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THE AUSTRALIAN AGRONOMIST MAGAZINE

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Recent detections of Brown Marmorated Stink Bug

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THE AUSTRALIAN AGRONOMIST

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TO PREDICT DROUGHTS, DON'T LOOK AT THE SKIES. LOOK IN THE SOIL... FROM SPACE

TO BE SURE, AUSTRALIA IS LARGE ENOUGH TO USUALLY LEAVE SOME PART OF OUR COUNTRY WAITING FOR RAIN. SO WHAT EXACTLY IS A DROUGHT, AND HOW DO WE KNOW WHEN WE ARE IN IT?

This question matters, because declaring drought has practical implications. For example, it may entitle those affected to government assistance or insurance pay-outs.

But it is also a surprisingly difficult question. Droughts are not like other natural hazards. They are not a single extreme weather event, but the persistent lack of a quite common event: rain. What's more, it's not the lack of rain per se that ultimately affects us. The desert is a dry place but it cannot always be called in drought.

Ultimately, what matters are the impacts of drought: the damage to crops, pastures and environment; the uncontrollable fires that can take hold in dried-up forests and grasslands; the lack of water in dams and rivers that stops them from functioning. Each of these impacts is affected by more than just the amount of rain over an arbitrary number of months, and that makes defining drought difficult.

Scientists and governments alike have been looking for ways to measure drought in a way that relates more closely to its impacts. Any farmer or gardener can tell you that you don't need much rain, but you do need it at the right time. This is where the soil becomes really important, because it is where plants get their water.

Too much rain at once, and most of it is lost to runoff or disappears deep into the soil. That does not mean it is lost. Runoff helps fill our rivers and waterways. Water sinking deep into the soil can still be available to some plants. While our lawn withers, trees carry on as if there is nothing wrong. That's because their roots dig further, reaching soil moisture that is buried deep.

A good start in defining and measuring drought would be to know how much soil moisture the vegetation can still get out of the soil. That is a very hard thing to do, because each crop, grass and tree has a different root system and grows in a different soil type, and the distribution of moisture below the surface is not easy to predict. Many dryland and irrigation farmers use soil sensors to measure how well their crops are doing, but this does not tell us much about the rest of the landscape, about the flammability of forests, or the condition of pastures.

Soils and satellites

As it turns out, you need to move further away to get closer to this problem – into space, to be precise. In new research, published in Nature Communications, they show just how much satellite instruments can tell us about drought.

"By combining these data with a computer model that simulates the water cycle and plant growth, we created a detailed picture of the distribution of water below the surface."

The satellite instruments have prosaic names such as SMOS and GRACE, but the way they measure water is mind-boggling. For example, the SMOS satellite unfurled a huge radio antenna in space to measure very specific radio waves emitted by the ground, and from it scientists can determine how much moisture is available in the topsoil.

Even more amazingly, GRACE (now replaced by GRACE Follow-On) was a pair of laser-guided satellites in a continuous high-speed chase around the Earth. By measuring the distance between each other with barely imaginable accuracy, they could measure miniscule changes in the Earth's gravitational field caused by local increases or decreases in the amount of water below the surface.

By combining these data with a computer model that simulates the water cycle and plant growth, we created a detailed picture of the distribution of water below the surface.

It is a great example showing that space science is not just about galaxies and astronauts, but offers real insights and solutions by looking down at Earth. It also shows why having a strong Australian Space Agency is so important.

Taking it a step further, we discovered that the satellite measurements even allowed us to predict how much longer the vegetation in a given region could continue growing before the soils run dry. In this way, we can predict drought impacts before they happen, sometimes more than four months in advance.

Map showing how many months ahead, on average, drought impacts can be predicted with good accuracy. author provided

This offers us a new way to look at drought prediction. Traditionally, we have looked up at the sky to predict droughts, but the weather has a short memory. Thanks to the influence of ocean currents, the Bureau of Meteorology can sometimes give us better-than-evens odds for the months ahead (for example, the next three months are not looking promising), but these predictions are often very uncertain.

Our results show there is at least as much value in knowing how much water is left for plants to use as there is in guessing how much rain is on the way. By combining the two information sources we should be able to improve our predictions still further.

Many practical decisions hinge on an accurate assessment of drought risk. How many firefighters should be on call? Should I sow a crop in this paddock? Should we prepare for water restrictions? Should we budget for drought assistance? In future years, satellites keeping an eye on Earth will help us make these decisions with much more confidence.

UNRAVELING OF 58-YEAR-OLD CORN GENE MYSTERY MAY HAVE PLANT-BREEDING IMPLICATIONS

IN DISCOVERING A MUTANT GENE THAT "TURNS ON" ANOTHER GENE RESPONSIBLE FOR THE RED PIGMENTS SOMETIMES SEEN IN CORN, RESEARCHERS SOLVED AN ALMOST SIX-DECADES-OLD MYSTERY WITH A FINDING THAT MAY HAVE IMPLICATIONS FOR PLANT BREEDING IN THE FUTURE.

The culmination of more than 20 years of work, the effort started when, in 1997, Surinder Chopra, professor of maize genetics at Penn State, received seeds from a mutant line of corn. At the time, Chopra was a postdoctoral scholar at Iowa State University, and he brought the research with him when he joined the Penn State faculty in 2000.

The mystery involved a spontaneous gene mutation that causes red pigments to show up in various corn plant tissues, such as kernels, cobs, tassels, silk and even stalks, for a few generations and then disappear in subsequent progeny. It might seem like a minor concern to the uninitiated, but because corn genetics have long been studied as a model system, the question has significant implications for plant biology.

"In corn, genes involved in pigment biosynthesis have been used in genetic studies for more than a century -- pigmentation in corn is a relatively simple trait, which makes it ideal for use as a marker for genetic research," Chopra said. "The mutant corn plants were identified in 1960 by Dr. Charles Burnham (University of Minnesota), and that seed was given to one of his students, Derek Styles. We received the seed from Styles in 1997, and we were entrusted to continue the research."

Chopra led efforts to introgress the genes from the mutant corn, dubbed Ufo1 -- Unstable factor for orange[1] -- into various inbred corn lines to be studied. Since he came to Penn State, Chopra's research group in the College of Agricultural Sciences has grown and backcrossed lines of corn plants at both the Penn State Agronomy Farm and in greenhouses on campus. In the last three years, the researchers, who recently published their findings in The Plant Cell, have grown more than 4,000 of the backcrossed plants to map where the cause of Ufo1 is located in the genome.

Using tissues from those hybrid plants, and employing RNA-sequencing techniques and gene-cloning tools along with next-generation sequencing, genetic mapping, and data-analysis capabilities not available to plant geneticists until relatively recently, researchers unmasked the culprit in the on-again, off-again, red-pigment-in corn mystery. They found Ufo1, which is only present in corn, sorghum, rice and foxtail millet.

But the Ufo1 mutant gene does not actually cause the red pigments to appear in corn -- that is caused by a gene called the pericarp color1, or p1. Researchers found that the Ufo1 gene is actually controlled by a transposon -- "jumping gene" -- that sits close to the Ufo1 gene. Transposons are sequences of DNA that move from one location in the genome to another, and can influence the expression of nearby essential genes.

When this transposon is switched on, the Ufo1 gene is also turned on, which triggers the p1 gene to signal the plant to produce the red pigments. But when the transposon is off, the Ufo1 gene goes silent and so does the p1-controlled pigment pathway. That is the main reason the Ufo1 gene went unidentified for so long and the mystery persisted, according to Chopra.

"In corn, genes involved in pigment biosynthesis have been used in genetic studies for more than a century - pigmentation in corn is a relatively simple trait, which makes it ideal for use as a marker for genetic research."
Professor Surinder Chopra

Researchers believe the mystery gene that triggers the mutant red pigments in corn may be a "master regulator" responsible for an over-accumulation of sugars in the leaves and an increase in a natural insecticide in the silk. Credit: Surinder Chopra Research Group/Penn State.

"We were able to narrow it down to a single gene out of several thousand genes that are aberrantly expressed in the Ufo1 mutant versus the wild-type plant," he said. "It is an incremental discovery, and yet it is a leap in basic science because it is likely to be valuable to plant breeders."

It is still not entirely clear how Ufo1 interacts with the p1 gene. The discovery's future significance likely will be less associated with red pigments than what the Ufo1 mutant gene controls in corn plants. Chopra believes it may be a "master regulator" that, when overexpressed, signals the plant that it is under stress, even in the absence of stress. Interestingly, Chopra pointed out, in Ufo1 plants, sugars over-accumulate in leaves, and the content of maysin, a natural insecticide made by corn plants, sharply increases in the silk.

"Learning about what controls the regulation of the normal or the non-mutant Ufo1gene will bring us much closer to a realistic breeding process in which we can tinker with gene expression to get higher maysin content or increased sugar content, which would be important in crop protection from pests and biofuel production, respectively," Chopra said.

"And, because it has a pronounced effect on the workings of the cellular machinery, we can now understand further the basic molecular pathway that normally happens during a stress to a plant," he said. "Understanding plant stress resulting from extremes of heat, cold and water is important because of climate change."

Photo credit: Surinder Chopra Research Group/Penn State.

Journal Reference:
Kameron Wittmeyer, Jin Cui, Debamalya Chatterjee, Tzuu-fen Lee, Qixian Tan, Weiya Xue, Yinping Jiao, Po-Hao Wang, Iffa Gaffoor, Doreen Ware, Blake C. Meyers, Surinder Chopra. The dominant and poor penetrant phenotypes of the maize mutation Unstable factor for orange1 are caused by DNA methylation changes at a linked transposon. The Plant Cell, 2018; tpc.00546.2018 DOI: 10.1105/tpc.18.00546

SCIENTISTS URGED TO FIGHT GMO FAKE NEWS

Professor Conway

Scientists must speak out about the benefits of new genetic technologies such as genetically modified organisms (GMOs) and gene editing, according to The University of Queensland's new Director of Crop Science, Professor Ian Godwin.

Ian is the author of Good Enough to Eat?, a new book about new genetic plant and animal breeding technologies.

It charts the history of genetically modified foods from the laboratory to the global dinner plate, and outlines the huge potential of new gene editing technologies, such as CRISPR.

He hopes the book will help end fear and misinformation generated by "fake news" about the safety of genetically modified foods.

"The future of billions of people literally depends on changing the narrative about how we view genetically modified food and genetic technologies," Ian said.

"If we are to produce more sustainable and nutritious food to meet the growing global demand – in the face of challenges from pests and diseases, eroded soils, lack of water and climate change – we need to be able to take the best from the latest genetic technologies and from organic and agro-ecological farming practices."

With 30 years' experience in agribiotechnology across crops ranging from sorghum, wheat and barley to beans and taro, Professor Godwin calls genetic technologies – such as CRISPR gene editing – a biological revolution.

"Genetically modified, or GM, crops use 37 per cent less pesticide, and increase crop yields by 22 per cent and farmer profits by 68 per cent – and the promise of new genome editing techniques is simply astonishing," Ian continued.

"But we have to stop pretending that 'natural is best' and challenge the notion that organic food companies are not actually big global companies with a conflict of interest when it comes to the GMO debate."

He said environmental groups that worked to restrict countries from growing or receiving GM foods proven to be safe and effective should be held morally accountable for their actions.

Sir Gordon Conway – author of One Billion Hungry: Can We Feed the World? – has described Good Enough to Eat? as "a lively dialogue" that tackles the "highly vociferous and unprincipled opposition from some sectors of the public who choose to ignore facts and realities" about GM food.

"Ian Godwin is a first-class scientist and his book gives us answers how food can be grown and engineered to meet one of the world's most important challenges," Gordan said.

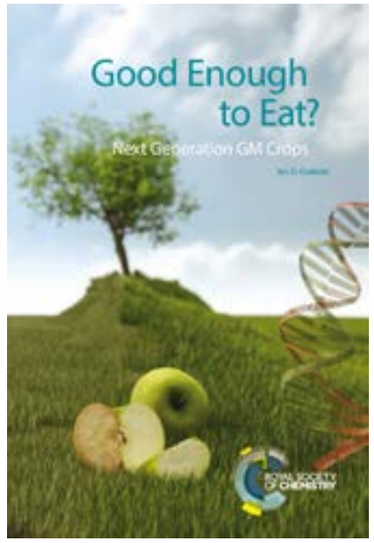
In the book, Ian describes his experiences eating some of the world's first gene-edited cabbage, prepared by Sweden's Chef of the Year 2010 Gustav Tradgårdh; a horror story working with celery; and his time as part of a sorghum and cotton team in Biloela in Central Queensland, where locals rushed to get washing inside before crop dusters flew overhead and dumped huge amounts of endosulfan and other chemicals on crops.

"In those days in peak season, spraying was happening every day in any given region, and some growers were spraying their crops up to 17 times per growing season to ward off caterpillars – but now GM cotton has reduced the need to spray for insects to once or twice per season."

Ian said genetic technologies would continue to play a critical role in world-leading crop science undertaken at UQ – which is ranked fourth globally in the field of agricultural science and has been recognised internationally for its plant breeding expertise.

"This is an exciting and challenging time for agriculture and the bio-economy," Ian said.

"Our focus will continue to be on improving crop productivity, food quality and sustainability in the crop sciences, and we will use every safe, effective and innovative tool in the toolbox to do so."



CULTIVATING INNOVATION IN AUSTRALIAN HORTICULTURE

Winston Churchill famously referred to gardening as the 'natural occupation of man' with Fellowships to be offered in his name in 2019 to encourage innovation within Australia's horticulture industry.

Under a partnership with Hort Innovation Australia, three Churchill Fellowships will be offered this year that will enable recipients to travel the world to access knowledge not readily available in Australia, harnessing it and growing the nation's collective horticultural knowledge by sharing it.

Some of Australia's foremost horticulturalists are Churchill Fellows including:

- Graham Anderson Avocado Grower
- Sally Dakis Cherry Grower
- Chris McColl Apple Grower
- Michael Silm Persimmon Grower

"As an industry, horticulture represents an important contributor to our nation's economy, and the Trust is excited to see how these Fellowships can impact Australia," said Churchill Trust CEO Mr Adam Davey.

"There are two things every Churchill Fellowship applicant needs to display – the first is to present a research project that will provide benefit to the Australian community.

"The second is showing how all of the skills, insights and knowledge they gather from world experts on the Fellowship can be shared once they return home."

Belinda Hazell was the proud recipient of the Hort Innovation Churchill Fellowship in 2018 and will travel to New Zealand, the United Kingdom, Ireland and the Netherlands this year to investigate the use of horticultural quality assurance standards to stay ahead of social license demands.

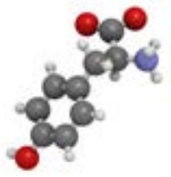
Adam said that the Churchill Trust is looking for Australians like Belinda, with even just a seed of an idea, to apply for these new Fellowships that are designed to drive innovation and transformation in the horticulture industry.

Hort Innovation is one of the nation's 15 Rural Research and Development Corporations, focused on supporting primary producers and growing the future productivity and profitability of Australia's fruit, vegetable, nut, plant and tree industries.

A recent study commissioned by Hort Innovation suggested the industry outperforms the average business in Australia when it comes to innovation – with almost 80 per cent of horticultural producers reporting some form of innovation, whether it was new to the farm or new to the industry.

Applications close 30 April 2019.

DUAL CONTROL: PLANT PEPTIDE HORMONE GENERATES DISTINCT CELL STRUCTURES FOR WATER FLOW



Water flow through plants is critical to our food supply: without proper water flow, plants cannot carry out photosynthesis, grow or reliably produce flowers, fruit or seeds. Water flows within specialized structures from the roots, through the stem to the leaves, where its evaporation is regulated by microscopic pores called stomata. All the water-conducting structures are produced by tightly controlled developmental sequences: cells must divide to produce the necessary cell types in the correct place at the right time. But many details of how these complex developmental processes are controlled remain unclear.

Osaka University researchers, in collaboration with laboratories in China, Germany, and Japan, have revealed a key piece in the jigsaw of mechanisms that control plant cell development. The team found that a peptide hormone is the signaling molecule that controls the development of two completely different types of cells, both of which are involved in creating the cellular structures for water flow. The hormone does this by binding to two distinct receptors in the two locations. The team recently published their findings in Nature Plants.

The team used the small plant Arabidopsis (Thale cress), which grows and reproduces rapidly and has a smaller, simpler genome than most crop plants. Their research methods included genetic modification, studying the plant's anatomy by microscopy using fluorescent dyes, and producing mutant plants using the latest gene editing technologies.

The researchers showed that the genes encoding the peptide hormone CLE9/10 are active in cells that lead to the development of stomata in the leaf and also in cells that are precursors of water-conducting vessels (the xylem) in the root.

"In the primordial cells in leaves, binding of CLE9/10 to a protein receptor controls the number of stomatal pores," said lead author Pingping Qian. "But in the roots, it binds to a different protein receptor, and there it controls the production of xylem vessels."

As well as identifying these two different receptors, the study also revealed that a co-receptor protein is involved in the leaf signaling system.

"In animals, there are examples of signaling molecules that are perceived by multiple receptors," says corresponding author Tatsuo Kakimoto. "This study shows that the same types of signaling systems operate in plants. It is interesting that the two developmental processes, involving distinct receptors in different parts of the plant, generate completely different structures that are both essential for water flow. These results have implications for understanding how multiple processes in plant development are coordinated."

PLANTS CAN SMELL, NOW RESEARCHERS KNOW HOW

Plants don't need noses to smell. The ability is in their genes. Researchers at the University of Tokyo have discovered the first steps of how information from odor molecules changes gene expression in plants. Manipulating plants' odor detection systems may lead to new ways of influencing plant behavior.

The discovery is the first to reveal the molecular basis of odor detection in plants and was more than 18 years in the making.

"We started this project in 2000. Part of the difficulty was designing the new tools to do odor-related research in plants," said Professor Kazushige Touhara of the University of Tokyo.

Plants detect a class of odor molecules known as volatile organic compounds, which are essential for many plant survival strategies, including attracting birds and bees, deterring pests, and reacting to disease in nearby plants. These compounds also give essential oils their distinctive scents.

Touhara's team exposed tobacco cells and 4-week-old tobacco plants to different volatile organic compounds. They discovered that odor molecules change gene expression by binding to other molecules called transcriptional co-repressors that can turn genes on or off.

In plants, the odor molecules must move into the cell and accumulate before they affect plant behavior. In animals, odor molecules are recognized by receptors on the outside of cells in the nose and immediately trigger a signaling pathway to recognise the odor and change behavior.

"Plants can't run away, so of course they react to odors more slowly than animals. If plants can prepare for environmental change within the same day, that is probably fast enough for them," said Touhara.

Speed is unnecessary for plants, but they may be able to recognize a much greater variety of odor molecules.

"Humans have about 400 odor receptors. Elephants have about 2,000, the largest number in animals. But based on how many transcription factor genes are in plants, plants may be able to detect many more odors than animals," said Touhara.

Touhara imagines applying these discoveries to influence crop quality or character without the complications of gene editing or pesticide use. Farmers could spray their fields with an odor associated with a desired plant behavior. For example, an odor that triggers plants to change the taste of their leaves to deter insects.

"All creatures communicate with odor. So far, our lab has studied within-species communication: insect to insect, mouse to mouse, human to human. This understanding of how plants communicate using odor will open up opportunities to study 'olfactory' communication between all creatures," said Touhara.

The University of Tokyo research team made their discoveries using tobacco plants, a common model organism. They expect research teams around the world will soon verify the discovery in many other types of plants.

Tobacco plants growing on a farm in North Carolina, USA. Researchers at the University of Tokyo used tobacco seedlings, a common model organism in research labs, to study how plants smell. The discovery is the first to reveal the molecular basis of odor detection in plants. Image courtesy of United States Department of Agriculture (USDA).

HARVESTING WILD GENES GIVES CROPS RENEWED RESISTANCE TO DISEASE

A GLOBAL ALLIANCE OF RESEARCHERS HAS PIONEERED A NEW METHOD TO RAPIDLY RECRUIT DISEASE-RESISTANCE GENES FROM WILD PLANTS FOR TRANSFER INTO DOMESTIC CROPS. THE TECHNIQUE PROMISES TO REVOLUTIONISE THE DEVELOPMENT OF DISEASE-RESISTANT VARIETIES FOR THE GLOBAL FOOD SUPPLY.

The technique called AgRenSeq was developed by scientists at the John Innes Centre in Britain working with colleagues in Australia and the US. It was recently published today in Nature Biotechnology.

The result speeds up the fight against pathogens that threaten global food crops, including wheat, soybean, maize, rice and potato, which form the vast bulk of cereals in the human diet.

Professor Harbans Bariana from the Sydney Institute of Agriculture and the School of Life and Environmental Sciences is a global expert in cereal rust genetics and a co-author of the paper.

He said: "This technology will underpin fast-tracked discovery and characterization of new sources of disease resistance in plants."

The current research builds on previous collaborative work done by Harbans with the CSIRO and John Innes Centre. It used two wheat genes cloned by this international team as controls and Harbans conducted the phenotype assessments for the study.

AgRenSeq lets researchers search a library of resistance genes discovered in wild relatives of modern crops so they can rapidly identify sequences associated with disease fighting capability.

From there researchers can use laboratory techniques to clone the genes and introduce them into elite varieties of domestic crops to protect them against pathogens and pests such as rusts, powdery mildew and Hessian fly.

Dr Brande Wulff, a crop genetics project leader at the John Innes Centre and a lead author of the study, said: "We have found a way to scan the genome of a wild relative of a crop plant and pick out the resistance genes we need: and we can do it in record time. This used to be a process that took 10 or 15 years and was like searching for a needle in a haystack.

"We have perfected the method so that we can clone these genes in a matter of months and for just thousands of dollars instead of millions."

The research reveals that AgRenSeq has been successfully trialled in a wild relative of wheat - with researchers identifying and cloning four resistance genes for the devastating stem rust pathogen in the space of months. This process would easily take a decade using conventional means.

The work in wild wheat is being used as a proof of concept, preparing the way for the method to be utilised in protecting many crops which have wild relatives including, soybean, pea, cotton, maize, potato, wheat, barley, rice, banana and cocoa.

Professor Harbans Bariana with wheat. Credit: University of Sydney

“We have perfected the method so that we can clone these genes in a matter of months and for just thousands of dollars instead of millions.”

Professor Harbans Bariana

Modern elite crops have, in the search for higher yields and other desirable agronomic traits, lost a lot of genetic diversity especially for disease resistance.

Reintroducing disease resistance genes from wild relatives is an economic and environmentally sustainable approach to breeding more resilient crops. However, introgression of these genes into crops is a laborious process using traditional breeding methods.

The new method combines high-throughput DNA sequencing with state-of-the-art bioinformatics.

"What we have now is a library of disease resistance genes and we have developed an algorithm that enables researchers to quickly scan that library and find functional resistance genes," said Dr Sanu Arora, the first author of the paper from the John Innes Centre.

Brande said: "This is the culmination of a dream, the result of many year's work. Our results demonstrate that AgRenSeq is a robust protocol for rapidly discovering resistance genes from a genetically diverse panel of a wild crop relative," he said.

"If we have an epidemic, we can go to our library and inoculate that pathogen across our diversity panel and pick out the resistance genes. Using speed cloning and speed breeding we could deliver resistance genes into elite varieties within a couple of years, like a phoenix rising from the ashes."

NEW ANALYTICS PLATFORM TO HELP FUTURE-PROOF FARMS

Australia's national science agency, CSIRO and rural technology start-up Digital Agriculture Services (DAS) recently launched an innovative new platform that combines artificial intelligence, machine learning and cloud-based geospatial technology to deliver reliable, independent and robust farm data and analytics.

The Rural Intelligence Platform is the first ever software to comprehensively assess and monitor rural land anywhere in Australia, drawing on information from trusted data sources on productivity, water access, yield, land use, crop type, rainfall, drought impact and more.

"The platform brings together in one place and refines a range of technologies developed by CSIRO in order to provide a picture of what has happened on a property over the years as well as the current situation," CSIRO Agriculture and Food Deputy Director, Dr Michael Robertson said.

The platform uses satellite imagery to track paddocks and their performance over time. Information from Australia's digital soil map is incorporated and climate information interpreted to show drought, frost, heat stress for livestock and other risks.

"The Rural Intelligence Platform will help the agribusiness community calculate the risks associated with certain investments or management decisions," Michael said.

DAS estimates that annually around $125 billion in agricultural economic decisions in Australia are based on unreliable or incomplete data.

"The platform provides accurate information that can help to identify vulnerability or the most promising options for investment that will build resilience," Michael said.

"This is a whole new model for rural analytics which will make it easier to quantify risk and prepare for challenges like climate volatility and change."

The Rural Intelligence Platform analyses data from a range of sources using machine learning algorithms to make sense of the data with a clarity that wasn't possible before.

The platform incorporates an AI-initiated Automated Valuation Model that is capable of valuing rural properties instantly with up to 90 per cent accuracy. Previously this was only possible for residential properties, where there are a wide range of valuation and analytic tools for real estate.

Since it was established in partnership with CSIRO in 2017, Melbourne-based DAS has secured a total of $4.25 million in funding from founding equity and R&D partner CSIRO, Australian ASX-listed agribusiness Ruralco and private investors.

DAS is already working closely with a number of leading companies to pilot the Rural Intelligence Platform, with some of the strongest uptake coming from the property, financial services and insurance sectors.

"Digital agriculture is far more than just on-farm technology, it's also about improving off-farm decision making and this platform lays the foundation for Australia to become a leader in new generation agricultural analytics," DAS CEO Anthony Willmott said.

"This is about supporting the ecosystem that supports the farmer – ensuring that farmers, business, policy makers and anyone invested along the agricultural ecosystem has the right rural data to make more informed decisions."

The market for digital agriculture in the Asia Pacific region is estimated to be worth $10-25 billion by 2028, fueled by pressure to meet challenges from population growth and climate change.

Digital Agriculture Services chief executive Anthony Wilmott

RISING TEMPERATURES MAY SAFEGUARD CROP NUTRITION AS CLIMATE CHANGES

Recent research has shown that rising carbon dioxide levels will likely boost yields, but at the cost of nutrition. A new study in Plant Journal from the University of Illinois, U.S. Department of Agriculture Agricultural Research Service (USDA-ARS), and Donald Danforth Plant Science Center suggests that this is an incomplete picture of the complex environmental interactions that will affect crops in the future -- and rising temperatures may actually benefit nutrition but at the expense of lower yields.

Two years of field trials show that increasing temperatures by about 3 degrees Celcius may help preserve seed quality, offsetting the effects of carbon dioxide that make food less nutritious. In soybeans, elevated carbon dioxide levels decreased the amount of iron and zinc in the seed by about 8 to 9 percent, but increased temperatures had the opposite effect.

“Iron and zinc are essential for both plant and human health,” said Ivan Baxter, a principal investigator at the Danforth Center. “Plants have multiple processes that affect the accumulation of these elements in the seeds, and environmental factors can influence these processes in different ways, making it very hard to predict how our changing climate will affect our food.”

“This study shows that a trade-off between optimising yields for global change and seed nutritional quality may exist,” said co-principal investigator Carl Bernacchi, a scientist at the USDA-ARS, which funded the research along with the USDA National Institute of Food and Agriculture.

The team tested the soybeans in real-world field conditions at the Soybean Free-Air Concentration Experiment (SoyFACE), an agricultural research facility at Illinois that is equipped to artificially increase carbon dioxide and temperature to futuristic levels.

“It’s a very controlled way of altering the growing environment of crops in agronomically relevant situations where the plants are planted and managed exactly like other fields in the Midwestern United States,” Carl said, who is also an assistant professor of plant biology and crop sciences at Illinois’ Carl R. Woese Institute for Genomic Biology.

Next, they plan to design experiments to figure out the mechanisms responsible for this effect.

EARLY IDENTIFICATION ALLOWS MORE EFFECTIVE WEED CONTROL

Weed identification is a valuable skill and most farmers can identify the common and important weeds on their farms. For most non-botanists, identification is easiest when the plant is mature and flowering – but to be effective, weed control decisions need to be made well before flowering.

With the increasing prevalence of herbicide resistance across all farming regions, accurate identification at early growth stages is essential to ensure the best control strategies are implemented when the weeds are at their most susceptible growth stage.

Dr David Thornby, Innokas Intellectual Services says the resistance profiles, even for closely related species, can be quite different, especially at the seedling stage.

“As part of a Cotton Research and Development Corporation project we have developed a new weed identification mobile app called ‘Weeds of Australian Cotton’ that provides a key to the characteristics of 50 weed species in cotton,” he says. “Clearly, the app will also have value for use in managing weeds in other crops grown in the same regions as cotton.”

The app allows users to make selections based on the observed characteristics of the plant, stem, leaves, flowers and seeds, the fleshiness or succulence of the plant and the presence of milky sap or latex. For grasses, users can key in specific details about the inflorescence, spikelet, floret and ligule features. As each detail is added the number of possible species reduces, until a few or just one remains as the best fit for the characteristics selected.

“Once there are just a few remaining options, the user can look at the photo gallery and choose the best-fit identification,” says David.

“The feature that really sets this app apart from other weed identification apps is that ‘Weeds of Australian Cotton’ includes a ‘cotyledon shape’ characteristic selection.”

“There are nine different cotyledon shapes to choose from. Using this feature of the app alone, users can quickly narrow down the most likely identification, and make decisions early regarding the best mix of weed control strategies to implement.”

Using the cotyledon shape as the only diagnostic selection, the 50 possible species can be rapidly narrowed down to less than eight possibilities in most cases. When cotyledons are present on very small plants found in the field, accurate identification can give growers a head start on planning a spray application.

The timing of herbicide application is product-specific but the general recommendation is for weeds to be ‘small and actively growing’. As a rule of thumb, ‘small’ would include pre-tillering for most grass species, less than 5 cm diameter for most rosette-forming species, and up to about 5 true leaves for other types of broadleaf species. As for ‘actively growing’, this is simply the absence of visible signs of moisture stress.

“Coverage is probably the most important factor to consider if weeds were sprayed at cotyledon stage,” says David. “Where feasible, increasing the water rate is the usual response, but it can be hard to hit such genuinely small targets. At this very small size good control could be expected, but they would have to come in contact with the chemical and so it is often practical to compromise by waiting until a couple of true leaves are present.”

“It is essential that label instructions are followed regarding weed size, product rate and application method as they apply to each product and weed species to achieve the best weed control result.”

It is best not to make too many assumptions about the weed spectrum present based on what was observed in the previous year. David emphasises the need for accurate identification and highlighted the fact that the app does not include every possible plant that could be growing on a cotton farm.

“The app only includes the 50 species that the development team identified as the key species affecting cotton production,” he says. “Misidentification is certainly possible, so if the options remaining at the end of your selections do not clearly match the plant you are looking at in the field, it is necessary to confirm identification with an expert, especially if the weed is proving hard to kill.”

The app is available for both iOS and Android mobile devices – search ‘Weeds of Australian Cotton’ on the Apple App Store or Google Play; or visit www.cottoninfo.com.au

A BEACON FOR WOMEN IN AGRICULTURE

For the past two and a half years, Susie Murphy White has been an Industry Project Manager for Pomewest, where she has established a reputation as the go-to technical expert among WA apple and pear growers.

Her instrumental advisory role in the Future Orchards® program, unflappable enthusiasm, expertise and commitment to helping WA pome fruit growers add value to their businesses in that role was recognized in June 2018 when was awarded APAL's 2018 Award for Excellence – Women in Horticulture.

Susie's was an unconventional route to the industry: before finding her passion in the apple and pear industry, she had spent most of her professional life in natural resource management, which included farm planning, salinity management, and revegetation for biodiversity in WA's wheatbelt.

"Growing up on a wheat and sheep farm, I'd spent most of my time giving recommendations to fill dry dams and reclaim salty land in the eastern wheatbelt – who knew it would lead to apples in WA's South West region?" she said.

Today, Susie's dynamic role ensures no two days on the job are the same. Through the Future Orchards initiative, she works closely with WA growers to equip them with practical, hands-on tools to boost fruit quality and productivity, as well as competitiveness on the world stage. Susie visits orchards to share cutting-edge industry insights and conducts trials and demonstrations with growers.

"It's just so important that we get out of our office and get into the orchard to make sure what we are doing is real," she said. "I love working with growers and seeing changes to management practices that improve their orchard production, profitability and sustainability."

Susie's Pomewest role also sees her connect orchardists at the forefront of innovation with industry events, on both a local and national scale. She believes that community ties are at the core of the WA pome-growing industry's ongoing success and relishes the opportunity to catch up with growers in her day-to-day work.

Recent events have included a tour to delivery centres and Market City [Perth's wholesale fresh produce market] to follow the fruit's journey through to the consumers, and leading a study tour to New Zealand with consultants AgFirst. Susie mentored the group of nine young growers – three of whom were women – on a tour of the country's leading orchards.

"The objective of the New Zealand study tour was to transfer orchard technology to Western Australian pome fruit growers, by feeding conversations among growers and changing practices in our industry. There is a generational shift in some WA orchards and this was an opportunity to encourage future orchardists to identify and develop skills and techniques that can be adapted to their circumstances," Susie said.

"It was an awesome opportunity to visit both Steve Sparks and Ross Wilson in their patch and see for ourselves what the New Zealand orchards were like and understand what the AgFirst consultants were talking about at the Future Orchards walks when they visit WA."

This New Zealand tour also speaks to Susie's passion for encouraging and engaging young women who are carving out careers in horticulture – a traditionally male-dominated space.

"Visually, it has been a very male-dominated field, but behind the scenes, women in orchard businesses are the ones who support and make the orchard run the way it should," she said.

"They have always been there – it is just great that they're being recognised for the roles they do and stepping up to take on more opportunities."

Susie is humbled to take on the role of mentor and prove to younger women in the industry that the sky is the limit when it comes to a career in horticulture. APAL's 2018 Award for Excellence – Women in Horticulture is a satisfying reminder that when industry supports women, great things unfold.

"There are many women out there in the agricultural and horticultural industries whom I have looked up to, so it's great now to be recognised as one of those women and know that others are looking up to me too," Susie said.

"I'm just absolutely thrilled. It is very rewarding to be recognised for the work that I do. I'm very lucky to work with a great group of growers, the team at Pomewest and the apple industry who are just as positive about the pome fruit industry as I am." Susie concluded.

RECENT DETECTIONS OF BROWN MARMORATED STINK BUG

AUSTRALIA IS FACING AN INCREASING THREAT FROM ONE OF THE WORLD'S MOST INVASIVE PESTS.

Six post-border detections have occurred in the current BMSB season (September to April) across Queensland, Victoria, and Western Australia on a variety of imported cargo, from terracotta pots to tractors and machinery. Three of the detections have been in Queensland, in Lytton, New Chum, and Fisherman's Island, two were in Melbourne, and one was in Fremantle.

This compares with only three post-border detections of BMSB in Australia in 2017/18. Two were in Western Sydney and one in Perth. All were associated with goods that had been imported from Italy.

The Australian Government Department of Agriculture and Water Resources is working closely with each of the affected state governments. Each detection has seen swift and effective response measures put in place.

The Department of Agriculture and Water Resources has issued a release highlighting recent facts and current biosecurity strategy related to the Brown marmorated stink bug (BMSB).

"It's had no trouble spreading through Europe, and after being found in the eastern US in 1998 it's taken less than twenty years for it to be found across the country."

Kevin Clayton-Green

How bad is the BMSB?

Expert Advisor to APAL's Apple and Pear Biosecurity Steering Committee Kevin Clayton-Green has called the BMSB "one of the most invasive plant pests in the world."

"It's had no trouble spreading through Europe, and after being found in the eastern US in 1998 it's taken less than twenty years for it to be found across the country," he said.

"When feeding on fruit it leaves damaging marks, which leaves the fruit unsalable. It can also completely defoliate young trees when they are most vulnerable."

Outbreaks of BMSB have caused significant losses to apple and pear growers in the eastern US since its arrival, and it is now regarded as a greater pest than codling moth.

Kevin noted that country areas with plenty of foliage are perfect breeding grounds for a pest that can quickly spread out of control. While not a risk to human health, BMSB is considered a high priority pest, and one that needs to be kept out of Australia.

"It has a tendency to hibernate, which makes it especially eager to infest packhouses and other storage buildings as well as homes and any other structure in which it can shelter such as boats on trailors, sheds etc. As such the impact of this pest will be felt not just by producers but the population as a whole.

"It is a concern not only to the apple and pear industry, but to the broader community as it can destroy many types of plants, from orchards to ornamental trees."

Between 1 September 2018 and 30 April 2019, additional import measures have been put in place for imported sea cargo. These measures apply to specific goods arriving from certain countries where BMSB presence is well documented.

What to look out for

BMSB is known to feed on more than 300 hosts, including agricultural crops such as apples, pears, nuts, grains, berries, cotton, citrus, soybean, nursery stock, and some ornamental and weed plant species. While feeding, the bug's saliva causes significant damage to plant tissues.

Adults range in length between 12-17 mm. They are mottled brown in colour and have a shield-shaped appearance. BMSB looks similar to native Australian stink bugs, but are larger and have distinguishing white bands on its antennae. It has a foul-smelling odour when crushed or disturbed.

There are five nymph stages that range in size from less than 3 mm to 12 mm long. The nymphs are orange and black when they first hatch but quickly develop a similar colouration to the adults. The juvenile, or nymphal stages, cause the most damage to plants and crops. Eggs are cream to yellow-orange and approximately 1.6 mm long and laid in clusters on the underside of leaves.

BMSB opportunistically uses cargo containers and freight vehicles to hitchhike across continents and oceans. The bug's ability to hitchhike, fly, and to feed on a wide range of plant hosts, enables it to spread rapidly when it is introduced to new areas, and its ability to lie dormant can allow it to travel around the world hidden in cargo.

BMSB can be confused with a number of other brown coloured stinkbugs that are present in Australia. There is a comprehensive identification guide available through the Outbreak website (outbreak.gov.au).

Biosecurity and your role

Everyone has a role in keeping pests and diseases out of Australia. The Department of Agriculture and Water Resources advised that anyone who works around or receives imported goods should always keep an eye out for pests.

The brown marmorated stink bug will stow away inside shipping containers, and they can be found within the goods in the container, including boxes and packaging. They also seek shelter in break bulk cargo including vehicles and machinery. Cargo does not have to have been recently imported for it to potentially contain the threat of BMSB; the bug has the ability to survive for long periods in cargo by remaining dormant.

If you notice any bugs or other pests, don't remove the contents of the container, shut the doors and don't allow the container to be moved – especially to an area outside if it's in a warehouse.

The most effective way to detect BMSB is by visually inspecting host plants. They are large bugs that emit a foul odour when disturbed.

Collect any dead or live specimens so our entomologists can confirm the species. Any live bugs should be held in a container that prevents them from escaping.

If you think you have spotted what could be a brown marmorated stink bug, phone the Exotic Plant Pest Hotline on 1800 084 881. This will put you in touch with your local department of primary industries or agriculture, from anywhere in Australia.

RIGHT GREEN FOR CROP, ENVIRONMENT, WALLET

Too much of a good thing can be a bad thing. That's certainly true for nitrogen fertilizers.

Without enough nitrogen, crops don't grow well. Yields are reduced significantly.

Applying too much nitrogen fertilizer, on the other hand, can hurt the environment. Nitrogen can enter the watershed, polluting aquatic ecosystems. Microbes can also convert the excess nitrogen into nitrous oxide, a greenhouse gas implicated in climate change.

"Managing nitrogen is vital for global food security," says Yuxin Miao, an agronomist at the University of Minnesota. "It is also crucial for reducing pollution and climate change."

Yuxin and his colleagues have been researching ways to efficiently manage nitrogen in agriculture. They compared several approaches. The researchers found that one approach, active canopy sensor-based nitrogen management, is the most efficient.

Sensor-based nitrogen management uses light sensors to actively monitor crop health and vitality. The sensors measure different wavelengths of light coming from crop leaves. These measurements serve as proxies for crop health.

Based on field measurements, software in the sensors can calculate how much nitrogen crops need. Farmers can use these data to apply optimal amounts of nitrogen to crops.

The goal is to "match nitrogen supply with crop nitrogen demand," says Yuxin. That allows crops to access nitrogen fertilizers exactly when they most need it. In turn, that could increase yields.

This approach has several benefits compared to other nitrogen management strategies. "It reduced overall nitrogen fertilizer application," says Yuxin "It also decreased nitrogen loss into the environment and lowered nitrous oxide emissions."

Canopy sensor-based systems have several other advantages as well. "Using sensors is fast and non-destructive," says Yuxin. "There are no additional costs beyond purchasing the sensors."

Also, the latest models of sensors are not influenced by environmental light. That means growers can get an accurate measurement no matter the weather--no need for clouds to clear.

There may also be monetary benefits. "This technology can reduce the use of nitrogen fertilizers," says Yuxin. "Farmers can lower production costs and increase economic returns."

To test different nitrogen management strategies, Yuxin and his colleagues conducted field experiments from 2008 to 2012. The study site was in the Hebei Province in northern China. The researchers tested the different strategies on a winter wheat and summer corn rotation system.

Some of the other nitrogen management strategies tested by Yuxin also reduced fertilizer use. But they all had drawbacks. For example, one system required testing the soil for nitrogen levels. "However, this system had labor, time, and cost limitations," says Yuxin.

Yuxin is now working to make improvements. Some of the new systems will be more suitable for high-yield cropping systems. Others may be more efficient than the current hand-held ones.

Yuxin hopes these sensor systems will have global reach. "This strategy of nitrogen management would work with major crops in many countries."

But Yuxin thinks that farmers can't do it alone. Farmers, researchers, and service providers will need to work together. "That can facilitate widespread adoption of this system, especially in developing countries," he concluded.

A student uses the GreenSeeker active canopy sensor to collect canopy reflectance data. The collected data will help determine the crop's nitrogen status.

THE ITSY BITSY SPIDER CAN MAKE A BIG IMPACT IN AGRICULTURE

BY RACHEL CRAMER

A NEW STUDY EXPLORES HOW CONSERVATION AGRICULTURE IN SOUTHERN AFRICA SUPPORTS SPIDER POPULATIONS AND DIVERSITY IN FIELDS, WHICH COULD HELP MITIGATE PEST DAMAGE AND POTENTIALLY LEAD TO HIGHER YIELDS FOR FARMERS.

According to the Food and Agriculture Organisation of the United Nations (FAO), herbivorous insects such as aphids, caterpillars and weevils destroy about one fifth of the world's total crop production each year. Spiders can help keep voracious pests in-check, but conventional farming practices (e.g. tilling, crop residue removal and monoculture) can harm or drastically reduce these beneficial bio-control agents.

There are more than 45,000 identified spider species around the world. From glaciers to tropical rainforests, they inhabit every terrestrial ecosystem on earth. Some can even live in tidal zones, and at least one species inhabits fresh water. While we tend to associate spiders with webs, only about 50 percent of the species catch their prey this way; the rest hunt on plants, on the ground or below it, using a variety of tactics such as stalking, stabbing, crushing – even seduction.

Although spiders have been around for 300 million years, some species are at risk of extinction due to habitat loss and fragmentation. Drastic reductions in vegetation – whether from a new parking lot or a tilled field – removes the food source that attracts their prey. Bare ground exposes their nesting sites and themselves, which makes it harder to hunt and easier to be hunted by birds and small mammals.

At the Chinhoyi University of Technology experimental farm in Zimbabwe, a team of researchers aimed to determine the response of spiders under different agricultural practices. Conventional farmers often prepare their fields for planting by physically breaking up and inverting the top 6-10 inches of soil. This practice of ploughing prepares a fine soil tilth, which makes it easier to plant; it breaks up and buries weeds, and reduces soil compaction to aerate the soil. But tilling also increases topsoil erosion from wind and water. It accelerates soil carbon decomposition, reduces soil water infiltration and disrupts microorganisms living in the soil, including beneficial insects and spiders.

The researchers conducted two experiments over the 2013/2014 and 2014/2015 cropping seasons to see how tilling, crop residue retention (i.e. leaving stalks and post-harvest organic matter in the field), fertilizer application and weeding affected ground- and plant-wandering spider species. They hypothesized that spider abundance and diversity would increase with lower levels of soil disturbance and more plant cover.

The results showed direct seeding into no-till soil increased the abundance of spiders and the diversity of species. Mulching also showed a positive effect. Contrary to their hypotheses and results from temperate regions, the application of fertilizer and intense weeding did not affect the spider community. The researchers attributed this to the difference in climatic conditions (tropical vs. temperate) of this study in southern Africa.

"Often the government's and farmer's immediate reaction to a crop pest issue is to apply a pesticide, but we can make use of biological control agents, which may be cheaper and less damaging for the environment."

Christian Thierfelder

"Often the government's and farmer's immediate reaction to a crop pest issue is to apply a pesticide, but we can make use of biological control agents, which may be cheaper and less damaging for the environment," says Christian Thierfelder, a co-author of the study. Christian is a cropping systems agronomist and conservation agriculture specialist with the International Maize and Wheat Improvement Center (CIMMYT) with long-term experience in sustainable intensification.

"Spiders, ants and beetles all do a really good job with little or no cost to the farmer," he adds. "For us, it's quite fascinating to see simple agronomic practices to affect and control crop pests. This also provides new avenues of dealing with the fall armyworm, an invasive species which has devastated crops across the majority of sub-Saharan Africa countries."

A robust number of studies from Europe, Australia and North America have shown the link between conservation agriculture and biodiversity, but Christian says that research on biodiversity in agronomic systems is relatively new in southern Africa. While the study in Zimbabwe helps fill this gap, more research is needed to show the connection between the abundance of spiders, beetles and ants with the suppression of insect pest activity.

For more information, read Spider community shift in response to farming practices in a sub-humid agroecosystem in southern Africa.

This research was jointly funded by Chinhoyi University of Technology (CUT) and the German Academic Exchange Program (DAAD). The CGIAR Research Program on Maize (MAIZE) supported this study through Christian Thierfelder's contributions.

RESEARCHERS FIGHT TO KEEP SMUT OFF AUSTRALIA'S SPORTING FIELDS

University of Queensland researchers are working on a new project to keep smut off our playing fields; but it's not the kind of smut that first comes to mind.

Couch smut (Ustilago cynoditis) is a type of fungus that infects green couch grass (Cynodon dactylon), the most widely planted turf in sporting facilities, public parks, back yards and school ovals around Australia.

Green couch grass is used at the Gabba, Suncorp Stadium, the Sydney Cricket Ground and most golf courses.

UQ Queensland Alliance for Agriculture and Food Innovation (QAAFI) researcher Dr Andrew Geering and his team have partnered with the turf industry through Horticulture Innovation Australia on a two-year project to tackle the disease.

"When couch smut infects green couch, it makes the turf bumpy, slow growing and also raises health concerns due to the clouds of allergenic grass," Andrew said.

"Most people now associate the word 'smut' with crudity, but it is actually an old Teutonic word for 'black mark, stain', which in the medieval ages seemed an appropriate term to describe a plant disease characterised by messy black spores.

"Although couch smut is very common in Australia, no-one's really looked at how it spreads or how to effectively control it," he said.

"We're looking at whether it is spread by mowing, whether it can be controlled with fungicides, and whether some hybrid cultivars of couch are immune to the disease."

Andrew said couch's hard-wearing qualities, salt resistance, and ability to be cut very short made it a popular choice.

He said the disease posed a major headache to greenkeepers because it affected the field's playing quality and posed a health risk, but little was known about controlling it.

"The fungus replaces the seeds in the seed head with a ball of black spores. In badly smutted fields anyone who falls in the grass becomes covered in spores which can cause a respiratory reaction."

"Smut also affects plant growth causing it to grow more upright so you don't get a nice smooth surface.

"It also weakens the root system, which slows the grass's growth rate and makes it less resilient to trampling."

Andrew said the best way to prevent the problem is to buy certified turf, but once the disease did sneak in there was no effective control for it.

"The fungal spores are produced in enormous quantities and can travel hundreds of kilometres in the wind, and it's hard to tell whether the grass is infected until you see the black flower heads," he said.

Infected grass can be taken out by spot-spraying with herbicide and there have been cases where entire sports fields have had to be re-turfed.

"We're looking at the management practices of smut in the wheat and sugar-cane industries, where fungicides are used, and where disease-resistant hybrids have been identified," he concluded.

DIVERSITY EXTENDS HERBICIDE 'LIFE' IN TRIPLE-STACKED COTTON

'DIVERSITY' IS ONE OF THOSE 'HOW MUCH IS GOOD ENOUGH' THINGS. IT IS OFTEN RECOMMENDED THAT FARMERS USE 'AS MUCH DIVERSITY AS POSSIBLE' IN THEIR WEED MANAGEMENT PROGRAM TO KEEP A LID ON HERBICIDE RESISTANCE, BUT IT IS DIFFICULT TO QUANTIFY HOW MUCH DIVERSITY WILL ACHIEVE ADEQUATE CONTROL.

Computer models, like the new 'Diversity' model, have proven to give reliable predictions of the real-world outcomes likely to result from the implementation of different weed management programs.

The Diversity model tracks the simultaneous evolution of resistance to multiple herbicides, using multiple genetic pathways, in several weed species at once.

With triple-stacked herbicide tolerance traits in genetically modified cotton expected to be available to Australian growers within the next five years, the Australian Cotton Research and Development Corporation has invested in research to determine how much diversity in control tactics is required to protect the effective life of this technology.

The model suggests that using more diverse strategies in weed control can add 20 years to the effective 'life' of this new herbicide tolerance technology. Modelling repeatedly shows that new technologies must be supported with several other herbicide and non-herbicide tactics and survivor management given the highest priority.

Bayer's XtendFlex™ technology confers tolerance to glyphosate, dicamba and glufosinate in cotton and was approved for commercial release by The Office of the Gene Technology Regulator in December 2016. Prior to commercial release, extensive work is underway to understand the system's fit in the unique Australian environment and to ensure growers will get the most from the technology.

XtendFlex™ cotton varieties are stacked with the Bollgard® 3 insect resistance technology, and are expected to provide growers with a robust pest and weed management tool.

The concern for weed scientists like Dr David Thornby, Innokas Intellectual Services, is that the triple-stack of herbicide tolerance is already compromised, with glyphosate resistance well-established in several weed species on many cotton farms. To-date, the problem is greatest in dryland cotton farming systems, but is also quite prevalent in non-crop areas of irrigated farms, such as along irrigation channel banks.

Having previously used computer modelling to assist in the development of the cotton industry 2+2&0 weed control strategy, David has led a team to develop a model to test how many tactics growers will need to implement to achieve effective control of three key weed species – sowthistle, flaxleaf fleabane and awnless barnyard grass – once the XtendFlex technology is adopted.

"Of the three key species studied so far, flaxleaf fleabane is expected to be an on-going problem for cotton growers."
Dr David Thornby

"Real-life experience aligns with the predictions made using the DAF Glyphosate Resistance computer model, with glyphosate resistance being evident in awnless barnyard grass within 13 years of commencing zero tillage, if glyphosate is the only product used for summer weed control and survivors are not controlled," he said.

"We also predicted that common sowthistle populations would exhibit resistance within 15 years if glyphosate was the only product, or 20 years if a few other tactics were implemented."

"We managed to predict that sowthistle would lag behind barnyard grass by a few years, under current and historical management strategies, and that has been borne out in the real world. This suggests that the computer models do provide reliable predictions of the speed at which herbicide resistance develops in weed populations, so we have built on this earlier work to develop the 'Diversity' computer model."

Using this new model has enabled researchers to test the effect of different weed control programs and scenarios on herbicide resistance in these three key species, with the aim of prolonging the effective life of the triple-stack herbicide gene technology in irrigated cotton systems.

"Using the model we can show that just using the three over-the-top herbicides in triple-stacked cotton crops will lead to a failure of the technology to control awnless barnyard grass within 10 years," he said. "This is because of the already wide-spread incidence of glyphosate resistance in this species, and the fact that glufosinate is only marginally effective on this species and dicamba is not effective at all."

"If a grower also implements the 2+2&0 best practice of two other practices – cultural or different herbicide modes of action – in both the crop and fallow, and zero tolerance of survivors, we can extend the effective life of the technology to control awnless barnyard grass and sowthistle to 30 years," he said. "For example, the use of the triple stack partners in a double knock tactic at least some of the time, including a pre-emergent herbicide and chipping survivors is a practical and effective control program to support the over-the-top herbicide options available with XtendFlex."

"Of the three key species studied so far, flaxleaf fleabane is expected to be an on-going problem for cotton growers," said David. "Glyphosate resistant fleabane can be hard to control with the XtendFlex herbicide options and the model suggests that at least two additional tactics would need to be applied every year to keep numbers low. Gaining control is challenging and given the amount of seed produced on these plants, even achieving a kill rate of 95 per cent is not sufficient to manage the seed bank."

Flaxleaf fleabane can germinate over a wide portion of the year, putting strong pressure on pre-emergent herbicides as well.

To-date, the Diversity model has only been used to test scenarios in irrigated cotton systems but plans are in place to test-run dryland cotton scenarios ahead of the release of XtendFlex cotton varieties in Australia. The model also has the capability to investigate the effect of including other crops in the rotation to assist with weed control.

The bottom line is that the triple-stack herbicide tolerance gene technology will be a useful tool for cotton growers but it is not a stand-alone weed control program. It must be supported with several other herbicide and non-herbicide tactics and survivor management given the highest priority.

David said growers should not put off implementing the 2+2&0 strategy in the hope that XtendFlex will fix their weed problems. It is possible to use intensive patch management to reduce the numbers of glyphosate resistant weeds, particularly awnless barnyard grass, and doing so will give growers a better starting point to maximise the effectiveness of the triple-stack herbicide technology when it is released.

LONG TERM COMMITMENT TO TOP QUALITY BRUSSELS SPROUTS

THE CRANWELLS GROW BRUSSELS SPROUTS IN SOUTH AUSTRALIA AND SUCCESSFULLY MANAGE THEIR CROP USING IPM-FRIENDLY PRACTICES. THEY ARE ONE OF ONLY TWO REMAINING BRUSSELS SPROUTS GROWERS IN SOUTH AUSTRALIA, FOUR GENERATIONS OF THE FAMILY OPERATION AND A FIFTH ALREADY WORKING IN THE BUSINESS UNDERLINES THEIR COMMITMENT TO THE FUTURE.

John and his wife, Julie, together with his brother, Robert, and his wife, Joadi, and their children, Erin and Josh, grow about 58 hectares of Brussels sprouts annually over two properties at Nairne and Langhorne Creek.

Trading today as AE Cranwell & Sons, the family's market gardening originally commenced with John and Robert's great grandfather, William Henry, in Ashton, nearer to Adelaide.

"They were growing sprouts in the '40s, but they were also growing everything else, including cherries, cabbages, lettuces, strawberries and even gooseberries," John said.

"We started growing sprouts exclusively from about 1970 and we grew leeks for a while, but then we were all sprouts again from about 2005."

They supply all distribution centres of the major retailers across Australia, as well as wholesale markets.

The Brussels sprouts are grown on a three-year land rotation, with 15 different varieties of seedlings from Boomaroo Nurseries transplanted from July to January and harvested from January to August.

John said they had to successfully manage the crops for up to seven months.

"They are a long lived crop – and it is a vegetable so you have to look after it," John said.

He said insects had become an increasing factor since resistance to organophosphate and synthetic pyrethroid insecticides became an issue in the '90s, and required constant monitoring. Greater use of more targeted products today, rather than broad spectrum, had also given rise to secondary pests.

Diamondback moth, aphids and thrips are some of the major insects, with massive flights of diamondback moth occurring as canola crops dry-off in broadacre areas.

The Cranwells have long been strong advocates of integrated pest management (IPM) and release parasites against diamondback moth and aphids sourced from James Altman and his team at Biological Services in Loxton.

"We release 'beneficials' weekly for the first few months until we get on to chemistry that's not so soft on them," John said.

He said they were also "sticklers" for rotating chemistry, especially not using two chemical groups at once.

"We are fortunate that we don't have close neighbours growing the same crops, so our chemical rotation strategy works very well."

"We like to use Group 28 (insecticides) at periods of peak pressure. With two different properties and multiple blocks, the peak pressure can be at different times and so the products are used at different times, helping maintain the rotation strategy," John said.

DiPel® biological insecticide, containing the bacteria Bacillus thuringiensis (Bt), is used when insect pressure is light.

The systemic and IPM-friendly Group 23 insecticide, Movento®, has been used against aphids and this year, following its registration for control of diamondback moth in brassica vegetables, it was used as an aphid and diamondback moth spray.

"We are using Movento after the Bt when the pressure is not that great and the diamondback moth larvae is at an early instar stage – and we have been very happy with it," John said. Different to most systemic insecticides, which, after leaf uptake are mainly translocated upwards in the plant's xylem along with water and nutrients, Movento, from Bayer, is translocated in the plant's phloem as well as xylem, resulting in transportation upwards and downwards to plant parts. It can better control sucking pests hiding on covered inner leaves than other insecticides, as well as populations that may have developed resistance to existing registered products.

"We release 'beneficials' weekly for the first few months until we get on to chemistry that's not so soft on them."
John Cranwell

In addition to aphids and diamondback moth, Movento offers control of silverleaf whitefly. Other than vegetable crops, it can also be used in stone fruit, mangoes, grapes, pome fruit and cotton for control or suppression of a range of pests.

It is highly compatible for tank mixing with other products and is "soft" on most beneficial species when used as directed, including parasitoids, syrphid flies, lacewings, predatory midges, ladybird beetles, predatory bugs and earwigs.

"We do two applications of Movento in a row no matter what, with emulsifiable oil and 500-1000 L/ha water rates," John said.

"It has a unique form of action and is so soft on 'beneficials'. Our IPM specialist was here and said, 'we are not going to release any more – you have thousands of them'.

"Movento is not quick acting – growers need to read the label and be aware of that. And the rate for diamondback moth and aphids is different. But it's a good product – it kills them."

Bayer Commercial Sales Representative Darren Alexander said for diamondback moth, the application rate needed to be increased to 400 mL/ha.

John said later, any surviving insects were knocked out by other insecticides including Avatar®, Proclaim® and Success® Neo insecticides.

"We spray every 10-14 days. We use all major, different chemical groups in a calculated strategy to prevent resistance and going from the softest to the hardest to fit in with our IPM program."

"The parasites get the bugs that the sprays don't get, or that are resistant."

He said the program helped to achieve the final objective of producing clean, green and hard Brussels sprouts that were free of blemish and would last in the fridge for at least two weeks.

Image (L to R): John and Darren make a closer inspection of one of the Brussels sprout crops on the Cranwell's Nairne property.

MAKING RESPONSIBLE RECOMMENDATIONS

As Agronomists, our roles are diverse and sometimes unexpected and to the ley person, it can be difficult to explain exactly what we do. We are consultants who bring an expert opinion to a cropping situation and it should always be our aim to make responsible recommendations based on experience, science, best practice and the latest research. It is only the best agronomists that will bring all of these elements to their service proposition.

What are the key elements to making these responsible recommendations? We have asked this regularly of our members over the years through surveys and interviews and some key elements continue to be raised, even over 25 years after our industry group was established. Many of them are embedded in the Crop Consultants Australia (CCA) Code of Conduct to which all members of this association must adhere. Others are more akin to best business practice. Below is short summary of those that never grow old.

They include:

- Do your own groundwork in your business well. Ensure that your business processes are up to date, your insurances and accreditations are in order and that you have a sound knowledge of your region and how the cropping sector operates in the area.
- Know your client well, their operation and their expectations of you as their consultant. Develop an understanding of their operation and their medium - and long-term plans for their cropping system beyond the current growing season.
- Practice judicious and regular monitoring to ensure that decisions are always being based upon up to date information. Make use of remote sensing and imagery available to you but ensure that this information is always ground-truthed by an experienced set of eyes. Make use of industry sampling protocols for insects and make use of up to date in paddock resources available such as the CRDC Pest Management Guide and the GRDC Ute Apps on your phone.
- Make use of the online guides to ensure you give attention to the correct thresholds and parameters for insect and pest populations in the crop.
- If under irrigation, be conscious of crop development and the established irrigation deficits. Without a doubt, water is one of our greatest assets and the social licence to farm and irrigate is under increasing scrutiny.
- Adhere to product labels, but in doing so, ensure that you develop a deeper understanding of the products that you are recommending and their active ingredients. It is this understanding that will enable you to make evidence-based recommendations. For example, in making insecticide recommendations, make use of the insect disruption tables in The Cotton Pest Management Guide. These tables provide a guide of the impact each insecticide will have on predator insects and whether they may inadvertently flare another pest species.
- No one person can be expected to know everything. Develop a network of learned professionals within the industry who you can confer with to discuss complex decisions when they arise. These may be experienced agronomists, researchers, extension officers or company representatives.
- Undertake a risk assessment on your recommendations considering all of the internal and external factors in the crop. What is the risk of drift on the application? What are the possible impacts on beneficial insects? ALWAYS communicate all these potential risks and their potential implications to the client.
- Remember that it is your role only to provide a recommendation that may, or may not be actioned by your client. If not, take the decision with professionalism and without confrontation and try to develop an understanding of the reasoning behind the ultimate decision making. It is only by doing this, you will develop a deeper understanding of your client and build on your own knowledge bank.

There are many other aspects to running a solid agronomy enterprise, perhaps the most innovative of which remain ‘commercial in confidence’ with their practitioners. In its role of promoting and enhancing crop consultancy as a profession, CCA aims to assist the promotion of this best practice by the organisation of mentoring and networking events for members and guests.

PEANUTS THAT DO MORE WITH LESS WATER

The beloved peanut usually grows in sandy soil where there might not be much moisture. But some varieties of peanut perform better in drought than others. They use less water when there isn't much to go around, and remain productive as drought deepens. Crop scientists are trying to find the peanut varieties best at it.

Thomas Sinclair at North Carolina State University and colleagues are studying peanut varieties to find a 'water conservation' trait. It would help the plant maintain a high yield during a drought.

"Crop varieties that have a greater yield than others, with less water, are crucial in maintaining or increasing the profits available to growers," he explains. "This may become especially important if, as predicted by some, climate change results in less rainfall occurring in less frequent events."

Peanut plants conserve water by having a lower transpiration rate as the soil gets drier. As soil water becomes less available, the plants adjust how much moisture they release, or transpire. By doing this early in the soil drying cycle, the plant conserves water for later as the drought gets worse.

"Somewhat surprisingly, nearly all plants show a decrease in transpiration with soil drying," Thomas says. "By decreasing water loss earlier in the soil drying cycle, water is conserved. This means there is more water available to sustain the crop as the drought goes on."

The researchers set out to find this water conservation trait through three sets of experiments. First, the team performed experiments in greenhouses to find plants with the trait. In order to confirm the trait would work in the field, researchers also observed the plants there. If there was a delay in leaf wilting during a drought, that was good news: water conservation was happening within the plant.

Finally, they let the plants grow and produce peanuts. They measured the yield to see if the plants were actually able to make more peanuts.

"This research was a three-phase study to identify a peanut line that had the potential for increased yields under drought conditions," Thomas says. "In fact, one line with a water conservation trait was found to have a greater yield than the current commercial line under water-limited conditions."

The researchers are preparing the paperwork for this more efficient line to be on the commercial market. It will be recommended for soils and environments where drought is fairly common. But ultimately growers will decide if this drought-tolerant variety fits their individual farming operations, Thomas explains.

Thomas says the next step in this research is exploring another trait, nitrogen fixation. Peanut plants use soil microbes to access vital nitrogen from the atmosphere. This process can be especially sensitive to soil drying. Past studies showed most U.S. peanut varieties start losing their ability to do this even before drought develops. Finding types of peanut that are able to sustain this activity, combined with the water conversation trait, would be a good combination for increasing peanut yield, Thomas adds.

"I am a crop physiologist who is interested in sorting out how plants grow and develop in the field to generate yield," he says.

"It has been a career challenge to develop a view of how crops use water and explore how all crops could more effectively use the available water."

MAKE HARD WATER EASY

Hard water often contains calcium or maganesium ions which interact with glyphosate to form insoluble complexes, rendering it inactive. Farmers and agronomists alike are heralding the arrival of Outright 770 Spray Adjuvant as a game-changer, particularly in hard-water conditions which can render herbicides such as Glyphosate significantly less-effective.

By using adjuvant Outright 770, the knock-down rate is much more immediate with a greater amount of the herbicide being absorbed by weeds and other invasive plants.

Outright 770 has been developed by Australian company, VICCHEM, specifically tailored for Australia's unique conditions with a results-based focus.

VICCHEM technical director for more than 20 years, Peter Jones, said hard water often contained calcium or magnesium ions which could interact with glyphosate to form insoluble complexes, rendering it inactive.

"However, hard water can be managed with VICCHEM's summer adjuvant range because the ammonium sulphate in Hot-Up, Outright 770 and Assert prevents this interaction, instead forming glyphosate-ammonium which is readily dissolved and absorbed," he explained.

Another benefit to busy farmers is the simple delivery for a more comprehensive result. Marshall Rodda, from Tarranurk near Jeparit, embarked on a large-scale summer weed program after the December rainfall in 2018 with immediate results in terms of efficiency and smackdown of a variety of weeds, melons and bindi, using a combination of broad-spectrum Glyphosate, Ester and Garlon, boosted with Outright 770.

"Outright 770 made it easier and quicker to spray by simply pumping the 3-in-1 adjuvant into the tank. No lugging bags of ammonium sulphate made it a much smarter and quicker option," said Marshall.

WHY IS MISTLETOE KILLING OUR MACADAMIA TREES?

MISTLETOE, the beloved festive kissing plant, has become famous in the Australian macadamia industry but for all the wrong reasons.

A research investigation, led by mistletoe expert Professor Dave Watson from Charles Sturt University, is investigating the significant effect that native mistletoes are having on the production of macadamia nuts in Queensland.

Funded by Hort Innovation through the Macadamia R&D levy and government contributions, the project is visiting a number of affected orchards in Gympie and Bundaberg to understand the factors that influence their distribution and impact, and to identify what management options are the most effective.

Dave said mistletoe was a parasitic plant that lived off the nutrients and water from a host tree.

"It uses the host tree as a root system to support its growth," he said.

"Mistletoe rely on birds to spread their seeds, in particular the Australian mistletoe bird that stems from the flowerpecker family and eats little else."

"The birds feed off the fruit but cannot digest the seed, and as such deposit them on to the branch of another tree, usually within minutes – causing rapid germination and sending a root into the host."

Dave said he had already identified three (3) individual species of mistletoe affecting macadamia tree crops.

"However, we actually have more than 90 different native species of mistletoe, 72 of which are endemic to Australia," he said.

"Mistletoe grows quite freely and unproblematically in the bush. The issue it raises with tree crops is that it diverts nutrients away from the host plant, and macadamia trees in particular, lose their ability to produce crop.

"A severe mistletoe infection can deplete a mature macadamia tree of all its nutrients within just three years, which if left unchecked, can cause the premature death of the tree."

Dave said this research would help develop options to mitigate the deleterious effect of mistletoe on Macadamia tree crops.

"Macadamias are the only horticultural crop in Australia to experience issues with mistletoe, and initial grower consultations have revealed that some of the newer varieties may be more susceptible to being affected," he said.

"This research will help to identify the underlying causes of increased mistletoe numbers in macadamia trees, and evaluate potential management options.

"Providing habitat for a native mistletoe feeding caterpillar and for wildlife who are partial to the taste of mistletoe could provide a low cost, and natural solution."

COMMON POLICY PREMISE ON LINK BETWEEN SOIL AND CROP YIELD IS VALID - TO A POINT

IN RECENT YEARS, POLICYMAKERS ACROSS THE WORLD HAVE LAUNCHED INITIATIVES TO INCREASE THE AMOUNT OF "SOIL ORGANIC MATTER," OR SOM, AS A WAY TO IMPROVE SOIL HEALTH AND BOOST AGRICULTURAL PRODUCTION. SURPRISINGLY, HOWEVER, THERE IS LIMITED EVIDENCE THAT THIS STRATEGY WILL ACTUALLY IMPROVE CROP OUTPUT.

A new paper by Yale researchers quantifies this relationship between soil organic matter and crop yields at a global level. Writing in the journal SOIL, they affirm that greater concentrations of organic matter indeed produce greater yields - but only to a certain point.

Specifically, they find that increasing soil organic carbon - a common proxy for soil organic matter - boosts yields until concentrations reach about two percent, at which level they tend to hit a saturation point. Thereafter, the researchers say, the increase in SOM begins to deliver diminished returns.

Even still, they find that roughly two-thirds of agricultural soils dedicated to two of the world's most important staple crops - maize and wheat - fall below that two percent threshold, suggesting the vast potential for agricultural policies that promote increased soil organic matter.

"The premise for so many sustainable land management practices is that if you increase soil organic matter you're going to increase production," said Emily Oldfield, a Ph.D. student at the Yale School of Forestry & Environmental Studies (F&ES) and lead author of the paper. "But when you dig into the literature, there are very few empirical studies that actually directly quantify that relationship."

"These results show that there is value in setting evidence-based SOM targets for many land stewardship initiatives," she said. "They also suggest that we must move away from a qualitative 'more is better' approach to soil health policies and toward specific regional and local targets that can achieve measurable agricultural outcomes."

Co-authors of the paper are Mark Bradford, professor of soils and ecosystem ecology at F&ES, and Stephen Wood, a scientist at The Nature Conservancy. SOIL is an interactive open-access journal of the European Geosciences Union.

It is well understood that building and maintaining soil organic matter is key to soil health. (SOM refers to organic matter found in the soil, including plant and animal materials that are in the process of decomposition.) It strengthens the capacity of soils to retain water and nutrients, supports structure that promotes drainage and aeration, and helps minimize the loss of topsoil through erosion.

For years, policymakers have emphasized the role of soil organic matter in a series of programs, including the "4 per 1,000" initiative of the Soils for Food Security - which emerged from the COP21 negotiations - and the U.S.'s "Framework for a Federal Strategic Plan for Soil Science."

And yet when it comes to its role in promoting crop production, there's been a surprising dearth of quantitative evidence, Mark says. For Mark, this gap in knowledge has been a nagging concern for nearly a decade; a 2010 National Research Council report on sustainable agriculture described organic matter as the cornerstone of most sustainability and soil quality initiatives,

"The premise for so many sustainable land management practices is that if you increase soil organic matter you're going to increase production."

Emily Oldfield

he recalls, yet offered no information on how much was actually needed to increase crop yields and reduce fertilizer application.

"I was always telling people about how important soil organic matter was, and yet here was a national synthesis from our top scientific body saying that we did not have the data to say anything meaningful," Mark said. "Our paper is the first really synthetic attempt to put numbers out there to guide practice by helping to establish targets."

To do so, they collected existing data on crop yields of maize and wheat that was paired with measures of soil organic matter at sites across the world. They found that the largest gains in yield occurred between concentrations of 0.1 percent and 2 percent. For example, yields were 1.2 times higher at 1 percent than 0.5 percent. But those gains tend to level off when concentrations reach 2 percent.

"The result is that we now have numbers, not just unverified ideas, that if you build organic matter you can improve outcomes -- such as less fertiliser and increased yield," Mark said. "It's a place to start to bolster soil stewardship efforts for a healthy planet and enhanced food security."

The analysis offers valuable insights for policymakers and researchers as they evaluate the relationship between soil carbon and crop yield, said Stephen, a Yale graduate who now is an applied scientist at the Nature Conservancy.

And while the research represents a global analysis, he said, the methodology will make it easier for targets to be identified at specific agricultural sites worldwide. "Because all locations will have different thresholds of how much a soil property can be changed and what level of a soil property is 'good' for that place," Stephen said.

"We now want to work on refining these relationships for specific regions and even specific farms, and we hope to forge partnerships with agriculture companies to realise this possibility." Mark concluded.

HIGH-PROTEIN RICE BRINGS VALUE, NUTRITION

More than 750 million people don't get enough nutrients from their food. More than two-thirds of those people live in places that consume a lot of rice. Can rice bred for extra protein be the answer?

"There are hundreds of millions of people around the world who depend on rice and eat it three times a day, but their access to protein is very limited by availability and cost," explains Herry Utomo, a professor at Louisiana State University. "High-protein rice can be used to help solve the worldwide problem across social, cultural, and economic issues."

Herry and his team developed a high-protein line of rice cultivar, 'Frontière,' which was released in 2017. The rice was developed through a traditional breeding process. It's the first long grain high-protein rice developed for use anywhere in the world, he says. On average, it has a protein content of 10.6%, a 53% increase from its original protein content. It also needs less heat, time, and usually less water to cook. This high-protein cultivar is currently marketed as "Cahokia" rice. It is grown commercially in Illinois.

However, breeding a crop for more nutrients like protein can cause yield to go down. The researchers are trying to combat this. They tested a total of 20 new lines of high-protein rice to see if any would have a higher yield. Their data showed the new high-protein lines improved yield by 11-17% compared to the yield of the first high-protein line. Grain quality characteristics differed. Herry says this new advanced line, with higher yield, is ready for final field testing prior to release.

Herry adds researchers developed high-protein rice because of the growing market for new products that can offer more nutritional value from major food crops, including rice. In addition to being eaten plain, the high-protein rice can be processed into specialty food for higher nutrition. Many products—from rice flour used in baked goods to rice milk, baby foods, cereals, and crackers—contain rice, and could benefit from more protein.

"We are now studying exactly how flours from this rice bakes differently than other rice flour," Herry says. "The interest in gluten-free baked products continues to grow. This will present another opportunity for rice growers to give people what they are looking for."

The next steps go in two directions, Herry says. "Because the original line is new to the market, marketing channels have to be put in place. In parallel, research for the next generation of high-protein rice lines is being carried out." Researchers hope these newer lines can ultimately be bought and grown by more farmers.

"Farmers don't have to change much to grow the high-protein line now on the market," Herry says. "The higher protein is an incredible added value they can get without any additional cost or changed practices."

NATURAL WEED CONTROL AN AUSTRALIAN FIRST

A natural weed control that will help manage one of Australia's most invasive introduced weeds has become the first woody weed bioherbicide to be granted federal regulatory approval – following an eight-year wait.

The Di Bak Parkinsonia fungal bioherbicide was developed at The University of Queensland by plant pathologist Professor Victor Galea and Dr Naomi Diplock.

BioHerbicides Australia (BHA) was formed by UQ's UniQuest commercialisation company in 2010, when it sought Australian Pesticides and Veterinary Medicines Authority (APVMA) approval to market the bioherbicide.

BHA managing director Peter Riikonen said the bioherbicide received regulatory approval last month, paving the way for Di Bak Parkinsonia to be safely used nation-wide.

"Parkinsonia is one of Australia's most invasive weeds, threatening rangelands, wetlands and natural waterways, as well as native plants and animal species," he said.

"This weed is so problematic that in many parts of the country, the law requires landholders to contain Parkinsonia bush on their properties.

"Current attempts to control this introduced species involve invasive mechanical clearing of land or potentially harmful chemical sprays, which is why our fungal bioherbicide has so much potential.

"The agent can be injected into the trunk of the Parkinsonia tree and cause it to die without damaging the surrounding environment."

Peter said a large study involving 90 trial sites across northern Australia was conducted and supported by Meat and Livestock Australia.

Victor said he co-developed the bioherbicide using naturally occurring fungi that causes plants to dieback.

"It was developed as a result of research conducted with Dr Diplock to explore the cause of dieback of Parkinsonia that occurs naturally in our landscape, with a view to harnessing it to create a natural management method," he said.

"The result has been a new and effective biological agent that is safe to use, causes minimal harm to the environment and will result in sustainable and ethical control.

"This bioherbicide, which can be made into capsules and injected into trees, will change the way we manage woody weeds in our landscape."

NEW SEED TREATMENT SHOWS STRONGER CROP BENEFITS

Trials of a new broad-spectrum fungicidal seed treatment now available to growers have shown comparable or better results than current industry standards for key diseases including rhizoctonia and crown rot, as well as loose smut in barley.

Growers and agronomists who visited the trials observed improved early crop growth and plants with healthier root systems and better vigour; stronger and greener plants with greater resilience to stress due to outstanding levels of disease control; better crop standing and tillering ability; no delays in maturity; and more robust and healthy root systems.

EverGol® Energy seed treatment, which builds on the strong reputation of EverGol Prime from Bayer, combines the proven disease control strengths of penflufen with the systemic activity of prothioconazole and metalaxyl in a new low dust formulation.

As a seed treatment, it offers control or suppression of a wide range of diseases including flag smut (seed and soil borne), common bunt and white grain disorder (seed borne) in wheat, covered smut in barley, fusarium head blight and seed borne crown rot in wheat and barley, and loose smut, rhizoctonia, pythium and crown rot (natural field infestation) in wheat, barley, oats and triticale. EverGol Energy can also be applied in-furrow for suppression of crown rot and pythium in wheat, barley, triticale and oats, giving growers additional flexibility.

Tim Murphy, Customer Advisory Representative with Bayer in South Australia, has coordinated trials in wheat and barley with the State's Mid North High Rainfall Zone Group at its site near Tarlee this season, as well as other locations.

A Predicta® B soil test confirmed the low disease status of the site before plots were inoculated with pythium, rhizoctonia and crown rot to express at high levels.

The performance of different application rates of EverGol Energy on seed was compared against registered rates of Vibrance®, Systiva® and Rancona® Dimension seed treatments and an untreated control (bare seed).

Tim said rhizoctonia and crown rot developed strongly at the site and there were differences in crop growth and vigour between the plots, which were also further exacerbated by moisture stress. Seasonal conditions in the trial resulted in very little expression of pythium disease.

"If crops get hit with these diseases at high levels, growers know they can expect inconsistent grain yields and quality," said Tim, who has been working with Bayer the past 20 years.

"At the registered application rate, EverGol Energy suppressed the diseases – plots treated with EverGol Energy were not compromised."

Tim said product development and industry trials with the seed treatment also showed class-leading control of loose smut.

He said using EverGol Energy also allowed growers the flexibility to use a foliar fungicide containing a Succinate Dehydrogenase Inhibitor (SDHI) fungicide, such as Aviator® Xpro®.

"Growers can come in with Aviator (Xpro), which is a combination of a triazole and an SDHI, for their first foliar disease treatment because, even though EverGol Energy contains an SDHI fungicide, it does not have any activity on foliar diseases.

Tim said applications of Aviator Xpro to plots in the Tarlee trial controlled septoria tritici disease extremely well when compared with other foliar treatments.

Bayer Commercial Sales Representative Graham Hatcher said the strong control of loose smut offered by EverGol Energy would be highly valuable for many growers who had crops hit hard by the disease this season, and considering the solid market outlook for barley.

He also expected EverGol Energy would be strongly earmarked for rhizoctonia-prone areas throughout grain growing locations in Australia.

WHY MEASURE PROTEIN IN THE FIELD OFF THE COMBINE HARVESTER?

BY PHILLIP CLANCY, NEXT INSTRUMENTS

IN 1963 J.S. RUSSELL SHOWED THAT GRAIN PROTEIN CONTENT CAN BE USED AS AN INDICATOR OF N STATUS IN CEREAL CROPS. FOR FIFTY YEARS IT HAS BEEN KNOWN THAT YIELD RESPONSE IN WHEAT WILL RESPOND TO NITROGEN FERTILISER WHEN THE PROTEIN CONTENT IS LESS THAN 11.4%. HOWEVER THERE WERE NO MEANS OF MEASURING THE PROTEIN CONTENT IN GRAINS IN THE FIELD IN 1963.

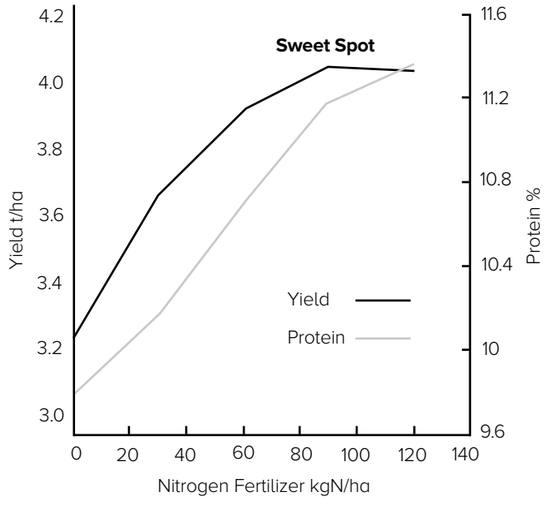
As such Russell's findings have virtually been overlooked for fifty years. Now that new sensor technology has evolved that makes on combine NIR analysis possible, then the importance of measuring protein in the field can be easily verified.

The CropScan 3300H On Combine Analyser measures protein, moisture and oil in grains and oil seeds every 7-12 seconds as the combine travels down the rows. The Protein and the Yield data taken off the combine shows where in the field there has not been enough Nitrogen fertilizer applied in order to achieve the full Yield Potential for the crop.

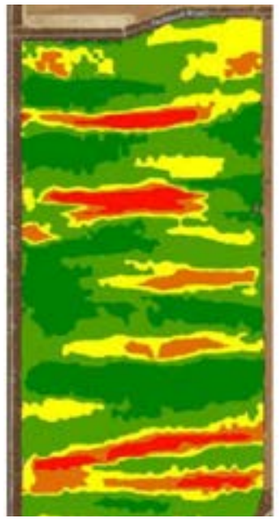
The Protein and Yield Maps show the variations in Protein and Yield across the field. The Protein/Yield Correlation Quadrant Maps shows the following zones:

The Yellow and Red zones make up approximately 45% of the field by area. In these two zones the grain protein content is lower than the average across this field. The yield in the Yellow zone is higher than the field average yield however it is still less than the 4t/ha expected in Australia. The Red zone shows the yield is less than the field average. The question is whether these zones could have yielded higher if more Nitrogen had been applied throughout the growing period. Since the grain protein contents were low, then the research suggests that this farmer lost yield in these zones.

Protein/Yield balance Plot

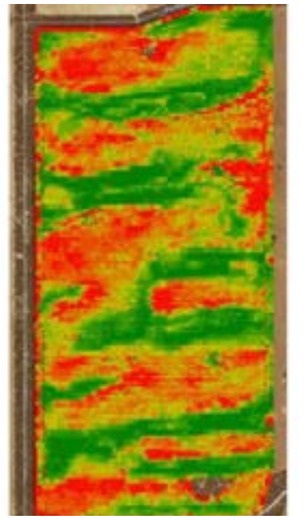


Protein Map



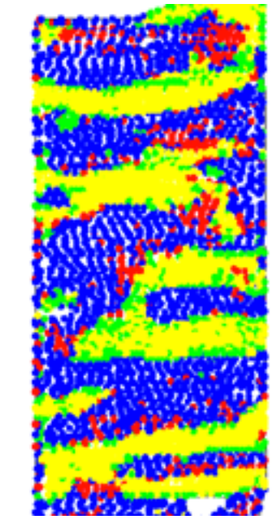
13.01 - 17.05 H1
11.51 -13.00 H2
10.51 - 11.50 APW
9.51 - 10.50 ASW
0.00 - 9.50 ASW

Yield Map



2964.9 - 48992.9 kg/ha
2348.5 - 2964.8 kg/ha
1885.2 - 2348.4 kg/ha
1642.7 - 1885.1 kg/ha
1468.9 - 1642.6 kg/ha
1239.5 - 1468.8 kg/ha
0.0 - 1239.4 kg/ha

Protein/Yield Correlation



High Protein/Low Yield
High Protein/High Yield
Low Protein/High Yield
Low Protein/Low Yield

An estimate of the lost yield for this field is:

Lost Yield = % Field x Field Size x Loss/ha
= 45% x 297ha x .8 t/ha
= 106 t

Cost of Lost Yield = 106 t x $280/t
= $29,937 = $101/ha

As well by increasing the Protein content to above 10.5%, then approximately 213 tonne of wheat would have been upgraded to APW from ASW and thereby increased the farmers payments by $22/t = $4704. The net result could have been a total of $34,641 or $116.60/ha.

The cost of the additional fertilizer is shown below:

40kg Urea per hectare
= 297 ha x 45% x 0.04 kg Urea/ha x $290/t Urea = $1550

60kg Urea per hectare
= 297 ha x 45% x 0.06 kg Urea/ha x $290/t Urea = $2325

80kg Urea per hectare
= 297 ha x 45% x 0.08 kg Urea/ha x $290/t Urea = $3030

When the CropScan 3000H was first introduced in 2013, our thinking was that farmers could gain a 10% increase in crop payments by blending in the field based on protein. It was not until 2017 that farmers stated reporting the much higher potential income increases by improving yield across their fields through the use of the Protein/Yield Correlation maps to make more accurate decisions on Nitrogen fertilization applications.

The example shown above is for one field on this farm of more than 10,000 hectares. Obviously not all fields are going to show the same high return for this technology, but when there is potential for more than 10 fold increase in revenues through more accurate Variable Rate Nitrogen Fertilization, then farmers have got to start taking notice.

"The question is whether these zones could have yielded higher if more Nitrogen had been applied throughout the growing period."

Phillip Clancy

NEW WHEAT JUMPS FROM TRIAL TO 50PC OF PROGRAM AT CARNAMAH

New wheat variety Havoc will make a substantial jump in hectares at Allan Griffith's Carnamah farm this season, going from a modest trial in 2018 to half the wheat program in 2019.

Allan, who grows wheat, barley and canola at 2400-hectare property, Dunromin, said the major increase was due to Havoc's quick maturity and high yield.

"We usually start dry seeding in May, as Havoc matures a week earlier than Mace, which is ideal for us," he said.

Allan obtained one tonne of Havoc seed to test against his commercial varieties Mace and Chief.

The Havoc was seeded at a rate of 43kg per hectare over 23ha, while Mace accounted for 70pc of the crop and Chief 30pc.

When they finished harvest in the first week of December, the results were in – 75 tonnes were stripped off the Havoc plot for an average yield of 3.26t/ha. The Chief yielded 3t/ha and Mace 2.8t ha.

"Havoc was the highest yielder, had low screenings and was better to handle due to its shorter canopy. We were very happy with it, so this season's program will be 50:50 Havoc and Chief.

"We missed out on good September finishing rain, but with the yields up and the price up, it was probably the best season on record for this area."

The 75t of Havoc will be seeded to 700ha at 65kg/ha this season, with the same allotted to Chief. Mace will be stored as backup seed.

This year will be the 82nd for the Griffith family at Dunromin – a property that was originally setup for livestock by Allan's father Ernie in 1937.

Allan took over the farm when his father retired in 1976 and now focuses solely on crops.

Havoc is marketed by Pacific Seeds, bred by LongReach Plant Breeders and is now free to trade farmer-to-farmer.

INDEPENDENT GM REPORT CONFIRMS SA MORATORIUM HAS COST FARMERS

CropLife Australia, the national peak industry body for the plant science sector, strongly welcomes today's release of the independent review of the South Australian Genetically Modified Food Crop Moratorium.

Matthew Cossey, Chief Executive Officer of CropLife Australia, commended the Minister Whetstone and the South Australian Government for having policy development guided by facts, data and independent analysis.

Matthew said, "The report's findings confirm that South Australian farmers have been held back by the moratorium, which is estimated to have cost the state's canola industry $33 million since 2004.

"Evidence provided to the review, and reflected in its findings, is the moratorium delivers no price premium or additional market access and has discouraged investment in public and private research and development. The review also found the cultivation of GM crops would increase productivity and provide environmental benefits for South Australia."

The findings mirror a recent report by independent market analysts Mecardo which provided clear evidence that the South Australian GM crop moratorium has not delivered any benefit to the state's farming sector. It found South Australian farmers had been denied the chance to increase profitability and environmental sustainability by not having access to GM crops.

Matthew continued, "I commend Professor Kym Anderson AC on a thorough report, which acknowledged the strong evidence from the agriculture and science sectors of the benefits and opportunities GM crops could provide for South Australia."

Matthew concluded, "CropLife Australia looks forward to the South Australian Government's response and outlining a path forward for genuine farmer choice in SA."

A BUZZY YEAR FOR HONEY BEE AND POLLINATION RESEARCH

Australia's 12,400 beekeepers are one-step closer to breeding varroa-resistant bees and trapping the serious and pervasive small hive beetle (SHB), as a result of industry's ongoing investment in a robust research, development and extension (RD&E) program.

With a vision to grow the long-term prosperity of rural industries, AgriFutures Australia works with industry to deliver research and development outcomes. It works in partnership with the AgriFutures™ Honey Bee & Pollination Program Advisory Panel to determine research priorities and make investment decisions.

It's a collaboration that continues to deliver positive benefits for the industry, according to newly appointed AgriFutures™ Honey Bee & Pollination Manager, Research Annelies McGaw. She believes the resilience of Australia's beekeepers is reflected in the dynamic RD&E program, which aims to safeguard the health of Australia's bees.

"Australian beekeeping is valued at $98 million, but its contribution to agriculture and the national economy is far greater," Annelies said.

"The RD&E Program addresses a number of key risks facing the industry including exotic pests and disease, economic pressures and reduced access to areas of native flora.

"We have 12 unique R&D projects underway that range from increasing the value of Australian honey as a health food to the probiotic development for bees by analysing gut bacteria in healthy bees, to name just a few."

One of the year's highlights was the findings of a three-year study into the SHB, led by Queensland researcher Dr Diana Leemon, which found that a lantern trap, together with a simple yeast based attractant, could effectively intercept and trap the SHB before it reached an apiary.

As the largest and leading apiary pest in warm, damp regions of eastern Australia, the SHB costs the industry $11 million on average per year. The project included the most comprehensive economic analysis of SHB ever undertaken, and provided a tangible outcome for industry to help manage the pest.

As Chair of the Advisory Panel, Doug Somerville said a key benefit of the Honey Bee & Pollination Program is its ability to bring together industry, leading researchers and government to collectively find solutions.

"A great example is AgriFutures Australia Science and Innovation award recipient, Dr Emily Remnant, from the University of Sydney, who is investigating how to build Australia's capacity to develop varroa-resistant bees," he said.

"Dr Remant's research has great promise as a future strategy against the varroa virus. Her research is investigating injecting a natural type of bacteria called Wolbachia into the abdomen of honey bees. Her trailblazing work could help to solve the world's most damaging cause of honey bee deaths."

Doug said the year had not been without its challenges, including the ongoing public debate about the authenticity and origin of Australian honey.

"Australia's beekeepers are among the best in the world and with the unprecedented movement of people and product it's in everyone's interest that there is a clear understanding of where our honey is sourced, as well as its botanical qualities," he said.

Commissioned by AgriFutures Australia, a recent review by the University of Melbourne's Dr Kale Sniderman found that the pollen content of most Australian honeys was distinctive at a global scale and that pollen analyses enabled our honeys to be identified and certified as produced in Australia.

Looking forward to 2019, Annelies said a critical component of the program is extension and delivering research findings to beekeepers and the broader supply chain.

"Without beekeepers, our honey stops. Continuous investment in people is essential, and we strive to build our industry capability in a number of ways. Most recently, we invested in a Women in Beekeeping Scholarship and sponsored a number of key events around Australia.

"A highlight on the industry calendar was the Australian Bee Congress, returning for the first time in 30 years. Held on the Gold Coast earlier this year, participants heard first-hand from our leading researchers on their various levy funded RD&E projects and outcomes."

The next major focus of the AgriFutures™ Honey Bee & Pollination Program is reviewing the current five-year RD&E Plan and identifying research objectives and priorities for the next plan, to be finalised by mid-2019.

For more information on the AgriFutures™ Honey Bee and Pollination Program, visit www.agrifutures.com.au/honey-bee pollination/

TASSIE'S TOP AG SCIENCE STUDENT RESEARCHES WETHER PRODUCTIVITY

Tasmanian Institute of Agriculture (TIA) student Lauren Rowlands has won a national scholarship and three awards recognising her achievements in agricultural science.

An Undergraduate Project Scholarship from the Australian Wool Education Trust (AWET) – one of 15 awarded nationally – is supporting Lauren' honours research into Merino wool production.

The research trial is taking place at Stockman Stud in the Southern Midlands, the region where Lauren grew up.

"Through my research, I hope to find out the most productive pathway for castrated Merino male lambs, known as wethers," Lauren said.

"Farmers want to know if wethers produce better meat or wool, and what they should be fed. I'm testing this out through two different pasture diets.

"With funding from the scholarship, my research will be especially rigorous. For example, I'm able to get the fleece samples professionally tested," she said.

AWET Secretary Mr Peter Sommerville said the industry-focused project design was a key reason for the selection panel's decision.

"Through the project, Lauren will develop her knowledge of wool production and solve a major question for local farmers," Peter said.

"The scholarship recognises Lauren's keenness to contribute to the wool industry and her ag science know-how. She shows huge potential for a successful career in agriculture."

In December, Lauren won the University of Tasmania's Alan Bray Prize in Animal Science for highest grades in the Animal Science Unit.

She was also awarded for the best overall results at third-year level in the Bachelor of Agricultural Science at TIA.

At just 21, Lauren is already working part-time in a field related to her studies.

"During my degree, I enjoyed doing work experience in biosecurity with the Tasmanian Government, and I've since landed a casual job as a biosecurity inspector," Lauren said.

Last year Lauren volunteered for TIA's National Merino Challenge team, which won first place and she was awarded the Tertiary Overall Champion. "Winning the National Merino Challenge 2018 influenced my decision to do an Honours project in wool research," she said. "The previous summer I had a completely different agricultural experience doing a practical internship on grapevine research with TIA." "All this experience helps you nut out which direction you want to go in. "My advice to students is to jump onto work experience and put yourself out there."

INTERNATIONAL RECOGNITION TO HELP PLANT HEALTH GROW

The first International Year of Plant Health will be held in 2020 recognising the importance of global cooperation to keep plants healthy and free of pests and diseases.

Australian Chief Plant Protection Officer, Dr Kim Ritman, said protecting our plant health is vital for food security, trade, the economy and environment.

"Australia is fortunate to be free of some of the world's most damaging plant pests and diseases that are present in other countries," Dr Ritman said.

"Healthy plants are essential for life—they feed people and animals, contribute to food security both here and overseas, and support jobs and income for people across the country.

"Through the International Year of Plant Health, countries from around the world will be joining forces to help promote the importance of keeping our plants healthy.

"Pests and diseases can spread from country to country and this is a great initiative which recognises that preventing these threats requires a global effort.

"Increasing awareness will allow us to highlight the risks we face and how everyone can do their part to keep plant pests and diseases out of our country."

The International Year of Plant Health was first proposed to the governing body of the International Plant Protection Convention (IPPC) in 2015 and received overwhelming support.

It was proclaimed by the United Nations General Assembly on 20 December and aims to support the UN Sustainable Development Goals, which focus on addressing global challenges to achieving a better, more sustainable future.

The IPPC provides a framework to protect the world's plant resources from the harm caused by pests and diseases. The IPPC is the leader in the global effort to promote and maintain plant health. Australia contributes strongly to the IPPC and benefits from the international standards it develops to facilitate safe trade.

For more information on the International Year of Plant Health, visit Food and Agriculture Organisation of the United Nations Health.

PRAIRIE STRIPS TRANSFORM FARMLAND CONSERVATION

Converting low-profit land brings big returns. Modern agriculture's large monoculture fields grow a lot of corn and soybeans, planted annually. The outputs from row crops can be measured both in dollars paid in the market and also in non-market costs, known as externalities. Soil, nutrients, groundwater, pollinators, wildlife diversity, and habitat (among other things) can be lost when crop yields are maximised.

Now it appears that prairie strips have an extraordinary power to change this pattern.

A prairie strip is much what it sounds like: a strip of diverse herbaceous vegetation running through a farm's rowcrops. In the American Midwest, chances are the soil that now supports crops was once covered in prairie before cultivation. Prairie plants are a mixture of native grasses, wildflowers, and other stiff-stemmed plants. They have deep roots that draw water and nutrients from far below the surface. They are perennials, returning to grow each spring.

"Research shows that areas of native prairie planted in the right places in a farm field can provide benefits that far outweigh losses from converting a small portion of a crop field to prairie," said Lisa Schulte Moore of Iowa State University.

"For example, when we work with farmers to site prairie strips on areas that were not profitable to farm, we can lower their financial costs while creating a wide variety of benefits."

Lisa is a team member with STRIPS: Science-based Trials of Rowcrops Integrated with Prairie Strips. STRIPS showed that converting just 10% of a row-cropped field to prairie strips:

- reduces soil loss by 95%,
- reduces overland water flow by 37%, and
- reduces the loss of two key nutrients (nitrogen and phosphorus) from the soil by nearly 70% and 77%, respectively.

It also leads to greater abundance and diversity of beneficial insects, pollinators such as bees and monarch butterflies, and birds. Going from zero to 10% prairie provided far more than a 10% increase in the measured benefits.

"Some of these benefits can impact our pocketbooks but are not accounted for by typical financial markets," said Lisa. These include ecological benefits such as flood control, cleaner water, and carbon from the atmosphere stored.

Market benefits also exist: more productive soil in the fields can, in time, translate into better yields, fiber and honey production, forage for livestock, and hunting leases.

The STRIPS research began in Iowa in 2007. Because of promising scientific results, five years later the researchers began working with farmers to introduce prairie strips onto commercial farms. While the research results have been more variable in these more complicated settings, the findings are encouraging and cooperating farmers are liking what they see.

The plantings require a modest investment in site preparation and seed planting. Maintenance tasks include some mowing in the establishment years and spot treatment for weeds. So far, the researchers have not seen competition between the prairie plants and crops that impact yield.

Conservation Reserve Program (CRP) contracts through the USDA's Farm Service Agency can greatly reduce the cost of establishing prairie strips. Overall, Lisa said, this is one of the most economical best-practice conservation steps farmers can take.

Still, lack of stable financial rewards for establishing and maintaining prairie strips is a barrier to widespread adoption. "Finding ways to return economic value to farmers and farmland owners is crucial," Lisa said. She is now focused on developing marketable products from prairie strips, such as renewable energy sources from prairie biomass. That would help make what is already a solid investment into a can't-lose proposition.

Prairie strips in Iowa. Photo: Lynn Betts/Conservation Districts of Iowa

A TANK MIX FOR BETTER RYEGRASS CONTROL

TANK MIXING PRE-EMERGENT HERBICIDES IS PROVING TO BE THE MOST EFFECTIVE WAY FOR FARMERS TO MANAGE HERBICIDE RESISTANCE, FOLLOWING A SERIES OF TRIALS AND OTHER INVESTIGATIONS IN RECENT YEARS.

Mixing herbicides is better than rotating them and can double their longevity, according to Dr Roberto Busi from the Australian Herbicide Resistance Initiative (AHRI).

This is also a key recommendation to come out of field research led by Dr Chris Preston and his colleagues at the University of Adelaide as part of the WeedSmart program funded by GRDC. (See Graph 1).

"In recent years, we have done a lot of work to understand how to get the best out of pre-emergent herbicides for managing herbicide-resistant weeds such as annual ryegrass and wild oats," Chris said.

"This included six trials done in collaboration with farming systems groups in southern NSW, Victoria and South Australia in 2012 where we compared the performance of Triflur X®, Avadex® Xtra, Boxer Gold® and Sakura® alone for reducing annual ryegrass spikes.

"When we used Avadex Xtra in tank mixtures with Triflur X, Boxer Gold or Sakura, the ryegrass control from all treatments improved significantly."

Chris said adding Avadex Xtra to Triflur X was an ideal tank mix for lower rainfall environments for extra control of ryegrass and wild oats, provided there was no trifluralin resistance.

"Avadex Xtra and Boxer Gold also improved ryegrass control, but the stand-out performer was Avadex Xtra and Sakura," he said.

"In higher rainfall areas with wheat yields of 4 t/ha and more, our work showed Avadex Xtra and Sakura is the starting point for ryegrass and wild oats control."

Field trials by Nufarm in 2017 and 2018 have consistently confirmed the value of tank mixing Avadex Xtra with other pre-emergent herbicides, even in a dry year.

Andre Sabeeney, Technical Marketing Lead with Nufarm, said the company's trials such as one conducted in southern NSW last year produced similar findings to those led by Dr Chris Preston in 2012. (See Graph 2).

"The other key finding from our research was how important it is to use a mix partner like Avadex Xtra when conditions at sowing are variable, such as the dry start in 2018," he said.

Andre added that it is no longer good practice to rely on a single pre-emergent, and it is also wise to understand the different properties of the herbicides used.

"Avadex Xtra and trifluralin are slightly volatile and once incorporated, this is beneficial when rainfall is marginal," he said.

"This is because the vapour activity fills the air pockets in the soil and allows some uptake via the roots and shoots. These two herbicides don't just rely on moisture to have an effect.

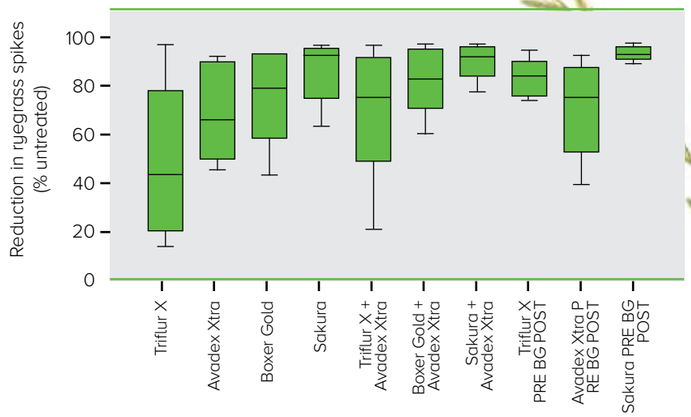
"When Avadex Xtra is added to Triflur X or Sakura, we see better and more consistent control of annual ryegrass than using any of these herbicides on their own.

"Our R&D work with higher rates has enabled Nufarm to obtain a unique registration which gives increased control and longer residual activity too."

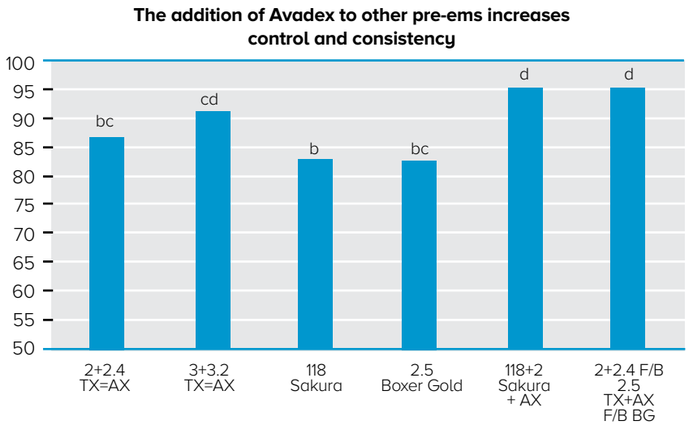
Andre issued a timely reminder to agronomists and farmers about rotating the chemistry they choose.

He recommended rotating between Group D herbicides, trifluralin or propyzamide, and Group J and K herbicides, Sakura, Boxer Gold and Avadex Xtra (see Figure 1).

Dr Chris Preston from the University of Adelaide has led a lot of work to understand how to get the best out of pre-emergent herbicides for managing herbicide-resistant weeds such as annual ryegrass and wild oats



Graph 1: Research led by Dr Chris Preston found that tank mixing Avadex Xtra with other pre-emergent herbicides produced better ryegrass control than using any of those herbicides on their own.



Graph 2: This trial in southern NSW last year showed better and more consistent control of annual ryegrass when Avadex Xtra is added to Triflur X or Sakura.

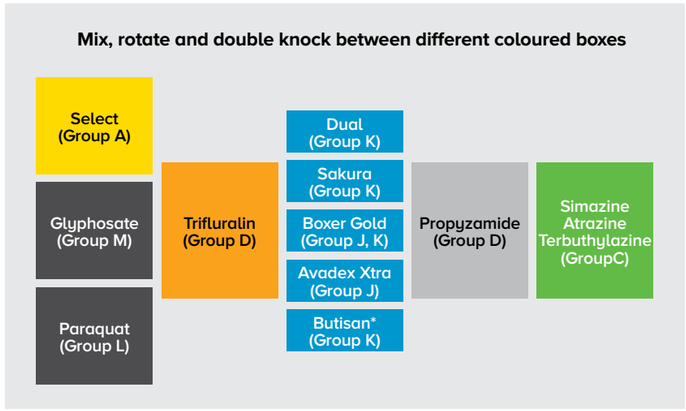


Figure 1: Agronomists and farmers should rotate the chemistry they choose to increase the longevity of their pre-emergent herbicides.

MANURE INJECTION OFFERS HOPE, CHALLENGE FOR RESTORING WATER QUALITY

WIDESPREAD ADOPTION BY DAIRY FARMERS OF INJECTING MANURE INTO THE SOIL INSTEAD OF SPREADING IT ON THE SURFACE COULD BE CRUCIAL TO RESTORING CHESAPEAKE BAY WATER QUALITY, ACCORDING TO RESEARCHERS WHO COMPARED PHOSPHORUS RUNOFF FROM FIELDS TREATED BY BOTH METHODS. HOWEVER, THEY PREDICT IT WILL BE DIFFICULT TO PERSUADE FARMERS TO CHANGE PRACTICES.

In a four-year study, overland and subsurface flows from 12 hydrologically isolated research plots at Penn State's Russell E. Larson Agricultural Research Center were measured and sampled for all phosphorus constituents and total solids during and after precipitation events. During that period, from January 2013 to May 2017, the plots were planted with summer crops of corn and winter cover crops of cereal rye. Half the plots received broadcast manure applications, while the others had manure injected into the soil.

Researchers evaluated loads of total phosphorus, dissolved phosphorus, particulate phosphorus and total solids against flow volumes to learn how phosphorus and sediment losses differed between plots. Shallow-disk injection of manure was found to be more effective than broadcasting manure in promoting dilution of dissolved phosphorus and to a lesser extent, total phosphorus. The broadcast manure plots experienced more runoff of particulate phosphorus than did the injection plots.

Importantly for no-till advocates, no difference was detected between application methods for total solids in the runoff – meaning manure injection, with its slight disturbance of the soil surface, did not cause sedimentation. No-till practitioners, who constitute slightly more than half of the dairy farmers in Pennsylvania, have been slow to adopt manure injection due to concerns about the practice causing sedimentation and muddying streams.

However, the precision and accuracy of the study, recently published in Agriculture, Ecosystems and Environment, was constrained by hydrologic variability, conceded Jack Watson, professor of soil science and soil physics, Penn State. His research group in the College of Agricultural Sciences conducted the study. Jack pointed out that the findings demonstrate that, even at a small scale, the effectiveness of a practice in accomplishing water quality benefits varies.

"This has been the case with previous phosphorus-mitigation field studies, as well," he said. "Even studies done with carefully constructed research plots like ours, which allow us to collect, measure, test and contrast runoff, are confounded by hydrologic variability."

But despite the variability, the findings showed that manure injection decreased the overall phosphorus losses, according to lead researcher Melissa Miller, a master's degree student in soil science when she conducted the study.

“Even studies done with carefully constructed research plots like ours, which allow us to collect, measure, test and contrast runoff, are confounded by hydrologic variability.”

Jack Watson

"When we looked at the total phosphorus losses from the plots, we were able to see a strong trend," she said. "It was revealed in both overland and subsurface flows following rain events."

That variability, however, complicates efforts to convince dairy farmers they should convert to manure injection, noted research team member Heather Gall, assistant professor of agricultural and biological engineering. She suggested that the practice, widely adopted, could help states comply with total maximum daily load stream regulations set by the U.S. Environmental Protection Agency to protect the Chesapeake Bay from nutrient pollution and associated algal blooms and dead zones.

"When we make recommendations to farmers about what they can do to improve runoff quality, we want to be able to tell them how well it will work," she said. "But how much manure injection will reduce the amount of phosphorus loss on a particular farm can depend on site characteristics, such as what kind of soil it has, what kind of crops are growing and the slope of the landscape. And so, we might not be able to tell a farmer definitively what to expect in terms of load-reduction benefits, making it difficult to make a compelling case that an investment in shallow-disc manure injection equipment will be worthwhile."

Jack explained that manure injection equipment is expensive and that it takes longer and requires more fuel for farmers to apply manure to their fields using injection than broadcasting or spreading it. For shallow-disc manure injection to be broadly implemented in the Chesapeake Bay drainage, he said, it will require substantial financial support from government or other off-farm sources. But it needs to be done, Jack believes.

"In the Mid-Atlantic and Northeast regions, we have a lot of dairy animals concentrated in a small area. We have all this manure that has to be gotten rid of and all the nutrients that go with it have to be disposed of on a small amount of land. It must be done in a way that will protect the Chesapeake Bay," he said.

And even if the phosphorus reductions are uncertain due to site variability, Jack added, there are the additional benefits from manure injection, such as reducing ammonia volatilization and reducing odor emissions, which have significant value as well.

SARDI JOINS FORCES WITH ADELAIDE UNIVERSITY TO INCREASE AGRICULTURAL RESEARCH CAPABILITY

The State Government has signed a significant agreement with the University of Adelaide to deliver benefits in research, development and extension for primary industries in the state.

Through the agreement, Primary Industries and Regions SA (PIRSA) and the University will utilise each other's strengths in research, development, extension and innovation to generate high-value outcomes for the agricultural sector and aim to attract greater external research funding.

Minister for Primary Industries and Regional Development, Tim Whetstone said key areas of focus under the agreement include crop and food sciences.

"The State Government is focused on growing the state's capabilities in agricultural research, development and extension and this agreement provides a strong platform," said Minister Whetstone.

"By leveraging PIRSA's strengths in applied research and extension and optimising the University's strengths in discovery and basic research, there are big research and development wins to be gained for the benefit of South Australia's primary industries sector, particularly in focus areas such as AgTech.

"The State Government already has a close working relationship with the University of Adelaide but this new partnership creates greater opportunities to grow the state's reputation as a world leader in agricultural research."

The University of Adelaide's Vice-Chancellor, Professor Peter Rathjen, said the partnership with PIRSA will provide ongoing benefits for South Australia.

"Throughout its history, through research and our graduates, the University of Adelaide has made a profound impact on Australia's multi-billion-dollar agriculture, food and wine sectors. This new partnership will help us to grow our research capability in these fields for the benefit of South Australia," said Peter.

"SARDI researchers and facilities have been co-located at our Waite and Roseworthy campuses for decades. While there has been much interaction between us during that time, this new partnership deepens our relationship and creates more opportunity for world-leading research based right here in South Australia.

"By combining our expertise and research efforts, we aim to confront the big issues faced by our primary producers. The results of this work will be felt from the laboratory to the paddock, to the supply chain, and into people's daily lives through the food they eat."

THE NEW FOUR MILLION DOLLAR SEED PLANT UNVEILED

More than 100 business partners, suppliers and staff took the opportunity to inspect the new $4 million Seed Force facility, which comprises offices, warehousing and seed manufacturing. Key shareholders and business partners from across Australia, New Zealand, France and the Netherlands were also in attendance.

Bruce Garrett, Seed Force group managing director, said it was pleasing to have so many long-term business supporters on-site to share the company's success.

"Our motivation for establishing this company has never changed; to make a difference to Australian farmers. However, without the support of all our customers, suppliers, staff and service providers, we don't have a business.

"We have invested heavily in expanding the capacity of our operation to ensure we can deliver to our customer's expectations.

"The new seed coating and treatment equipment, pallet racking, warehouse bin management, business software and bespoke office space means we can continue to do this as we grow."

As a shareholder and key breeding partner, Samuel Gasté, new markets director for RAGT Semences in France, said he was honoured to be in Australia to celebrate with Seed Force.

"As an international seed breeding company, our partnership with Seed Force in Australia and New Zealand is an important and strategically significant one for us.

"We value the partnership and the value that it represents for our company. It is so pleasing to be here to mark this milestone and commitment to the future."

RAGT Semences are the breeder of RGT Planet, which Seed Force develops and markets for Australia. Guests had the opportunity to drink Coopers Pale Ale that had been brewed using the new variety, which is anticipated to receive local malt accreditation in the next couple of months.

Business development manager Mike Gout spoke to the value that the company's research and development pipeline adds to Australian growers, with fellow director David Gould thanking the local team and business partners for their support, and preparations for this celebration.

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