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GRDC

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Startups power industry advancement

GRDC's GrainInnovate venture capital fund is investing in agtech startups that are driving the future of the grains industry

By Tim Spencer

GRDC manager business development

■ From the introduction of transformative innovations in the late 19th century, such as the stump-jump plough and the self-propelled combine harvester, the Australian agricultural industry's legacy of innovation has been remarkable.

This imperative to continue innovating remains as important as ever, as the industry seeks to enhance crop productivity, adapt to shifting climate patterns, address sustainability concerns and navigate the evolving nature of the grains industry workforce.

For 31 years GRDC has supported Australian growers by investing in research, development and extension for growers' benefit, boosting profitability and sustainability.

In 2019, GRDC introduced an investment innovation partnering with Artesian Venture Partners, Australia's largest and most-active early stage venture capital firm, to form the GrainInnovate venture capital fund.

The success of the fund reflects the industry awareness of GRDC combined with the investment expertise of Artesian. Robert Williams, Artesian's director of agrifood, says: "The partnership between GRDC and Artesian is an example of a unique approach where institutional investment joins forces with industry to collaboratively identify key challenges faced by growers and to deploy capital into startups that are developing innovative and commercial solutions to these challenges.

"As the portfolio develops, GrainInnovate continues to scale the impact it is delivering for the benefit of growers and the industry as a whole."

PATIENT INVESTMENT

The GrainInnovate fund uses a one-off investment of $25 million, spread over five years, from GRDC with matching co-investment by Artesian.

Key criteria for GrainInnovate support of a company are the uniqueness of the technology it is developing, whether it fills a gap in the agtech marketplace that will directly benefit Australian grain growers, and the enterprise's risk profile. GrainInnovate is a minority investor, leveraging co-investment with reputable, knowledgeable, local and global funds.

The fund takes a patient approach, investing from seed to growth stage in agtech startups. Agtech development can require an annual cropping season to evaluate a prototype. This means that a longer-term investment timeline is required, together with staged investment as the agtech grows and achieves key milestones.

PORTFOLIO

To ensure the fund's overall success, a broad 'portfolio' approach has been taken, with investments across diverse fields in multiple businesses. To date 21 start-up companies – with interests ranging from farm connectivity to digital agriculture, weather risk management, biosecurity and field robots – have received investments ranging from $50,000 to $2.5 million.

A selection of these is showcased in this *GroundCover*™ Supplement: Verge Ag, SwarmFarm, DataFarming, Hillridge, Pairtree Intelligence, Farmlab, Zetifi, Bioscout, Laconik, LoamBio and ZoomAgri.

User case studies are paired with most of the start-ups, while a significant new GRDC investment, Frost and Heat Management Analytics (FAHMA), demonstrates how agtech startups and GRDC's traditional research partners can converge capabilities to help decision-making for growers dealing with climatic constraints.

The GrainInnovate investments bring new people with new capabilities, passion and purpose to the grains industry. Their innovations share a common focus on solving grower challenges with innovative technology. The new technology will power more-profitable, efficient operations – together with enabling different ways of carrying out research to support growers. □

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Risk experience motivates insurance innovation

Innovation does not stop at the farmgate. A new insurance concept is aimed at reducing the financial risk to farm businesses from climate change

■ Dale Schilling has witnessed first-hand the devastating impact of extreme weather on his family's wheat and sheep farms in north-western Victoria and the Eyre Peninsula in SA. It led him to co-found Hillridge, an innovative risk management startup, with finance and strategy expert Dai-Kyu Kim in 2018.

Traditional crop insurance typically only covers fire and hail, leaving growers exposed to other weather-related risks such as drought, frost, heat stress and excess rain. Claims require damage assessments, and an agreement between insurer and insured about the damage value. Claims can be delayed or even denied.

In contrast, weather insurance pays out based on a pre-determined calculation, making it more transparent, fairer and faster than traditional insurance. Using an automated weather insurance platform, growers can obtain quotes within minutes based on the likelihood of poor weather in their area.

"With Hillridge's technology, you can come up with a bespoke risk transfer solution that is right for your farming business. By offsetting downside risks, you can have confidence to explore options like planting higher-revenue crops, investing in inputs to maximise yields, forward selling and accessing premium markets," Mr Schilling says.

Hillridge has partnered with Nutrien Ag Solutions, Mitsui Sumitomo Insurance and Victor Insurance Australia (a subsidiary of the global insurance company Marsh) to develop the platform. The GrainInnovate fund invested in Hillridge's growth through its 'seed' and 'angel' rounds of investment.

"We also work with other companies such as Crop Risk Underwriting and Liberty Specialty Markets in Australia, and have received support from Cicada GrowLabs, the NSW Government, the City of Sydney, and the Extreme Tech Challenge over the years," Mr Schilling says.

The weather data is sourced from Scientific Information for Land Owners (SILO), an agricultural weather data service provided by the Queensland Government that covers all of Australia. SILO data is derived from weather data published by the Bureau of Meteorology.

"We are also working with the Department of Primary Industries and Regional Development in WA, and other weather data providers, to incorporate more weather data into our network," Mr Schilling says.

He says one of the biggest challenges has been raising awareness among growers about this insurance innovation.

"Growers may have been aware of multi-peril insurance – which is no longer available in Australia – or weather derivatives, which are available to large corporate agribusinesses, but this is the first time that weather risk transfer has been made available at scale to growers through insurance."

Hillridge is also working with two other GrainInnovate investees, DataFarming and Pairtree Intelligence, to help inform growers' decisions around managing frost and heat. This project, 'Frost and Heat Management Analytics', is being enabled by investment from GRDC and CSIRO. □

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CASE STUDY

WET HARVEST COMPENSATION

Peter*, a wheat and canola grower near Griffith, NSW, was worried about excess rain in the lead-up to harvest 2022.

The threat of a wet harvest damaging his crop was weighing heavily on his mind, but the cost of wet weather insurance cover during a La Niña also concerned him.

He turned to the Hillridge online system to tailor a weather insurance policy for his situation and bought the cover through Nutrien Ag Solutions. He rationalised that he could afford the premium, but could not afford the hit to his finances from a wet harvest.

Peter says a weight was lifted off his shoulders when he pressed the 'purchase' button: "It was a relief to have it. I liked the fact that you could play around with the cover options, like how much rain you might receive, and then that would make a difference to the premium. Doing this enabled me to find the best cover for my situation."

In the end, the worst-case scenario did happen. The area around Griffith flooded and Peter's crop was severely damaged by heavy rain. Hillridge's technology triggered a claim and he was paid by Mitsui Sumitomo Insurance within weeks of the event. This compensated for a price decrease for his wheat and canola due to a loss of product quality, filling what would have been a large hole in his finances.

*surname withheld.

Photo: Hillridge

Hillridge co-founders Dai-Kyu Kim (left) and Dale Schilling have developed an innovative insurance product to address climate risk.

Bots on the ground – farming's new army

KEY POINTS

- Lightweight robots reduce load on soils
- Robot platforms can carry a range of technologies
- Automation via robots reduces labour demand and boosts productivity

Frustration was the impetus for Andrew Bate to venture into the startup tech domain.

"I'm a grain grower and I was frustrated by the sheer size and weight of modern farming machinery and the damage it was doing to our soils – even with controlled-traffic farming," Mr Bate says.

"I saw robotics as an opportunity to decouple productivity from machine size. Small, lightweight, autonomous vehicles working in 'fleets' or 'swarms' could farm our country better than large tractors and machinery.

"I was also excited to investigate new farming techniques, tools and machinery that could be enabled with robotics – things that would never work or be practical on the back of a tractor. I saw robotics as the 'unlock code' for the next wave of agtech and better farming systems."

Automation also signified a solution to both labour shortages in regional areas and increased productivity, as robots can work around the clock.

SWARMFARM JOURNEY

There have been a lot of partnerships along the way for SwarmFarm.

"We started in 2010 with university partnerships but became somewhat frustrated with academic pursuits interfering with commercial outcomes," Mr Bate says.

"Then in our early days we partnered with leading businesses which were interested in innovation in agriculture, including Westpac, Telstra, Elders, ADAMA and others, to support our early growth."

Since then, SwarmFarm has been able to access support and grants from both the Queensland and federal governments, including the AusIndustry Entrepreneurs program and Ignite Ideas, and it continues to grow and attract investment.

Mr Bate says it is important to choose investors who match the company's values and vision. "Our last investment round included Emmertech (a Canadian agtech fund), GRDC's GrainInnovate and the Australian investment fund Tenacious Ventures. All these funds have direct connections to grain farmers, which is super-important to us."

ABOUT THE BOTS

Mr Bate describes SwarmFarm as "integrated autonomy".

"We build lightweight, autonomous robots and we partner with other innovative companies to integrate their cutting-edge technology onboard as tools and attachments," he says.

"We are both a software and a hardware company and we build all of our own technology end-to-end in-house."

SwarmFarm develops the software for autonomy, control systems for robots, and apps to operate robots. It sells direct to farmers and provides a field team to support use of its robots to end of life.

The company is also continuing to design and build prototypes

The SwarmFarm team.
Photo: SwarmFarm

of new robot concepts.

The company's journey transforming this futuristic realm into farming today has, not surprisingly, met a few challenges along the way.

"We started before Google had a driverless car program or you could buy a drone from Harvey Norman," Mr Bate says.

"Autonomy is deep technology, and we had to build everything from scratch – software, robots, the business model and support processes to service our customers in an entirely new market."

SwarmFarm has led the way as one of the only companies in the world with robots now commercially available to growers. To do this, it had to introduce an entirely new concept to market and prove both the product and its market fit.

The company launched its first commercial robots in 2016 with a fleet of four that it used for contract weed spraying in Central Queensland.

"We now have 52 robots in the hands of Australian farmers and our customers have sprayed over 570,000 hectares with our bots. We are now expanding manufacturing capability and are on track to produce 150 robots in 2024."

INTEGRATING TECHNOLOGY

The company has an app store and software package called SwarmConnect™ that makes it easy for other companies to integrate their technology onboard the autonomous robots.

"We currently have 10 companies that have released products through SwarmConnect™ that have been designed specially to integrate onboard our robots. These include sprayers up to 24 metres wide with 3500-litre tanks, green-on-brown weed detection, green-on-green weed detection, mowers and slashers."

The robots are also fitted with weather stations that can direct the robots to start and stop spraying according to the weather conditions. Mr Bate's team is also looking at integrating chemical-free weeding technology on the robots. □

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SwarmFarm robots with spraying and slashing equipment.

Photo: SwarmFarm

CASE STUDY

BOTS DELIVER MULTIPLE BENEFITS

Summer and winter cropping at North Star in northern NSW can create a constant annual workload for Simon Doolan, who farms in partnership with his wife Sandy.

"We have four to five full-time staff and are always looking for ways to farm smarter," Mr Doolan says.

The Doolans were early adopters of GPS and autosteer technology some 20 years ago, and it is these sorts of innovations that are important in reducing waste in cropping operations.

"Reducing overlap and using variable-rate application are important cost savings, especially when input costs keep rising," Mr Doolan says.

As it has also become challenging to source farm labour, 18 months ago Mr Doolan leased a robot from SwarmFarm.

Dubbed Lima2, it has been deployed in the weed management program trailing an 18-metre Hayes boomspray.

"Without a doubt, we are now getting better weed control and saving labour," Mr Doolan says.

"We are using less chemical and the unit has a lighter footprint, reducing compaction. The robot also has a precise turning circle, which further reduces compaction.

"And we find the apps SwarmFarm has developed to operate the bots very user-friendly."

Mr Doolan says Lima2 is also equipped with weather instrumentation to 'know' when to stop if the weather is not conducive for spraying and when to resume. He says this reduces spray drift as well as increasing operational efficiency.

"Lima2 has freed up our farm labour to do other work, such as looking after areas prone to erosion, or activities that generate more income for the business."

However, he says the bots do need a level of supervision and he has been servicing them when required.

"They are not set-and-forget, as they are new technology and we need to check their performance."

Mr Doolan says it is great to work with and be supported by an innovative Australian company that has the interests of Australian growers at the heart of its business model. However, he says there are limitations as SwarmFarm does not have the business scale of a multinational.

"The (three-year) lease arrangement with SwarmFarm gives us flexibility as it provides the opportunity to upgrade the technology when improvements have been made," he says.

Shared values drive PA solutions

Photo: DataFarming

DataFarming's Digital Agronomist™ puts the power of data layers in growers' hands to enable them to make more informed decisions.

■ Efficiency, sustainability and profitability of farms are top of mind for husband-and-wife team Tim and Peta Neale. Their passion for delivering user-friendly digital agriculture tools that enable growers to farm smarter has been a feature of their extensive careers in agriculture.

The Neales are agtech pioneers who ventured into the sector 25 years ago, but more recently established DataFarming in 2017.

"We saw three main problems facing growers that DataFarming addresses: variability in production, lack of objective data for decision making, and low adoption of digital ag technologies," Mr Neale says.

"There can be 300 per cent variability in production within paddocks and most growers add the same rate of inputs across the paddock, which has economic and environmental implications."

DataFarming's solution is a simple web-based platform – The Digital Agronomist™ – which combines several tools.

The master tool in the set is the provision of satellite imagery from the European Space Agency to farms every five days for free. Every few days, satellites generate a new colour-coded picture of Australia with normalised difference vegetation index (NDVI) images. These images can be used by growers and agronomists to identify anomalies in paddocks, including weed hotspots, insect damage, soil type variation, disease outbreaks and water drainage issues. These can be valuable prompts to go and investigate further.

The company also offers value-added products such as high-resolution images, stacked satellite imagery that layers up to five years of imagery for one location, together with variable rate zone files. All this is powered by custom software based in AWS (Amazon Web Services).

DEVELOPMENT SUPPORT

DataFarming has worked collaboratively with commercial, government and academic partners, and is an integration partner with six other software companies.

Mr Neale says GrainInnovate has been instrumental in providing seed funding to help the business get started and grow, and, importantly, it has helped validate the business as the fund is industry backed.

"GrainInnovate is a fantastic and unique initiative by GRDC, and we certainly hope growers feel they have received good return on that investment in us," he says.

DATAFARMING GROWTH

"Software development is really hard and finding good staff or agencies to support these developments is a real challenge, especially when we choose to be located regionally in Toowoomba," Mr Neale says.

Despite these challenges DataFarming has made incredible progress since its inception. The rate of adoption has been testament to the Neales' focus on ensuring the platform is simple to use, low cost and easy to access.

"Before we came along, only four per cent of farmers had looked at a satellite image of their property – we have reached nearly 40 per cent of the market within five years," Mr Neale says.

Husband-and-wife team Tim and Peta Neale have been stalwart advocates for the benefits that agtech can bring to farming enterprises. In recent years they have launched the startup DataFarming to assist growers in making more informed farming decisions.

Photo: DataFarming

"That is around 35,000 farms, 170,000 fields, 18 million hectares of processed data. We have continued growing at around 110 farms a week since day one.

"We want to develop more products for Australian growers – from four current products to 10. This will help drive mass market adoption of precision agriculture tools so agronomists and farmers can benefit. Our anticipated development of automated tools will also assist growers to meet sustainability requirements easily."

Mr Neale says the company will stay regionally based in Toowoomba to ensure connection with growers, but plans to expand globally. □

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CASE STUDY

RETURN ON INVESTMENT DRIVES DIGITAL ADOPTION AT BINGINBAR

The Simpsons have experienced many changes in farming technology over the 155 years the family has farmed 'Binginbar' at Gollan, between Wellington, Dubbo and Dunedoo in central NSW. Since 2016, Binginbar Farms has been implementing a digital transformation.

CEO Nathan Simpson says the family farms more than 4000 hectares with a 60:40 mix of cropping and pasture.

Annual rainfall is about 550 millimetres, with 275mm growing season rainfall, and crops are produced on a seven-year rotation. Dual-purpose wheat, canola and barley are grown in sequence with perennial pastures for finishing up to 70,000 lambs a year.

"We started using GPS guidance in 2007 and then recording yield with yield maps in 2009," Mr Simpson says.

"We then moved into documenting all our application records via MyJohnDeere."

It was in 2018 that Mr Simpson started using DataFarming's services.

Combining DataFarming's offering with services provided by his agronomist, Hayden Hollis from Agricore, Mr Simpson has been building data layers of the property to inform management decisions.

Photo: Nathan Simpson, Binginbar Farms

An aerial photo of a 'Binginbar' paddock where farm management practices are being better informed using satellite imagery and data layering through the adoption of DataFarming tools.

POWER OF MAPS

"We have mapped paddocks for electrical conductivity, which gives us a spatial picture of the soils' composition – the amount of salt, sand, clay, organic matter and water content – across a paddock," Mr Simpson says.

This can be layered or 'stacked' with elevation and topography maps, and NDVI maps generated by satellites, provided through DataFarming, enabling real-time decisions to be made in response to circumstances in the paddocks.

The top-down view provides a valuable perspective on crop and soil information that is not achievable at ground level. But the power is in using multispectral cameras such as NDVI, which can capture reflectance from crops in the non-visible spectrum that helps identify crop anomalies not visible to the human eye.

"This means we can make better-informed decisions on in-crop inputs such as top-dressing nitrogen, weed management and pest management," Mr Simpson says.

Following harvest, further data layers that capture spatial responses in the form of crop yield across a paddock can be collected.

"Hayden is then able to generate a profit map for each paddock for us, which is essentially a gross margin map as a record of seasonal performance," Mr Simpson says.

"It is these maps that we refer to at the start of each season to make much more informed decisions about our cropping program for each paddock.

"Our use of this technology is all about improving efficiency and return on investment. If we can optimise inputs and target areas in paddocks where we get the best returns, we will drive profitability.

"If we can produce more biomass and therefore grain or meat with the same or arguably less inputs than a conventional approach, then the entire system becomes much more sustainable.

"The other side of this coin is if we can achieve higher plant production in a sustainable manner, this has the side benefit of being able to sequester more carbon into our soils, further adding to our production gains."

DECISION SUPPORT

Photo: Verge Ag

Verge Ag develops software that creates a digital version of the paddock to design more efficient trafficking pathways for farm equipment.

Building the paths for autonomous farming

Transitioning to autonomous farming is expected to be as transformative as the shift from draught-drawn equipment to motorised tractors

■ Autosteer and GPS guidance brought a step-change to broadacre farming practices, reducing operator fatigue, increasing accuracy and improving efficiency. But with increasing production and machinery servicing costs, where will the next transformation come from?

GRDC's manager transformational technologies Liam Ryan says, "The timeliness of operations is a key profit driver in Australian grain production systems. In-paddock operations such as seeding, spraying, spreading and harvest all have a narrow window in which they need to be undertaken. Growers encounter financial losses when breakdowns, inefficiencies or poor coordination affect the ability to complete a task within the optimum window."

Verge Ag saw the opportunity to explore this question and, specifically, the transition to autonomous farming by introducing its novel approach to planning equipment pathways.

"We are developing a solution that helps farmers to execute field operations remotely, which enables farming to be truly autonomous." chief operating officer of Verge Ag, Godard says.

Verge Ag says it combines entrepreneurs, investors, farmers, software developers and even aerospace engineers to bring 'out-of-the-box thinking' to agriculture.

ABOUT THE TECHNOLOGY

"Our product, Launch Pad™, simplifies farm planning to reduce in-field decision making," Godard says.

"We look at in-paddock operations from the perspective of both the paddock and the equipment. Using digital elevation models to characterise the topography and knowledge of the terrain and other field spatial attributes, we design paths for equipment – paths that are efficient from cost and sustainability perspectives (such as traffic compaction and erosion issues).

"We are helping farmers consider all potential scenarios when planning field operations to develop a controlled, programmed, plan."

The platform is a web application that can be accessed from a desktop computer, tablet or mobile phone device. It is compatible with all major original equipment manufacturers' display and guidance formats.

To develop the software Verge Ag is applying its own mathematical optimisation techniques to develop path-planning algorithms and artificial intelligence to precisely characterise the land.

"Our algorithms utilise boundary, topography and equipment information to automatically generate headlands and inner tracks," Godard says.

"Growers can then modify and optimise these track layouts to best fit their individual requirements. They can use our interactive tools to optimise paddock trafficking, manage headlands more efficiently, minimise overlap and machine operating time, and reduce soil compaction and erosion.

"Multiple plans can be created to compare operations on a paddock-by-paddock basis, allowing growers to plan, execute, refine and capture their operational knowledge over time."

SUPPORTING THE ENDEAVOUR

Verge Ag has paying customers in the US, Canada, Australia, Brazil, Ukraine and the European Union, primarily equipment dealership groups and precision agriculture consultants.

"We have around 20 million hectares of unique boundaries from all over the world in Launch Pad™. This was ingested by customers looking to trial the application and extract operational value. On average we acquire 40 or more new users a month. We have trial users in over 25 countries," Godard says.

"As growers start to plan multiple operations on these 20 million hectares of boundaries we already have, we will be saving those path plans and other scenarios. This data will train our algorithms to build detailed models – a 'digital twin' of a farm. This digital twin will characterise the spatial attributes of a field (terrain, obstacles, etc.) and also the equipment and soil. With every path plan created on that field, we are enhancing the digital model of that paddock."

Verge Ag was recently in Australia, touring the grower regions and attending evokeAG, the region's premier agtech event, hosted by AgriFutures.

"GrainInnovate investment has helped us scale our product to new geographies like Australia and focus on building local partnerships that can extract direct value from Launch Pad™.

"GrainInnovate's investment also opened many opportunities to work with agricultural equipment dealerships and grain growers in Australia." □

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Customised dashboards combine agtech tools

A Molong, NSW, startup business is using dashboards to aggregate data and overcome incompatibilities with agtech tools

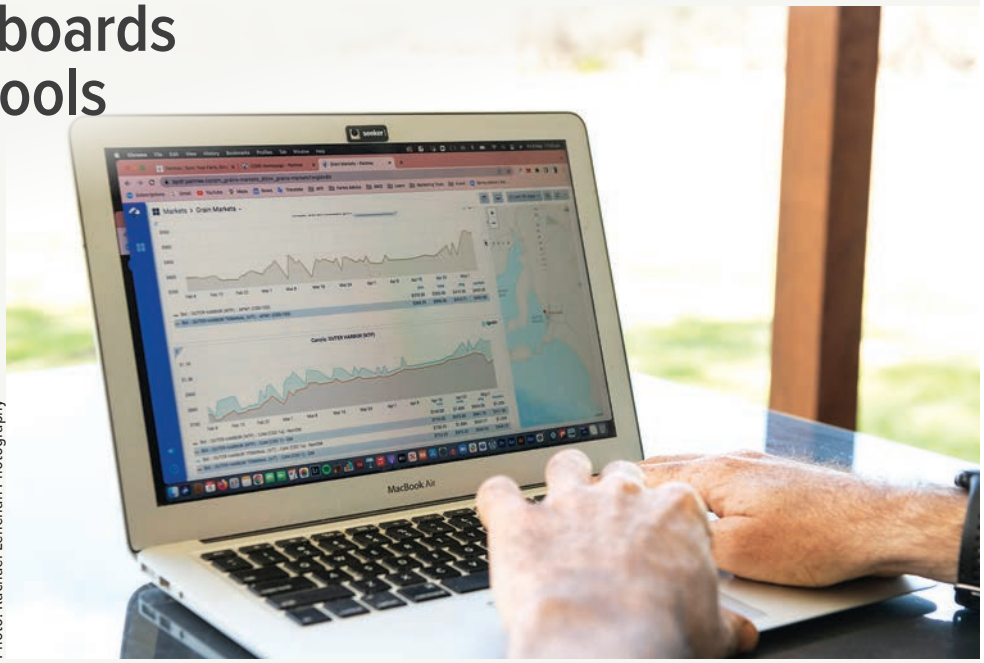

Photo: Rachael Lenehan Photography

The Pairtree Intelligence dashboard.

■ Agricultural technology has generated a plethora of digital solutions for growers to optimise farming operations. While these are promising, many growers are overwhelmed by the increasing number of tools and services and the inability of many to 'talk' to each other.

To illustrate this Hamish Munro, a farmer and co-founder of the startup Pairtree Intelligence, estimates that 80 per cent of growers use between five and 10 apps and digital platforms for farming operations that are not interoperable.

Pairtree Intelligence specialises in the Internet of Things sensors, apps and imagery. Since 2018, the company has connected more than 130 different agtech and digital agriculture data sources and has more than 100 reusable app integrations for farmers, agribusinesses and agronomists.

"It is about data stacking in a centralised place to better inform on-farm decisions," Mr Munro says.

KEY SERVICES

Pairtree Intelligence provides three key services to agricultural industries: Pairtree PLUS, Pairtree White Labels and Pairtree Pipes (API). Pairtree PLUS is a universal dashboard for farmers to access all their agtech programs through a single login.

Pairtree White Labels allows consultants and agronomists to build 'connected' solutions on the Pairtree platform for geospatial and temporal (time) services. It allows clients to opt-in data to the service and gain improved insights and analytics for their operation.

Pairtree Pipes (API) allows agtech companies, corporates and agribusinesses that engage with growers to more efficiently access growers' data (with permission) for their own platforms.

Mr Munro says he had a personal interest in driving the startup.

"We were involved in R&D extension projects that required farmers to manually enter data, which was not efficient," he says.

"Our platform is built on the web and, as there are continual data updates, it is best used in the office for strategic planning. But while designed for a desktop, the dashboards are still 'mobile reactive', which allows their use on smartphones or tablets."

'COMPLEMENT NOT COMPETE' APPROACH

"Dealing with a wide range of maturity in the agtech space – from long-term established solutions to startups – has been a challenge for us," Mr Munro says.

"We use a 'complement and not compete' approach, which has been accepted well by the agtech sector.

"Our integration partners have strong businesses servicing their clients, and we just need to add value to their data by integrating, aggregating and analysing the data for operational use.

"This is why we focus on the White Labels and Pipes API, because farmers still require consultants and agronomists to translate the data in meaningful and actionable ways."

GROWTH AND EXPANSION

In 2018, when Pairtree started, there were three founders working in the business. Now the business has nine staff and four contractors.

"We have been continually building our services and now are at a point where we can facilitate farmers to share their data with permission," Mr Munro says.

Mr Munro sits on the National Farmers' Federation Farm Data Code committee (as a farmer and agtech provider) and Pairtree was the first company to rewrite its terms and conditions to ensure farmers' data is protected.

GrainInnovate support has ensured that Pairtree can focus on the grains industry. Since the investment, it has secured a large contract with Syngenta Australia to deliver disease models to farmers. Weather stations are used to calibrate the service to a location. This theoretical disease model tool is multi-crop and will allow for improved scouting by looking at disease risks over time, as well as understanding where paddocks at risk may be.

To help inform growers' decisions around managing frost and heat, Pairtree is working with DataFarming and Hillridge, two GrainInnovate investees, in a national GRDC and CSIRO investment, 'Frost and Heat Management Analytics'.

Further, Pairtree is active in the livestock sector, so mixed farmers can connect livestock and grains information into a single platform. □

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Improved frost and heat tools from big data

National project to utilise on-farm agtech data to improve preparedness and responses to frost and heatwaves

Heatwaves and frost events have been the focus of tremendous research activity over decades, generating a sizeable amount of data from Australian environments. Parallel to this growth of data and expansion of knowledge has been the development of new agtech tools and methods of monitoring the environment, but grower-ready tools for frost and heat management have been scarce.

A GRDC investment of $6.26 million over four years with CSIRO (a partnership worth $9.5 million total), has taken the opportunity to converge both the analysis of data and new agtech tools to enable growers to make more-precise decisions relating to climatic constraints. The project has gained the acronym FAHMA – Frost and Heat Management Analytics.

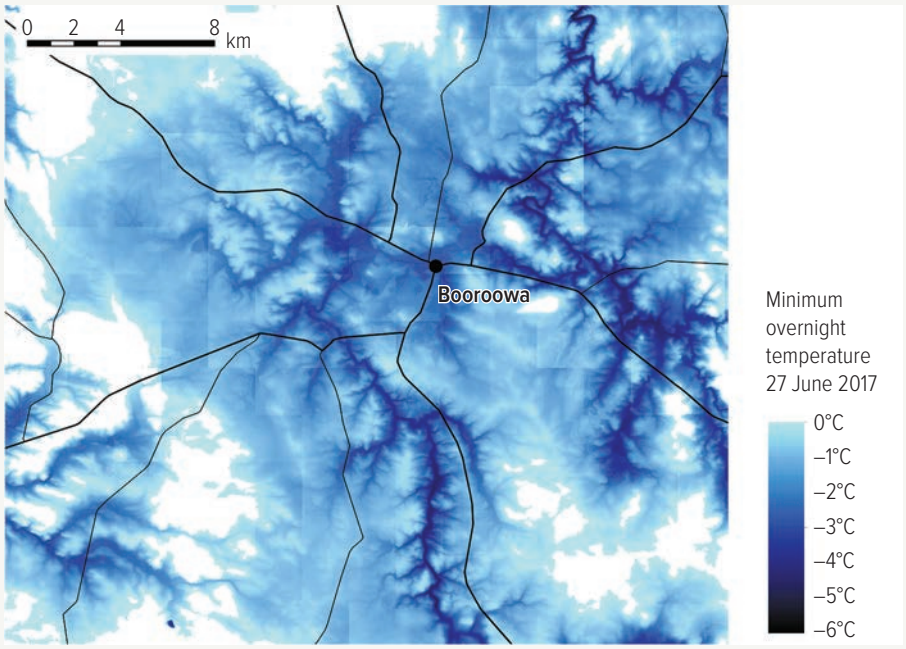
Dr Julianne Lilley is co-leader of FAHMA, which brings together many grains industry players across Australia to focus on the issue. Dr Lilley says the time was right to try a different approach to seeking solutions to managing these constraints.

"It is about working with people who have gained insight as well as amassed data on these issues by combining the data and sharing insights to identify gaps in our knowledge," she says.

"Core to the project is to improve and validate frost and heat damage functions in the Agricultural Production Systems sIMulator (APSIM) crop model for wheat, barley, canola, lentils and chickpeas, so we can improve the ability to predict the impact of these events on grain yield.

"As lentils and chickpeas are lagging behind, with few studies on the impacts of frost and heat on these crops, field-based research on these will be carried out concurrently in the FAHMA project."

By combining the science of temperature mapping with crop damage caused by frost and heat stress, the project aims to integrate data over large spatial areas but also deliver sub-paddock scale insights to growers.



New tools are being developed through GRDC's national Frost and Heat Management Analytics investment such as this frost severity map from 27 June 2017 at the CSIRO Boorowa Agricultural Research Station. Generated by CSIRO from satellite-based models at sub-paddock scale (30 metre resolution) and in near-real-time.

Source: Dr Randall Donohue, CSIRO

Fellow FAHMA co-leader Dr David Deery, also from CSIRO, says by combining these data sources and working with renowned agtech companies, growers and advisers will be able to make better-informed decisions for managing these climate risks pre-season and in-season.

The project vision is depicted in Figure 1.

GROWER PARTICIPATION

"Crucial to the project has been engagement with grower groups, research agencies and agtech companies from the start," Dr Deery says.

"It is fundamental to understanding the needs of growers and advisers and to design solutions that are user-friendly and supported by data and knowledge.

"The project is taking a more-practical approach by working backwards from the needs of the end-users."

The project partners include: CSIRO (lead agency), Eratos, Square V, Hillridge, Pairtree Intelligence, Agworld, DataFarming, Elders, Delta Agribusiness, Birchip Cropping Group, Grower Group Alliance, NSW Department of Primary Industries, South Australian Research and Development Institute (SARDI), the Western Australian Department of Primary Industries and Regional Development, Charles Sturt University and the University of Queensland (Queensland Alliance for Agriculture and Food Innovation).

The project started with a consultation phase using Square V, a regional

Victorian company that specialises in user experience research for designing and building the right product that meets the needs of end users.

Square V consulted with growers, agronomists, grower group leaders and frost and heat researchers across Australia to gain insights into management needs and constraints.

TECHNOLOGY CONVERGENCE

The data streams created in both APSIM and the GRDC National Phenology Initiative have taken years to assemble and GRDC is now seeing leading research organisations seeking to collaborate with new investment from its GrainInnovate agtech program to build capability and take the research forward.

GrainInnovate-supported businesses such as Pairtree Intelligence, DataFarming and Hillridge are bringing their capabilities to the challenge.

"These partnerships will enable transformation of the science into analytics products that aid key sowing decisions, in-crop management decisions, and underpin the development of new risk management tools," Dr Deery says.

The project is set to validate its first tool, based on minimum temperature mapping using temperature sensors.

This work has been undertaken by Dr Uday Nidumolu and his team from CSIRO with Dr Peter Hayman from SARDI. The maps generated are accurate and at a scale that is relevant for growers to act upon.

The GrainInnovate investees will be involved in the validation work. DataFarming provides new digital tools and precision agriculture technology based on satellite imagery, which now services some 35,000 farms. Its products help growers manage spatial variability across paddocks, identifying where to apply inputs for the maximum return.

DataFarming will deploy the outputs of the CSIRO research into practical solutions for when events such as frost occur. For example, near-real-time frost maps will direct where to check for damage, and rapidly determine the extent of losses, to help with decisions such as to cut for hay or let the crop go through to harvest.

"Agronomists are often under a lot of pressure to quickly make the right decision over large areas of crop. This tool will definitely help that process and will be available on the phone or tablet in the paddock," says DataFarming managing director Tim Neale.

Pairtree Intelligence specialises in the integration of sensors, services, apps and imagery. It has the capability to connect these tools in user-friendly dashboards or, with permission, share that data to other providers. Within the FAHMA project, Pairtree will share frost data with farm management platforms, so that all parties can monitor crop health.

Hillridge has built a platform that helps farmers buy insurance for extreme weather events, such as the severe frosts and heat stress events that lower the yields of winter crops. Farmers log on to the platform and can create a bespoke policy for their farm.

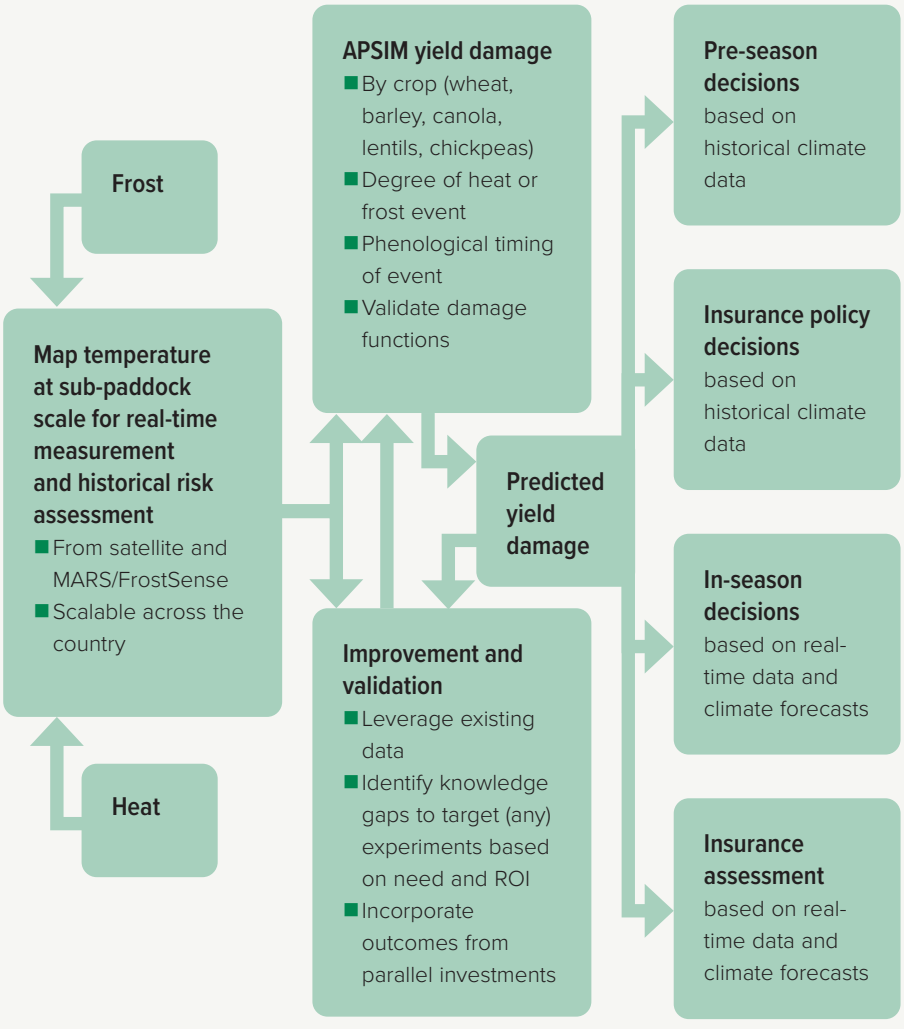
"Weather insurance has been hampered by a lack of weather monitoring stations that are close enough to farms to be of use for insurance. By using direct satellite-based readings of overnight ground temperatures, insurers could use our platform to offer cover to all grain farmers, regardless of how far the nearest Bureau of Meteorology station is," explains Hillridge's chief executive, Dale Schilling.

Keep a watch out for more tools becoming available for growers through the FAHMA project. □

GRDC Code CSP2204-009RTX

More information: David.Deery@csiro.au, 02 6246 4869; Julianne Lilley, Julianne.Lilley@csiro.au

Figure 1: Frost and Heat Management Analytics project vision.



Source: CSIRO

Digitised soil data to lift paddock productivity

The same software once used in military aerospace operations is now being deployed to measure and manage soil productivity

Photo: FarmLab

Sam Duncan and Shahriar Jamshidi have combined unique interests and experience to form an ag startup driving improved soil health decisions.

■ Innovative agtech startup FarmLab has seized the opportunity to marry its expertise in providing aviation solutions with the needs of Australian farmers.

Soil is a fundamental resource for grain production. With better information about its productive capacity, improvements in grain performance can be achieved. But there is a lack of digitisation of soil data and most soil samples are not georeferenced to log spatial variation.

With experience serving in the Royal Australian Air Force and a keen interest in agriculture and startups, Sam Duncan's focus shifted to agtech, which led to FarmLab, a solution to this very challenge – an easy-to-use environmental measurement software.

"The lack of digitised and georeferenced soil samples was hindering farmers' ability to make decisions about yield-limiting factors and nutrient applications," says Mr Duncan, the chief executive and co-founder of FarmLab.

Founded in 2016 and located at Armidale, NSW, the business was initially based on a mobile app to help agronomists barcode soil samples.

"We partnered with some of Australia's leading laboratories back then – Environmental Analysis Laboratory (EAL) at Southern Cross University and APAL in Adelaide. Our clients would send them samples, and the labs would send us the results for us to map for our clients," Mr Duncan says.

"FarmLab co-founder Shahriar Jamshidi, who is chief technical officer, had developed the software for an aviation company to track and record while in midair the offload of fuel.

"This taught us a lot about getting the software to work offline, or in comms-degraded environments – perfectly suited for Australian agriculture. We took that architecture and developed the first version of the mobile app for FarmLab."

SUPPORT TO GROW

FarmLab received investment from GrainInnovate in 2020 after participating in the SproutX Accelerator Program in Melbourne.

"We saw it as a critical step because it gave us strategic support from the industry. It helped us validate the idea and knowing that GRDC was supportive of FarmLab meant we knew we were solving a valid problem," Mr Duncan says.

He says the innovation develops auto-

generated soil test reports for agronomists and they are now experimenting with artificial intelligence to help write reports based on soil test results.

FarmLab now covers about 2000 farms across Australia and has 20,000 soil samples planned for 2023. The team is working with growers to help them enter the emerging environmental market space using measured soil data.

"We have been working closely with the Clean Energy Regulator to develop its soil carbon legislation into FarmLab. This means that project managers and farmers can use FarmLab to measure soil carbon in line with Australian government legislation – which is considered one of the highest standards for soil carbon measurement in the world," Mr Duncan says.

"We're also working with GRDC to commercialise the ConstraintID tool to help growers identify subsoil constraints across paddocks and integrate these into FarmLab to support assessments with on-ground measurements."

Soil carbon measurement is being bolstered further as FarmLab and its partners have received $8.4 million in round one of the National Soil Carbon Innovation Challenge grant in 2022.

"In addition to this, we're building capacity in the US with ranchers and growers to support them to collect soil samples and measure soil using FarmLab. This has demonstrated that the work we've been doing in Australian agriculture is cutting edge." □

More information: Sam Duncan, sam@farmlab.com.au, farmlab.com.au

CASE STUDY

TECH AND SCIENCE MERGE FOR VISUAL PRODUCTION ANALYSIS

Penny Frederiksen farms 'Glen Vale', a 150-hectare grazing and dryland cropping property near Warwick on the Darling Downs in Queensland. She was interested in understanding more about the health of her property's soil – in particular, the carbon levels that are critical to productivity and sustainability.

To gain insights into these factors, FarmLab partnered with VRM Biologik, a local agronomy and inputs business, to assess soil carbon and biodiversity on Glen Vale.

The goal was to develop an overview of production drivers and current carbon levels on Glen Vale for the land manager, and use soil tests as the basis for this analysis.

To achieve this, FarmLab developed a desktop estimate of carbon for the property. This provided an initial assessment of soil carbon using a licensed version of the CSIRO's LOOC-C tool. The report predicted current carbon levels of 1.7 per cent with maximum levels in the region estimated at 4.8 per cent.

To further optimise the sampling process, VRM Biologik used FarmLab to look at recent productivity based on vegetation indices across the property. This helped identify areas where soil was not performing optimally and was used to strategically determine locations for sample collection.

Paddock history, with more focus on cropped paddocks than grazed ones, and proximity to strata were key factors considered in determining sample locations. The Fredericksens were consulted for feedback on the strata and sample plan prior to conducting the sampling.

Using the FarmLab mobile app, Clinton Buck from VRM Biologik collected samples at 10 pre-determined locations on Glen Vale. At each site, photos were taken and notes were entered in the app to capture field conditions and relevant sample information. FarmLab was used to quickly create additional data collection fields to estimate biodiversity and soil texture.

Personalised sample labels were provided by FarmLab to improve accuracy and reduce time taken when logging the soil data.

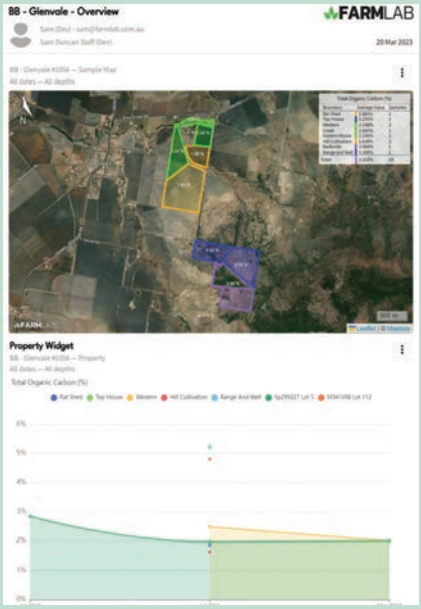
Once the samples were collected, they were submitted to the Environmental Analysis Laboratory (EAL) at Southern Cross University for agronomic and carbon testing. EAL used the FarmLab portal to automatically upload and display results for the client.

"Like 65 per cent of the population, I'm a visual learner," Ms Frederiksen says.

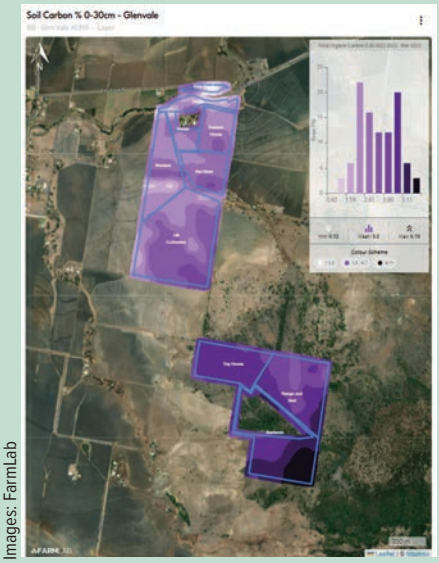
"Using the maps was particularly helpful in receiving and understanding the information gathered."

Mr Buck says: "We were able to generate a highly accurate map using FarmLab.

"This helped us better understand and consult with our client on exactly where they lacked carbon, and the areas they could focus on to improve yield."



A FarmLab automated agronomic report.



Images: FarmLab

A soil map automatically generated for Glen Vale from soil test results using FarmLab analytics.

Tech to improve productivity and safety in the bush

■ Growers are keen to embrace digital technology but, for many, a lack of reliable in-field connectivity is standing in the way.

For entrepreneurial network engineer Dan Winson, understanding the scale of this problem set him on a path of discovery and invention that has led to new connectivity options for farmers.

Mr Winson grew up in Wagga Wagga and is a wireless network engineer by training. He completed a double degree in business and information technology and a master's degree in wireless networking at Charles Sturt University.

"I'm not a farmer but growing up in Wagga and with family connections to the land, I've had more exposure than most network engineers to the problems farmers face as our lives become more reliant on connectivity," he says.

"However, it wasn't until I started researching the issue that I realised traditional telcos aren't well-positioned to service remote areas. The cost for the infrastructure investment just doesn't stack up in many low-population-density areas."

Mr Winson was teaching at TAFE in 2016 when he started focusing more intently on whether an alternative approach could fill the gaps left by traditional operators. In 2018 he took long service leave to work full-time on the project. Since then, the project has blossomed into technology company Zetifi, with a team of 25 developing and building new connectivity solutions.

"One key thing that spurs the interest of startup founders is seeing innovators out there having to solve the problem for themselves," Mr Winson says.

"In my case, I heard about a grower who had built his own 53-metre telecommunication tower on his property to create long-range wi-fi. That sort of action stands out and validates the need for better solutions that can be applied more broadly.

"You think: hang on, if someone is willing to do that then there must be a large opportunity to solve this problem for the others who are not in a position to actually solve it themselves."

Photo: Zetifi

Zetifi has attracted attention and investment from Telstra and others to continue the development of its remote area connectivity solutions. Telstra chief executive Vicki Brady (right) recently joined Zetifi chief executive Dan Winson (left) on a visit to the farm of a Zetifi collaborator, grain grower Andrew Dumaresq, to see their products in action.

ZETIFI TOOLS

A problem can be solved in multiple ways and, in the years since the company began, Zetifi has narrowed its solution to two main products: the ZetiRover and ZetiCell.

"In some cases, the best solution is to build a private network," Mr Winson says.

"Other times we find you can provide a more-flexible solution and better connectivity for in-field operations by just using a vehicle-based hotspot or repeater; we call this the ZetiRover."

The ZetiRover is a box mounted on top of a tractor, sprayer or harvester. It combines the coverage from Telstra, Optus or satellite networks to convert patchy coverage to fast, long-range wi-fi connectivity for hundreds of metres.

"A grower then has a 'bubble' of wi-fi around their vehicle which allows them to make phone calls, monitor farm access, or just access the internet for anything they may need in the field," Mr Winson says.

The ZetiCell works on a similar principle but is mounted in a fixed location using mains power or solar panels, providing a permanent bubble of wi-fi in high-use areas such as around sheds or yards.

Simplicity is key to Zetifi's approach and Mr Winson says hiding from users the networking complexity involved in their products is one of their key design principles.

"Ease-of-use drives adoption and our devices can simply be plugged into the cigarette lighter power socket and you get a bubble of wi-fi around your tractor," he says.

Making the devices suitably rugged for on-farm use has also been a challenge, says Mr Winson says.

"Through trial, error and testing, including cooking products in a pie warmer to simulate the Australian summer, we've ended up with products that are now proving themselves robust in a wide range of temperature extremes, rain, dust and vibration," he says.

Zetifi's improved connectivity not only enhances general communication but also potentially boosts farm

productivity by enabling the use of sensors, wireless cameras for farm security, autonomous tractors and other tools.

COLLABORATION

Initially, Zetifi completed two startup accelerator programs run by Telstra and the SparkLabs program Cultiv8.

"From there, we raised around $1 million with support from GRDC as well as a range of angel investors," Mr Winson says.

"Gaining momentum, we were then able to access a range of state and Commonwealth-level grants totalling more than $5 million. This enabled us to thoroughly test our products, show what we can do, and commercialise our technology.

"With all that behind us, last year we had the runs on the board to raise $12 million through a Series A funding round that was led by GrainCorp Ventures and Telstra.

"With traction in Australia and preparation underway for sales in Canada and the US in the near future, we're ready to transition to mass production and make our products available to more people."

Zetifi plans to continue most of its manufacturing, prototyping and tooling at its Wagga Wagga head office. □

More information: zetifi.com; Kate Finger, kate.finger@bcg.com.au

CASE STUDY

PADDOCK TO CLOUD: A NEW ERA

Since it was founded more than 31 years ago, Birchip Cropping Group (BCG) has often led the charge when it comes to innovation.

Kate Finger is a project manager within the BCG research team and says that knowing the ' pain points' for growers drives the hunt for solutions.

BCG services about 500 grower members covering the southern Mallee, Wimmera and north central areas of southern Victoria. It is an area with many wireless blackspots.

"We are constantly hearing from growers about issues with connecting agtech devices or just simply being able to make reliable phone calls out in the paddock. Whether it be to talk to their agronomist or other service providers, inconsistent connectivity has a large impact on productivity, as growers often have to return to the office to do this rather than in real-time in the paddock," Ms Finger says.

"We started trialling Zetifi tools three years ago, installing ZetiCells on three properties and using the ZetiRovers on BCG's fleet vehicles.

"We saw immediate productivity gains. Phone calls and even video conferences could be taken by staff in the field and we reduced the double handling of data entry as we could upload data straight from the paddock to the cloud.

"It also improved our work safety practices due to vastly improved communication.

"Additionally, it meant we could attract high-quality research and management staff together with their families to our regional location as we could offer improved connectivity, an important drawcard during COVID-19 lockdowns and thereafter."

The three growers involved in the pilot study saw such benefits with the improved connectivity that they have retained the tools. They experienced improvements not only in communication but also in connectivity of sensors. As a result, they were able to monitor water levels in troughs and increase farm security by keeping track of people accessing their properties.

"Lack of connectivity is regularly cited as the main barrier to adopting new technology and improving productivity," Ms Finger says.

She says that new connectivity options from companies such as Zetifi mean that waiting for a new phone tower in a district is no longer the only solution.

Photos: Zetifi

ZetiCell installation on a farmhouse roof provides outdoor wi-fi as an alternative to mobile coverage in an area that would otherwise be a connectivity blackspot.

Photos: Demi Taylor, BCG

ZetiRover unit installed on one of Birchip Cropping Group's utes with Kate Finger on the controls.

Disease surveillance automated

Combining sensors and automation is providing a step-change for monitoring and managing fungal diseases

Members of the growing BioScout team (from left): Edward Gubbins, Dr David Wood, Henry Brindle, Thomas McMenamin, Lewis Collins, Dr Michelle Demers, Mikali Anagnostis and Lucy Horne.

Photo: BioScout

■ Relying on intuition and symptomatic indicators to manage disease in crops can result in spraying too much, too often or at suboptimal times – but automated disease surveillance heralds a step forward in both detection and management.

Airborne fungal diseases cause crop yield and quality losses in broadacre agriculture, horticulture and viticulture. The diseases they cause remain a stubborn problem because plants show no symptoms during the early stages of infection, precisely when fungicides would otherwise be most effective. Once plants show symptoms, it is often too late for effective and economic control.

Weather conditions and/or crop growth stages are currently used by growers to decide when to apply crop protectants – although they have no way of knowing whether any infectious material is present on-farm. This means that to stay safe, growers tend to spray more than they might need. This results in higher input costs and, eventually, disease resistance.

It was this agriculture-wide issue and a few chance meetings with plant pathologist colleagues that captured the attention of BioScout chief executive Lewis Collins during his engineering doctoral studies at the University of Sydney. The issue required a solution that brought together different scientific disciplines including plant pathology, agronomy and engineering. This was the perfect fit for Mr Collins' background in mechatronic engineering and biological science and his ideas for a sensor that could detect early stage infection.

"One of the largest challenges has been taking my PhD research project to a fully commercialised product that works every day under Australian farm conditions," Mr Collins says.

"BioScout's sensor technology actually monitors the air for disease-causing spores in near real-time. This provides growers and viticulturists with early intelligence on the presence of airborne spores, allowing more-effective use of fungicides based on actual threat."

Mr Collins says this has resulted in yield increases with fewer fungicide applications.

BioScout's systems also help growers evaluate the effectiveness of any control measures taken, helping them to finesse their disease management strategy.

ABOUT THE TECHNOLOGY

BioScout sensors capture airborne particles such as fungal spores, pollen and dust, and monitor the air in near real-time. These particles are analysed using high-resolution imaging and artificial intelligence algorithms that have been developed

to quantify particulates of interest.

The sensors also function as weather stations, providing weather data such as temperature, wind speed, wind direction, rainfall, humidity, pressure and air quality.

"This means users can access airborne particulates of interest and local weather and environmental data through a single (on screen) dashboard," Mr Collins says.

"Although challenging, we have been able to engineer the sensors to work autonomously in remote agricultural environments, including with low connectivity."

The software behind the sensors has also been made user-friendly.

As the BioScout technology can be calibrated to detect particular particles, it also has potential to detect chemicals and therefore spray drift, which the team is in the early stages of investigating.

Beyond addressing fungal disease detection, BioScout's technology also has the ability to detect pollen and determine concentration levels. This has the potential to improve insights into crop pollination and provide a warning system for asthma sufferers.

INVESTMENT AND COLLABORATION

Mr Collins says the GrainInnovate seed investment in early 2022 allowed BioScout to evolve from a five-person team servicing trial partners to a 17-person team servicing the world's largest airborne disease sensor network.

"However, it has also taken a lot of time to create the dataset required to develop machine learning algorithms," he says. "To do this, millions of spores had to be identified and labelled by BioScout's team over the years.

"Then, to make the data easily digestible and engaging for the growers and customers, BioScout had to develop novel software solutions."

Mr Collins says collaborations with companies within GRDC's network were paramount in addressing the challenges outlined above, especially addressing data shortages and developing early case studies to fine-tune the value propositions for the technology. □

More information: Lewis Collins, 0401 372 535, lewis@bioscout.com.au, www.bioscout.com.au; Andrew Newall, 0418 224 422, andrew.newall@adama.com

CASE STUDY

BIOSCOUT PROVIDES THE MISSING PIECE IN PATHOLOGY PUZZLES

Prior to joining ADAMA as a portfolio manager (insecticides and agtech), Andrew Newall was an experienced broadacre agronomist.

ADAMA develops solutions to plant production challenges from paddock intelligence and Mr Newall's experience fitted with this.

"We were keen to work with BioScout to see how the technology could enable us to find a missing piece in fungal disease management," Mr Newall says.

ADAMA is developing disease prediction models for significant diseases of grain crops. These models will give greater insights into disease development, allowing for improved applications of fungicides to achieve better results.

"But there was a missing piece of field intelligence that we needed," Mr Newall says.

"For us, the holy grail has been information on spore capture and activity to know exactly when the disease spores may be present in a crop.

"This is really important to assist in more-precise fungicide application to mitigate any possible resistance build-up to fungicides and ensure longevity of our products, as new products are a challenge to develop.

"If we can overlay this fungal spore information with data on the environmental conditions that are conducive to disease development, we can significantly improve fungicide applications."

ADAMA has been test-driving BioScout's ability to drive more-informed decisions for *Septoria tritici* blotch management in wheat, Botrytis in faba beans, net form of net blotch in barley and Sclerotinia in canola.

"Working with BioScout devices in the field, we can really get to know the nuances of fungi as their spores all have different features," Mr Newall says.

"Utilising automated devices is more efficient than using traditional manual devices. We can detect when there are periods of high risk in real-time during the season.

"If we can understand spore activity along with disease infection risk, we can then match our fungicide applications more precisely. Improving fungicide choice and application will not only ensure we are using the right product at the right time, it will also improve the sustainability of our production systems."

Photo: BioScout

This BioScout automated disease sensor uses new disease detection methods to produce real-time disease data, while also providing weather monitoring. BioScout uses this data to provide farm-level disease risk profiles, allowing for improved disease management.

Turning variable-rate data into paddock-scale research

KEY POINTS

- Laconik has developed a novel software solution to conduct 'swarm trials' across whole paddocks to capture spatial variability
- Prescription maps developed from responses to the trials can be synced with major digital platforms
- The 'swarm trial' data can provide growers with a higher degree of confidence in a product's field performance

Photo: Craig White, Bayer

Laconik founder Dr Darren Hughes (left) is working with Bayer's market development team to generate data with a higher degree of integrity and quality to bring products to market. He is pictured with Craig White, Bayer agronomist and knowledge transfer and engagement lead.

Deciphering the effects of genotype, environment and management practices on crop performance is core to the science of crop agronomy, but for decades the main platform has been small, white-pegged, plot trials.

These small plots are often confined to discrete areas or fencelines of growers' paddocks to avoid intruding on commercial crops. This means they might not capture environmental spatial variability for problems such as root and leaf diseases and soil constraints.

"Small-plot trials remove real-world variables," says Dr Darren Hughes – and this was the driving interest for him to develop the startup company Laconik in 2017. Dr Hughes has built a software solution that changes small trials to 'swarm trials' across whole paddocks.

It is a way of also addressing the lack of adoption of trial findings by placing improved on-farm experimentation in growers' hands.

"Laconik is an enabling platform," Dr Hughes says. For example, he says many growers have the capability already on their seeders and spray rigs to apply chemicals at variable rates across their paddocks, but generally are not fully utilising these functions.

Laconik provides a way to use this data to create 'swarms' of trials across paddocks – capturing spatial variability and responses to a variety of fertiliser or chemical treatments, or different outcomes from crop variety or sowing rates.

The prescription maps created can be synced with major digital platforms.

These treatments are harvested with the crop and a yield map is generated. A profit gap map can then be generated from the crops' response to the swarm trials treatment, which could be either different rates of fertiliser, fungicide, insecticide or other treatment.

Laconik has worked with GRDC National Grower Network members and with GRDC support to investigate possible nitrogen carryover from frosted crops and aspects of fallow management.

The company is now partnering with several multinationals, which have started using the platform to evaluate new herbicides, fungicides and biological products.

INVESTMENT SUPPORT AND CHALLENGES

The nature of financial investment for agronomic-related startups needs to be carefully considered, Dr Hughes says.

"Unlike the 'fail-fast' methodology of building a typical startup, building a startup in agriculture (which is) focused on solving problems in the grains industry means we have to work with the annual nature of the growing season. It takes 12 months to develop a new feature, test it in the paddock and gather customer feedback."

Agriculture needs patient capital from supportive investors, he says.

"At Laconik, we have been lucky to have been supported with investment from GrainInnovate and Wavemaker, a Singapore-based venture capital firm. We have leveraged investment from Australian grain growers, with capital from Asia, and have deployed it to solve problems in the Australian grains industry."

Laconik will soon be undertaking its next capital raising to develop new software features and expand into the North American market. □

More information: Dr Darren Hughes, 0436 115 462, darren.hughes@laconik.com.au, laconik.com.au; Rick Horbury, head of market development Australia and NZ, Bayer Crop Science, 0429 055 154

CASE STUDY

FUNGICIDE PERFORMANCE AT THE WHOLE-PADDOCK SCALE

Tim Murphy is a market development agronomist for Bayer Crop Science based in SA. Mr Murphy and Bayer's market development team have been using Laconik to evaluate the grain yield and economic response to the fungicide Aviator® Xpro® at whole-of-paddock scale.

Aviator® Xpro® is registered for the control of blackleg and upper-canopy blackleg infections, Sclerotinia, alternaria and powdery mildew in canola.

"At this stage of product development, we have done the small-plot trial work to obtain the label registration for upper-canopy blackleg. In 2022 it was time to demonstrate the efficacy of Aviator® Xpro® at the grower level," Mr Murphy says.

Previously, growers would spray strips or half a paddock with a new product formulation and observe the efficacy and yield response. This approach does not always provide the most accurate comparison of a product response due to the spatial variability of a paddock.

"Product performance can be affected by a range of factors including soil type, slope and elevation, and air flow through the canopy, which can be highly spatially variable. Growers have been asking us to find a way to give them confidence in performance across a paddock in addition to our replicated trials," Mr Murphy says.

"So, with Laconik's swarm trial approach we can allow for this spatial variability more precisely, and capture a broader level of product performance and understanding. This results in a higher degree of confidence in the field performance of a product and its return on investment."

Figure 1a shows the swarm trial layout on a satellite map of the farm used to evaluate Aviator® Xpro® to control both upper-canopy blackleg and Sclerotinia in a canola crop. Figure 1b shows the trial responses in the raw yield data.

Disease response was ground-truthed in the swarm trials by sampling representative transects of canola plants. Each swarm trial can be easily located within the crop by recording GPS location from the spray machinery.

From this information both grain yield and economic 'heat maps' can be generated, highlighting the spatial variation across a paddock (Figures 1 and 2).

"In this example we used Laconik's enabling platform to demonstrate the benefit of Aviator® Xpro® fungicide application for the control of upper-canopy blackleg and, ultimately, yield. The resulting yield response can be seen in the return-on-investment maps," Mr Murphy says.

"By using the swarm trials across the paddock, we were able to show that the 680 and 800 millilitres per hectare rates of Aviator® Xpro® delivered the highest return on investment. Being able to work in this way with growers and their equipment to capture greater spatial responses to our products and demonstrate these returns has been fantastic.

"Not only does the Laconik platform enable growers to see and evaluate a fungicide's performance over greater paddock spatial variability, it builds capability amongst growers for this type of on-farm trial work as they are able to deploy the user-friendly platform, with minimal assistance from Laconik, themselves."

Figure 1: a) Swarm trial layout to evaluate responses to different rates of Aviator® Xpro® in Pioneer® 45Y93 CL canola, South Australia 2022. b) Raw yield responses following Aviator® Xpro® application in Pioneer® 45Y93 CL canola, South Australia 2022.

a) Swarm trial layout

Treatments

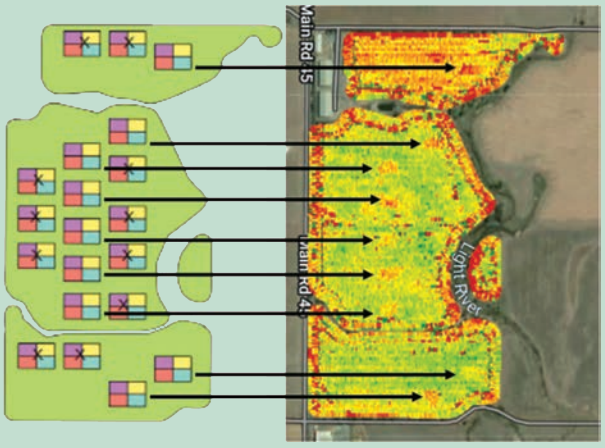
Treatment	Area (ha)	Rate (ml/ha)
UTC	3	0
Aviator® Xpro®	3	560
Aviator® Xpro®	42	650
Aviator® Xpro®	3	680
Aviator® Xpro®	3	800

X = No trial

Trial layout

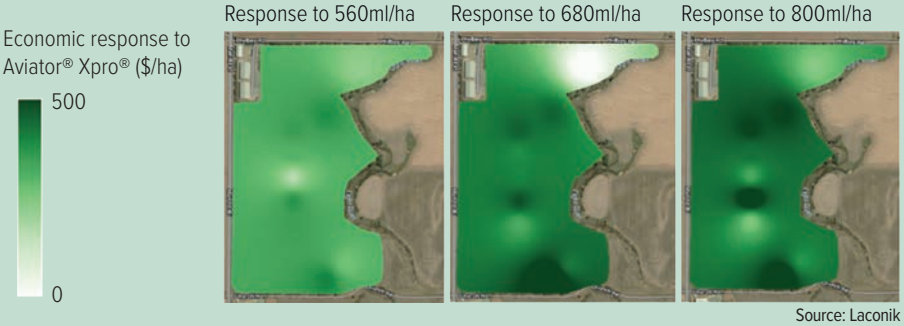
b) Raw yield responses

Raw grain yield data



Source: Laconik

Figure 2: Return on investment dollars per hectare ($ROI) paddock response to Aviator® Xpro® at three rates in Pioneer® 45Y93 CL canola, South Australia 2022.



Source: Laconik

Microbes building soils and new business

Photo: Loam Bio

Through a better understanding of the role microbes play in soil carbon cycles, Loam Bio is developing ways to simultaneously sequester carbon and boost crop yields.

By harnessing the power of microbes an innovative startup is partnering with growers to tackle climate change

With climate change and ecological sustainability top of mind for most grain growers, startup company Loam Bio is looking to address one of the key challenges – soil productivity – with seed inoculum products that can have potential to increase soil carbon in cropping systems.

Soils are the largest terrestrial carbon reservoirs, but intensive farming has meant that in agricultural soils this reservoir has been depleted by up to 60 per cent in some areas.

Loam Bio co-founder Tegan Nock says that by increasing soil carbon not only do we sequester more carbon, but also we improve soil health and structure, as well as increasing water-holding capacity and nutrient availability – boosting crop yields and system sustainability.

"The Loam Bio team is leveraging the mechanism that microbes use in natural systems to develop seed inoculums that build soil carbon," Ms Nock says. "It gives growers the ability to improve yields and stabilise soil carbon."

CARBON CYCLING AND MICROBES

Loam Bio is tapping into the improved understanding of carbon cycling. Atmospheric carbon dioxide is sequestered in soil via a multi-stage process. Plants first convert carbon dioxide into simple sugars via photosynthesis.

Some of these sugars are then secreted into soil in the form of root exudates. These substances are rich in labile carbon compounds and are utilised by microorganisms at the plant–soil interface. Through this process, carbon is eventually deposited in soil as soil organic carbon in aggregates and in mineral-associated fractions. The carbon is retained at varying rates, depending on a range of biotic and abiotic factors.

Soil microbial communities have diverse functions and physiology that can contribute to retaining and stabilising soil carbon. Emerging technologies have allowed researchers to identify and isolate soil microorganisms with these characteristics, and to develop microbial formulations that can enhance soil carbon.

"Since we acquired the foundational research from the University of Sydney and established the business in 2019, we have invested in a further 36 greenhouse trials, 198 small-plot trials and analysed 57,789 soil samples in the lab to substantiate and validate the research," Ms Nock says.

Identified through bioprospecting, Loam Bio has screened more than 2500 soil fungi for their performance and is focusing on a functional group of fungi known as dark septate endophytes. These are a diverse group of fungi that occur in all major ecosystems. They colonise plant roots, forming complex relationships with plants, and have been shown to improve growth, health and nutrition of the host plant. The plants and microbes work together to build carbon in the soil and keep it there in aggregates bound by fungal filaments.

"Loam's research and development has focused on applying these microbes as a live seed inoculum prior to sowing to help kick-start the relationship, and is continually evaluating its performance in boosting soil carbon levels and plant performance."

LOAM BIO SUPPORT AND COLLABORATION

"It is challenging to build stable soil carbon in cropping systems so to underpin our product development, we have established a strong science program partnering with global leaders to expand the understanding of our technology's impact," Ms Nock says.

Australian collaborations include Western Sydney University, the Australian National University and the University of Queensland, where the focus is on further developing and understanding various aspects of the technology.

The GrainInnovate program has provided ongoing support and strategic advice throughout the growth of Loam Bio's business, starting as a seed investor.

Funding from investors, including Horizons Ventures, CSIRO's Main Sequence Ventures, the Australian Government's Clean Energy Finance Corporation and GrainInnovate, has seen Loam Bio move from small-plot trials demonstrating total carbon increase against control of three per cent in barley and five per cent in canola, to an expanded

CASE STUDY

CARBON CAPTURE FOR CROPS AND CLIMATE

Best-practice farming principles are fundamental for Steve Nicholson's farming business.

"A systems approach with attention to sound science is required to drive both profitability and sustainability of our farming system," Steve says.

"This involves attention to planning, preparing, controlling weeds and diseases, selecting the best variety for the best sowing time, operating well-maintained machinery and ensuring timely operations."

Steve is a member of Loam Bio's SecondCrop carbon project program, which combines the use of Loam Bio's recently released CarbonBuilder microbial technology with grower-first projects.

SecondCrop refers to taking a second crop from a paddock in the form of carbon credits.

Steve operates 'Eniver', a mixed farm of about 4000 hectares between Forbes and Grenfell in New South Wales. Annual rainfall is 620 to 650 millimetres and the soils range from heavy black to red gravels. About 2500 breeding ewes are run on the property, peaking at up to 5000 head with lambs, while cattle are opportunistically stocked mainly in the creek country, with steers bought in, fattened and sold.

"Building soil carbon content is fundamentally a good thing as it is a source of healthier crops and pastures with bigger root systems, which drives our productivity," Steve says.

Steve has been farming Eniver for 22 years and in that time has adopted minimum-tillage practices and ensured constant ground cover to build carbon. He has been regularly soil testing and has seen organic carbon content rising every year. He has experimented with various soil amendments to boost soil health in the past, including phosphate solubilising bacteria. It is this pursuit of improving soil health that ignited his interest in the activities of Loam Bio.

"Loam Bio's endophytic fungi discovery is exciting, but it is also its innovative business model that could be a game changer," Steve says.

"If we can fix carbon in the soil in a less-labile form, we stand to not only boost soil health but also sequester carbon more effectively, reducing carbon dioxide release to mitigate climate change."

Steve is one of the first growers to use Loam's recently released CarbonBuilder seed inoculum outside of trials, and he is encouraged by the recently released 2022 small-plot trial data.

"This is entirely feasible with the total carbon increase seen in Loam's 2022 small-plot trial data for canola and barley of between three per cent to five per cent against controls.

"Loam Bio works with a grower to assess the carbon status of your paddocks and then to build it. Loam Bio's business model is to share the Australian carbon credit units generated, so there is little work or financial investment required by a grower."

national field trial program in 2023.

Understanding Loam's technology performance across the variability of conditions in Australian cropping – soil, weather, systems, inputs – is key, and Loam has grown its in-field trial program, partnering with agronomy networks, grower groups and corporates.

"We have partnered with leading companies like GrainCorp, along with agronomy networks, to ensure we are developing solutions that integrate into existing Australian cropping systems."

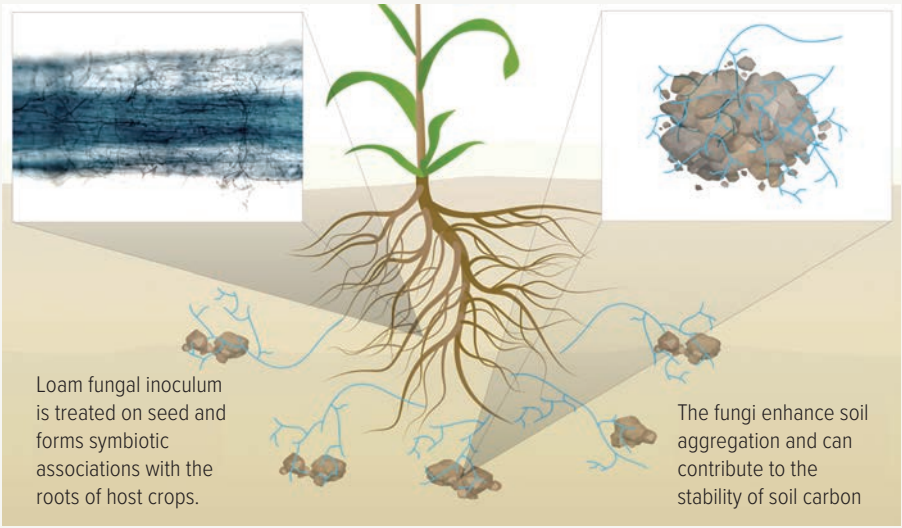
With its academic partners, Loam has developed the capabilities to better understand and measure stable carbon at-scale, which enables better management of carbon variability from season to season. This, coupled with a broad geographic trial program that seeks to understand building stable soil carbon across Australia's variable soils, is providing growers with greater confidence that stable soil carbon can be built in their systems. □

More information: loambio.com

Photo: Rachael Lenehan Photography

Loam Bio staff working with Steve Nicholson to build soil carbon on his property 'Eniver' to benefit both crops and climate.

Figure 1: Novel Loam Bio seed inoculum in action.



Source: Loam Bio

Computer vision verifies grain identity

Quality control of grain supply chains is set to be enhanced with new computer vision technology

■ Artificial intelligence, computer vision and the Internet of Things are the technical ingredients behind new methods to improve the accuracy and efficiency of grain analysis.

The technology stands to replace time-consuming visual analysis with a fast, objective measurement process.

A technology and spin-off company, ZoomAgri, is the result of two Argentinian grain traders, Fernando Miguel Martinez de Hoz and Jacob Rommelaar, teaming in 2017 with electrical engineer Matias Micheloud.

Leveraging artificial intelligence, computer vision and the Internet of Things, they are providing accurate, reliable and efficient quality assessment.

ZoomAgri's Asia-Pacific regional manager, Nicolas Martelli, says the technology provides real-time results and eliminates the need for visual testing. He says this allows everyone in the supply chain to make decisions based on reliable and consistent data.

"Being able to better measure quality allows all supply chain stakeholders to be more efficient," Mr Martelli says.

"Accurately determining the quality and purity of grain before transporting or processing helps reduce overall waste."

Matt Devine, GRDC manager value chain innovation, says there has been quite a lot of development in hyperspectral imaging in recent years.

"Combined with advances in computing power, these two factors provide an opportunity to explore new solutions to faster and consistent sample testing to deliver time and accuracy savings to Australian growers."

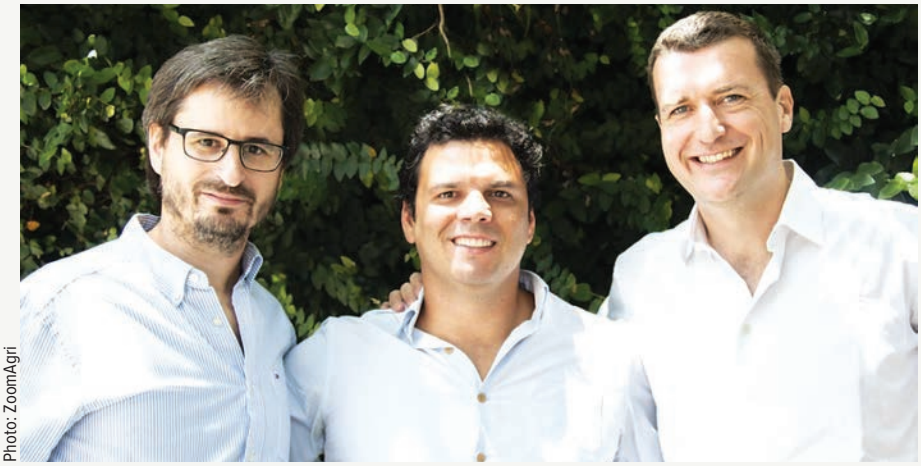


Photo: ZoomAgri

ZoomAgri co-founders (from left) Matias Micheloud, Fernando Miguel Martinez de Hoz and Jacob Rommelaar.

PRODUCTS

ZoomAgri has two products: ZoomAgriOne, which can determine the variety of barley and wheat, and ZoomAgriSpex, which can determine the quality of coarse grains and oilseeds including corn, soybeans, wheat and barley.

ZoomAgriSpex specifies a number or percentage of broken kernels, skinnings, foreign matter, defects, colour, shape and sieve size. ZoomAgri's aim, in Australia, is to replicate visual assessments.

A scanner is used to capture an image of a sample, which is processed using ZoomAgri's proprietary neural networks (a common term for machine learning) that use algorithms to compare the scanned images with preloaded images. The networks are 'trained' to classify the sample based on the visual quality traits for that variety and provide results within three minutes.

"By training the artificial intelligence to recognise the quality and variety of grains or oilseeds, ZoomAgri produces consistent results with a minimum of 98 per cent accuracy," Mr Martelli says.

The database for this contains more than 200 million images of individual grains and oilseeds.

PARTNERSHIPS

"To develop ZoomAgriOne in Australia, we have partnered with InterGrain, one of the largest plant breeders in the country, to provide us with the high-purity samples required to train our AI algorithms," Mr Martelli says.

"We have established a strong customer base with some of the biggest maltsters and handlers in the world, including AB InBev, Cargill, Malteries Soufflet, Boortmalt, ADM, Bunge, Cargill Dreyfus, Viterra and COFCO. As well as working with InterGrain in Australia, we work with Malteurop, Coopers, Riordans, the Department of Primary Industries and GrainCorp."

GrainInnovate investment and support have enabled ZoomAgri to accelerate the development and deployment of its grain variety recognition technology. This investment facilitates further innovation and refinement of the technology, leading to new applications and increased market reach.

CHALLENGES

Developing its solution was not without challenges, Mr Martelli says.

"One of the key challenges we faced was in developing and training our proprietary neural networks to accurately classify a wide range of agricultural commodities across different regions and growing conditions," he says.

"This required significant investment

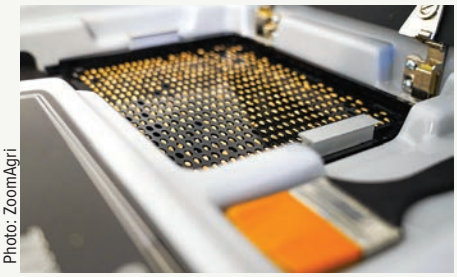


Photo: ZoomAgri

A ZoomAgriOne unit assessing wheat purity.

Jeremy Thiblet, Malteurop Australia and New Zealand regional operations manager.

Photo: Malteurop

in data collection and processing, as well as ongoing refinement and improvement of our algorithms to ensure accuracy and consistency.

"Another challenge was developing a reliable and robust hardware device that could capture high quality images in different environments and under varying lighting conditions. This required extensive testing and optimisation to ensure that our scanners could consistently produce accurate and reliable data.

"Additionally, we faced challenges in gaining the trust and buy-in of industry stakeholders who were used to traditional testing methods and sceptical of new technologies. To address this, we invested in building strong relationships with industry partners and educating them on the benefits of our solution through targeted marketing and outreach efforts.

"As a global company, we also needed to adapt our technology and approach to the unique cultural, regulatory and market conditions of each country we entered."

Today, ZoomAgri has customers in 24 countries across six continents. □

More information: Nicolas Martelli, nicolas.martelli@zoomagri.com, zoomagri.com; Jeremy Thiblet, jeremy.thiblet@malteurop.com

CASE STUDY

PURITY VERIFICATION IN THE MALT INDUSTRY

Although the origins of malting are buried in ancient times and probably date back to Egyptian days, the science and specifications of the process continue to be at the forefront of technology.

Malting is the biological process of turning barley into malt and involves three stages: steeping, germination and kilning to dry and stabilise the malt. As each barley variety contains different starches and enzymes that are involved in these stages and behave differently, the malt conditions are customised for each variety.

For this reason, the varieties are segregated when they are grown, stored, shipped and processed, and must be of high quality and purity.

Jeremy Thiblet, Malteurop's Australia and New Zealand regional operations manager, says Malteurop's commitment to its malt business starts before any grain enters the process.

"We ensure our suppliers are aware of our quality standards and work with them to ensure they are met," Mr Thiblet says.

"To do this we have rigorous attention to detail when it comes to incoming grain inspections and testing procedures."

To make sure the company stays ahead of the curve for managing quality on-site, it has been investing in technology that can verify purity of the barley varieties received.

"Where previously we were using the human eye to differentiate between barley varieties, which was fallible and time-consuming, we are now adopting machine vision technology to reduce errors and improve efficiencies by providing real-time information."

For the past two years, every load of malt barley received at Malteurop's plants has been tested using ZoomAgriOne to ensure it meets at least 90 per cent purity.

"This means that we know exactly how to set our specifications to optimally malt each load that is processed through the malt house," Mr Thiblet says.

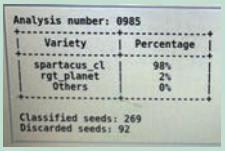
"We have randomly cross-checked samples with genetic analysis and this has confirmed the accuracy of ZoomAgriOne's analysis.

"ZoomAgri also calibrates the machine several times a year and can recalibrate remotely, which is a great advantage."

Mr Thiblet says rejecting barley loads that do not meet purity specifications can be costly and inefficient for growers, maltsters and brewers.

"Being able to have full confidence in the purity of a load creates good traceability throughout the supply chain."

ZoomAgriOne deployed at Malteurop Geelong barley receival point.



Photos: Malteurop

GRAINNOVATE
INVESTMENT PORTFOLIO

FARM CONNECTIVITY

FLEET

zetifi

FARMTECH

SWARM FARM ROBOTIC AGRICULTURE

ALTERRATECH

BioScout

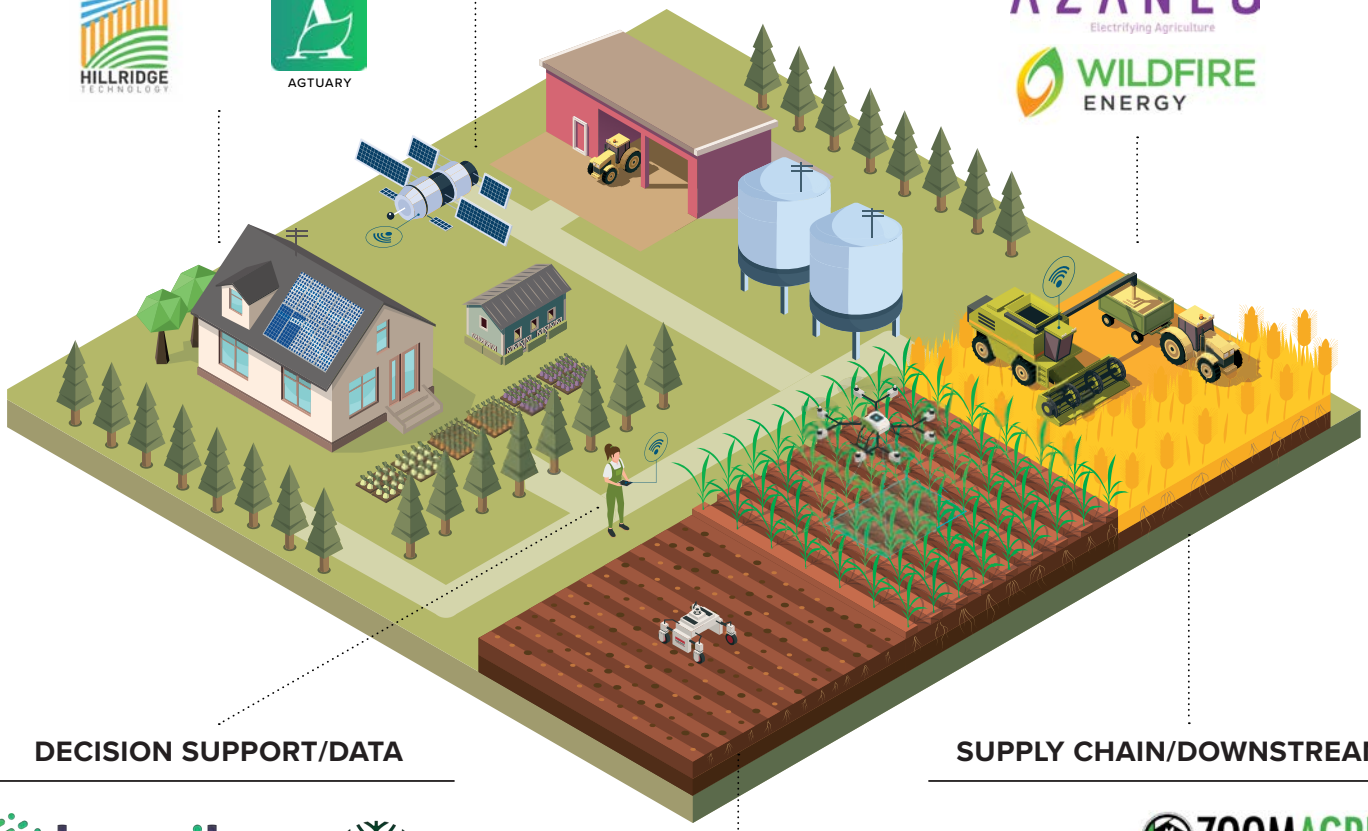
AZANEO
Electrifying Agriculture

WILDFIRE ENERGY

FINTECH

HILLRIDGE TECHNOLOGY

AGTUARY



DECISION SUPPORT/DATA

laconik

DATA FARMING

regrow

FARMLAB

VERGEAG

PAIRTREE

SUPPLY CHAIN/DOWNSTREAM

ZOOMAGRI

Whole.

ISD

TELESENSE

BIOTECH

loam

sustinent:::

artesian

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION