right assessments or support to remain mobile.'

Carolyn said that as a woman in STEM, she took it for granted that female researchers can do whatever they want.

But her teenage daughter reminded her of an important point recently:

'She said "Oh Mum, women only got to vote quite recently" and I forget these startling facts. I take it all for granted. Perhaps every now and again I should stop and reflect about how we need to support more women to go into science. Women have an important contribution to make,' she said.

As people live longer and it is increasingly believed healthier lives, keeping people on the road in a car, or mobile on a scooter as long as safely possible is critical to the length and quality of their lives.

'That's what helps keeps people at home, and able to live independently. They don't have to move into nursing homes. People can have a terrible downward spiral if they lose access to the community through loss of transport.'

Having already completed her Doctorate years before, Carolyn became an occupational therapy driver assessor to help ensure that people who had disabilities could continue to drive for as long as they safely could.

Public Transport Victoria has funded Carolyn to explore whether basic infrastructure needed a rethink to adapt to changing community needs.

She said not enough buses – the biggest transport linker in communities – could take mobility scooters; scooter standards did not align with buses; there were too few buses in rural and regional areas forcing some older folk to take their scooters on dangerous journeys on potholed roads; there were not enough occupational therapy driver

assessors in regional and rural areas; and footpaths stopped at the edges of towns.

This complex problem is more acute in rural and regional areas, and nationally there are around six deaths and 700 hospitalisations annually.

'Although all scooter users are at risk of falls, tips and colliding with cars, these risks are particularly high for scooter users in rural areas where they are more likely to need to drive on the road.'

Better education for scooter users is needed around how to drive them, especially the idea that they must follow pedestrian road-rules. Scooter accident numbers are higher than officially documented since they are classified as falls rather than a 'scooter road accident'.

Keeping country people on the road safely is also exacerbated by an acute shortage of driver assessors available to ensure their physical and cognitive fitness to drive.

> *'We've got people driving who shouldn't be. Others who may give up driving prematurely. We've got people driving without aids and adaptive equipment, such as a spinner knob for people driving with one arm. That would make their lives so much better.'*

Australia also had a problem with increasing numbers of baby boomers getting older and developing dementia. People may be okay to drive in the early stages, but `as soon as they're not safe, we need to identify them and say: "Time to stop".'

For other boomers who need to relinquish driving, transitioning to using a scooter may be possible. Carolyn has developed world-first 3D scanning technology to help ensure the dimensions of mobility scooters and bus passageways are more compatible, as part of a multi-disciplinary team.

Improving jobs and growth through stronger, lighter Australian steel-making

Federation University's Dr Fatemeh Javidan has spent years testing steel to better understand the trade-offs between increased strength and brittleness, and so develop higher standards to encourage greater take-up of stronger, lighter steel. She hopes Australia can eventually corner the world market in high-strength steel, which will improve national jobs and prosperity.

While Australia accounted for half of the sea-borne market for iron ore in 2016[1], global steel-making is so competitive that Australia only produces a fraction of world steel-making[2], and is heavily reliant on marginally costed imported steel for Australian projects[3].

Stronger, lighter steel would drive up demand within Australia, which in turn would drive up Australian-made steel-making, for both domestic use and export.

'Steel is one of the main sources of income in Australia. If the building design guidelines are updated to using innovative steel, the demand in the construction industry goes higher and this can increase Australian steel production. That would result in less import from other countries, especially because Australian manufacturing will be within the standards that the markets want.'

Fatemeh – who is an Australian of Iranian heritage – encourages young women to study civil engineering because it shapes the modern world. She is inspired by three things: the unexpected creative aspects and design potential of new lighter steel; the changing nature of engineering culture; and increased opportunities for young women in areas such as 'trendy' bio-engineering, textile engineering and design fabrics.

'After you have passed learning the theories, and doing the maths, when it comes to your actual designs or structures, that's when you can add your creativity. If you get into research, you then have ideas and the space to bring them into practice.'

Notions of male-dominated, 'hard-hat' stereotypes of engineering were outdated. The phenomenon of girls giving up on engineering after poor initial results in maths and science were not a permanent barrier to a rewarding career, she said.

'There are different, rewarding disciplines that girls will be interested in if they are made more aware of those.'

Steel is projected to be in ever greater demand worldwide as developing countries establish greater levels of transport, housing, water, gas and electricity supply networks, sanitation works and factories. Demand increases again as prosperity increases, especially in the white goods and apartment blocks associated with increased urban densities[4].

However, the carbon intensity of cauldron-based steelmaking means production of one tonne of steel generates almost two tonnes of carbon dioxide emissions. Steel-making accounts for about five per cent of the world's total greenhouse-gas emissions[5].

'If we are able to produce much stronger steel and use them across the construction industry, that means that we are using less mass of steel. That is good for sustainability. Everyone's concern is that we are producing so much steel, we are creating so much CO_2 emissions and we are having this footprint on the Earth.'

Studies of high-strength steel, reported by the United States highways administration for example, have shown that mass can be reduced up to 30 per cent, leading to significant sustainability benefits.

Greater take-up of more sustainable steel would also significantly lower costs across construction because even though high strength steel is costlier, *'the amount of mass that we are reducing is greater. So there is a cost benefit as well.'*

Fatemeh has worked closely with the manufacturers of advanced tensile steel, studying its behaviour under different stress conditions, and formulating predictions of strength and behaviour of prefabricated steel components.

Ultimately, she is developing guidelines for the design of high-strength steel members, while complying with national building codes, since present standards are limited to a certain strength, which dictates the steel used. Unlike the automotive and manufacturing industries, the construction industry is not up to date with the technologies and advancements of high-strength steel.

Fatemeh has been supported by the Research Training Program 2018, and the Research Grant Scheme 2019, both provided by Federation University's School of Science, Engineering and IT.

Federation University

[1] *Iron ore still has an important role to play in Australia's economy, March 21, 2016, Flavio Menezes, Professor of Economics, The University of Queensland, The Conversation.*
[2] *Senate Economic References Committee inquiry into the Future of Australia's Steel Industry, Submission 16, Arrium, Mining and Materials.*
[3] *Ibid, pg 1.*
[4] *Op cit Professor Menezes.*
[5] *Steelmaking, a major emitter of climate-altering gases, could be transformed by a new process developed at MIT, [Press release], MIT, 2013.*

Innovative digital tool to improve mental health and wellbeing among aged care workers

Staff are at the frontline of Australia's aged care homes and are being empowered to take greater care of their mental health and wellbeing by co-creating a new digital tool aimed at improving workplace-related mental health.

Improving aged care staff workplace mental health and wellbeing may ultimately also benefit the residents they work with.

Australia's rapidly ageing population – the oldest of Australia's baby boomers are entering aged care homes now – means the aged care workforce will triple by 2050.[1] Some 70 per cent of direct residential care staff work as personal care workers, 15 per cent are registered nurses, and 10 per cent are enrolled nurses.[2] All three occupations will be involved in the trial of the tool.

The Royal Commission into Aged Care Quality and Safety has been especially concerned about the workforce numbers and skills mix of aged care workers, especially their attraction, retention and career paths, remuneration and qualifications levels, as more Australians live longer[3] and demand quality care.

Federation University's Professor Britt Klein, in partnership with Ballarat Health Services and Prevention United, are co-creating a workplace mental health and wellbeing digital tool for frontline workers in aged residential care. The Wellbeing Assist project is supported by the WorkSafe WorkWell Mental Health Improvement Fund.

'Aged residential care staff are working under conditions of high demand and high effort, low control and low pay. Insecure employment contracts and shift work can add considerable work-related stress.'

'In addition, aged care workers are also under the spotlight at present given the Royal Commission into Aged Care Quality and Safety, potentially adding additional pressures onto workers in this sector,' Britt says.

The Royal Commission foregrounded an important recent review that questioned the effectiveness of quality arrangements. While the accreditation of residential care providers has had a positive impact on the quality of care, especially by removing sub-standard homes, and raising the standard of quality of care across the sector, accreditation may not have been adequate in delivering quality of care outcomes.[4]

Britt stressed that the digitally-based tool will be voluntary, co-designed with staff and management, and ensures anonymity of individual workers by only feeding back aggregated mental health and wellbeing workplace-based data to management.

'Here, management will be provided with workplace related mental health and wellbeing unit-level data around how each one of the ten Ballarat Health Services aged residential care units are tracking.'

For example, indicators will be provided on a digital dashboard, possibly similar to a traffic-light system: if it's green, staff are collectively reporting everything is going well. If it's orange, this would alert management to look into the aged residential care unit some more. If it is red, then immediate action would be required.

The tool would also ensure greater transparency of worker mental health and wellbeing, especially when running multiple aged residential care sites.

> *'If you have a mechanism that can inform management in real time about how things are tracking from afar, you can act. However, being informed also needs to be coupled with the provision of resources that can be easily implemented in the workplace. This tool will do this as well. Therefore, we expect the implementation of the digital tool will lead to better outcomes in terms of workplace mental health and wellbeing.'*

During the upcoming trial, the residential aged care workers will answer a variety of co-design questions about the workplace climate of the facility that particular day, as well as how they are feeling more personally.

The tool will keep track of the workplace group-based data and feed this back to management and their personal wellbeing data will be fed back to each worker individually. For example, if their personal stress levels are increasing over time, the digital tool will alert them to personal resources to help them to manage this issue.

Wellbeing Assist follows on from another aged care oriented digital platform called iSeeBehaviour, which was supported by a Telematics Trust grant. This platform was developed to assist aged care staff implement and monitor patient-centred psychological interventions, where appropriate, in response to behavioural and psychological symptoms of dementia.

The iSeeBehaviour tool can also help identify triggers and provide individually tailored intervention strategies and provide worker stress reduction support.

Britt aims to broaden the digital platform to offer more tools to families and carers, who themselves can experience mental health issues. The initiative is part of a longstanding passion by Britt to 'do more for our elders' by harnessing technology, especially in regional and rural areas.

Federation University

[1] *Navigating the Maze: An Overview of Australia's Current Aged Care System, Royal Commission into Aged Care Quality and Safety, February 2019, Background Paper 1, p 27*
[2] *As above, p 26*
[3] *Medium and Long Term Pressures on the System: the Changing Demographics and Dynamics of Aged Care, Royal Commission into Aged Care Quality and Safety May 2019, p 2*
[4] *Navigating the Maze, p 50*

Looking into Australia's interior to see how science can better support farmer resilience

Southern Cross University (SCU) researcher Dr Hanabeth Luke cut her research teeth on better understanding the diversity of attitudes around the polarizing issue of unconventional gas development in New South Wales and Queensland. With the support of the Soil Cooperative Research Centre (CRC), Hanabeth is now turning her attention to understanding farmer needs and challenges, and what they most need from science and research in our rapidly changing times.

Hanabeth is deeply motivated by helping regional communities and farmers to become more resilient, bringing communities to science, and vice versa.

Being a woman in a STEM career, she had been extremely lucky to have a supportive husband who did 'the lion's share of the parenting.' SCU had also been very supportive of her research journey as she became both a mother and Doctor of Philosophy.

'There's so many different academic pathways for young women. It's a really exciting career I feel very fortunate to be in, and I really do love my work.'

Hanabeth's research focuses where society, land, industry and community intersect, especially on the idea of 'social license to operate', or levels of community acceptance for a project or land use.

'I am concerned about ways to better engage people in decision-making, including mechanisms we can use to better understand community acceptance or support for a project or activity. Industries can be more in touch with community aspirations, while the man and woman on the street can have more input into decisions that will affect their local communities.'

With Australia regarded as one of the countries most at risk from global warming, and the world turning its attention to how we respond to changing weather patterns and reduced water availability,[1] farmers are at the front-line of questions about innovation and adaptation.

Hanabeth says the Soil CRC wants to better understand social dimensions of farming over time, especially barriers to the uptake of new scientific innovation and technology. Her background is in environmental science, but she turned to the tools of social psychology and rural sociology 'because I could see so much fantastic science being ignored.'

'I'm working with top rural sociologists to survey farmers across ultimately six farming regions of Australia to find out what farmers are doing: what their practices are, how they manage their farms, and what they need from the organisations that support them. Importantly, what do they need from scientists?'

The survey questions will be co-developed with local farmers and natural resource managers, and spatially referenced so the social data can be cross-referenced with other spatial data from the area, such as soil type, rainfall type and local topography.

Australian farmers had a well-deserved reputation for flexibility in dealing with the characteristically variable and harsh conditions of Australian climate, and an 'extremely good' understanding of their soils, but their famed resilience is being increasingly tested.

'Farmers have been used to dealing with unpredictable weather patterns for a long time. But there's additional stress now that these droughts are lasting longer. You're seeing evidence of a shift in the seasons and shorter wet seasons and all the things that go with that, including significantly increased fire risk, like we're seeing in the Northern Rivers.'

'Farmers are on the forefront of that change and farms cover half this country. Working with farmers is critical in having a more... I wouldn't use the word sustainable, I'd use resilient landscape and resilient Australian population, supporting healthier systems.'

She has secured funding to oversee two new PhDs, funded by the Soil CRC and fellow RUN member, Charles Sturt University. These researchers will investigate how farming systems are working, farmer responses to climate change, and regenerative agriculture approaches, from no-till farming to permaculture.

Spracklen et al. reported in Nature (2012) that 'for more than 60 per cent of the tropical land surface, air that has passed over extensive vegetation in the preceding few days produces at least twice as much rain as air that has passed over little vegetation.'[2]

Our work is about asking simple questions that can be of use to policy makers right now, says Hanabeth, such as 'Why are farmers still clearing trees at the rate that they are when there's clear evidence that land-clearing actually decreases rainfall?'

Southern Cross University

[1] *Palutikof, J. P. (2010). The view from the front line: adapting Australia to climate change. Global Environmental Change, 2(20), 218-219*
[2] *Spracklen, Arnold, Taylor (2012) Observations of increased tropical rainfall preceded by air passage over forests. Nature 489:282–286*

Doing research to ensure the strongest ecosystems are protected from global warming

Early work of Southern Cross University's (SCU's) Amanda Reichelt-Brushett on port contaminants found they were risking the success of coral spawning events, and led to the prevention of dredging during coral spawning periods in north Queensland. Her research is dedicated to tropical marine ecotoxicology, developing test methods to represent taxonomic groups such as cnidarians (including corals) in toxicity assessment.

More recently, Amanda turned her attention to the dispersal of mercury – a neurotoxin used in small scale gold mining by 50 million people worldwide - in the Maluku region of eastern Indonesia, the fishing ground for Indonesia, and an important global tuna fishery.

'In this region where I work, 90 per cent of protein resources for human consumption come from the ocean. People depend on the ocean as a healthy system as it is directly linked to their own health and livelihoods. Food safety and food security are essential.'

Her formative motivation as a woman in STEM dates from childhood explorations of rock pools, the wonder of trying to catch little fish, but being appalled by the discovery of crabs stomped on and killed by someone.

> *'Human beings have been one of the most destructive species on the planet, but we also have empathy and can learn from our mistakes. I am inspired by understanding our impacts to help create solutions for the problems facing the environment now and in the future.'*

The Maluku region is the geo-centre of the Coral Triangle countries of Indonesia, Malaysia, Papua New Guinea, the Philippines, the Solomon Islands and Timor-Leste, and bounds Raja Ampat, ground zero for coral diversity globally.

Indonesian authorities are working hard to manage fishery resources across a vast region subject to illegal poaching. These fisheries feed Jakarta, and tuna is exported to the United States (US), Japan and Vietnam.

Artisanal and small-scale gold mining accounts for a fifth of the world's annual gold production, and is the single largest source of anthropogenic mercury emissions, responsible for releasing 1000 tonnes of mercury into the environment annually, says the United Nations Environment Program (UNEP).

The use of highly toxic, mercury-based extraction and processing methods in unregulated regions in Africa, South America and informal markets elsewhere, puts poor miners and their communities at risk of brain damage, vision and hearing loss and delayed childhood development, according to the UNEP.

Amanda and her Indonesian colleagues discovered mercury used to extract gold from ore in small scale gold mining in Maluku leads to highly contaminated tailings, which are distributed through the environment and

found to be concentrated in marine sediment up to 82 times higher than recommended safe levels, and was at elevated levels in seafood, fish, mollusks and crustaceans.

Amanda was supported with funding from the Australian Research Council (ARC) Linkage Infrastructure, Equipment and Facilities Fund to measure total mercury, mercury species and the amount of the toxic form, methyl mercury.

'Contamination at the moment is quite localised, but definitely there is a risk of long-term impacts to human health.'

Education about the type and the amount of fish people should eat is important. Even in Australia where we consume higher order predators such as shark and swordfish, the recommended maximum is only two fish meals per week.

Indonesia and the Philippines are part of a US$180-million UN initiative aimed at improving conditions for miners across eight countries while cutting mercury emissions. Under the initiative, mercury is phased out by connecting miners to formal markets for responsibly produced and sourced minerals.

'Indonesia is our closest neighbour and has 260 million people, 10 times that of Australia. The people have amazing resilience. We can learn from them, and they can learn from us. We should really value that relationship we can have with a neighbour.'

Indonesia's Academic Mobility and Exchange scheme has supported Amanda's collaborators to train on specialist equipment at SCU and develop research outputs. SCU's Marine Ecology Research Centre has supported return visits and analysis using ARC funded equipment.

Southern Cross University

Colony cages a better option says poultry expert

University of New England researcher Tamsyn Crowley has been on the frontline of Australia's defences against food pathogens, and says our intensively farmed chicken flocks may be better off living in a hybrid system of barn and cage known as 'colony cages.'

Tamsyn – who has worked at protecting the national flock from threats such as avian influenza - says the public wants to understand how its meat is produced, but emotion has overcome the facts. Chicken is Australia's #1 choice for meat consumption ahead of pork, beef and lamb.

Tamsyn's first experience of the poultry industry was travelling around with her father, 'keeping him awake in the car' as he delivered automation machinery. Now she is motivated by helping to protect human and animal health, her innate curiosity and technology.

'I started off looking at plants. I have always been someone that asks lots of questions and love technology. I moved onto a CSIRO position looking at a gene expression technology platform, and that saw me move from plants to chickens.'

After having her first child and worrying about the continuity of her science career, she successfully picked her career up again by looking into markers to tell whether chickens were stressed.

Australians often base their ideas of how chickens should live on the outdated idea that a small backyard flock is happier because they love being outside to roam, socialise and scratch in dirt.

But to produce the food Australians require for their daily meals requires many flocks in the thousands in regional areas and city rims, which means stepping up to intensive systems of either cages, barns or free range.

'Once you have anything in intensive systems, you have trade-offs. Once you've got thousands of birds, you have a much higher chance of disease. You also have big social challenges.'

The biggest challenge is the important phenomenon of the pecking order. Chickens dislike being in a massive group where they cannot establish their pecking order, and this leads to serious adverse social behaviours.

Chickens in free range systems do get to display much of their innate behaviour such as scratching in the dirt. They have freedom of movement to perch and flap their wings, but because they are in large flocks, they are also free to turn on each other and peck each other to death.

'That's one of the challenges of free range because you've got no way of segregating them. Yes, they can run around outside, but they still want to establish that pecking order so the mortality rates can be quite high.'

If they are outside in free range, they are exposed to various threats from that outside world, some of which can impact humans down the chain. Chickens outside are more likely to get diseases such as avian influenza from contact with free-roaming ducks.

An alternative to free range is large flocks kept in one big shed, which protects them from avian influenza, and from Australian temperature extremes or events such as that which killed thousands of English chickens in the 2019 European heatwaves. But again, because they are not kept in small groups, the same pecking order dynamic still comes back into play. They are also subject to risks from increased exposure to parasites from walking around in their own refuse.

The third alternative is the much-maligned system of cages – which can be well or badly managed – where chickens are often healthier, and have less exposure to disease because they are not walking around in their own refuse. But chickens in cages cannot perch, they cannot dust off, and they cannot flap their wings around.

'They mightn't be going, "Wow this is the best life I've ever lived", but they are usually a lot healthier than free range chickens. So it's about trade-offs.'

'If you would prefer your chicken and eggs to come from a chicken that's been outside and scrummaged around and dodged predators like hawks or foxes that's okay. But they will also often be treated with a lot more stuff because they're in contact with the outside world.'

Australia does not have its poultry production system right yet, and research is needed on the combination of the barn and the cage: the colony cage.

'Then you can have small groups of hens, for people who have issues with cages, but there's a perch, a dust bath, and a scratch pad.'

These projects are funded by the Poultry Cooperative Research Centre and AgriFutures Chicken Meat Program.

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University of New England

Sports scientists turn to micro-technology to improve player performance for women

University of New England (UNE) sports scientist Dr Cloe Cummins is using micro-technology devices to develop a scientific framework to inform rugby league training and recovery, match outcomes, and provide an improved basis for training professional players, especially women.

First introduced to the National Rugby League over a decade ago, the increasingly sophisticated devices can measure 1000 data points a second, providing coaches with vital statistics such as running distances, acceleration bursts and collision intensity.

The technology - developed by Australian government science agencies - is an export success having been adopted in the United States (US) by teams such as the Dallas Cowboys and the Green Bay Packers to track and measure player performance.

Cloe, a UNE postdoctoral research fellow, has been at the forefront of research since undertaking her PhD at the University of Sydney where she investigated the application of Global Positioning System (GPS) and micro-technology sensors within elite rugby league, a physically demanding, high intensity team sport.

'The technology allows us to better understand the physical demands of an athlete during both training and competition, whereby we can attain variables such as total distance travelled, their distance covered at high-speed and even their impact forces in a collision. We then use that personalised information to inform the training practices, or recovery and injury prevention protocols of each athlete.'

Experts have suggested that with the launch of professional football, netball, rugby league and cricket codes for women over the past few years, that 'there has never been a better time to be a woman in Australian sport.' [1]

However, Cloe said very little was known empirically about the nature of the demands of rugby league on women's bodies.

'There's a real lack of data and research on the physical demands of female rugby league players. Because of that, we really have a lack of understanding of the demands of training and match play on female rugby league players, at all levels of participation.'

Further, Cloe said that due to the lack of female specific sports science literature within an applied setting, it is possible that the training, recovery and intervention protocols have been largely informed by results from the male dominated research literature.

'We know that female rugby league players, particularly adolescents, have an increased prevalence of lower limb and shoulder injuries, which is likely attributed to physiological and biomechanical differences including movement patterns and decreased strength.'

Accordingly, Cloe said that her future focus in research is on the development of training, recovery and injury prevention protocols specific to female rugby league players.

As fans of *Moneyball*, the best-selling book about the ground-breaking and influential use of detailed match data in US baseball would know, previous methods relied on costly and time-consuming video replay, and annotation.

'Whereas now we can put a small device on a player which collects millions of data points about the dynamics of the motion. It is incredible technology.'

'In addition to GPS, these devices also have inertial sensors in them, so we can look at the forces across three planes of motion, being up and down, left and right as well forward and backward directions. This has allowed us to undertake new research on the impacts or collision forces in sport.'

'These advances mean that training processes and protocols are monitored and adjusted on a scientific basis, and injury prevention, recovery and conditioning drills can be individually tailored to athletes, and their positions in the line-up. For example, forwards are known to undertake more collisions of a higher force than backs, which has implications for both post-game recovery and training.'

'The large volume of objective data that is now available to rugby league teams has facilitated interesting and novel applications in the visualisation and analysis of this information. For example, physical performance and match statistics data can be analysed using machine learning techniques to identify the factors that may contribute to match outcome.'

Cloe believes 'it is a very exciting time to be a sports scientist working with female athletes.'

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[1] *Toffoletti, K., & Palmer, C. (2019). Women and Sport in Australia—New Times? Journal of Australian Studies.*

From starry nights to the night owls finding thousands of new alien exoplanets in our skies

When the University of Southern Queensland's (USQ's) Dr Belinda Nicholson takes up her post-doctoral place at Oxford, she will be helping advance the inter-generational effort to bring exoplanets – planets orbiting stars other than our Sun - into ever sharper focus.

Belinda's stargazing will be split between Oxford's Physics Department, where Edmund Halley, who correctly predicted the year of the return of the comet that bears his name is among alumni, and USQ, as an Adjunct Research Fellow.

USQ hosts the Southern Hemisphere's only dedicated machine, MINERVA-Australis, to follow up exoplanet leads from the latest generation space-based telescope: the NASA/MIT Transiting Exoplanet Survey Satellite, TESS.

MINERVA, for Miniature Exoplanet Radial Velocity Array, is a group of 70cm aperture telescopes at the Mount Kent Observatory, used to confirm the planet detections by TESS, and characterise them. The Queensland observatory has played a pivotal role in the discovery of 13 new exoplanets to date.

Belinda's research journey began with a Bachelor of Science at the University of Melbourne where she majored in Physics, and was first exposed to astrophysics, followed with a Master of Science:

'I was just fascinated by everything that was happening in astronomy in Australia. I just wanted to keep doing the research, but also be part of the community as well.'

From there, Belinda saw the PhD post advertised at USQ, and was intrigued by the problem of modelling the winds emanating from the stellar surface of our own Sun, and other stars as well.

At Oxford, she will join the Exoplanet Group, supported by a Junior Research Fellowship at Somerville College, the first college to admit women for a university education.

Since the first so-called 'hot Jupiter' was discovered by a ground-based telescope in the mid-1990s, astronomers have now confirmed the presence of 4000 exoplanets, ranging from uninhabitable gas giants, worlds where metal boils, to small worlds in 'deep freeze', says NASA.

However, only a fraction of the new alien worlds are rocky, and likely to maintain surface water in the not-too-hot and not-too cold habitable zone: as of 2019, 34 so-called super-Earths or mini-Neptunes, 20 Terran-sized planets and one Mars-sized planet have been discovered.[1]

'If we're ever going to be able to find an Earth-like planet around a Sun-like star, we need to start to really tackle this problem of how do we understand and account for the behaviour of stellar surfaces?' Belinda says.

Belinda seeks to better understand what she describes as younger, 'badly behaved' stars for two reasons: first, younger stars have more to teach us about planet formation, since stars are so important to planet formation; and second, studying their surfaces can help us understand the signal the surface generates, which can mask the lesser signal of a small planet.

Cutting edge astronomy is considered Big Science – which is very expensive, and so has given rise to a highly collaborative, international and systematic model of investigation. So much so that the missions of Kepler, TESS and the James Webb telescope to be launched in 2021, dovetail into each other. The James Webb will observe exoplanets – and their all-important atmospheres – directly.

Kepler mostly studied a single patch of sky to estimate that there are more exoplanets in our galaxy than stars, but the new worlds Kepler found were especially distant, between 300 and 3,000 light years away. According to the Planetary Society, this makes them 'tough targets' for follow up observations.[2]

However, TESS shifts the universal search to brighter, much closer stars, meaning the majority of the exoplanets TESS finds will be just 30 to 300 light years away.

'So, TESS is finding transiting planets and then MINERVA follows them up. As soon as those candidates come down, we're pointing our telescopes up to those stars and trying to confirm those planets, and measure the masses of those planets.'

'That's really USQ's amazing role in international exoplanet science at the moment. We're contributing a great deal to confirming these planets, and we can do that because we've got our own observatory. We can just spend all the time that we want following up on these planets.'

MINERVA-Australis is supported by the Australian Research Council, Mount Cuba Astronomical Foundation and institutional partners.

UNIVERSITY OF SOUTHERN QUEENSLAND

[1] *Habitable Planets Catalogue, University of Puerto Rico at Arecibo. Retrieved from http://phl.upr.edu/projects/habitable-exoplanets-catalog.*
[2] *Jason Davis, (April, 2018). Preview: NASA's TESS prepares for 2-year exoplanet hunting mission. Retrieved from: http://www.planetary.org/blogs/jason-davis/2018/20180409-tess-preview.html*

Niloofar likes getting her boots muddy to better protect Australia's export crops

The University of Southern Queensland's (USQ's) Dr Niloofar Vaghefi may use the latest DNA-level investigation tools to better protect the Australian summer grains that help feed Asia and Africa, but there's nothing she enjoys more than trudging about in the paddocks of growers getting her boots muddy.

Niloofar – who came from Iran to do a masters in Agricultural Science – travels from northern New South Wales to across Queensland to talk to growers and walk across hundreds of paddocks to identify the hungry pathogens that attack mungbeans and sorghum.

Sorghum is a grass plant regarded as a staple for hundreds of millions of people in Asia and Africa, while mungbeans are pulse crops that are popular in many Asian dishes. Most of the Australian production of these crops occurs in New South Wales, Queensland, South Australia and Victoria. Most crops are exported, or used for local human consumption, or as an important local feed source for livestock.

Niloofar says she has worked in laboratories and institutes here and in the United States, and her experience as a female researcher has felt 'very supportive and very positive.'

While she understands that women may still be under-represented in research leadership roles, she is very positive women will soon get there, and will soon close the gap.

'This is, for me, it's really not a job; it's the constant learning. So, if you do have an inquisitive mind and you enjoy answering questions, or making an impact doing something that actually has an impact on people's lives, it's great being a female researcher in agriculture in Australia.'

Niloofar, who is now a Grains Research and Development Corporation Research Fellow in USQ's Centre for Crop Health, says the better she understands how diverse populations of pathogens survive and multiply in the field, and leap from field to field, the better she can help enhance crop productivity and profitability.

'When working on plant pathogens, it is important that we remember that a disease is caused by a whole population of a pathogen, not only one individual. So I do a lot of field work. We look at tens of mungbean paddocks, especially the paddocks that have disease in them.'

The better Niloofar identifies the most adapted and prevalent genetic types of a pathogen, the lesser the risk that commercial crop breeders introduce what they think are pathogen resistant plants, but in fact find the crop fails since a different type of the pathogen is present. She says it is essential she works in a regional university, since she has greater access to the fields and the growers experiencing the problems she helps solve.

Niloofar says she is most interested in and concerned about the most aggressive and highly adapted types

of the pathogens, and to determine the best control measures. Even though the samples may all look the same, fast genome sequencing is done to categorise their genetic differences or determine their fungicide resistance. She mines the genome of the pathogens, and uses that information 'to defeat them in the field.'

Her PhD was on molecular plant pathology, and focused on a disease of pyrethrum, which is cultivated in Tasmania for the natural pesticide produced by its daisy flowers. Pyrethrum seeds produce the natural insecticide pyrethrin, which is regarded as so safe it is sold in supermarkets for household use.

> *'Pathogen populations are quite variable. They have the ability to evolve, they can adapt to control measures. They can become more aggressive, and resistant to fungicides. It's a constant battle, trying to manage diseases in a sustainable way that slows down the rate of evolution. They are not going to wait there for us to defeat them.'*

The accelerating evolution of the pathogens is driven by large crop monocultures, and thus the far greater availability of what for them is food. The challenge is exacerbated by the hotter and drier conditions in some parts of the country, and wetter conditions in other parts of the country as different pathogens thrive in different ecological niches, she said.

'For me as a plant pathologist in this situation, the priority is to focus on those diseases that actually cause more damage in drought and in hotter and dryer conditions. For example, tan spot disease that affects mungbeans, and charcoal rot that impacts sorghum, cause more damage in hotter and dryer conditions.'

UNIVERSITY OF SOUTHERN QUEENSLAND

From faster detection to molecular dissection of chlamydial infections in Australian animals

University of the Sunshine Coast (USC) researcher Dr Martina Jelocnik investigates the genetic diversity, nature and evolutionary origins of chlamydial infections in livestock and wildlife.

Martina's sleuthing of genetic links is especially important to the Australians who each year contract Chlamydia from infected native birds; the stud farmers who will lose their foals; and the farmers who incur economic losses due to Chlamydia infected cattle and whose lambs develop polyarthritis.

Martina's PhD work provided the first epidemiology – which concerns the incidence, distribution, and control of diseases - on chlamydial infections in Australian sheep and cattle, and the insight that spill-over infections are a major factor in koala chlamydial disease.

'We have molecular evidence that supports our hypothesis that the Chlamydia in koalas came with the importation of livestock from European colonisation. We then also looked at the global epidemiology of this infection; including wildlife ruminants from Europe, further extending our screening to more koalas, and Australian livestock.'

'In doing so, we identified that this same pathogen also causes economically significant diseases in Australia, such as conjunctivitis and polyarthritis in sheep, encephalomyelitis in cattle and even abortions in livestock,' she says.

Martina said their research group works relentlessly on Koala Chlamydia vaccine, and of which they were very hopeful because the vaccine is 'very promising. Then we can take the lessons from the koala vaccine and develop a vaccine for livestock as well.'

Martina said that being a woman in STEM has its challenges, but she is passionate about her work. The challenge is in securing the funding to continue her investigations: 'The biggest challenges are finding funding for your work and maintaining employment.'

'There is a big uncertainty. Hopefully, the funding and employment opportunities will change. Nevertheless, USC is a great place to work and very exciting place to do your research. And it is very exciting time for Chlamydia research in Australia.'

As an avid science communicator, Martina routinely involves herself within regional communities where she engages with schools and the public, and communicates the findings of her research.

On the back of University Medals and her PhD, Martina has been awarded a highly competitive Australian Research Council Discovery Early Career Research Award fellowship, with research to focus on the epidemiology of chlamydial infections in birds and horses, and development of innovative diagnostic methods for chlamydial pathogens.

The circulation of Chlamydia across the wildlife/livestock/human interface is regarded as dynamic, and has been particularly hard to understand. Martina said her motivation since her Honours was to help better protect human and animal health:

> *'Although it seems that Chlamydia is everywhere, there is still so much more that we need to learn. Chlamydia has the capacity to spill over to us and to make us sick. We want to know as much as we can. First, to inform the general public, to protect their health; and, second, that we protect domesticated animals and the wildlife as well.'*

Due to limited diagnostic options for veterinarians to detect animal-borne chlamydiae, Martina has been developing rapid diagnostic tests to be used at the point-of-care, to better protect veterinarians, livestock and native wildlife from the blight of Chlamydia.

Chlamydia is hard to diagnose since it grows inside cells.

'Chlamydia will not grow on traditional bacteriological plates. So, then we thought that we need some easy, fast and rapid molecular detection. Presently, I am working on such diagnostic options for Chlamydia, and other pathogens.'

Recently she described the first cases of *C. psittaci* in horses and the risk that they pose to human health. Chlamydial infection in horses has been linked with equine pregnancy losses and early foal deaths and spill over to humans causing serious disease.

Meanwhile, Martina is working with wildlife hospitals and Australia Zoo to trace the Chlamydia from a proportion of native Australian birds, as her studies showed that birds may have infected very valuable horse stock. She also looks for Chlamydia in a range of new wildlife and livestock hosts.

USC

How automated vehicle technologies might lead to new types of crashes

There were 1145 road deaths in Australia in 2018[1], with the majority attributed to human error: people were in the wrong place at the wrong time, got tired, drove under the influence of drugs or alcohol, drove too fast, looked at their phones or just made a tragic miscalculation.

There have been significant improvements in road safety over recent decades, yet fatalities and serious injuries continue to occur, costing Australia an estimated $29 billion a year, according to government road safety statistics.[2]

Fully autonomous vehicles (AVs) – self-driving or driverless cars – could reduce road deaths by up to 80 to 90 per cent, according to experts relied upon by Australian transport officials.[3]

'That's the end argument. It's the idea of eliminating human error. We know that drivers currently make mistakes and that can cause accidents. That's where road agencies are seeing the benefit - a technology that can avoid those sorts of crashes,' says the University of the Sunshine Coast's (USC's) Dr Gemma Read, an Australian Research Council Discovery Early Career Researcher and Senior Research Fellow.

Gemma is motivated by 'human factors': the application of knowledge from a range of disciplines, to improve the design of technologies to improve safety, prevent accidents and optimise well-being. Her PhD was on rail crossing safety, especially pedestrian safety.

However, this previously unthinkable prospect of lives saved – a drastically reduced road toll – is still far off as estimates show that the transition to even a 75 per cent fully autonomous national vehicle fleet is two decades away.[4]

Until then, the existing fleet – which already has early elements of automated technologies – will increasingly share the roads with increasingly automated vehicles, and other road users such as motorcyclists, pedestrians, people with prams and cyclists.

Regional areas are expected to benefit from AVs due to ride-sharing, but encounter enhanced risks from kangaroos at dusk and dawn. German testing found kangaroos were the animals whose behavior was most difficult to predict.

Since 2014, electric car-maker Tesla's vehicles have come equipped with hardware-based 'Autopilots', which provide automatic steering, lane keeping and speed adjustments in response to other traffic. One British Tesla S 60 driver has already been banned from driving after switching his car to autopilot and moving the passenger seat while going at 40mph on a motorway, BBC News reported in 2018.

Gemma is midway through her three-year investigation of how autonomous vehicles might interact with traditional vehicles and vulnerable road users, as the fleet is increasingly mixed during the long problematic years of transition.

'I'm focused on the unintended consequences associated with how people behave around AVs, given that they will behave in a risk averse way. We need think about how these technologies will be integrated within our road system, which often relies on social interactions, such as eye-contact at roundabouts.'

Her modelling, developed with colleagues at the University of Melbourne and USC, suggests new sorts of crashes may arise during transition as people learn about the unerring responses of AVs, and exploit their in-built risk aversion for their own all too human purposes.

'If AVs do behave flawlessly, and they detect a cyclist pull out, they will always stop to prevent an accident. That's fantastic! But what does the cyclist learn? The cyclist learns that that this type of vehicle doesn't pose a threat to them anymore. In a congested city, this could lead to gridlock.'

Conversely, if a cyclist becomes habituated to pulling out in front of AVs, and mistakenly does this when encountering a manually driven vehicle, a new type of crash results.

'There's that argument that we might make it so safe that people assume safety and take less care for their own safety.'

In all jurisdictions in Australia, the driver still needs to be in control of the vehicle, which means they must keep their hands on the steering wheel. Tesla – which believes its autonomous vehicles will ultimately be better at driving without crashing than humans – has been lobbying authorities to accelerate the adoption of AVs to reduce road fatalities faster.[5]

USC

[1] *Bureau of Infrastructure, Transport and Regional Economics (2018). Road trauma Australia 2018 statistical summary, p 1*
[2] *Research report 140, Safety, Bureau of Infrastructure, Transport and Regional Economics (2014) pg ix.*
[3] *As above, p 60*
[4] *As above, p 60*
[5] *Tesla Comments regarding National Transport Commission's May 2016 Discussion Paper, 'Regulatory Options for Automated Vehicles.' p 2*





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