Sydney Institute of Agriculture

Georgika

Image courtesy of Amanda Nash, taken at Nowley Farm

Edition 6, November 2021

Georgika

Georgika - an online newsletter for those interested in academic aspects of the Ag sector

From the Director

Brent Kaiser

Welcome to our last edition of Georgika for 2021.

In this edition we introduce you to five new Theme Leaders: Cameron Clark (Animal Agriculture), Federico Maggi (Carbon, Water and Soil), Tom Roberts (Quality Food) and Daniel Tan (Development Agriculture), who join Tom Bishop (Digital Agriculture) and Floris van Ogtrop (Urban Agriculture). Our thanks go to our outgoing Theme Leaders Yani Garcia, David Guest, Robin McConchie and Budiman Minansy for their support over the past 3.5 years.

We hope you will join us for our annual Research Showcase on ***Tuesday 30 November,*** held online via Zoom Webinar. This year's theme is Digital Agriculture - Driving a $100 Billion Ag Industry by 2030. Full details are provided below.

Australia's imminent push or pledge towards net zero greenhouse gas emissions by 2050 is a bold and exciting ask considering our historical governmental hesitancy, and the overreaching conflict with the base idea. It is encouraging that the conversation is now at the forefront of forward policy decisions across all political divides, leading to an exploration into the technologies and changed practices that the entire community will need to commit to meeting a net zero emissions environment. From an agricultural and forestry context, our collective contribution to net greenhouse gas emissions for Australia range between 13 and 18%. This is a significant footprint that is ultimately and intimately linked to the very food we eat daily, and the fibre we use for clothing and shelter. Managing this contribution will be a community wide responsibility as the benefits of a healthy agricultural industry remain paramount to our high standards of living and prosperity as a nation.

I believe it is important that agricultural industries (plant and animal), governments, and the community take on this challenge to be part of a collective solution to achieve net zero emissions. Innovation and scientific discovery have been the hallmark in the successful expansion and delivery of agriculture for over a century. This must continue, but be increasingly focussed on emission mitigation strategies (direct, indirect) that enable the continuation of food and fibre production in Australia. All agricultural industries and associated secondary industries need to be involved. By 2050, ~289 million tonnes of protein will be required to feed an expanding global population, this is roughly 40% more protein than we currently produce on the planet today (plant and animal combined). Agriculture will need to deliver this protein but hopefully with a technology latitude that ensures increased sustainability and resourcefulness is met within a net zero gas emission allowance. The Sydney Institute of Agriculture will continue to lead and direct research into emission abatement at all levels of primary production, but also across the supply chain as foods and fibres reach the consumer. There are exciting opportunities for agricultural research and development (soil, plant, animal, economics and engineering) at the Sydney Institute of Agriculture.

Image courtesy of Dr William Salter

Annual Research Showcase - Digital Agriculture

Free Webinar
9am to 3pm
Tuesday 30 November

Digital Agriculture - Driving a $100 Billion Ag Industry by 2030

Digital Agriculture focuses on the knowledge underpinning, and research required, to deliver a functioning digitally-enabled production and supply chain for agricultural food and fibre. The global mission over the next 10 years and beyond is to produce increased amounts of food and fibre more efficiently, in terms of the use of water, nutrients and physical inputs into the production process. Digital agriculture presents a novel method to meet this global challenge. It is an approach that brings to bear the power of digital and information technologies to the business of agriculture with great potential for success. The introduction of digital agriculture is predicted to have an enormous impact to our economy, including an increase in the gross value of production across the Australia agricultural sector by 25%, and in some parts such as the grains industry, the increase is estimated to be as high as 51%. These figures ignore the enormous social and economic benefits that digital agriculture technologies can bring through embedding provenance, traceability and customer feedback in the supply chain of commodities such as wheat. The Digital Agriculture theme within SIA brings together researchers across the university with expertise and skills to realise these new opportunities.

The Sydney Institute of Agriculture welcomes your attendance at our annual Research Symposium series. This year we highlight the advances in Digital Agriculture at the University of Sydney and across Australia. The Showcase will include the following topic sessions:

1. On-Farm Digital Sensing and Analytics
2. On-Farm Digital Decision-Support Tools
3. Digital Supply Chains

Register below to receive the Zoom link.

View the full program and register here

Theme Leader Updates

Plant Breeding and Production

Richard Trethowan

Faba beans

Faba bean is the second most important grain legume after chickpea in the sub-tropical grain growing region of Australia. The University of Sydney has been breeding faba bean varieties from Narrabri based campus for this region since 2010 and Kedar Adhikari leads the breeding program. Kedar is pictured centre below with team members Abdus Sadeque and Emma Whitton.

Developing high yielding and disease resistance varieties with superior seed quality is a continuous process. In this endeavour, a new faba bean variety, FBA Ayla, has been released this spring to provide a better faba bean variety to growers in this region. This is the fourth faba bean variety released by the University of Sydney and almost 100% of area under faba bean in the northern region is occupied by these varieties.

FBA Ayla is a high yielding variety across all faba bean growing areas of northern NSW and southern Queensland. It has out-yielded current faba bean varieties by at least 4–5% in the last five years. Faba bean rust is a major disease in this region and FBA Ayla has similar level of rust resistance to the current variety PBA Nanu which has slightly better rust resistance than the earlier released varieties. It is moderately resistant to bean leaf roll virus, another important disease in the northern region. Its uniform and superior seed size over PBA Warda will make it readily acceptable for marketing, while smaller seed than PBA Nasma will improve handling at seeding. FBA Ayla is suggested as a replacement for PBA Warda and PBA Nasma for northern New South Wales and southern Queensland. There is no extra care needed for growing this variety as its agronomic package is similar to growing other faba bean varieties. Growers can expect higher yield from this variety without compromising any disease resistance and seed quality.
You can find more information about the variety by clicking here

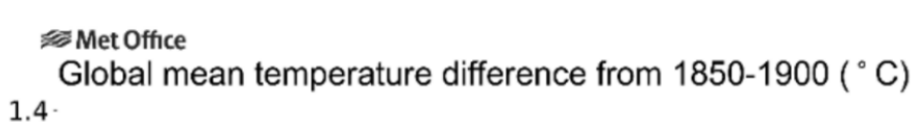
Read further about Plant Breeding and Production

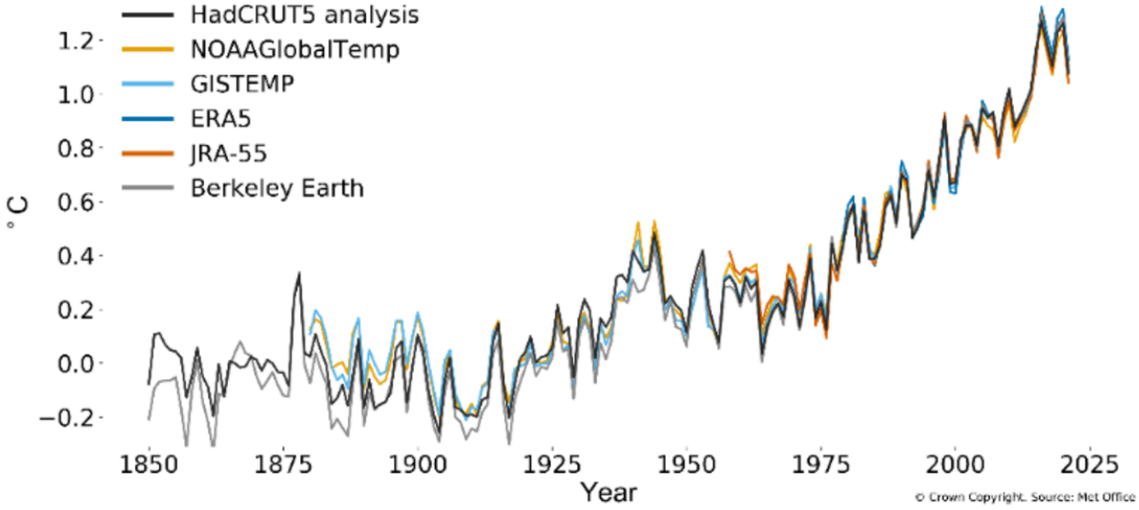
Carbon, Water and Soil

Federico Maggi

My first Theme update cannot overlook what has happened this year - the release of the 2021 IPCC report in August and the COP26 meeting in Glasgow the past weeks. There is no doubt that climate change is happening and there is no doubt that this is happening because of mankind. In the spot of the IPCC is the frightening picture that climatic changes are accelerating like never before - WMO reports the past 7 years are the 7 warmest on record - and that it is unlikely the global temperature will settle to targets agreed in earlier UN meetings if greenhouse gas emissions continue. At the COP26, UN member countries have agreed to reduce the use of coal. They indicate that methane emissions, and not only carbon dioxide, should substantially be reduced, but I add that other greenhouse gases like nitrous oxide should be on the spot as well. All these are big challenges, perhaps the “true” big scientific challenges of this century. All touch in a way or another SIA’s Themes, not just CWS, and is my belief that all of us could contribute fundamental research in this big challenge.

In relation to the above, plants have the capability to literally pump carbon into soil and manage water for their best benefit. Would that be a way to remove carbon dioxide from the atmosphere? See what recent work by Feike Dijkstra unravels.



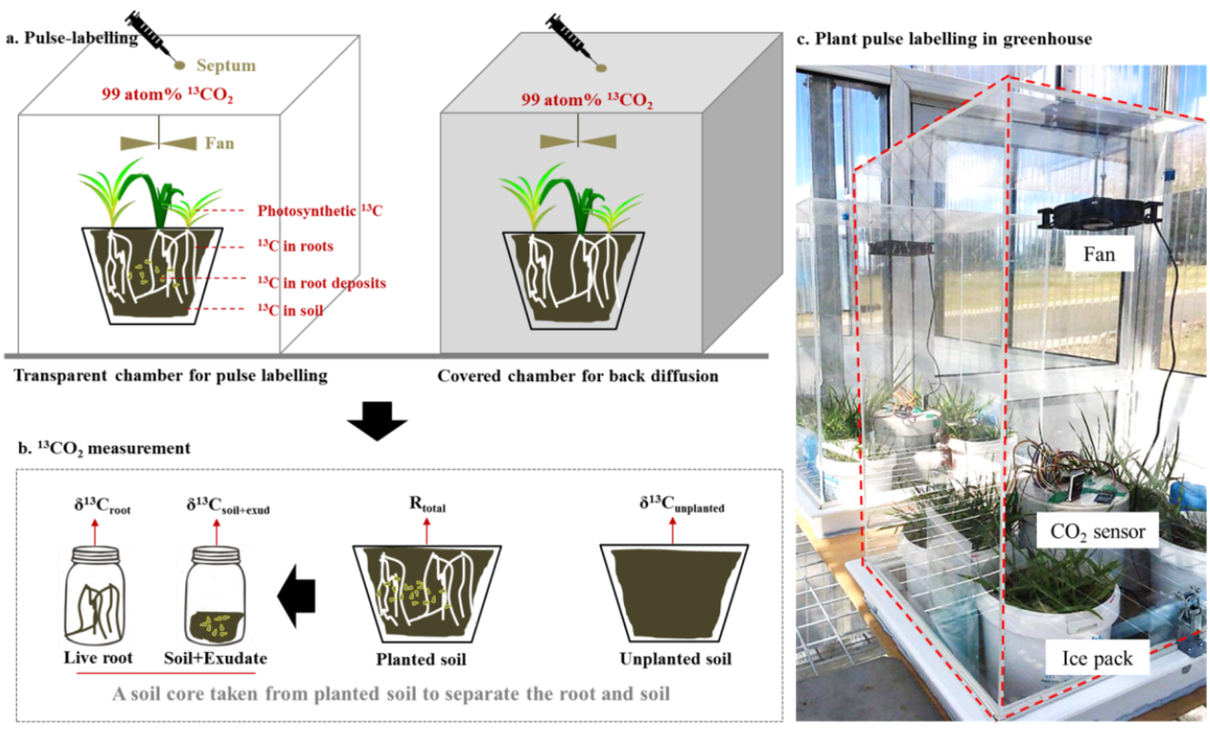


What are the carbon costs for plants to take up nutrients and water? Feike Dijkstra

How much carbon do plants allocate below ground to take up nutrients and water? While simple and important, there is surprisingly little known about this question. The efficiency of below-ground carbon allocation for nutrients and water will likely have large consequences for the productivity and competitiveness of individual plant species and communities in natural and agricultural ecosystems.

Using a novel 13C-CO2 labelling method, visiting scholar Ruzhen Wang, and SIA researchers Bahareh Bicharanloo, Milad Shirvan, Claudia Keitel, and Feike Dijkstra found that up to 31% of carbon allocated below ground goes towards root exudates (or rhizodeposition)1. Root exudates may help the plant with getting more nutrients, but plants may also allocate carbon to support fungi that form symbiotic relationships with plants (mycorrhiza). These same investigators showed that carbon allocation towards root exudation and mycorrhiza are particularly important for nutrient and water uptake under drought conditions2, and that further depend on whether plants form associations with arbuscular or ecto-mycorrhiza3.

This research was supported by the ARC Discovery project: “What are the carbon costs for plants to take up nutrients and water?”



Read further about Carbon, Water and Soil

Digital Agriculture

Tom Bishop

How well are we preparing our graduates for research in Digital Agriculture?

At the recent virtual eResearch conference a report called Advancing Data-Intensive Research in Australia was released.

While it is broader than Agriculture it is a very good summary of many issues of interest to our community such as making data FAIR, the rise of the data scientist, research compute and training. It made me reflect on how our undergraduate Agriculture curriculum has changed over the past decade to reflect this new world. A decade ago students could only do spatial science and remote sensing as electives, and the statistics they learnt was with menu-driven commercial software, and was steeped in classical Biometry based around experimental design.

Today, students start to interact with spatial data as part of first year agriculture units, and in senior units they start to use cloud computing through Google Earth Engine to analyse spatial data. The statistics training still covers the basics of classical Biometry but the end point is machine learning and predictive modelling, rather than more complex experimental designs. It is also taught in the R ecosystem so all students graduate with skills in scripting. Importantly, there has been a shift away from commercial to free and open source software, meaning they can use the same software used at university no matter where they work in the future. On a personal level I can see that starting PhD students from this curriculum are much better prepared for research in Digital Agriculture compared to those of a decade ago, who had to spend much of their first year gaining these foundational skills.

AgReFed and an Australian Research Data Commons Platform Project

The University of Sydney recently joined AgReFed which is short for Agriculture Research Federation which was originally formed to create a community to make agricultural research data more FAIR (findable, accessible, interoperable and resuseable). Further details can be found at https://www.agrefed.org.au/.

Its next evolution is development of a platform to allow sharing of data analytical pipelines for processing and analysis of agricultural data. This work is being funded by a 3 year Australian Research Data Commons Platforms Project and the first stage of the University of Sydney's involvement will be to create analysis pipelines to running machine learning models while accounting for measurement error. The use case here will be soil carbon observations which can be taken in the field with spectroscopy which has higher errors than a laboratory measurement. Any estimate of soil carbon change needs to account for this measurement error.

Another part of the project will be to use a soil survey of L'lara and take this dataset from its current location on institutional data stores to make it FAIR. This is important work as it can showcase the datasets we have generated on our university farms but also helps ourselves by having such datasets being documented for future generations of researchers. Hopefully the learnings from this process will lead to a collective effort to make more of our research data FAIR.

We hope you can join us online for our Research Showcase - Digital Agriculture on Tuesday 30 November (details above).

Read further about Digital Agriculture

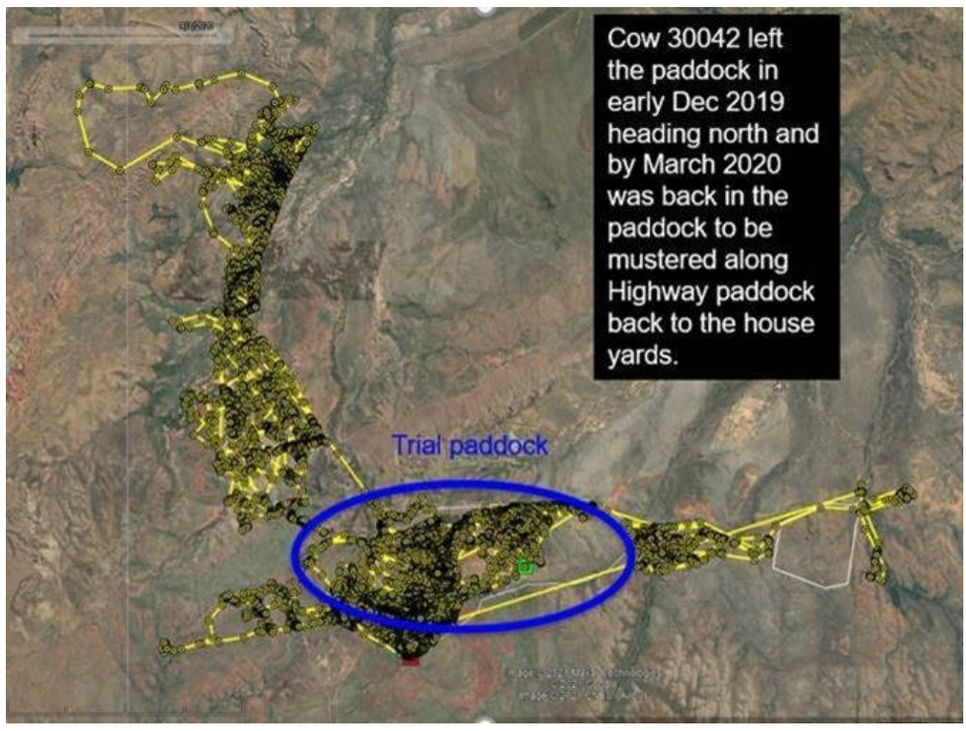
Animal Agriculture

Cameron Clark

Understanding and predicting cattle and sheep survival in commercial conditions

An MLA Donor Company project working with sheep and beef cattle producers has been collecting unique information using remote monitoring tools for live weight, behaviour, satellite-connected birthing alert devices, weather, satellite and drone imagery, and yard-collected information to determine factors affecting the survival of animals under commercial conditions. Remote weighing provides information on changes in live weight as affected by weather, nutritional status, lactation, and birthing events. An impressive network of committed sheep and cattle producers collaborate with researchers in SIA to collect data in the Northern Territory and the central west region of New South Wales.

Collared cows from the NT trial site



Movement of one trial animal at NT site

At the Northern Territory site where Christie Pearson is based, technologies used on site include GPS collars, birth alert sensors and GPS ear tags. These have shown the large distance that individual animals roam, despite being placed in paddocks after mustering times.

This sort of information has not been collected under these conditions previously and sheds a lot of light on the challenges which face the industry especially in regard to animal traceability. The implementation of herd level GPS ear tags is one way we can monitor the whereabouts of individuals in near-real-time. Towers placed in strategic places within the paddock enable ear tag communication with LoRa and cellular connectivity.

Two papers from the beef side of the project can be found: remotesensing-1023963; remotesensing-1361873

Sheep using the walk over weigh station at trial sites in NSW and lambs in one of the trial paddocks

The sheep side of the project, run by Greg Sawyer, has locations in Dubbo, Parkes, Tullamore, Cudal, Armatree and Peak Hill with 3 predominate sheep breeds -- Merino (poll and horn), poll dorset and border leicester. EID's are fitted to the animals prior to entering the trial sites and lambs born are also fitted with an EID. As each animal walks through the walk over weigh station for water, mineral supplement, or feedstuffs its body weight is recorded and remotely sent from the location to the University of Sydney database. The information provided is allowing researchers a unique understanding into the ewes' behaviour and body weight throughout pregnancy and lactation. Outcomes that have been achieved so far include pedigree association, lactation curve changes for single and twin bearing ewes, body weight and age assessment, year on year assessment of the same ewes, and 3 various structural designs of the walk over weigh station.

Read further about Animal Agriculture

Development Agriculture

Daniel Tan

Demonstration of agricultural drone and machine planters for rice

Background: The ACIAR project CSE/2015/044 "Sustainable intensification and diversification in lowland rice systems in North-West Cambodia" led by Daniel Tan, hosted a demonstration of spray drone technology and machine planters for rice at Don Bosco Agro Technical School, Battambang, Cambodia on 22 September 2021.

The project which commenced on 1 November 2016 and terminated on 31 October 2021 has had a particular focus on mechanised planting of rice under dry and wet seeding conditions and during 2021, the use of spray drones to apply pre-emergence herbicide in row-seeded rice.

The demonstration was attended by approximately 26 people, including the Australian Ambassador to Cambodia, H.E. Pablo Kang. Apparently, this is the first time the Ambassador has been able to visit outside the capital, Phnom Penh in seven months due to the COVID-19 pandemic. The Ambassador made special mention of the impressive collaboration achieved by CamSID (ACIAR) with Cambodian Agricultural Value Chain Program (CAVAC), Brooklyn Bridge to Cambodia (BB2C) and the private sector for research and development on agricultural mechanisation.

The Event also enabled us to connect with Mr Shahroz Jalil the new team leader of CAVAC. Shahroz is from Bangladesh and has a keen interest in the work CamSID has been conducting on mechanised drill seeding of rice. CAVAC also contributed significantly to setting up for the Event by organizing the marquee.

Read further about Development Agriculture

Urban Agriculture

Floris Van Ogtrop

Recently Karina Wong, supervised by Brian Jones, Daniel Tan, Ali Khoddami and Floris van Ogtrop, completed her honours project which explored growing different purslane varieties in a deep-water culture system under different light intensities, exposure times and frequencies and different nutrient mixes. Purslane can be added to salads and more and is high in vitamins and omega 3 fatty acids. However, it is also high in oxalic acid, which can cause an upset stomach. Blanching will reduce break down oxalic acid, but it would be nice to throw in fresh. While Covid19 played havoc with her ability to complete her experiments, Karina discovered links between different light intensities and exposure times and oxalic acid content, where lower intensity and exposure times decreased oxalic acid content and yield. So, it appears it is a bit of a balancing act between reducing oxalic acid and increasing yield. This balancing act is similar for nitrate where decreased nitrate also decreases oxalic acid content and decreases yield. There is much much more to be done, so watch this space.

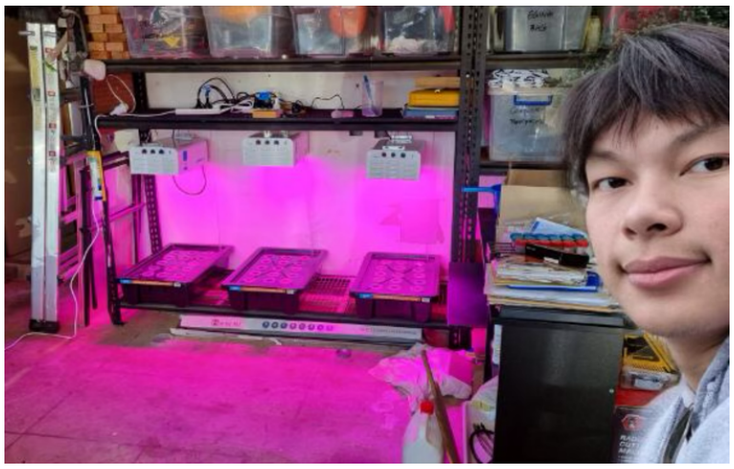
Karina Wong (Honours student in Urban Agriculture) and Tom

Purslane growing in a deep-water culture

Shaw (former student now working at Invertigro

system under broad spectrumstrip lighting at Invertigro

Also close to finishing his honours project is Oscar Wang who has been looking at “organic” fertilisers for use in hydroponic systems that have been derived from fermented food scraps, and fertilisers developed from fish waste fed by organic veggies. I will provide a summary of his findings in the next edition. Currently we have Abby Hill working on developing a life cycle analysis for the protected cropping industry (aka controlled environment agriculture) and we potentially have two new recruits, Arushi who will look at biofortification in Purslane and other species together with Claudia Keitel and Floris van Ogtrop and Tyler who will look at rapid detection of plant pathogens in protected cropping systems together with David Guest, Kelly Scarlett and Jimmy Botella (UQ) and Floris van Ogtrop.



Oscar Wang with his deep-water culture systems that he set up at home tobe able to continue his work during the lockdown

Recently I have seen an explosion of Mushroom Mad enthusiasts growing mushrooms in and around their houses, some in impressive set ups. Similarly, several start-ups I am working with in the urban ag space are keen to explore growing mushrooms on the organic waste they produce and so add to the circularity of their systems.

Our mushroom expert Michael Kertesz to tell us why mushrooms are so popular.

Traditionally, mushroom cultivation as part of “urban agriculture” involved growing mushrooms in the dark, damp cellar of a house, with high humidity and the temperature controlled by the underground location. These days, there has been an upsurge in small companies growing mushrooms, often in locations such as converted shipping containers or warehouse spaces where air-conditioning can provide the necessary climate control. This has become somewhat of a “trend” industry, focussing on popular “exotic” mushrooms such as oyster mushrooms, enoki or shiitake. These are commonly grown on agricultural wastes such as sawdust, paper waste or straw, but urban wastes such as coffee grounds are increasingly also used. Urban mushroom cultivation is the ultimate form of recycling, turning a locally sourced waste product into a nutritious and healthy food source.

As part of our research, we are growing oyster mushrooms on our Mushroom Research Unit on Darlington Campus using spent coffee grounds from local cafes and coffee processing waste (silverskin or chaff) from the roasters on City Road, and combining this with locally sourced sawdust. The resulting mushrooms taste great, but they only contain low levels of caffeine - they won’t replace your morning coffee! We are also collaborating with Architecture and Design to grow reishi, turkeytail and yellow oyster mushrooms as a source of biocompatible solids – reishi, for example, is used to produce mushroom leather for high-end vegan leathergoods, while pressed slabs of oyster mushroom mycelium have been used overseas as insulation and building products.

Small scale urban mushroom cultivation has been explored widely in the developing world as a means to provide additional earning capacity and food for family units, especially in low-income areas. This has potential for application in Australia as well, with a central source supplying colonized substrate, and the mushrooms providing income via local markets. Fresh exotic mushrooms still have rarity value in Australia, since they make up <5% of the overall mushroom market - so they command higher prices than the button mushrooms we are all more used to.

Read more about mushrooms in our Quality Food update from Tom Roberts below.

Read further about Urban Agriculture

Quality Food

Tom Roberts

Radical innovation has the potential to change the world of food. Four key food innovations happening now are:
* cell culturing of meat, poultry and fish
* 3-D printing of plant-based meat alternatives
* gene editing; and
* developing and scaling up of ancient/native/obscure species of microbes (e.g., bacteria, microalgae), plants (e.g., native grains) and animals (e.g., insects) to boost food production, productivity and profitability, and lower its carbon footprint

The rapid rise of cell culturing to produce meat, poultry and fish foods has been made possible because of the decades of work on cell culturing for medical research (e.g., on cancer). Massive investment is being poured into start-up companies in this space. Prominent examples are BlueNalu in the U.S., and Future Meat in Israel, but companies are also making it happen in Australia, including Vow.

3-D printing allows plant-based production of foods that have the texture, bite and release of flavours as exemplified in meat, as well as imparting juiciness and desired mouthfeel. Redefine Meat in Israel is leading the world in the 3-D printing of analogue cuts of meat, but Australian companies could catch up via collaboration with engineers and scientists in the SIA.

The first commercial food product made using gene editing has been around since 2019. TALEN-based manipulation of soybean was used to create a high-oleic line that prevents the production of trans fats. Russia is investing billions into CRISPR-based genome editing of 30 crop and livestock species for commercialisation by 2030. Perhaps Australia should be doing the same, and our plant and animal scientists in the SIA are perfectly positioned to contribute to this research.

Developing and scaling up of ancient/native/obscure species to enhance food production and make it more environmentally friendly is a strategy perfectly suited to the SIA given Australia's wonderful native biota, indigenous heritage and the support in the University for interactions with first nation's peoples. The Indigenous Grasslands for Grain program led by Angela Pattison (based at the University's IA Watson Centre in Narrabri) is a good example of an initiative that has the potential to increase the resilience of agriculture and food production in Australia, as well as provide social benefits for indigenous communities.

Michael Kertesz is a molecular microbial ecologist whose main research focus in recent years has been on the microbial ecology of mushroom compost. He has a long-standing interest in microbial sulfur and phosphorus metabolism in agricultural soils, with a particular interest in identifying and characterising the specific bacteria that are key in mobilising these elements for plant nutrition and the genes responsible for these processes. Because composting is a microbial process, understanding the microbial communities and activities in much compost is essential for high-yielding, high-quality mushroom crops. Michael and his team, including PhD student Meghann Thai, have uncovered literally thousands of bacterial species in mushroom compost that previously were unknown. They are currently scanning these in a multiyear project with composting yards all over Australia to identify compost quality biomarkers that can be used to forecast mushroom crop yield and quality. They have established a nitrogen balance for mushroom composting for the first time and are currently investigating alternative nitrogen sources for mushroom growers to replace or supplement poultry manure (currently the main N input). Clearly, the microbial activities are key in this process.

This year Michael has also started a new project on compost viruses, isolating several bacteriophage suspected to play an important role in nutrient cycling within the compost. Most of the work is on button mushrooms, but his team also grow some exotic mushrooms (oyster, reishi, turkeytail) in the dedicated the dedicated Marsh-Lawson Mushroom Research Unit on Darlington campus. This work is supported by three major grants from the Australian Mushroom Industry/ Hort Innovation, and because of Michael's expertise he is now also a member of the Australian industry's strategic investment panel (though naturally he has to leave when his own work is discussed!).

Tanya Latty and her research group are investigating the potential use of insects as bioconverters to turn various waste streams into useable products such as livestock feed, biodiesel and fertilisers. Black soldier fly (Hermetia illucens) is the most well-studied bioconversion insect. Adult black soldier flies are large dark coloured flies with a distinctly wasp-like body shape. Despite their intimidating appearance, the adults are entirely harmless. They rarely feed and do not generally become pests. Black soldier fly larvae are voracious feeders and can consume a wide range of wastes including faeces and food scraps.

In a recent publication, former honours student Lily Logan (now working at Vow), Tom Roberts, and Tanya Latty found that while black soldier fly larvae had poor survivorship when fed 100% chicken faeces, mixing faeces with small amounts of other poultry waste streams (eggs, meat) ameliorated the negative impacts of faeces and allowed the larvae to convert waste into high protein biomass. They suggest that black soldier fly could be a useful tool for reducing poultry waste while creating a potential food source for livestock.

In another study, Tanya Latty collaborated with Claudia Keitel and former honours student Stephanie MacKillop to investigate a new bioconversion species, the Australian garden soldier fly (Exaireta spinigera). Unlike black soldier fly, the garden soldier fly is native to Australia. They found that the garden soldier fly was an effective bioconverter of food scraps quickly turning them into high protein larval biomass. Moreover, garden soldier fly larvae were able to maintain high bioconversionperformance even at colder temperatures. This is significant as the black soldier fly is a tropical species that needs relatively warm temperatures to achieve optimal bioconversion. They suggest that the garden soldier fly is a promising bioconversion agent particularly in cooler parts of Australia. Tanya cautions that while insect bioconversion offers an exciting solution to the twin problems of waste management and food production, there are a number of logistical and technical issues that need to be resolved. For example, what are the microbiological risks associated with waste-fed larvae? Can larval diets be tailored to achieve optimal nutritional composition for the targeted livestock species? And for the garden soldier fly, protocols for efficient mass breeding are needed. Global interest in insect bioconversion is growing rapidly so it's a great time to be working with these fascinating insects.

Tim Langrish and his team conduct engineering experiments and modelling of the gastro-intestinal tract. Working with David Fletcher and PhD student Xinying Liu (mathematical modelling), as well as PhD students Chao Zhong, Yongmei (Daisy) Sun and Shu Cheng (experimental studies), Tim studies the fluid mechanics, mass transfer and reaction engineering behaviours of the gastro-intestinal tract, mainly for in-vitro human studies.

Tim Langrish and his team are addressing several research aims, including distinguishing between physical and (bio)chemical problems in digestion, and improving in-vitro testing procedures for digestion studies. They bring engineering perspectives to this area, including the fields of fluid mechanics and mass transfer (areas of mainly chemical, civil and mechanical engineering that are collectively described as transport phenomena) with reaction engineering. An example of a computer-controlled section of an in-plastico intestine is shown in the photo below (from Chao Zhong), where a dye tracer is being used to follow the fluid flow patterns that are being compared with numerical simulations.

Image above: Dye tracer following fluid patterns (image credit: Chao Zhong)

University Farms

Nowley Farm

The E J Holtsbaum Agricultural Research Institute (also known as Nowley Farm) is a 2,083 hectare property combining cereal grain production and a cattle breeding and fattening enterprise. The property was gifted to the University by E. J. (Ted) Holtsbaum.

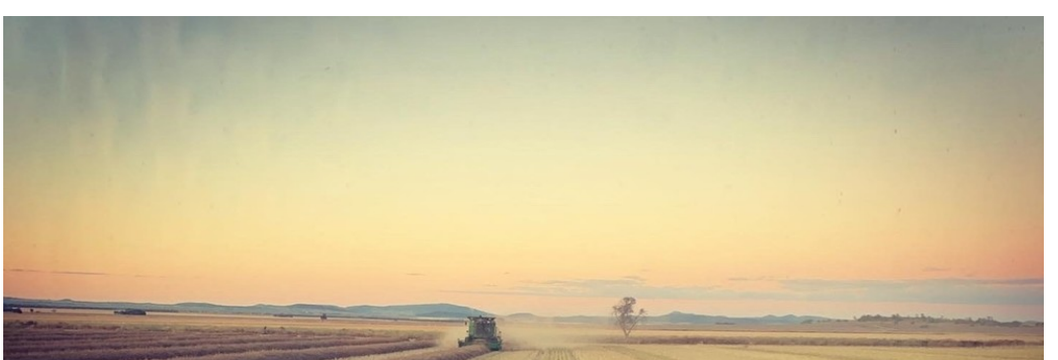
Nowley is located in the Liverpool plains area of NSW and is used for both animal (1,083 ha pastures) and plant production (1000 ha cropping) on a large scale. The dryland cropping area is one of the largest available to the University.

Amanda Nash is based at Nowley Farm and provided an update of recent activity on the farm:

We are currently harvesting our 260 hectares of canola, after a delay from all these rain events. Hopefully we will complete this over the weekend (if it doesn't rain) and go straight on to harvesting our lancer wheat, and then chickpeas. We have also recently planted our summer crops of cotton (185ha) and sorghum (235ha). Our cattle herd are busy raising their calves and are looking great.

Our opening image was taken by Amanda, as well as the stunning images below.

Enjoy more images from Nowley Farm by following their Instagram page. Thanks Amanda!



Social Media

The Sydney Institute of Agriculture is on Instagram (Sydney_Sia) and we are also on Twitter (Sydney Agriculture). Follow us at the links in the box below.

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