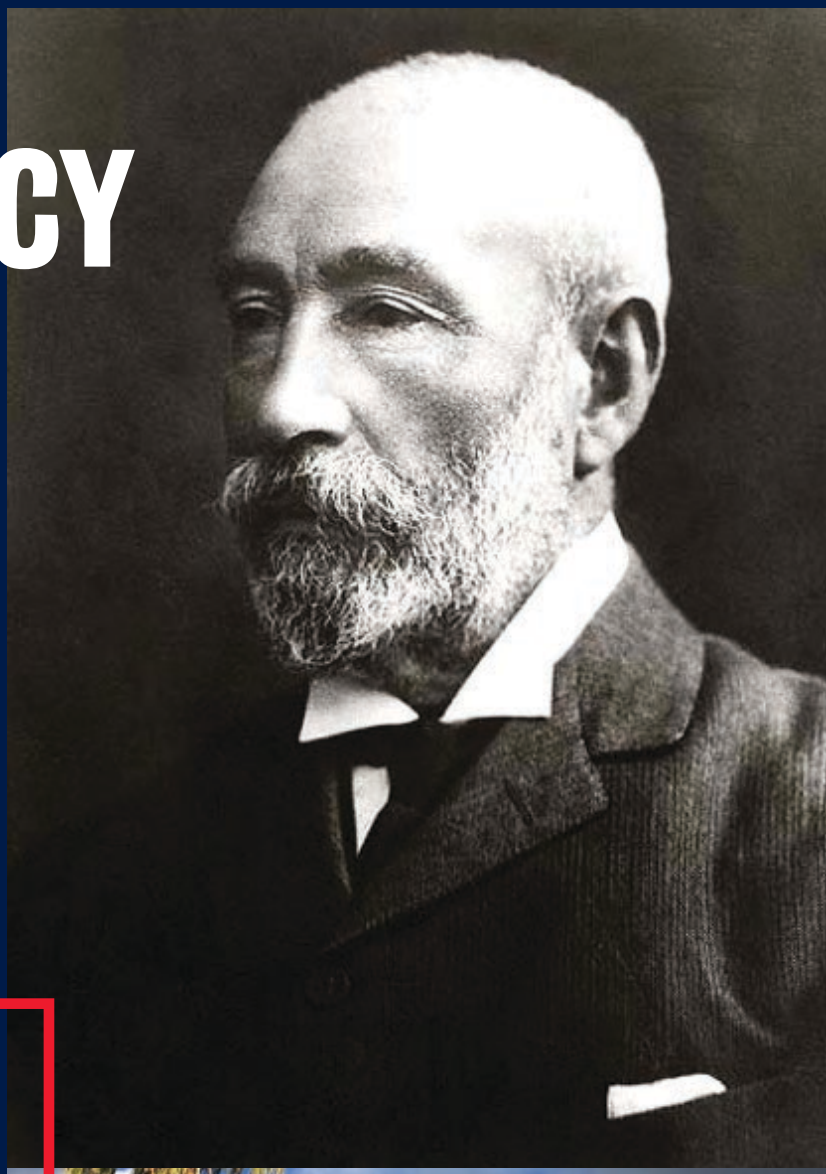
THE UNIVERSITY of ADELAIDE

Annual Report 2020

WAITE RESEARCH INSTITUTE

adelaide.edu.au/wri

THE PETER WAITE LEGACY AND VISION



Peter Waite was a visionary. The son of a Scottish farmer, he emigrated to Australia in 1859 and prospered in the fledging colony of South Australia. Throughout his journey from the pastoral lands of the mid-north of South Australia to the boardroom of the "General and Commission Agent Company", later to become Elders Smith & Co Ltd, Peter Waite embraced and developed innovative and contemporary farming practices.

Peter Waite gifted his homestead, Urrbrae House, and the surrounding property of 299 acres (121 ha) to The University of Adelaide in 1923 for agricultural education and research purposes. The Waite Agricultural Research Institute commenced operations on the site in 1924.

IN EXPLAINING HIS GIFT, PETER WAITE WROTE:

"I have been much influenced by the wonderful work our agriculturalists and pastoralists have accomplished hitherto in the face of the very great odds they have had to meet. With comparatively little scientific training they have placed our wheat, wool and fruit in the highest estimation of the world: our sheep have been brought to such perfection that they are sought after not only by all our sister states, but South Africa. Our agriculture machinery has been found good enough even for Americans to copy; and our farming methods have been accepted by other states as the most up-to date and practical for Australian conditions. We have now reached a point when it behoves us to call science to our aid to a greater extent than hitherto has been done, otherwise we cannot hope to keep in the forefront."

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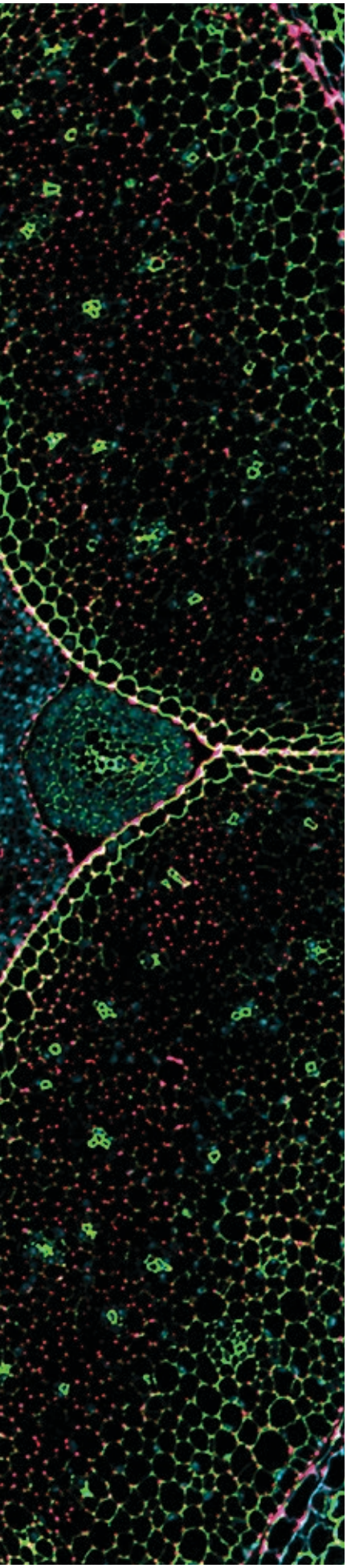
WELCOME.

Barley flower cells that contribute to fertility and seed size.



DEPUTY VICE CHANCELLOR (RESEARCH):

The University of Adelaide's seven research institutes are its flagship research and innovation powerhouses, each one strategically aligned with an area of strength and depth of expertise. The Waite Research Institute (WRI) builds on the Waite's impressive legacy and history of delivering world-leading science and solutions in agriculture.

The WRI brings together researchers from across the agriculture, food and wine spectrum, and thereby covers all three campuses (Waite, Roseworthy and North Terrace) and multiple Faculties and Schools. Working in areas as diverse as ag-tech, agri-economics and trade, consumer and sensory studies, plant breeding, soil ecology, wine and viticulture, agronomy, pests and disease, animal wellbeing and even space horticulture, WRI members are by the very nature of their disciplines engaged in addressing real-world challenges such as sustainable agriculture, the impacts of climate change on plants, and food security.

Under the leadership of Professor Matthew Gilliham, the WRI is pursuing multidisciplinary, large-scale research and innovation initiatives, many of them in conjunction with industry and government partners. While some of these will take time to bear fruit, the 2020 year has seen good progress in a range of areas.

These initiatives are complemented by the University's new Agrifood and Wine FAME (Focus And Magnets for Excellence) Strategy, launched in late 2020. This Strategy provides a platform that enables us to attract the best researchers and partners, and deliver positive impacts for our State and Nation through research excellence and its translation.

This report provides an overview of these activities, as well as illustrating how our world-class fundamental and applied research is driving impact and improving outcomes for the vital agriculture sector.

Professor Anton Middelberg
Deputy Vice-Chancellor and Vice-President (Research)

THE WAITE RESEARCH INSTITUTE AT A GLANCE

The Waite and Roseworthy are Australia's most recognised and respected agricultural research and teaching brands

Roseworthy Campus

Waite Campus

The Waite Campus is the largest concentration of agricultural research and teaching in the Southern Hemisphere. Located 7km from the CBD in the south-eastern suburbs of Adelaide, South Australia, the precinct hosts:

- The University of Adelaide's School of Agriculture, Food and Wine (AFW)
- CSIRO (Agriculture & Food; Land & Water)
- South Australian Research and Development Institute (SARDI)
- Australian Wine Research Institute (AWRI)
- Australian Genome Research Facility (AGRF)
- Arris Pty Ltd
- Plant & Food Research (Australia)
- Fight Food Waste Cooperative Research Centre
- Food SA
- Potatoes SA
- ThincLab Waite
- Adelaide Glycomics
- Australian Plant Phenomics Facility (The Plant Accelerator)
- Terrestrial Ecosystems Research Network (TERN)
- Urrbrae House Historic Precinct, including the Waite Arboretum

In addition, the Waite hosts the following specialist research centres of national significance:

- ARC Centre of Excellence in Plant Energy Biology
- ARC Industrial Transformation Training Centre in Innovative Wine Production
- ARC Industrial Transformation Research Hub for Wheat in a Hot Dry Climate
- Wine Innovation Cluster (WIC)

The Roseworthy Campus, 60km north of Adelaide, is the site of Australia's first agricultural college, established in 1883, and merged with the University in 1991. It has a history of excellence in dryland agriculture, natural resource management and animal science. Major University investment over the past 10 years has seen a renewed focus on animal and veterinary science. Specialist centres and facilities hosted there include the Davies Research Centre, the Australian Centre for Antimicrobial Resistance Ecology and Weatherbys Scientific Australia.

Over the last century, the Waite and Roseworthy have developed through the pursuit of excellence in agricultural science and collaboration between the co-located organisations to become:

- A global leader in agriculture, food, wine, animal and natural resources science, exploring and informing critical national and global issues and challenges such as Australian agriculture industry competitiveness, food security, sustainable intensification of agricultural production, food, nutrition and health, advanced agricultural systems, and adaptation to climate variability and change;
- An international model of research, development, industry application and teaching through the co-location of institutional partners, with capability in whole of value chain approaches from gene discovery to consumer needs;
- Renowned for high-quality education and training in agriculture, food and wine through undergraduate and postgraduate coursework and research degree programs;
- Leading centres of research capability for animal and veterinary science, grains, plant breeding, soil and wine science and natural resource management within Australia.

ACROSS THE CAMPUSES ...

18
WORLD-CLASS RESEARCH ORGANISATIONS, NODES AND CENTRES

1700+
RESEARCH AND TECHNICAL STAFF

240+
POSTGRADUATE STUDENTS

1200+
UNDERGRADUATE STUDENTS

120M+
RESEARCH INCOME/ EXPENDITURE PER ANNUM

350M+
RESEARCH AND TEACHING INFRASTRUCTURE

600+
RESEARCH PUBLICATIONS PER ANNUM

INTERNATIONALLY RECOGNISED FOR DELIVERING TRANSFORMATIONAL AND HIGH IMPACT AGRICULTURAL TECHNOLOGIES & SYSTEMS

What is the difference between the Waite Research Institute, the Waite Campus and the Waite Precinct?

The Waite Research Institute is the modern successor to the original Waite Agricultural Research Institute, and is one of seven Institutes of The University of Adelaide in areas of strength and strategic importance. Its remit extends beyond the Waite Campus, to support activities across all three of the University's campuses (Waite, Roseworthy and North Terrace). It is the flagship for Agricultural Research and Innovation at the University of Adelaide.

The Waite Campus is the site, owned by the University, and is referred to in relation to all university-only activity, including research and education.

The Waite Precinct is the collective name for the co-located organisations, agencies and entities on the site, all of which engage in complementary R&D and industry-aligned support for SA's vibrant agriculture, food and wine sectors.

Where does the WRI fit in?

The Waite Research Institute (WRI) was established in 2009 to reinvigorate the vision and legacy of Peter Waite and support The University of Adelaide's commitment to agricultural research, development and teaching. The Waite brand carries an iconic status world-wide that remains synonymous with research of the highest quality, focussed on innovative solutions for improving agricultural systems.

The WRI is a University 'front door' for communication to and interaction with industry and the public in our research and innovation programs in Agriculture, and central coordination point for internal activities.

The co-location of several complementary non-University research organisations such as PIRSA-SARDI, CSIRO, the Australian Wine Research Institute (AWRI), Zoos SA, the Country Fire Service, and companies including AGRF and Plant & Food Research (Australia) is a strength of our Agricultural precincts. There are strong collaborative links between these organisations including infrastructure co-investments.

The WRI supports the University in developing and funding strategically important initiatives and by building research capacity and performance through investment in people and infrastructure. The WRI has resourced and coordinated support for new research initiatives, and targeted support of existing areas of strength, spanning fundamental discovery to on-the-ground impact. The intention is to drive research activity in new and exciting areas of national and international need. Our role is to maximise synergies between our university community at all three campuses and with our industry partners to deliver impact.

In pursuing these aims, the WRI has invested in research leadership and ECR professional development, equipment purchases, small and large projects of strategic value, salary support for key research staff at various stages, large grant and Centre of Excellence bids and grant-writing support. We also support communication channels and host shared events with our partners, host a Waite precinct website, and facilitate workshops, symposia and meetings that enhance our collaborative research. Steady increases in the Waite's competitive research grant funding and industry collaborations, publication numbers and HDR completions have all occurred on the WRI's watch, and the Excellence in Research Australia (ERA) rankings for all Waite-based disciplines remain above (4*) or well above (5*) world-class.

WRI VISION, GOALS & GOVERNANCE

Vision

The Waite Research Institute (WRI) stimulates and supports research and innovation that builds capacity for Australia's agriculture, food and wine sectors.

The WRI's broad vision is to drive the innovation to secure a sustainable future for Agriculture—by creating high-quality, nutritious and climate-resilient products. We do this not in isolation, but in close partnership with the agriculture, food and wine sectors.

To achieve this vision, we will invest in outstanding researchers and advanced facilities across multiple scientific disciplines, in both new strategic initiatives and areas of established strength.

Goals

1. Research with impact in sustainable intensification of agriculture in a changing climate
2. Building large-scale initiatives across disciplines
3. Enhancing excellence through researcher development
4. Connecting researchers with industry

MAJOR RESEARCH THEMES

- **Animal Science**
- **AgTech**
- **Wine & viticulture**
- **Crop science**
- **Food technology**
- **Sustainable agriculture**

Governance

In 2020, the WRI's financial reporting was managed through the School of Agriculture, Food and Wine, in conjunction with the Office of the Deputy Vice-Chancellor (Research) (DVCR). The WRI assess opportunities and review applications, making investment decisions based on the minimum 7:1 leverage requirements now established for all University Institutes.

The WRI continues to seek, assess and support opportunities

- for building research excellence and capacity in areas that align with existing and emerging strengths in agriculture, food and wine;
- that have strategic value for the University;
- that can demonstrate breadth of impact;
- that offer value for money through leveraging co-investment;
- that deliver tangible returns; and
- that foster multi-disciplinary efforts to address important problems.

WRI Staff

Professor Matthew Gilliham
Director

A/Professor Matt Tucker
Deputy Director

Ms Carolyn Mitchell
Executive Officer (1.0FTE)

Mrs Keryn Lapidge
Strategic Communications Officer (0.9FTE)

DIRECTOR'S OVERVIEW

While 2020 was obviously an unusual and challenging year, WRI researchers continued to do outstanding work by bringing to bear skillsets from a range of disciplines.

I was heartened by the depth of community spirit shown by our members in this past year, perhaps best embodied by our graduate students who self-organised and rallied the university community, to ensure our international students and Early Career Researchers were supported during the COVID-19 lockdowns and restrictions. Particular mention for Melanie Ford, Emma Aspin and the whole Agriculture Postgraduate Society (AgPOGS) Team whose energy at a time of great uncertainty reflected the best of human qualities.

Exciting new ventures in 2020 included the award of seven ARC Discovery grants (our highest number ever awarded in a single year), strategic, multidisciplinary bids submitted in gene technologies and barley, the renewal of large breeding programs and centre agreements, and the development of new areas to us such as space horticulture, synthetic biology and the use of machine learning in crop, animal and soil management.

The WRI continues to perform a key enabling role, supporting its people through investment in professional development, coaching and mentoring programs, unique research infrastructure and services that attract leading researchers and enable research excellence, and strategic support for individuals, partnerships and Centres in key strength areas to maximise the opportunities for innovative and significant research.

The WRI took on several new roles in 2020, including driving the support of closer links with the SA State Government's Primary Industry and Regions Department (PIRSA), where through partnership we possess that whole of research value chain from blue sky research through development, to extension and adoption on the farm. Activities included the development of new proposals in drought resilience and oat research. In 2021, amongst other activities, we will work with PIRSA on eliminating the threat of fruit fly to our Horticulture sector.

In early 2021 we bid farewell to our engine room – and some might say the heart and soul of WRI for many years – as Carolyn Mitchell, our executive officer, and Keryn Lapidge, our communications officer, both take up new opportunities elsewhere. I would personally like to thank Carolyn and Keryn for their many years of service, since 2011 and 2016 respectively, and the dedication they have shown in making WRI the success that it is. I am sure all WRI members will join with me in wishing them well with the next phase of their careers.

Lastly, I would like to pay tribute to all of our members' efforts in 2020. Research is not the easiest of career choices and involves often more rejection than success (especially when it comes to research funding applications), so much hard work goes unnoticed and unacknowledged. Therefore, when success does come, it should be celebrated. I hope you enjoy reading about some of their many highlights for 2020.

Our doors are always open so please get in touch if you want to explore new opportunities with us.

Professor Matthew Gilliham
Director, WRI

THE 2020 YEAR IN REVIEW

The WRI's contingent of ~350 researchers across four faculties and three campuses of The University of Adelaide and our affiliated industry partners continued to bring their wide range of expertise to bear on critical ongoing challenges in agriculture and food production in 2020.

The year started with the Adelaide Hills and Kangaroo Island bushfires. Members of the WRI assisted grape growers and winemakers from the Adelaide Hills affected by the bushfires with volunteer viticultural damage assessment and remediation and the use of the winemaking facilities (including cold storage) at the University's Waite campus. The Waite has a long association with the nearby Adelaide Hills, with a large number of winemakers in the region having studied here.

While the pandemic saw face-to-face interactions curtailed and many staff working from home, good progress was made on a range of major initiatives. For example, there were a total of $76m in active GRDC-funded projects underway in 2020 across the University, including new agreements signed in faba bean and durum wheat breeding, and projects commenced on crop variability, herbicide resistance, chickpea disease, nitrogen fixation and barley yield. Lab and field work were able to proceed with some constraints, and many staff took the opportunity offered by enforced periods of shutdown to write, complete and submit research publications; the spike in numbers will be evident in the next 12-24 months.

All the University's Institutes were reviewed mid-year, partially based on a retrospective benchmarking exercise which looked at 2019 research income attributed (by researchers/members) to Institute activity, investment and support. The WRI again compared extremely well with a leveraged income of 16:1, testament to the excellent work being done by members and the continued strength of agrifood & wine research in generating income for the University.

Other ongoing initiatives that have WRI co-investment, such as the Fight Food Waste CRC, the ARC Training Centre for Innovative Wine Production and the Research Consortium Program for Agricultural Product Development, made impressive inroads on their goals in 2020. Others, including the ARC Industrial Transformation Research Hub for Wheat in a Hot and Dry Climate and the ARC Centre of Excellence in Plant Energy Biology, completed their current funding cycles. New initiatives in development during 2020 included Oats, Future Crops and Drought Resilience hubs.

The WRI was also involved in the development of a new University-wide AgriFood & Wine Strategy late in 2020, with four key SA-based research missions at its heart – Dryland Agriculture, Value-Added AgriFoods, Supporting the AgriFood & Wine Value Chain, and Biosecurity & Livestock Wellbeing. These are already leading to new multidisciplinary combinations and impetus towards larger bids.

The WRI supported a grant and publication writing program for early and mid-career researchers in the last quarter of 2020, and the year was rounded out with seven ARC Discovery project grants awarded to The University of Adelaide in agriculture-related disciplines, the most ever in a single year (see page 13).

Awards, Grants and Publications

Overall in 2020, WRI members won around $30m in external research funding, including significant industry contracts as well as the Category 1 grants from government and RDC sources. Notably, they also produced a significantly increased number of peer-reviewed publications – 569 in total.

New research projects funded in 2020 included the following:

- **A/Professor Bettina Berger** – 'The development of an accurate, high throughput, affordable and relevant screen for LMA risk for the Australian wheat industry', GRDC ($1.12M), and 'OzBarley: from genome to phenome and back again', ARDC ($400,000).
- **The Australian Plant Phenomics Facility (APPF)** has been subcontracted by Monash University as Lead Organisation to deliver part of a larger-scale project aimed at 'Establishing Australia's Scalable Drones Cloud (ASDC)'. The three year project, enabled by funding from the Australian Research Data Commons ($855k), is a coordinated investment of $1.71m in total involving collaborators from Monash University, CSIRO, APPF, TERN and Auscope.
- **Dr Scott Boden** – 'Phenology in Oats', led by Ben Trevaskis (CSIRO), GRDC ($350,000); and 'Increasing grain quality and production traits in Australian wheat cultivars', SA Grains Industry Trust ($174,000).
- **Professor Rachel Burton** has won two significant ARC Linkage grants in the last 16 months for her novel crops work in *Agave* and *Plantago ovata*, total value $1.25m.
- **A/Professor Cassandra Collins** – 'Rapid surveillance and assessment of fire damage in South Australian vineyards for decision making'. PIRSA, South Australian Wine Industry Development Scheme (SAWIDS) ($178,000).
- **Professor Kerry Wilkinson** – Mitigating taint in wine due to vineyard exposure to bushfire smoke, CRC-P ($950,000). Partners include Cassegrain Wines, AWRI, PIRSA.

Individual member award winners throughout the year included:

- **Professor Kerry Wilkinson** was named STEMM Educator of the Year (University/RTO) at the 2020 SA Science Excellence Awards (COVID-delayed).
- **Dr Rhiannon Schilling** was named a 2020 South Australian Tall Poppy in recognition of her research into improving crops to overcome soil constraints. She also commenced a new position at PIRSA-SARDI, where she now leads the Agronomy program.
- **Dr Josh Philp** was awarded the Daniel Walker Order of Merit for ECR Excellence.
- The WRI's inaugural publication awards (in the four categories of our membership – Research Leader, EMCR, Industry and Student) based on citations and journal impact factor were announced at the WRI Research Showcase in December and awarded to (respectively): **Emeritus Professor Steve Tyerman, Dr Megan Shelden, Dr Ehsan Tavakkoli** and **Patricia Adu-Yeboah**.

Communications and Engagement

The Waite website (**www.thewaite.org**), managed and resourced by the WRI, is a valuable and heavily-used portal that is enhancing interaction and communication with external stakeholders. Averaging 4,000 visitor sessions and 20 events/seminars from across the precinct listed each month, the site has 700+ subscribers to the weekly update service and features high-quality agriculture, food and wine content that is being regularly drawn on by UA media/marketing/communications and external media outlets.

Due to the COVID-19 pandemic, the WRI's annual research showcase event was held online as a webinar in early December. Attended by over 100 people, the half-day program of short talks covered the full range of disciplines, campuses and topics now encompassed by the WRI, including animal and plant sciences, soil, weed, climate and other environmental challenges for food and wine production, ag engineering developments, sensory, social sciences work, and more. The Executive/Managing Directors of PIRSA-SARDI and AWRI were also featured in the program to give updates on their partnership activities with the University.

The WRI's seminar series also moved to webinar form in 2020, with well-attended sessions on a wide range of subjects; some achieved significant (up to 1,100) post-webinar views on YouTube. Speakers from across The University of Adelaide have delivered talks, with regular presentations by PIRSA-SARDI researchers also featured in the program.

HIGHLY CITED RESEARCHERS

Professor Matthew Gilliham, Director of the WRI, is among four Waite researchers to feature in the 2020 list of Highly Cited Researchers. The others are Emeritus Professor Steve Tyerman, Professor Dabing Zhang and the late Emerita Professor Sally Smith.

The University of Adelaide jumped from 8th to 5th in Australia in terms of the number of researchers (across 17 fields) on the Web of Science Highly Cited list for 2020.

Regarded as the world's most influential researchers, the annual list names scientists and social scientists who produced multiple papers ranking in the top 1% of citations in 21 broad research fields. It is a measure of the number of times their research is referenced by other researchers – demonstrating significant research impact globally.

ARC DISCOVERY PROJECTS FUNDED IN 2020

Researchers and WRI members working across the broad agriculture discipline were awarded seven ARC Discovery grants in November 2020, the most ever won in a single year. Details of the successful projects are:

^ Applications that received WRI input/support/investment in development
** Graduates of the WRI's Research Leadership Development Program*

Vincent Bulone

Unravelling cell wall polysaccharide biosynthesis in pathogenic zygomycetes. This project aims to define mechanisms that control cell wall composition and stability in *Rhizopus oryzae*, a zygomycete fungus responsible for life-threatening human infections. The biochemical properties and function of vital enzymes involved in a newly discovered cell wall polysaccharide biosynthetic pathway will be determined using innovative approaches at the interface of biochemistry, microbiology, cell biology and structural biology. Expected outcomes include new knowledge on the enzymes that synthesise major fucose-based carbohydrates, to guide the future development of novel strategies for antifungal therapies. The data will also be applicable to animal protection from related zygomycete pathogens.

Rachel Burton*

Novel cell wall genes ripe for the picking. This project aims to investigate the role of recently discovered plant cellulose synthase-like CslM genes and to define the polysaccharide product associated with them. Successful identification of the polysaccharide is highly likely to increase our fundamental understanding of how cell walls are made, how cells stick together or fall apart as well as facilitating the training of the next generation of cell wall biologists in challenging molecular and biochemical techniques. This new knowledge could increase our understanding of fruit ripening, and how it might be manipulated. This could have significant downstream commercial benefits if applied to breeding programs of economically important fruit such as grapes, tomatoes and strawberries.

Waite glasshouses at sunset (courtesy of James Cowley, COE PEB)

Georgina Drew and Doug Bardsley

Hydro-social Adaptations to Water Risk in Australian Agriculture. This project aims to understand how Australian farmers adapt to water resource limitations and governance constraints. We will address this significant challenge by identifying how social and cultural perceptions of water risk inspire farmers to create resilient management solutions in line with policy guidelines. Through ethnographic fieldwork and the analysis of historical patterns of water use, the research seeks to identify the hydro-social adaptations that enable farmers to effectively respond to change. The new knowledge will foster water risk management via the culturally appropriate tailoring of interventions. Outcomes will support the long-term viability of Australian agriculture, with relevant lessons for managing drought globally.

Matthew Gilliham*^

Investigating a novel signalling pathway for crop improvement. This project will dissect a newly identified signalling pathway in plants that regulates plant water use and carbon gain. It will deploy multiple techniques, including novel biosensors, to understand the links between the metabolism of plants and their environmental responses. The project will build partnerships with scientists at leading international institutions for enhanced outcomes, including access to specialised equipment and upskilling of our scientists. The generation of barley with the latest gene editing techniques aims to produce a non-GM crop with the potential for enhanced root C sequestration, lower water use and improved yield, three key goals for agricultural sustainability in the face of a drying Australian climate.

Peter Langridge and Scott Boden^

Harnessing genetic diversity for complex traits. Genetic diversity underpins crop improvement but has become increasingly narrow in our major crops. Strategies exist for mobilising simple traits (e.g. disease resistance) from wild accessions or landraces into cultivars, but there are no effective approaches for introducing complex traits, including stress tolerance or components of yield. Using barley as an important crop and a genetic model, the project aims to address this problem by applying a novel approach; partial redomestication of wild accessions by introgressing genes required for modern farming, then evaluating the resulting partially adapted germplasm in hybrids with elite cultivars. The project expects to generate new and diverse germplasm pools for breeding.

Matthew Tucker*^

Decoding tissue-specific components of cereal grain development. This project aims to investigate how barley flowers produce cells that deliver nutrients into developing seeds. This project expects to generate new knowledge through international collaboration and technical improvements in cell biology and genetics, overcoming current methodological limitations to precisely influence seed size, shape and quality, which are traits of agricultural relevance to the Australian cereal industry. Expected outcomes include strengthened international partnerships, leveraged funding and increased knowledge of plant reproduction. This should provide significant benefits, including upskilled researchers, improved research capacity and genetic targets to optimise seed production in challenging climatic conditions.

Dabing Zhang (with Brent Kaiser*)

How do plant roots align nitrogen uptake to soil opportunities? Improved nitrogen use efficiency (NUE) in crop plants is required to achieve sustainable plant agriculture practices that maximise productivity while minimising nitrogen fertiliser-dependent pollution. Current high-input monoculture plant production systems suffer from poor NUE and can contribute to local and global nitrogen pollution outcomes. Improving how plants manage their nitrogen uptake will improve NUE and help support Australian plant agriculture. This project will investigate novel technologies that re-engineer nitrate transport activity. The project will also investigate the biochemical and molecular links between nitrogen uptake on root development required for improved plant growth.

Frost damaged barley in field trials at Loxton

WRI SEED FUNDING INVESTMENT OUTCOMES

Since its inception, the WRI has regularly invested in both large and small projects via a range of mechanisms, including open calls for applications, with proposals assessed on both scientific merit and strategic value by multidisciplinary panels of senior academics. Earlier seed funding rounds, in 2013-14, for example, to a range of WRI member projects across soil science, plant breeding, entomology, viticulture and food/nutrition science, continue to produce outcomes several years later. Significant researcher track record gains, funding, publications, collaborations and networks built, and data/knowledge accrued since then have all been built on this previous work.

More recent ARC Discovery, Linkage Project and Centre of Excellence wins can be traced back to initial WRI investment in key researchers and projects that have led to ongoing benefits for the University and the agrifood and wine sectors. Like the slow-burn nature of research itself, these outcomes take time to manifest fully.

In late 2019, the WRI invested in a number of small projects across the University with potential to lead to further leveraged income and build new collaborations in key areas of convergence. Many of the 14 successful applications for funding (see table) were in the ag-tech area, reflecting the growing importance of this intersection of machine learning/computer science/engineering with the more traditional agricultural disciplines, as well as the expertise The University of Adelaide has in these areas.

This funding round was designed to enable pilot/proof-of-concept work that is likely to deliver return-on-investment and/or aligns with the strategic goals of the University in the agrifood and wine space.

The following highlights have arisen from these 2019 projects to date.

Frost screening in wheat using teraherz imaging: A preliminary study

Project leader – Professor Jason Able

Agricultural scientists and engineers at the University of Adelaide have identified a potential new tool for screening cereal crops for frost damage.

This research, now published in the journal *Optics Express*, has shown they can successfully screen barley plants for frost damage non-destructively with imaging technology using terahertz waves (which lie between the microwave and infrared waves on the electromagnetic spectrum).

With frost estimated to cost Australian grain growers $360 million in direct and indirect losses every year, it is crucial that growers' decisions on whether to cut the crop for hay or continue to harvest are made soon after frost damage has occurred. However, analysing the developing grains for frost damage is difficult, time-consuming and involves destructive sampling.

Frost damage can happen when the reproductive organs of the plant are exposed to air temperatures below 0°C during the growing season, with the amount of damage dependent on the severity and occurrence of frost events.

Cereal crops like barley and wheat show a wide range of susceptibility to frost damage depending on the genetics, management practices, environmental conditions and

their interactions. For example, one-degree difference in temperature could result in frost damage escalating from 10% to 90% in wheat.

Supported by both the WRI and the Grains Research and Development Corporation (GRDC), the project's researchers, including Dr Wendy Lee, Dr Ariel Ferrante and Associate Professor Withawat Withayachumnankul, found that terahertz imaging can discriminate between frosted and unfrosted barley spikes, and that the results were repeatable over many scans. This imaging technology was also able to determine individual grain positions along the length of the individual spike.

This technology may potentially be developed into a field-based tool, which could be used by growers and agronomists to assist with their crop management and help minimise losses due to frost. It could also be used immediately by plant breeders to make more rapid and more informed selection decisions about the performance of one breeding line over many others.

Further R&D is required to enable field deployment of terahertz non-destructive inspection for early frost damage and the research team is now looking to develop a working prototype for field tests with other collaborators.

"BARLEY AND WHEAT SPIKES SUBJECTED TO FROST DO NOT NECESSARILY SHOW SYMPTOMS FOR MANY DAYS UNTIL AFTER THE FROST EVENT. THIS TECHNOLOGY HOLDS PROMISE FOR IDENTIFYING FROST DAMAGE BEFORE SYMPTOMS CAN BE VISIBLY DETECTED."

Professor Jason Able

STIMULATING NEW, MULTIDISCIPLINARY AREAS OF RESEARCH ACTIVITY

PROJECT TITLE	CHIEF INVESTIGATOR	BUSINESS UNITS	$ FUNDED
Frost screening in wheat using terahertz imaging: A preliminary study	Able, Jason	AFW, ECMS	$10,000
Development of a Deep Learning Model for Genomic Prediction	Baumann, Ute	AFW, ECMS	$22,000
Beyond Biofuels - Innovative conversion of industrial hemp and sorghum residues into value-added products	Burton, Rachel	AFW, ECMS	$6,000
3D printed renewable and biodegradable nanocellulose materials	Coad, Bryan	AFW	$20,000
Detection of Anti-nutritional Compounds in plant-based feed	Falconer, Robert	AFW, ECMS, CSIRO	$14,000
Development of a Soil Nitrogen Probe Packaging	Kostecki, Roman	AFW, PhysSci, Fac. Science	$7,000
Bio-fertilisers and biologically produced methane from anaerobic digesters	Medwell, Paul	AFW, ECMS	$20,000
Food Irradiation Testing (FIT): Concept Demonstrator Towards Establishment of National Capability	Saarela, Maria	AFW, IPAS	$20,000
Smart colorimetric labels for in-field risk mitigation and monitoring of pesticides use	Santos, Abel	AFW, ECMS	$21,000
Marchantia polymorpha: A simple model to investigate complex salinity tolerance mechanisms	Wege, Stefanie	AFW, UoM	$5,000
Edible insects: Realising the potential of an emerging agricultural industry	Wilkinson, Kerry	AFW, SARDI, CSIRO	$18,000
ARC Industrial Transformation Research hub (ITRH) for Sustainable Barley Quality	Tucker, Matthew	AFW, ECMS	$14,950
Building Space Horticulture for SA	Westra, Seth Hessel, Volker	AFW, ECMS	$25,000
Research project development between The University of Adelaide and Morocco	Env Institute, WRI	Env Inst, WRI, Biol Sciences	$10,000

Space Horticulture development for SA

Project leader – Professor Volker Hessel

Research relevant to agriculture in extreme environments such as space promises to be a disruptive source of innovation for dryland agriculture, with the potential to forge new international partnerships through the Australian Space Agency and the South Australian Space Industry Centre. WRI seed funding has co-supported the establishment of projects and the purchase of equipment designed to develop space horticulture in SA alongside the significant investment in space and defence capability. Drought resilience, sustainable and resilient farming techniques and space/extreme environment agrifood and bioprocessing are the focus of these projects.

Space is unforgiving and systems must be circular and self-sustaining, reflecting the ever-increasing pressures on terrestrial agriculture. Controlled Environment Agriculture and other highly efficient bio-systems are fundamental to meeting this challenge, incorporating robotic technologies and autonomous systems, sensing and processing technologies and continual data analysis, all of which will also be relevant to some of the toughest technical challenges in the terrestrial agrifood and wine sector in arid and semi-arid regions.

A 1m x 1m x 1m engineered closed environment-life support system (ECCLES; 'space greenhouse') has been designed and fabricated by ECMS researchers to contain an LED light source (commonly used in greenhouses), gas monitoring sensors, gas vents, a camera for experimental documentation, and Peltier elements for simulating the cold harsh space environment.

A random positioning machine (RPM) has been purchased and used for several experiments, simulating random motion, microgravity, lunar and Martian gravity, with mounted specimens of postcard size. The experiments include the dissolution of fertilisers into soil under microgravity, and some early crop growth investigations. Both ECMS and Waite researchers are now conducting microgravity experiments.

Data from related projects will be used for system modelling ('digital twins') of plant stressor effects, and the investigations will start with light, including cosmic rays. The aim is to use stress to foster crop growth rather than eliminating it. Another aim is to transform plants in their productivity of nutrients, intending to use them as smart bioreactors; not only for food, but for health (biopharmaceuticals) and construction materials for space habitats (fibres).

Investment in space agriculture will provide stretch technologies for earth agriculture and, importantly, will promote engagement between agriculture in South Australia and a new community of researchers operating at the cutting-edge of technology.

Edible insects: realising the potential of an emerging agricultural industry

Project leader – Professor Kerry Wilkinson

This project sought to identify foods (including pet food) amenable to nutritional enrichment via the addition of insects or insect flour, and to establish consumer acceptance of these foods.

Consumer trials comparing acceptance of different pastas (including three commercial pastas made with cricket flour) were completed in September 2020.

A collaboration with South Australian pet food manufacturer, Urban Petfood, has also been established, and production of a prototype dog treat made with cricket flour is underway. A consumer survey and trial investigating acceptance of dog food made with insects (by both dogs and their owners) is planned, with two research papers also in the pipeline.

The emerging industry relationships seeded by this project will hopefully culminate in joint applications for research funding, as well as assist in raising the profile of this underrated, plentiful and sustainable protein source.

Pasta made from cricket flour

WRI ACTIVITIES AND OUTCOMES IN 2020

1 Research with impact in sustainable intensification of agriculture in a changing climate

Investment in research that future-proofs and ensures profitable and productive agriculture in the face of limited natural resources, increased costs of energy and inputs, urbanisation and environmental degradation is critical for the planet and our growing population. The agriculture, food and wine sector must meet these challenges against a background of serious climate change impacts such as seasonal instability, severe heat and storm events, warmer regions becoming marginal for some enterprises, and the need to reduce carbon emissions. These complex and inter-dependent issues need the kinds of high quality, integrated and interdisciplinary research that members of the WRI can provide.

A selection of research highlights from 2020 addressing these challenges is featured here.

Fertiliser research enters a new era

Enhanced spreading, improved efficiency and reduced environmental impact will be the focus of continuing fertiliser research under a new five-year R&D partnership agreement between The University of Adelaide and US-based fertiliser producer The Mosaic Company.

Based at the University's Waite Campus, the Fertiliser Technology Research Centre (FTRC) focuses on the fundamental processes controlling fertiliser efficiency in a wide range of soils globally. The Mosaic Company, the world's largest provider of potash and phosphate fertilisers, has been a major industry partner since the centre's establishment in 2007.

In 2020, the FTRC, led by Professor Mike McLaughlin, applied for patents on superhydrophobic coatings for fertilisers to improve their physical quality – reducing caking, degradation and dust generation. New equipment co-funded by WRI is helping to evaluate these new formulations.

Hydrophobicity is arguably the key requirement for a fertiliser coating designed to reduce the effects of humid storage conditions leading to agglomeration, dust, poor flowability and heterogeneous spreading in soils. This is an issue to varying degrees for all commonly used soluble nitrogen, phosphate and potassium fertilisers used globally on soils. The FTRC has investigated the effects of high humidity on the moisture absorption and caking tendency of fertilisers coated with a natural beeswax including a roughener to impart superhydrophobic properties, and its effect on the release of nutrients from the granule to soil.

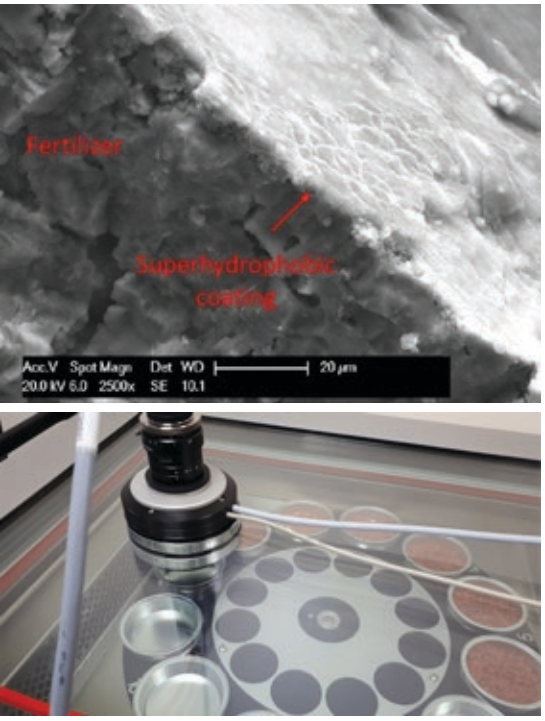
Due to the concerns regarding the biodegradation of fertiliser coating materials and their possible persistence in soil, the degradation of the superhydrophobic coating material in soils was also evaluated. The coatings were successful in significantly improving the physical quality of granular fertilisers due to superhydrophobic properties, did not significantly affect nutrient release from the granule, and were rapidly biodegradable once applied to soil. These biologically-based superhydrophobic coating materials offer a simple method to protect granular fertilisers from physical degradation in transport and storage, do not affect nutrient release and are environmentally benign.

NATIONAL HORTICULTURE TREE GENOMICS PROGRAM–PHENOTYPE PREDICTION TOOLBOX AS17000

The Phenotype Prediction Toolbox will deliver tools and technology that enable downstream breeding and management research and development projects to better exploit the interaction between phenotype and gene expression due to external stimuli, genetic variation, or both. Phenotype prediction will therefore be at the forefront of the National Horticulture Tree Genomics Program in which almond is one of five crops investigated. The Phenotype Prediction Toolbox will develop tools to implement methods for identifying elite germplasm through prediction of phenotype from genomic information and provide knowledge on the impact of external stimuli on gene expression controlling important phenotypic processes. These outputs will support the development of advanced management systems for Australian horticulture.

This 2018-23 project is funded through Horticulture Innovation Australia Limited - Frontiers Funds.

Photo: Almond blossom



Above: The water vapour sorption analyser in use at the University's Fertiliser Technology Research Centre

Professor McLaughlin's globally recognised expertise in phosphate and novel fertiliser technologies also led to his inclusion on a new international panel on responsible plant nutrition, convened for the first time in February 2020. The International Fertilizer Association (IFA) announced the inception of the Scientific Panel on Responsible Plant Nutrition to meet the growing need for scientific research and expertise to further improve nutrient stewardship. Composed of prominent plant nutrition experts from leading research organisations around the world, the advisory panel will provide scientific expertise and advice to the fertiliser industry, as well as the broader community of stakeholders engaged with agrifood systems. Its critical mission is to advance sustainable plant nutrition as it plays a key role in solving the challenges facing agricultural systems around the world by improving agricultural productivity and soil health while minimising nutrient losses to the environment.

The Centre's research over the next five years will be focused around developing fertilisers with enhanced spreading and handling qualities, testing the effects of new materials in formulations, and pairing fertilisers with plant traits, bio-stimulants and microbial technologies for enhanced agronomic efficiency and minimised environmental impacts.

Potential increases in pollination efficiency

Scientists at The University of Adelaide and Shanghai Jiao Tong University in China have discovered two proteins in rice involved in pollen aperture formation which are essential in the successful pollination of flowering plants.

Their study, published in the journal *Nature Plants*, was undertaken to better understand the molecular control of plant pollen aperture formation in rice, with a view to acquiring new knowledge to improve cereal productivity and ultimately benefit global food security.

Professor Dabing Zhang of The University of Adelaide and Shanghai Jiao Tong University Joint Lab for Plant Science and Breeding led the research, which reveals the importance of the aperture for rice grain yield and exposes the mechanisms controlling pollen aperture development in cereal species.

Pollen apertures are portals on the surface of pollen which mark the site where the pollen tube emerges and allow water uptake, which are critical for pollen germination and agricultural yield.

Different plant species vary in the size, shape, position and number of pollen apertures, but little is known about how these species-specific apertures form and what controls this process.

Manipulation of pollen aperture formation and male fertility will be useful for developing new hybrid rice plants with high yield and better quality. This new knowledge could also be applied to other crop varieties to improve breeding outcomes.

Better barley for malting and brewing

A multidisciplinary collaboration building on the University's already strong research focus on understanding barley growth and development in both optimal and challenging environmental conditions, was supported by the WRI during 2020.

The goal is to help growers sustainably produce more barley of a higher quality and that can attract a premium price tag. WRI researchers are working with Professor Rob Falconer from ECMS, who has expertise in malt quality, to determine how this relates to grain quality, and how it can be predicted faster and with greater certainty in breeding programs.

This project opens doors for further industry collaboration, with Waite campus researchers already having strong links with stakeholders, including Coopers and Glencore. Understanding the chemical compounds that contribute to beer flavour to satisfy both domestic and international markets is now a research priority for these industry partners.

Professor Falconer and fellow researchers from the School of Chemical Engineering and Advanced Materials are also using their protein chemistry expertise to develop wine-making solutions for protein haze problems and improved grape juice flotation. These projects are in collaboration with scientists from the Australian Wine Research Institute and the School of Agriculture Food and Wine.

"BARLEY IS WORTH AROUND $600M TO OUR LOCAL ECONOMY AND THE MAJORITY IS EXPORTED FOR USE IN THE INTERNATIONAL MALTING AND BREWING SECTOR."

Associate Professor Tucker, Deputy Director of the Waite Research Institute.

Also in 2020, the "OzBarley" project, led locally by A/Profs Bettina Berger and Matthew Tucker, was funded by the Australian Research Data Commons. The aim of the project is to develop a publicly available Genotype-to-Phenotype (G2P) data asset meeting FAIR principles that is specifically designed by, and for, Australian researchers and breeders focusing on barley as an economically important model crop.

This multi-institutional project builds on academic and industry strengths in barley breeding, bioinformatics, phenotyping and big data analysis. Partners include the Australian Plant Phenomics Facility, Bioplatforms Australia, CSIRO Agriculture, Federation University, Australian Grain Technologies, Intergrain, Secobra Recherches and the International Barley Hub (Scotland).

LAPEROUSE

In 2020, French barley breeding company SECOBRA released its first variety in Australia after many years of collaborative research and development with The University of Adelaide. *Laperouse* (tested as WI4952) is a new barley variety bred at the Waite, with research investment from GRDC and developed by SECOBRA Recherches' Australian breeding program, based in Adelaide.

Laperouse has been tested in the National Variety Trials system since 2016. It has been evaluated over several years in agronomic trials, with interest in its high-yield potential coupled with good straw strength and standability. It began its Stage 1 malt accreditation assessment in 2020, and could be granted malting status in March 2022, at the earliest.

Laperouse has been bred for:

- high grain yield in medium-high rainfall zones
- improved physical grain quality
- earlier sowing opportunities than other spring barley varieties
- excellent straw strength and lodging resistance
- improved Net and Spot form of net blotches

Laperouse was in seed production in 2020 and will be available to growers from Seednet Partners across Australia in 2021.

BEAST

Beast (tested as AGTB0113), the first barley developed by Australian Grain Technologies, has been selected from the advanced germplasm pool sourced from The University of Adelaide, and is derived from a cross including *Compass* and *Hindmarsh*. *Beast* has vigorous, quick-maturing traits, and may be best suited to low-medium rainfall situations. It has performed well across many environments, and will be released as a feed variety. It has been accepted into the Barley Australia Malt Accreditation Programme, however a result on its malt status will not be known until at least the 2023 season.

Beast has been bred for:

- Very high yielding in low-medium rainfall environments
- Quick maturity, almost a week quicker than Compass~
- Excellent performance in stressed, tight finishing environments and seasons
- Compass plant type, with similar early vigour
- Competitive physical grain quality package, with test weight and grain size comparable to most commonly grown varieties
- Feed quality, but has entered the malt accreditation process.

Smoke Taint CRC-P to address a growing wine industry problem

A new project to help Australia's winemaking industry understand and respond to the impact of taint from bushfire smoke has received $950,000 in Cooperative Research Centre Project (CRC-P) funding from the Federal Government.

Outcomes from the research, co-supported by the WRI, will provide economic and social benefits to the wine industry, and is part of a broader $2,387,017 project.

Producing wine in Australia has become increasingly challenging. Grape and wine producers have not only been affected by drought, but more recently by smoke exposure from the 2019/2020 bushfires.

The 2007 Victorian bushfires cost the industry more than $100M in lost production due to smoke taint. The financial impact of the 2019/20 bushfires, which impacted prominent wine regions across the ACT, NSW, SA and Victoria, is expected to be significantly larger. Losses due to not harvesting smoke tainted fruit by far exceeded physical losses due to the bushfires.

NSW-based Cassegrain Wines is leading the project, with research to be concurrently undertaken at The University of Adelaide's School of Agriculture, Food and Wine by Professor Kerry Wilkinson, a world leader in smoke taint research.

The new industry-research project will develop new methodologies and strategies for the Australian wine industry to manage taint from grapes exposed to bushfire smoke. It will build on the understanding of how smoke affects grapevine physiology and the composition and sensory properties of grapes and wine gained over the past decade to evaluate promising mitigation strategies, including novel winemaking additives and treatment processes that remove smoke compounds from wine.

The project is supported by a number of industry and research partners including international technology company Ligar, which is at the forefront of molecular imprinted polymer technology – a very promising smoke taint treatment process. Other project partners include The Australian Wine Research Institute, VA Filtration, and De Beaurepaire Wines.

THE 2007 VICTORIAN BUSHFIRES COST THE INDUSTRY MORE THAN $100M IN LOST PRODUCTION DUE TO SMOKE TAINT. THE FINANCIAL IMPACT OF THE 2019/20 BUSHFIRES, WHICH IMPACTED PROMINENT WINE REGIONS ACROSS THE ACT, NSW, SA AND VICTORIA, IS EXPECTED TO BE SIGNIFICANTLY LARGER.

MEASURING MEAT QUALITY

Medical technology previously used in humans is now finding new applications in meat and livestock. A team of medical engineers and livestock researchers from the Davies Livestock Research Centre at Roseworthy have been collaborating on one such technology – a medical needle fitted with an optical fibre camera that was developed to detect human cancer cells is now being used to measure intramuscular fat (IMF) in sheep and beef carcases. This enables high-speed assessment of hot carcases without damaging the meat.

IMF is a key indicator of eating quality in red meat and is particularly difficult to measure in lamb carcases, which are not currently individually graded. Meat & Livestock Australia (MLA) is investing in new technologies dedicated to achieving this to unlock opportunities for the red meat industry, including new levels of market access and dedicated red meat feedback for producers.

Testing continues to enhance accuracy and speed of measurements, with hopes this technology will be commercialised and available to producers in around three years.

Transforming agricultural waste into new products

The Research Consortium for Agricultural Product Development (RC-APD) is a $10.9 million (including cash and in-kind), four-year program funded by the Government of South Australia. It brings together nine South Australian-based companies from the agriculture and food sector, and nine national and international academic institutions and industry partners to develop high-value products from agricultural waste. The research activities of the RC-APD are undertaken in three cross-disciplinary programs across the campuses and faculties of The University of Adelaide, and also at the University of South Australia, in conjunction with industry partners.

Since its launch in 2019, the RC-APD has focussed on projects such as:

- Extracting molecules from mushroom stalks and turning them into a transparent film – this, in combination with a molecule that blocks UV radiation, has potential for both the skincare industry and as a coating for outdoor furniture and textiles;
- Isolating and identifying anthocyanins from apple and berry waste for use in skincare formulations and other health-promoting products;
- Examining the different forms of starch in potatoes, which can be used for a range of commercial products such as nutraceuticals, pre-biotics and bioplastics. Waste from potato skins and downgraded potatoes can be the source material for these products and many others;
- Trialling cellulose molecules from brussel sprouts stalk waste and other biomass as replacements for glass fibres in filtration systems and plastic materials.

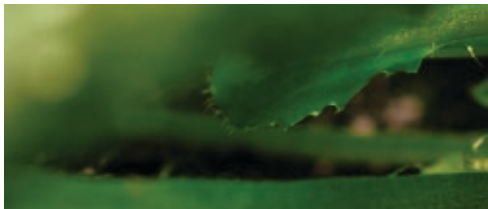
In addition to research progress on the above, 2020 highlights for the RC-APD include the launch of the website - **https://rcapd.org.au/**, research undertaken by several undergraduate and higher degree students, the engagement of a commercialisation consultant and the appointment of Chief Investigator Associate Professor Tara Pukala as the new President of the Australian and New Zealand Society for Mass Spectrometry (ANZSMS).

2 Building large scale initiatives across disciplines

A key aim of all the University's Research Institutes is to leverage funding and invest in initiatives that bring in significant funding support from external agencies and industry partners, giving all stakeholders the best chance of shared success. The expanding of the WRI's membership to include livestock/animal science, social scientists, engineers and computing specialists, will enable stronger multi-disciplinary teams to be formed in pursuit of these opportunities.

An example of an initiative developed in 2020 (and funded in early 2021) is the South Australian Drought Resilience Adoption and Innovation Hub (SA Drought Hub). Involving multiple groups, organisations and faculties, the SA Drought Hub will undertake research, development, extension, adoption and commercialisation activities to improve drought resilience and preparedness on SA farms.

The SA Drought Hub is one of eight in Australia established by the Australian Federal Government. Each will bring together research and expertise that support and facilitate effective testing and scaling up of new solutions into commercialisation and adoption.



Arabidopsis plants – courtesy of ARC CoE Plant Energy Biology

IN 2020 AROUND 70 PER CENT OF THE STATE AND MORE THAN 4,500 FARMING PROPERTIES WERE AFFECTED BY DROUGHT. AUSTRALIAN FARMERS FACE A WIDE RANGE OF RISKS, BUT THEY ARE PARTICULARLY EXPOSED TO VARIABILITY IN CLIMATE.

ARC INDUSTRIAL TRANSFORMATION RESEARCH HUB FOR WHEAT IN A HOT, DRY CLIMATE

Wheat is a major food for many regions around the world. It is the second most produced crop in the world, providing approximately 20% of the daily calories and protein for 4.5 billion people.

The Wheat Hub, which was funded from July 2015 to June 2020, brought together university-based wheat researchers and Australia's three major wheat breeding companies (Australian Grain Technologies, Longreach and Intergrain) to exploit global diversity for wheat and advanced genomic technologies for faster development of heat and drought-tolerant varieties which make better use of nitrogen fertiliser. A wrap-up showcase of the Wheat Hub's work was held online in November 2020.

Through the Wheat Hub, leading Australian breeders gained access to the latest resources in genomics. During its five-year term, as well as outcomes previously reported, the Wheat Hub assisted LongReach PB to release a new cultivar, *Hellfire*, which has had an 11% yield improvement over their current best variety, *Spitfire*, while maintaining high grain protein content.

In addition, breeders are all now using drones routinely with confidence and are expanding how they use them in their trials. This increased confidence can be attributed to their interactions with both the Wheat Hub and the University's Unmanned Aerial Research Facility (URAF), including training, best practice guidance for capturing data, and the development of software and an image analysis pipeline.

A by-product benefit of the Wheat Hub for the University's research more broadly is that URAF have been able to use the procedures and analysis tools developed by the Wheat Hub for other agricultural research, including SAGIT and SARDI projects. They have also been used for non-agricultural impact with organisations such as TERN, the Department of Environment and Water, Green Industries and others, for feral cats, recovery after bushfires, and monitoring marine vegetation. The ARDC Australian Scalable Drone Cloud project is using the Hub's drone protocols, analysis pipeline and collected data as exemplar models for the establishment of cloud-based service for Australian researchers to process and analyse drone imagery for agricultural and conservation research.

2.1 Collaborative and Strategic Partnerships

The WRI has supported and co-invested in a range of centres, groups and strategic initiatives over the last several years as external funding has ebbed and flowed. Key past centres to benefit from WRI co-investment and/or in-kind support include the ARC Centre for Plant Cell Walls, ACPFG and FOODplus.

In 2020, outcomes from Centres, initiatives and groups that have had WRI co-investment, sponsorship or support included the following.

UA-SJTU Joint Laboratory in Plant Science & Breeding

Professor Dabing Zhang established the UA-Shanghai Jiao Tong University Joint Laboratory in Plant Science & Breeding at the Waite in January 2015 and was substantially co-supported by the WRI until the end of 2018.

Professor Zhang was a co-author of 12 high-impact publications during 2020, including papers in *Science and Nature Communications*. He again made the global list of Highly Cited Researchers from the Web of Science Group. He also submitted an application for an ARC Laureate Fellowship in 2020.

ARC Centre of Excellence in Plant Energy Biology (COE PEB)

2020 was the final year of core ARC funding for COE PEB, but the centre will continue for the next three years through funding initiatives external to the ARC CoE scheme. Many of the postgraduate students associated with the COE PEB have completed or are nearing completion.

Research on GABA (gamma-aminobutyric acid), a signal of metabolic status, has culminated in multiple publications, including a recent *Nature Communications* paper. GABA has been found to be an additional regulator of stomatal opening in plants, therefore impacting a plant's water use efficiency. This work by the Gilliham Lab in collaboration with Professor Rainer Hedrich, University of Wurzburg, will continue through an ARC Discovery Grant.

Wine Australia have invested in a four-year project led by Professor Steve Tyerman examining cell death in grape berries that may be linked to GABA metabolism and signalling in respect of controlling organic acid accumulation.

In 2020, in two publications, PEB staff and students collaborated with others to overturn long-established dogma that sodium exclusion from shoots always contributes to salt tolerance in cereals, and found that the identical mutation in the equivalent sodium transporter from wheat and barley confers this trait without compromising performance.

COE PEB researchers have also continued to work and publish on:

- understanding the role of aquaporins in plants, focusing on their multi-functionality in transport of both water and solutes;
- salt exclusion in wheat and grapevines has continued and been published on the critical proteins for encoding salt tolerance in these valuable crops;
- the role of chloroplasts and root suberisation in salt tolerance;
- understanding of mucilage production in *Plantago ovata* seeds;
- a genome wide association study of fructan accumulation in barley grain;
- the effects of manipulating mixed-linkage glucan on seed morphology; and
- the first reported use of CRISPR-Cas9 technology in barley in Australia.

In 2020, the Burton lab was successful in applying for ARC funds with the award of a Discovery grant entitled 'Novel cell wall genes ripe for the picking' to explore applications of modifications in cell wall properties from improving processing of fruit.

In collaboration with other Australian Research Council (ARC) Centres of Excellence, Q&ARC was launched.

The video series went behind the scenes at leading universities and institutions and offered a unique chance for the community to get to know some of the brightest and most curious minds in the country. Episode 8 was created by PEB and featured PhD student Daniel McKay providing an account of his experiences as a plant scientist, what plant energy biology is and why it is important for future-proofing our global food security.

To better enable industry-research engagement within the plant and agricultural sciences PEB ran an event in collaboration with the ARC Centre of Excellence in Translational Photosynthesis. The Industry Engagement and Showcase Event saw PhDs and ECRs pitch projects and engage with partners from the Grains Research and Development Corporation.

ARC Industrial Transformation Training Centre in Innovative Wine Production

The second iteration of this ARC Industrial Transformation Training Centre, co-supported by the WRI, commenced in February 2018.

The Centre continued to grow in 2020, welcoming four new PhD students, bringing the Centre's total personnel to 45. A special issue of the Australian Journal of Grape and Wine Research was dedicated to the Training Centre in 2020, at a time when many Centre researchers were unable to access laboratory or other facilities resulting in delays to their experimental work. However, these circumstances provided many with the opportunity and time to focus on their writing endeavour. The Special Issue, published in April/May 2021, comprised eight review and research articles authored

by the Centre's staff, students, industry partners and collaborators. The Special Issue is expected to increase the Australian and international wine industry's awareness of the Centre and its researchers and will assist in continuing to build stronger relationships with existing partner organisations and lead to new opportunities. In addition to this special issue, Centre members contributed to a further 15 research articles published in peer reviewed journals and another three published conference papers.

Centre members also took advantage of opportunities to present their research online with over 30 talks to the public as well as a number of invited talks at international conferences. Two online workshops also allowed researchers to update the Centre's industry partners on project progress.

A further highlight for the year included Centre members Professor Vladimir Jiranek, A/Professor David Jeffery, Professor Kerry Wilkinson, Professor Steve Tyerman, Dr Renata Ristic, and Charles Sturt University's Professor Leigh Schmidtke, being awarded the 2020 Australian Council of Graduate Research award for Excellence in Graduate Research Supervision. This annual award recognises higher degree by research (HDR) supervisors who have demonstrated a track record of successful HDR candidate outcomes and engagement in high quality supervisory practice and research supervision leadership.

Administered by The University of Adelaide, the ARC Training Centre for Innovative Wine Production collaborating partners include AGRF, Availer, AWRI, Chalmers Wines Australia, Coonawarra Grape and Wine Inc., CSIRO, Charles Sturt University, E. & J. Gallo Winery, Lallemand Australia, the NSW Department of Primary Industries, Pernod Ricard Winemakers, VA Filtration (SA) and Wine Australia.

The AgriFood & Wine Industry Engagement Priority

The WRI again provided the backbone of the University's AgriFood & Wine IEP through 0.8FTE in-kind support in 2020.

In 2021, WRI takes over full leadership of the IEP. Formerly known as the Food Innovation Theme, the AgriFood & Wine IEP is now one of five formally recognised in the University's strategic plan as key areas of research strength (aligned with industry importance in South Australia). The WRI has supported the development of the AgriFood & Wine IEP across Faculties, campuses and disciplines through:

- developing appropriate strategies and structures
- facilitating cross-disciplinary efforts
- supporting key partnerships and business development activities across the University, and
- communicating widely with internal stakeholders
- development of the University's AgriFood and Wine Strategic Plan.

SAGI-STH – Statistics for the Australian Grains Industry (Southern Growing Region)

The largest single current investment for the WRI is in the Biometry Hub's multi-year, multi-partner Statistics for the Australian Grains Industry (Southern Growing Region) program (SAGI-STH), funded by the Grains Research & Development Corporation (GRDC).

Since its establishment in 2016/17, SAGI-STH has been value-adding and enhancing the quality of GRDC funded experimental research in the southern growing region. The objectives of SAGI-STH are to increase the statistical capacity in the region, while advancing research project outcomes from both regional and national GRDC investments.

More than 40 GRDC research projects have now been given direct SAGI-STH support, including the design and analysis of experiments as well as field sampling and processing of complex data. The total budget of the projects supported by SAGI-STH exceeds $70M and 20 joint publications have been published in international scientific journals.

In 2020, the Biometry Hub group seamlessly switched to providing fully efficient online research support to the industry partners and R&D agricultural departments in the Southern region, including South Australia, Victoria and Tasmania. The online platform of the group enabled all the major activities to continue, including statistical advice, experimental designs and data analytics for large GRDC projects, SAGI-STH training program and follow-up webinars, SAGI-STH research internship program for researchers on grains-related projects and research collaboration in statistics and data sciences.

Highlights of the year include:

1. A new project funded by GRDC in collaboration with AGT and AIML on investigating the efficiency of Machine Learning methods in plant breeding (fully funded post-doctoral position in the Hub for 12 mths)
2. Software applications for data collection and visualisation of field and laboratory research and for field data collected automatically and extracted from public and proprietary data repositories (Five apps developed)
3. Growth in research publications of the group, including a series of research papers on optimal experimental designs in waste management, field sampling design and applications of advanced statistical methods in agronomy, plant science and plant breeding research (30 papers published in 2020/21)
4. Monthly meetings of StatsPD@Waite with three international presentations by statisticians from CIMMYT, Argentina and USA
5. Several PhD and MPhil (Biometry) students graduated in 2020/21.

The group started the Biometry Hot Desk program supported by the Schools of Agriculture, Food & Wine and Animal & Veterinary Sciences. The program provides the initial support in statistics and data analytics to RHD students in the Schools.

The SAGI program was reviewed by GRDC in 2020. SAGI is extended until July, 2022, with an additional funding (expected 800K, under negotiation) in 2021/22 from GRDC to support the Biometry Hub in delivering the SAGI-STH agenda.

3 Enhancing excellence through researcher development

The WRI has invested heavily in the leadership training and mentoring of the School of AFW's early to mid-career researchers since 2011, and continues to make the area of people development a priority. In addition to the flagship Research Leadership Development Program, developed by the WRI in conjunction with executive coach Karilyn Fazio of the Impetus Team, the WRI also funds short professional development workshops delivered each year on a range of relevant topics, open to researchers and HDR students from across the School.

Past graduates of the WRI's Research Leadership Development Program are now prominently and regularly featuring in promotion rounds, grant successes, high-impact publication results, media and industry engagement activities and awards.

The program's objective was to increase and foster the leadership skills, behaviours and personal ambitions of the participants. The full benefits of these investments in individuals often take time to be fully realised, but several members of the early cohorts to undertake this program demonstrated dramatic improvement and accelerated achievement across a range of areas within 12 months – and these benefits are still unfolding. The School of AFW and the Waite more broadly are reaping the rewards of investment in this younger generation of researchers.

Plantago in flower (courtesy of James Cowley, COE PEB)

Professional Development program for EMCRs

In 2020, a series of grant and publication writing workshops for EMCRs, supported by the WRI, were delivered by Dr Maria Gardiner of ThinkWell, resulting in several new applications being submitted. These included four Discovery Projects, two Future Fellowship and two DECRA Fellowship applications to the Australian Research Council, and two applications to other funding bodies.

Feedback on the program was that it was highly beneficial; the two DECRA Fellowship applicants in particular reported they had not felt ready to stretch for this goal and would not have submitted these applications without the encouragement, peer feedback and coaching provided in these workshops. Outcomes are still pending.

Grant Writing support

Since 2011, the WRI has offered a grant writing service to researchers for fellowship, project and centre applications, and in 2020, this was expanded from one to two regular grant writing consultants, with an additional specialist consultant employed for expert feedback on a large Hub bid.

Addressing compliance, eligibility, readability and scientific merit, the grant writers have worked on several applications in the past year, including ARC Industrial Transformation Research Hubs, ARC Laureate, Future and DECRA Fellowships, ARC Discovery and Linkage Project applications, a joint Australia-China Research Centre bid and a feasibility grant.

4 Connecting researchers with industry

With most campus visits/tours, public events, and face-to-face meetings cancelled due to the pandemic, industry engagement was somewhat limited in 2020. However, regular meetings with key industry partners and stakeholders continued online and the WRI played a role in facilitating connections through its webinar series, the Research Showcase in December, and via the AgriFood & Wine IEP.

In addition, the following visitors and events were hosted early in 2020:

- A press conference by Tim Whetstone MP, then SA Minister for Primary Industries & Regional Development, on the lifting of the SA moratorium on Genetically Modified crops;
- A Barley symposium on 3-4 February that brought together researchers and commercial breeders from across Australia;
- The Ambassador of Georgia;
- A Nepali delegation of business leaders and politicians;
- David Basham MP, the incoming SA Minister for Primary Industries & Regional Development;
- A Nottingham University leadership group;
- The Ambassador and Consul-General of Italy.

The 2020 year also saw ambitious projects developed by and awarded to WRI members in the ARC Linkage program, which is designed to promote national and international research partnerships between researchers and business, industry, community organisations and other publicly funded research agencies. Linkage grants encourage the transfer of skills, knowledge and ideas as a basis for securing commercial and other benefits of research. The successful applications included plantago, agave and soil ecology projects, and all will be aimed at helping Australia's valuable primary industries sector to diversify, become more resilient and profitable, and develop new products and management techniques based on applied and scientifically rigorous research.

WRI PARTNERS

The Waite Research Institute comprises researchers/members and collaborators from a wide range of partner entities both within and external to the University. These partnerships are an integral and valuable part of the WRI's success.

The WRI's primary partner on the Waite Campus is The University of Adelaide's School of Agriculture, Food and Wine.

Location: Hartley Grove, Waite Campus, Urrbrae

The School of Agriculture, Food & Wine (AFW) is one of four Schools within the Faculty of Sciences at The University of Adelaide. The School is a world-class concentration of scientific research, education and product-conferring capability, the centrepiece of the Southern Hemisphere's largest collection of expertise in plant genomics, crop improvement, sustainable agriculture, animal science, dry land farming, horticulture, viticulture, oenology, wine business and food and health. The School comprises more than 70 academic and research staff, and several hundred postgraduate and undergraduate students move through the School's suite of degrees each year.

The School is organised into three departments and incorporates several research disciplines, including:

- Farming Systems
- Food & Nutrition
- Plant Breeding & Genetics
- Plant Protection
- Plant Physiology, Viticulture & Horticulture
- Soil Science
- Wine Science
- Biometry

The School of Agriculture, Food and Wine also encompasses the following specialist research centres and entities:

Australian Plant Phenomics Facility (APPF) - The Plant Accelerator

Location: Hartley Grove, Waite Campus, Urrbrae

The Plant Accelerator, a national facility established under the Commonwealth National Collaborative Research Infrastructure Scheme (NCRIS), is a world-leading plant phenomics facility offering state-of-the-art plant growth environments and the latest technology in high throughput plant imaging for the repeated measurements of the physical attributes (phenotype) of plants automatically and non-destructively. The services enable academic and commercial plant scientists to better understand the factors controlling the performance of particular crops; factors including the genetic make-up of the plants, the soil conditions, chemical and nutrient treatments, and environmental stresses. This facilitates an acceleration of crops improvement - generating crops that are more productive, disease tolerant and viable in marginal conditions.

The APPF has two nodes; The Plant Accelerator involving the research institutions at the Waite and The High Resolution Plant Phenomics Centre involving CSIRO Plant Industry and the Australian National University in Canberra.

ARC Centre of Excellence in Plant Energy Biology (Adelaide node)

Location: Plant Research Centre, 2b Hartley Grove, Waite Campus, Urrbrae

The University of Adelaide established a node of the ARC Centre of Excellence in Plant Energy Biology (PEB) in 2011. The current version of the centre began in 2014 with Professor Steve Tyerman and Associate Professor Matthew Gilliham as Chief Investigators.

The Centre comprises The University of Western Australia, Australian National University, The University of Adelaide and La Trobe University, ten Chief Investigators and over 130 internationally competitive staff and students. It is funded primarily through the Australian Research Council ($26 million) and $14 million from the partner universities to fund the Centre through to 2020.

The research focus of the Centre is to better understand the way in which plants capture, covert and use energy in response to environmental change. The long-term goal is to enhance energy efficiency to improve sustainable productivity of plants. At the Adelaide node the aim is to improve the efficiency of plant energy use by manipulating the transport properties of gatekeeper cells for water, carboxylates, phosphate and salt.

ARC Industrial Transformation Training Centre in Innovative Wine Production

Location: Wine Innovation Central Building, Waite Campus, Urrbrae

Based at The University of Adelaide's Waite Campus, the ITTC for Innovative Wine Production has been made possible by $2.4 million from the Australian Research Council - Industrial Transformation Research Program, additional support from Wine Australia and $1.2 million in cash and in-kind support from the project partners. The Training Centre will provide new knowledge, methods and technologies as well as highly skilled PhD and postdoctoral researchers to tackle the main challenges for the Australian wine industry – climate warming, water restrictions, changing consumer preferences and rising wine alcohol content – leaving the industry better placed to make the wines that the market and consumers want.

Incorporating 12 partners (including all of the WIC members – see below), the Centre represents a unique and exciting training opportunity for 14 PhD and 4 postdoctoral researchers to work closely with leading research centres and Australian and international companies from the wine and food sector.

wineinnovationcluster.com
Synergy in grape & wine research

The Wine Innovation Cluster

Location: WIC Building, cnr Hartley Grove and Paratoo Road, Waite Campus, Urrbrae

The WIC is a virtual entity and partnership of four leading Australian grape and wine research agencies. Based on the Waite Campus, the WIC strives to build collaboration and create synergies in research and development across the co-located partner organisations for the benefit of Australia's multi-billion dollar wine industry.

The WIC encompasses ~70% of Australia's national wine R&D capability, and was established in recognition of the fact that enhanced coordination and integration is necessary to build the quality outcomes needed by the wine and grape growing industries to meet future challenges.

Collectively, the WIC partners cover the entire grape and wine research, development and extension spectrum and the WIC is continuously exploring opportunities for collaborative research projects. Since it was established in 2008, the WIC partners have worked on more than 35 collaborative projects that have attracted more than $27m external funding; strong industry partnerships on many of them attest to their relevance.

University partners at the North Terrace and Roseworthy campuses include:

Centre for Global Food & Resources

Location: North Terrace Campus

The University of Adelaide's Centre for Global Food and Resources (GFAR) has a global reputation for creating and applying knowledge on secure and resilient global food and resource systems.

Working with Australian primary producers and agribusiness to understand both the capacity and drivers of success, GFAR is cultivating the next generation of agribusiness and resource professionals, through a unique mix of business fundamentals, practical experience and global connections. With world-leading agricultural and wine research and training facilities extending to campuses located at Waite and Roseworthy, GFAR conducts innovative interdisciplinary research, using a whole of systems approach, addressing economic, policy, agribusiness and social issues affecting global food systems. In addition, we connect relevant partners ranging from industry organisations and enterprises to government institutions and policy makers. Our networks extend across the globe with strong research partnerships with agricultural, food, health and environmental scientists, as well as industry, government and NGOs, with the aim of achieving healthy, resilient and productive communities and landscapes that are food, water and resource secure.

School of Animal & Veterinary Sciences (and the Davies Centre)

Location: Roseworthy Campus

The School of Animal & Veterinary Sciences (SAVS) has international leaders in animal behaviour, biology, population health, infectious diseases, reproduction, livestock and equine health research. The Davies Research Centre is conducting world-class research, knowledge transfer and delivery of applications to build the sustainability of the red meat industry. Ruminant animal experts explore the interactions between genetics, physiology, management and the natural environment to improve animal productivity, welfare and the quality of the resulting food for consumers.

With key links to the beef, sheep, pork and poultry industries, the Roseworthy campus research environment fosters collaboration and partnerships for delivering evidence-based outcomes in a 1671 hectare farm setting and modern laboratories. Co-located partners include PIRSA-SARDI, Weatherbys Scientific Australia and Zoos SA.

ThincLab. Waite

ThincLab

Location: Hannaford Building, Waite Road, Waite Campus, Urrbrae

ThincLab Waite is Adelaide's first agtech, food innovation and wine focused incubator.

ThincLab support start-ups in the agri, food and wine sectors. It provides a nexus for startups, mentors, investors, agribusiness, corporates and academics to connect and collaborate.

Members of ThincLab Waite benefit from a range of services to support their startup including:

- A global network of industry experts and our dedicated AgTech Expert in Residence.
- Access to the ThincLab programs (ThincSTART, ThincSCALE and ThincGROWTH) and our ThincSprint.
- Access to ThincLab masterclasses and networking opportunities.

Non-University partners

The Waite and Roseworthy campuses of The University of Adelaide are unique in the number of non-University research partners co-located there. These partners include Federal and State government agencies as well as national research centres and industry-funded organisations such as the Australian Wine Research Institute. All have added greatly to the richness of the research environment, co-investing in buildings and other infrastructure and forming effective collaborative relationships with each other.

CSIRO

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

LOCATION: Prescott, Taylor, Cornish and WIC West buildings, Waite Road, Waite Campus, Urrbrae

CSIRO, the national research provider, innovates for tomorrow and offers solutions and technologies today – for its customers, all Australians and the world. CSIRO's research at the Waite Campus seeks to create value for its customers through innovation that delivers economic, environmental and social impact, with particular focus on Australia's agricultural, environment (land and water) and mineral resources sectors. CSIRO's Waite-based agricultural research is focussed on southern farming systems, wine grapes and horticulture, genomic science for crop performance, soil carbon and nutrient cycling and agricultural adaptation to and mitigation of global change. CSIRO Land and Water's research focuses on environmental resilience, environmental toxicology, managing terrestrial and aquatic ecosystems, water in the resources sector, economics, productivity and sustainability. In the minerals sector, CSIRO's Waite-based research focuses on intelligent mining and resource management. All of this work is conducted in partnership with a range of research, industry and commercial partners, including the other organisations based at the Waite.

PIRSA-SARDI

LOCATION: Plant Research Centre, 2b Hartley Grove, Waite Campus, Urrbrae

SARDI, a Division of the South Australian Department of Primary Industries and Regions (PIRSA), is the SA Government's principal research institute for primary industries creating opportunities to ensure the agriculture, food, aquatic and bioscience industries are internationally competitive and ecologically sustainable. SARDI focusses on value-chain linkages, food security, natural resource and climate adaptation, product integrity requirements, innovation capability and enabling technologies, supplier competitiveness and biosecurity. SARDI science programs are aquatic sciences, livestock and farming systems, and sustainable systems. SARDI has 350 scientific, technical and support staff working at 10 regional research centres in South Australia.

Australian Wine Research Institute (AWRI)

LOCATION: Wine Innovation Central Building, cnr Paratoo Road East & Hartley Grove, Waite Campus, Urrbrae

The Australian Wine Research Institute (AWRI) is the Australian grape and wine industry's own research organisation. It supports a sustainable and successful grape and wine industry through world class research, practical solutions and knowledge transfer. Established in 1955, the AWRI is governed by an industry-led, skills-based Board and is a member of the Wine Innovation Cluster located at the Waite Research Precinct in Adelaide. The AWRI's activities are guided by its mission and values, an industry-endorsed research, development and extension plan and an internal business plan. AWRI Commercial Services is the commercial arm of the organisation and provides advanced analytical and consulting services on a fee-paying basis.

The AWRI supports grapegrowers and winemakers by:

- Undertaking strategic and applied research based on the priorities of the Australian grape and wine industry
- Providing a helpdesk service to answer queries from producers and conducting problem-solving investigations
- Presenting roadshow workshops and seminars in Australian wine regions
- Delivering technical information via the John Fornachon Memorial Library, the AWRI website and regular email bulletins
- Producing publications including an Annual Report, AWRI Technical Review and the Agrochemicals 'Dog Book'
- Conducting events including the triennial Australian Wine Industry Technical Conference, the Advanced Wine Assessment Course and Research to Practice modules
- Providing NATA-accredited analysis and assistance with wine export
- Supervising postgraduate students and providing lectures to under-graduate students.

Australian Genome Research Facility (AGRF)

LOCATION: Plant Genomics Centre, Hartley Grove, Waite Campus

AGRF is a not-for-profit company, established in 1997 under the Commonwealth Major National Research Facility (MNRF) Program, and currently supported by NCRIS through BioPlatforms Australia. It is Australia's largest provider of genomics services and solutions. AGRF has laboratories in Adelaide, Brisbane, Melbourne, Perth and Sydney. The Adelaide node provides a range of services to industry and academia, including illumina and Ion Torrent "Next Generation" sequencing, Sanger DNA sequencing, nucleic acid extraction, controlled environment growth rooms, and varietal identification services. The Adelaide node provides a direct link to the specialist, large scale, and Bioinformatics services provided by AGRF's national network, and is accredited by NATA to ISO17025:2005.

Arris Pty Ltd

Location: Hartley Grove, Waite Campus, Urrbrae

Arris is an innovative Australian-owned consulting and communications company, providing services in two distinct areas: agricultural & environmental services, and marketing/communications. The Arris team has a unique mix of qualifications and experience in science, agriculture, communications, event management, education and training, graphic design, web design and computer technologies and provides services for a diverse range of clients.

Fight Food Waste Cooperative Research Centre (FFW CRC)

LOCATION: Level 1, WIC Building, cnr Paratoo Road and Hartley Grove, Waite Campus, Urrbrae

The Fight Food Waste Cooperative Research Centre brings together industry, research and the community to capitalise on Australia's food waste opportunities. Winning this fight will save Australia $20 billion per annum in food waste through increased industry profitability and reduced food insecurity, as well as enhancing Australia's reputation as a sustainable and trusted producer of premium food products.

Through three research and development programs, the FFW CRC will REDUCE food waste across the supply chain, TRANSFORM unavoidable waste into innovative high-value co-products, and ENGAGE with industry and consumers to deliver behavioural change.

Plant and Food Research (Australia)

LOCATION: Northern Barns, Building 4G Waite Road, Waite Campus, Urrbrae

Plant & Food Research is a science and innovation company. It is a subsidiary of Plant & Food Research New Zealand Ltd which is a Crown Research Institute.

At its core, Plant & Food Research aims to enhance the value and productivity of horticultural, arable, seafood and food and beverage industries to contribute to economic growth and the environmental and social prosperity of our clients and the communities they live in.

Already working with The University of Adelaide on agricultural product development, and almond orchard systems and harvest technologies, the Waite node will drive research collaborations aimed at enhancing production, sustainability and value-adding in the horticulture, food and agriculture industries.

APPENDICES

Appendix 1

WRI MEMBERS IN 2020

Able, Amanda
Able, Jason
Alperstein, Lucien Thandi
Andelkovic, Ivan
Armstrong, Claire Elizabeth Jane
Arsego, Fabio
Asenstorfer, Robert
Asif, Ahsan
Badu, Manoj
Baird, Roslyn
Baker, Gregory Richmond
Baldock, Jeffrey
Ballard, Ross Alexander
Bartowsky, Eveline
Bastian, Susan
Baumann, Ute
Berger, Bettina
Betteridge,Alice Livingston
Betts, Natalie
Bianco-Miotto, Tina
Boden, Scott
Bose, Jayakumar
Boss, Paul Kenneth
Boutsalis, Peter
Bowring, Frederick
Brewer, Philip
Brien, Chris
Bruning, Brooke
Brunton, David John
Buhl, Jerome
Bulone, Vincent
Burton, Rachel
Byrt, Caitlin
Cao, Shifeng
Capone, Dimitra Liacopoulos
Cargill, Margaret
Carragher, John
Cavagnaro, Timothy
Cedamon, Edwin
Chalmers, Kenneth
Churchman, Gordon
Coad, Bryan
Collins, Cassandra
Collins, Helen
Collins, Nicholas
Cook, Amanda Anne
Coqui da Silva, Rodrigo
Cossani, Mariano
Coventry, David
Coventry, Stewart
Cozzolino, Daniel
Crisp, Peter
Croxford, Adam
Cu, Suong
Culbert, Julie
Daly, Jamee
Danner, Lukas
Davey, Rowena
David, Rakesh
Davidson, Jennifer Anne
Davies, Kerrie
Davies, Philip
De Bei, Roberta
Degryse, Fien
Delaporte, Kate
Denton, Matthew
Derkx, Adinda
Deveney, Marty
Dockerill, Jacinta Caitlin
Dolman, Fleur
Doolette, Ashlea
Dowling, Alyce Hayes
Dry, Peter
Dundas, Ian
Edwards, Petra Tamar
Esteves Leghi Voyer, Gabriela
Evans, Marg
Farquharson,E lizabeth
Ferrante, Ariel
Fincher, Geoffrey
Fisk, Ian
Fleet, Benjamin
Ford, Christopher
Ford, Melanie
Fox, Rebecca
Franco Garcia, Alex
Fruzangohar, Mario
Fung, Elisabeth
Garcia, Melissa
Gardner, Jennifer
Garnett, Trevor
Garrard, Tara
Gautam, Deepak
Genc, Yusuf
Giblot Ducray, Daniele
Gibson, Robert
Gill, Gurjeet
Gilliham, Matthew
Glatz, Richard
Gogel, Beverley
Gong, Xue
Gontar, Blake Matthew
Grant, Cameron
Grbin, Paul
Greenwood, Emma Catharine
Groom, Scott
Habili, Nuredin
Haefele, Stephan
Hanold, Dagmar
Hayes, Julie
Hayman, Peter
Henderson, Sam
Henschke, Paul
Herderich, Markus
Hettiarachchi, Ganga
Hill, Kelly
Hogendoorn, Katja
Hranilovic, Ana
Hrmova, Maria
Hsieh, Yves
Huang, Chunyuan
Huang, Shan
Hume, Ruby Zelda
Humphries, Alan
Islam, A
Ismail, Ismail Ahmed
Iwasaki, Jay
Janik, Les Joseph
Jansz, Jackson Wallis
Jarrett, Richard
Jefferies, Stephen
Jeffery, David
Jenner, Colin
Jewell, Nathaniel
Jiranek, Vladimir
Johnson, Trent
Jolley, Jessica
Jones, Graham
Kabiri, Shervin
Kaiser, Brent
Kalenahalli, Yogendra
Kang, Wenyu
Keller, Michael
Kelly, Jennifer Margaret
Kesser, Merek Marie
Khani, Mohsen
Khoo, Kelvin
Kimber, Rohan Benjamin Essex

Kleeman, David
Knight, Emma Rae
Koltunow,Anna
Kookana, Rai
Koopman, Darren
Kovalchuk, Nataliya
Kravchuk, Olena
Krishnan, Mahima
Kuchel, Haydn
Kustos, Marcell
Kwiatkowski, Maria Jolanta
Lake,Lachlan
Langridge, Peter
Langridge-Reimold, Ursula
Lanyon, Sasha Renee
Leigh, Roger
Leijs, Remko
Levin, Kara Ann
Li, Gang
Li, Yongle
Lines, Thomas Edward Parkin
Linsell, Katherine
Little, Alan
Liu, Haipei
Liu, Huajian
Long, Yu
Longbottom, Mardi
Lyons, Graham
Macdonald, Lynne
Malone, Jenna
Mao, Dili
March, Timothy
Mares,Daryl
Markovic, Marijana
Maronich, Andrew
Marschner, Petra
Mason, Sean
Mather, Diane
Matthews, Stuart
Mayo, Gwenda
Mc Kay, Alan Craig
McBeath, Therese
McDonald, Glenn
McGaughey, Samantha
McLaughlin, Michael
McLean, Hylton
McNamara, Imogen Hayley
McNeill, Ann
McQuillan, Maximilian Dirk
Meinecke, Helli
Melino, Vanessa
Merriam, Alicia Blyth
Michelmore, Simon Frederick
Mortimer, Jenny
Muhlack, Richard
Muhlhausler, Beverly
Muirhead, Katherine
Navarro, Divina Angela
Nayar, Sasi
Nielsen, Sharon
Nuberg, Ian
O'Brien, Patrick Vaughan
Oakey, Helena
Okada, Takashi
Okamoto, Mamoru
Oliver, Stephen
Ophel-Keller, Kathy
Ouyang, Jingyun
Pagay, Vinay
Pahl, Stephen
Paull, Jeffrey
Pearson,Allison
Peirce, Courtney Anna Emelia
Penfold, Chris
Perry, Kym David
Peter, Josephine Jasmine
Petrie, Paul Robert
Petrovic, Tijana
Philp, Joshua
Philpot, Amanda Grace
Phogat, Vinod
Pitt, Tim
Plett, Darren
Porker, Kenton Dean
Potumarthi, Ravichandra
Preston, Christopher
Puglisi, Carolyn
Qiu, Jiaen
Qu, Yue
Ramesh, Sunita
Randles, John
Rengasamy, Pichu
Rettke, Michael
Ristic, Renata
Roche, Nathan
Roy, Stuart
Ruggiero, Kathy
Ryder, Maarten
Sadras, Victor
Salomon, Matthias Johannes
Sarpeleh, Abolfazl
Schilling, Rhiannon Kate
Schultz, Carolyn
Schwerdt, Julian
Scott, Eileen
Seger, Andreas
Shelden, Megan
Shi, Bu-jun
Shirley, Neil
Singh, Rohan
Smernik, Ronald
Smith, Andrew
Smith, Sally
Sosnowski, Mark
Stewart, Sue
Stiglingh, Andrea Donne
Stirling, Erinne
Stockley, Creina
Sumby, Krista
Summers, David McCulloch
Sundstrom, Joanna
Sutton, Timothy
Swinbourne, Alyce Maree Farraday
Sznajder, Beata
Tavakkoli, Ehsan
Taylor, Julian
Terry, Robyn
Tester, Mark
Thomas, Dane
Timmins, Andy
Todd, Cathryn
Torok, Valeria
Tricker, Penny
Trueman, Austin Myles
Tucker, Matthew
Tyerman, Stephen
Unkovich, Murray
Van Helden, Maarten
Vandeleur, Rebecca
Vassos, Elysia
Verbyla, Arunas
Walker, Michelle
Wallwork, Hugh
Wassie, Molla Mesele
Watson, Tommaso
Watson-Haigh, Nathan
Watts-Williams, Stephanie
Waugh, Robbie
Wege, Stefanie
Whitford, Ryan
Wilhelm, Nigel Shane
Wilkinson, Kerry
Wirthensohn, Michelle
Wood, Katie
Xu, Bo
Yang, Xiujuan
Yazdani, Maryam
Zerner, Michael
Zhang, Dabing
Zhang, Jin
Zhou, Jia
Zhou, Jo
Zhou, Yi
Zhu, Ying
Zhu, Yongguan
Zwer, Pamela

Appendix 2

FINANCIAL STATEMENT 2020

EXPENDITURE	
WRI AREAS OF ACTIVITY	
Research with impact	$487,116
Building large-scale initiatives	$138,460
Researcher development	$26,776
Connecting with industry	$8,265
Sub total	**$636,517**
Staffing and Administration	$303,927
TOTAL SPEND IN 2020	**$940,444**

INCOME (TO MEMBERS OF THE WRI)	
Category 1	$18,509,789
Category 2	$2,911,142
Category 3	$4,132,493
Category 4	$687,734
Other (NCRIS)	$3,257,832
TOTAL IN 2020	**$29,498,991**

Appendix 3

PUBLICATIONS IN 2020

01
BOOK

08
BOOK CHAPTERS

561
JOURNAL ARTICLES

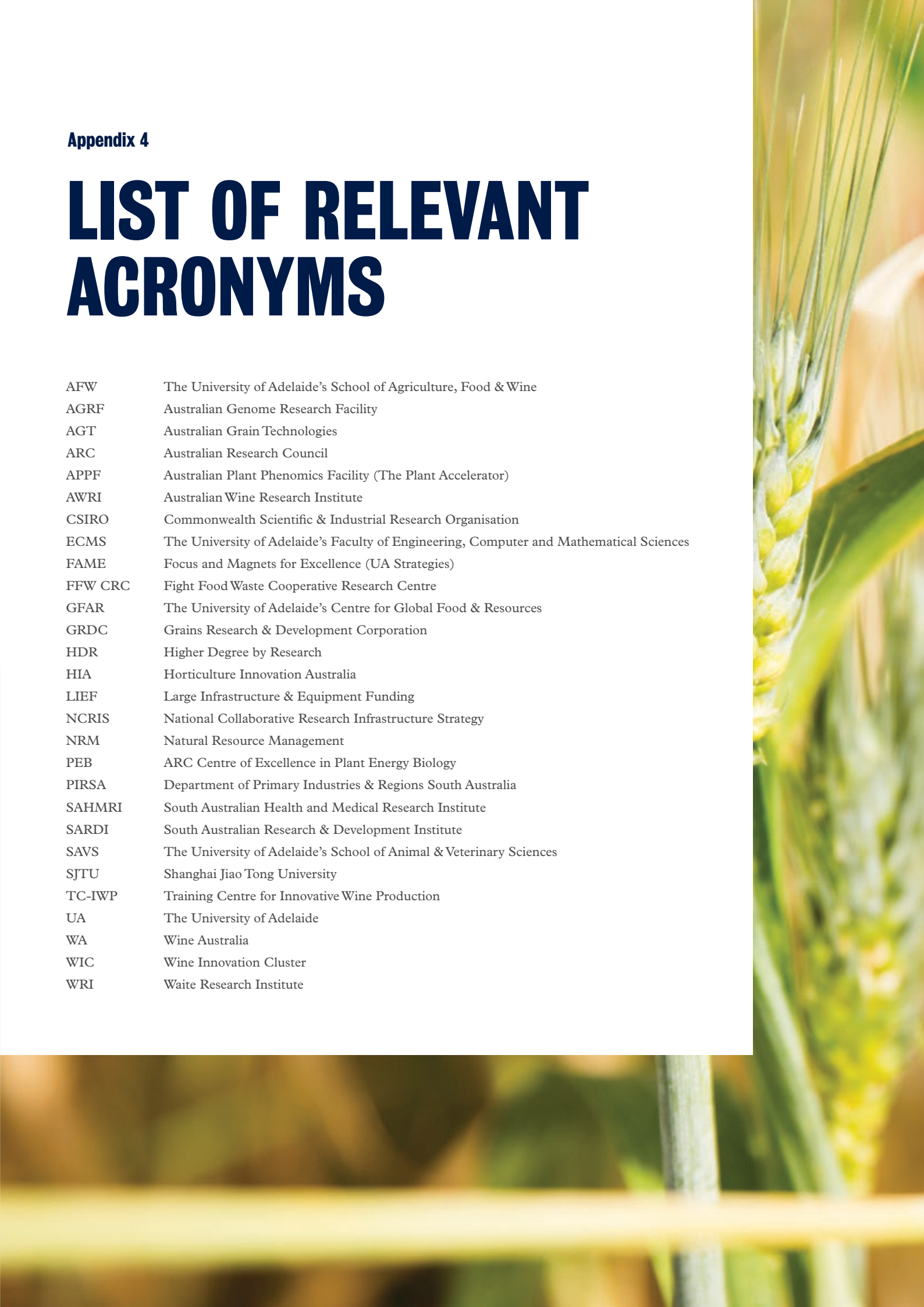
15
CONFERENCE PAPERS

To view or download the full list of WRI publications from the 2020 calendar year, go to www.adelaide.edu.au/waite-research-institute/about#publications

Appendix 4

LIST OF RELEVANT ACRONYMS

AFW	The University of Adelaide's School of Agriculture, Food & Wine
AGRF	Australian Genome Research Facility
AGT	Australian Grain Technologies
ARC	Australian Research Council
APPF	Australian Plant Phenomics Facility (The Plant Accelerator)
AWRI	Australian Wine Research Institute
CSIRO	Commonwealth Scientific & Industrial Research Organisation
ECMS	The University of Adelaide's Faculty of Engineering, Computer and Mathematical Sciences
FAME	Focus and Magnets for Excellence (UA Strategies)
FFW CRC	Fight Food Waste Cooperative Research Centre
GFAR	The University of Adelaide's Centre for Global Food & Resources
GRDC	Grains Research & Development Corporation
HDR	Higher Degree by Research
HIA	Horticulture Innovation Australia
LIEF	Large Infrastructure & Equipment Funding
NCRIS	National Collaborative Research Infrastructure Strategy
NRM	Natural Resource Management
PEB	ARC Centre of Excellence in Plant Energy Biology
PIRSA	Department of Primary Industries & Regions South Australia
SAHMRI	South Australian Health and Medical Research Institute
SARDI	South Australian Research & Development Institute
SAVS	The University of Adelaide's School of Animal & Veterinary Sciences
SJTU	Shanghai Jiao Tong University
TC-IWP	Training Centre for Innovative Wine Production
UA	The University of Adelaide
WA	Wine Australia
WIC	Wine Innovation Cluster
WRI	Waite Research Institute



KAURNA ACKNOWLEDGEMENT

We acknowledge and pay our respects to the Kaurna people, the original custodians of the Adelaide Plains and the land on which the University of Adelaide's campuses at North Terrace, Waite, and Roseworthy are built. We acknowledge the deep feelings of attachment and relationship of the Kaurna people to country and we respect and value their past, present and ongoing connection to the land and cultural beliefs. The University continues to develop respectful and reciprocal relationships with all Indigenous peoples in Australia, and with other Indigenous peoples throughout the world.

FOR FURTHER ENQUIRIES

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