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Inside

The New Zealand Institute of Agricultural & Horticultural Science Inc

Funny the way things work out!

WELCOME TO THIS ISSUE of *AgScience*. Our feature articles are quite diverse in terms of the topic areas covered. One considers the reproductive biology of Hieracium or hawkweed, native to Europe but established as an invasive weed in New Zealand, while the second examines the human health benefits derived from a berry extract. This is quite a contrast but it is also a nice example of the scope and breadth of the research carried out by agricultural and horticultural scientists. Perhaps it is a reminder, too, that although we may have our own areas of special interest and expertise, we need to be aware of what is happening around us and that successful outcomes will usually require inputs from a number of sources.

The NZIAHS recently co-hosted a plant biology conference in Palmerston North, following on from a similar meeting in 2013. One of the features appreciated by participants at both meetings was the range of topic areas and the chance to see papers presented by agronomists, physiologists, geneticists and bioinformaticians. Now that we no longer have conference week (one of the changes noted during our review of NZIAHS activities), joint meetings with different societies are an important way of making sure we interact and maintain links with colleagues in other research fields.

The importance of a good diet and the benefits of fresh fruit and vegetables are something that we acknowledge, even if the information is not always acted upon. Understanding how and why different components of our diet are beneficial provides a different perspective and so it was with interest that I read the report on blackcurrant extracts and their impact on reducing the levels of oxidative compounds in plasma and promoting muscle recovery after exercise. I was even prompted to ask why enhancing the inflammatory response was a positive outcome. An inflammatory response is part of our body's reaction to stress, whether that be through injury and infection or through exercise and muscle activity. So rather than being something we should always avoid, inflammation is part of the recovery response and part of building immunity. It would appear that something in New Zealand blackcurrants aids this process. A good outcome for us and for the growers.

A deeper understanding of the biology of Hieracium reveals not only why this plant has successfully established itself as a weed in New Zealand but also some of the different and amazing aspects of plant reproductive biology including the production of clonal seed. The history of scientific studies on Hieracium and the link to Gregor Mendel is a nice story. It struck a chord with me on several levels – how the relevance of our work is not always seen immediately (maybe not even in our lifetime); how it's pretty neat that something that Mendel puzzled over 150 years ago is now making some sense and we have an explanation for why it caused him some problems; that sometimes, even if you are smart, some things don't work out and – fortunately – usually this is not what you are remembered for.

Continuing on the theme of "Funny the way things work out", at our annual general meeting on 3rd July I completed my term as President of the NZIAHS. In my President's report I reflected on how I have enjoyed the role more than I thought I might. I have benefited from taking a more active role within the Institute and have appreciated the chance to work with different people, especially the members of the council. I leave with a much better appreciation of what the Institute does, especially in promoting and advocating for agricultural and horticultural science. I have enjoyed my involvement with three reasonably large conferences and the far larger Horticultural Congress. The leap of faith made by the organising committee was massive but the success of the event and the goodwill and profile it engendered will be of benefit for years to come. I also have a much better appreciation of the value of the awards that the Institute administers. They are appreciated by the recipients but they also reinforce the worth of what we do and celebrate it. There is a loyalty and affection for the Institute from our members that is quite heartening. Long may that continue!

David Lewis
Immediate Past President

MESSAGE FROM INCOMING PRESIDENT

For those of you whom I have not had the pleasure of meeting, I am a Science Team Leader in the Land & Environment Group of AgResearch, based at Grasslands in Palmerston North. I started my agricultural career working school vacations on my uncle's farm near Marton and from that experience decided to do a BAgrSci degree at Massey, majoring in agronomy and soils and graduating with first class honours in 1989. At that point I was awarded a membership in the NZIAS (as it was then) and picked up a science position with MAFTech (as it was then) at the Whatawhata Research Centre (as it still is). My first piece of work there was identifying suitable legume species and ecotypes for summer-dry hill country, a challenge which is still very relevant now. The Whatawhata team experience was a fantastic baptism into the multi-disciplinary environment that is hill country research. After 5 years I had the privilege of being sponsored by AgResearch to do a PhD in grassland ecosystem science at Colorado State University, where I had to merge agronomic and ecological concepts, with some exposure to modelling, in order to ground the systems thinking. Returning to New Zealand in the late 1990s I was based at Ruakura, where the agricultural and environmental worldviews were beginning to interact in earnest and my attention was caught by the value of non-grassy vegetation for achieving sustainability goals. During this time I also got involved in the Waikato Section, with a great little team active in running seminars and events of local relevance. After a virtual sabbatical in Western Australia in 2007 studying landscape ecology, I relocated to Palmerston North to work in climate change impacts on pastoral systems. Seduced by the dark side I took up a team leader role – it's a diverse team, well-reflected in the name "Soils, Land Use and Global Change". I still get a little time to devote to research on pasture and soil systems, weed management and ecological restoration. In 2011, I joined the NZIAHS Council and am now honoured to be your incoming President.

Mike Dodd
President

by Bob Edlin
Editor

$7.3m for agricultural research partnership

THE GOVERNMENT ANNOUNCED IN July it would invest $7.3 million over five years in an agricultural research partnership, Pastoral Genomics, to improve pasture grasses and lift the performance of livestock farming.

Pastoral Genomics is an industry-led research partnership involving DairyNZ, Beef+Lamb NZ, Grasslands Innovation, NZ Agriseeds, DEEResearch, AgResearch, and Dairy Australia. Its objective is to provide pastoral farmers with better forage cultivars that will increase productivity, profitability and environmental sustainability of New Zealand's pastoral farming systems.

The Government funding, provided through the Ministry of Business, Innovation and Employment's research partnerships programme, will be matched by industry funding.

Science and Innovation Minister Steven Joyce described the research as "strategically important to New Zealand" because it aimed to increase productivity, profitability and environmental sustainability of pastoral farming, a large part of our agricultural sector.

He emphasised the pastoral sector's economic importance. "New Zealand has a strong primary sector," he said. "Just over half of our total exports of goods and services by value are primary products. We need to build on this strength with constant innovation, and by taking full advantage of our strength in agricultural technologies."

The Government's investment in the partnership was expected to boost the sustainability of the country's pastoral farms and increase the value of exports by the sector, contributing to the Government's Business Growth Agenda goal of increasing the ratio of exports to GDP.

Primary Industries Minister Nathan Guy similarly said the funding was a strong investment into one of New Zealand's most important industries.

"New Zealand farmers are the best in the world, but we need to keep innovating and investing in scientific research to maintain this. This kind of work will help us achieve our goal of doubling the value of primary sector exports by 2025."

The partnership intends to use non-regulated biotechnologies, including genomic selection that does not involve genetic modification, to help progress breeding and commercialisation of high-performing forages for grazing livestock. The forage cultivars are expected to have improved nutritional content and be more resilient to drought and disease.

A few weeks later Finance Minister Bill English – questioned in Parliament about economic diversification – said that "under the excellent leadership of the Hon Steven Joyce, the Government's programme through the Business Growth Agenda is encouraging a range of industries to develop in New Zealand."

The question was prompted by the slump in dairy prices.

English was astray with his figures when he said the dairy industry accounts for 20% of New Zealand's exports "and, actually, it is a bit less than that". In the year to June last year dairy exports actually accounted for 30% of our exports and in the latest June year – because of the drop in values – it accounted for 25%.

Even so it is by far our biggest export and English said Labour's question about diversification was "a bit like asking why New Zealand does not diversify from rugby because the All Blacks are too successful. We have got all our eggs in the All Black basket."

The fact was that dairying was a well-performing industry, the Government would hope it would keep performing. "If you think that having too much dairy is a problem, look what happens when you have a bit too little," he said.

Nevertheless the lower exchange rate would cushion the economic blow to the dairy industry and encourage the expansion of tourism. It would also underpin the profitability of meat and wool, horticulture, and the film industry.

In mid-August a patsy question from a party colleague enabled Steven Joyce to provide more information about industry diversification.

Wine industry exports had almost doubled from just under $800 million in 2008 to $1.4 billion this year. Beef export revenues had grown from $1.8 billion in 2008 to $3.1 billion in the year to March 2015. Information and communications technology sector exports had more than doubled to $930 million in 2014.

One of the key initiatives to further diversify the economy was to boost research and development investment in different sectors, Joyce said. The Callaghan Innovation centre was investing a substantial amount of new spending in research and development grants, and he had just announced the availability of another 233 positions for research and development student grants this summer.

Whether agricultural and horticultural scientists should be cheered by the Government's priorities is a moot point.

New Zealand has a grant scheme to encourage research and development, Joyce said, whereas Australia has a tax credit scheme and "the research and development here is skewed far more heavily towards high-tech sectors such as information and communications technology and high-tech manufacturing".

Nearly 42% of business research and development investment in New Zealand was now in the manufacturing sector and computer services make up another 25%. "That suggests that we are going to see further diversification and growth in these sectors in the years ahead."

By Dr David Lewis
Immediate Past President

Plants for the future

NZIAHS AND THE NEW ZEALAND branch of the International Association of Plant Biotechnologists (NZIAPB) in early July co–hosted the 'Plants for the Future' conference at Massey University in Palmerston North.

The conference was specifically a plant biology meeting but a wide range of sessions covered topics such as breeding for complex traits using genome sequence information, tree architecture and orchard planting systems, and how our mix of pasture species can influence and mitigate environmental impacts. The organising committee was pleased with the number of delegates – nearly 100 – and feel this is indicative of the value of shared activities where interests and membership of different societies and institutes overlap. The variety of session topics was another feature. While being able to attend some sessions of direct interest, participants also could catch up with research areas outside their usual sphere of work.

One of the trends noted for science is that we are now past the genomics era, where the focus was simply on getting the genome sequence for a particular species. We are now looking at how that genetic information is being used and how we deal with some of the foibles of our crop plants. New Zealand scientists have been heavily involved with the genome sequence projects for several major horticultural crops – kiwifruit, potato and apple. The green kiwifruit (Actinidia deliciosa) in particular presents some challenges, being hexaploid and therefore having six sets of chromosomes. One paper described the construction of linkage maps for the six genomes which will be used subsequently to identify markers for different quality traits that can be used in the development of new cultivars. Similar approaches have been taken for potato, white clover and polyploid species, where identifying the genes associated with particular traits can be a challenge.

Understanding complex traits calls for a wide range of germplasm for comparisons, both genotypically and phenotypically. Some papers focussed on how we can store germplasm efficiently, but in ways that make it possible to avoid specific pathogens. The storage of kiwifruit germplasm was considered both as long-term cool-storage tissue culture collections and using cryopreservation technologies. Other papers looked at the underlying genetic control of developmental events such as flowering and branch development; critical information not just for our wider knowledge of plant biology, but also for their impact on factors such as crop yield, tree architecture and planting densities.

Themes of sustainability and how we respond to particular climatic conditions were considered and not just under New Zealand conditions. Water-use patterns in date palms in the United Arab Emirates and in avocado trees in Kenya were monitored using modelling systems developed in New Zealand. In these two cases, the environmental conditions were dramatically different, but the desired outcome in managing a limited resource was similar. The solutions, however, will be quite different in a desert environment relying on ground-water reserves compared with a tropical grassland, reliant on the twice-yearly rainy season.

The lead paper in the Biotechnology for Industry session focused on forage crops and what made technology attractive to industry. Essentially it focused on the value proposition and opportunities created for industry. Ryegrass endophytes and new pasture species such as plantain were examples of these technologies rapidly adopted by New Zealand farmers. Looking forward, crops that can tolerate a variable climate, provide flexibility in farm management options or provide health benefits for humans and animals are of interest.

This was a great meeting with some diverse themes which met several of the roles of the Institute: to provide an opportunity to showcase our science, promote interactions with people from other organisations and to celebrate agricultural and horticultural science.

Dr Ross Bicknell
Plant & Food Research, Lincoln

Studying apomixis in Hieracium: revisiting Mendel's nemesis

HIERACIUM IS A REMARKABLE plant in many ways. In its native Europe it is well known among naturalists, with its own group of devotees who meet every year to discuss their latest findings and to enthuse over the plant's beauty. In New Zealand we know it as an invasive weed of high-country pasture. Beauty and aggressive behaviour aside though, for me the most intriguing thing about Hieracium is that it no longer uses sex to produce its seeds. Instead, seeds form as exact clonal copies of the mother plant through a process called apomixis.

Hieracium is a prolific producer of seeds. Like its close relative the dandelion (Taraxacum officinale), Hieracium forms a 'fairy clock' seed head including about 100 viable seeds. Over summer, a clonal mat of connected rosettes may produce hundreds of thousands of seeds, each with a ring of pappus acting like a parachute to aid in its dispersal by wind. It's easy to see why Hieracium has become such a successful coloniser.

In my lab we study the genetic control of apomixis. The trait is known to occur in more than 40 families of flowering plants and is widespread among ferns, mosses and algae, although it goes by different names in different groups. In animals the equivalent process is called parthenogenesis. If you've ever wondered why you see only one aphid on a plant today yet hundreds within a week, the reason is that aphids are parthenogenic – they are actually born pregnant.

Apomictic species are all around us. Familiar examples include citrus, blackberry, dandelion, St John's wort, pampas grass, and Kentucky blue grass. Among our native plants, examples include Pomaderris and Coprosma, and there will be many more that we have yet to find. Most of our work, however, focuses on Hieracium for the simple reason that it is a very good model system to study this unique trait. Hieracium is small, easy to grow, has a short generation time and produces seeds by a type of apomixis that is of particular interest.

The first person we know to have studied inheritance in Hieracium was Gregor Mendel. He was determined to understand the genetic mechanisms underlying inheritance. His early studies were on mice but he was soon discouraged from continuing this work because sex wasn't regarded as an appropriate topic of study for a young monk. After considering a range of plant species, he settled – as is well known – on the garden pea as a suitable subject of study. Garden pea was a good choice for this work: it had large flowers that were easily emasculated and crossed, it was self-fertile, easily cultivated and available in a number of true breeding forms, and it was a true sexual species using meiosis and fertilisation to generate its seedling progeny.

In a relatively short time Mendel amassed enough data to propose in his famous paper of 1866 that inheritance was particulate, binary and that the factors involved displayed dominance. It was a momentous discovery. It was so far ahead of its time, however, that the scientific elite simply chose to ignore it. Mendel wrote numerous letters to members of the scientific community with little effect. Intriguingly a letter from Mendel was even found unopened among Charles Darwin's effects. Quite conceivably, Darwin was the one person who may have perceived the wider implications of Mendel's work and scientific history (not to mention Mendel's scientific career) would have been quite different had that letter been opened on arrival.

The one person who did take an interest was Carl von Nägeli, a leading botanist at the University of Zürich. Mendel's letters to Nägeli survive so we know Nägeli suggested to Mendel that he test another plant to validate his results in pea. The plant Nägeli proposed for this study was Hieracium. For Nägeli this was a natural choice since he was interested in the taxonomy of Hieracium. For Mendel it couldn't have been a more unfortunate recommendation. Hieracium was as easy to grow as pea but the flowers were microscopic and almost impossible to emasculate. The "true breeding" lines available were clones not homozygotes and, of course, Hieracium doesn't utilise meiosis and fertilisation to generate new seeds because it's an apomict.

We don't know exactly how many crosses Mendel attempted with Hieracium but extrapolating from his data, it must have been close to 10,000. This is vastly more than he conducted on pea, yet the results were simply uninterpretable. Mendel finally wrote the work up in a small paper in 1869 concluding that inheritance in pea and Hieracium showed "almost opposed behaviour" but he went on to speculate that they both still represented "the emanation of a higher universal law". Very soon after this Mendel stopped his scientific studies and concentrated on his administrative role in the church.

Obviously, we now know far more about the biology of this remarkable plant and, somewhat ironically, it is now proving to be a very useful model for studying mechanisms of inheritance. Our published findings demonstrate that dominant determinants operate at two unlinked loci that control apomixis in Hieracium and we've recently determined more than a megabase of sequence at one of those loci. Consequently, I believe we can now say that Mendel was indeed right about the universality of the laws of inheritance. Even apomixis in Hieracium operates by these laws.

Staying physically fit and mobile with help from New Zealand blackcurrants

WE ALL KNOW EXERCISING is good for our health and fitness but for most of us it's difficult to maintain. Furthermore people increasingly are becoming aware that intense training can have some drawbacks, including lowering the body's immune defences and increasing risk of muscle damage. Highly trained sports people have suspected this for many years and have been searching for answers.

While there is a lot of hype out there, imagine if there truly was a food that could help us gain the most from our exercise regime, prevent some of these issues and help keep us fit, mobile and healthy. Scientists at Plant & Food Research believe they may have some foods to help.

UNIQUE NEW ZEALAND BLACKCURRANTS

New Zealand blackcurrant is one of the fruits that has shown promise. Blackcurrants arrived in New Zealand with European settlers in the 1800s and New Zealand now grows the world's fourth largest crop volume. It has long been accepted that fruit, vegetables and grains are good for us but only more recently have scientists begun investigating plant bioactive compounds and the mechanisms by which they keep us healthy. Berries such as blackcurrants, blueberries and cranberries are known for their free radical and oxidative stress fighting antioxidant qualities, containing valuable bioactive compounds such as anthocyanins, polyphenolics, flavonoids or phytonutrients as they are sometimes described. New Zealand blackcurrants in particular are characterised by a high density of anthocyanins and therefore have a deep colour and additional advantages in terms of sensory characteristics and sweetness.

ENHANCING EXERCISE BENEFITS

A lot of research has been carried out over many years to find a food nutrient which can provide an elixir for assisting exercise. Vitamins, fish oils, anti-inflammatory drugs and complex vitamin-mineral supplements have all been researched, but found not to fully support exercise benefits. In fact, research suggests some of the stresses exercise imparts on the body are part of the ensuing health benefits and hence taking some nutrients (such as vitamins) at high doses may actually undo some of the beneficial effects of the workout.

In contrast, some fruit and vegetable extracts and foods rich in polyphenols and flavonoids are now being recommended for their ability to decrease oxidative stress and modulate exercise-induced inflammation and assist immunity. Data suggest that New Zealand blackcurrants might contain the "just-right" balance of the important compounds.

Studies in Japan where scientists evaluated the ability of New Zealand-grown blackcurrants to reduce inflammation in muscle groups related to sustained computer use and keyboard typing were the first to highlight the positive link between blackcurrants and exercise. The Japanese research flagged the potential of blackcurrants to reduce lactic acid build-up in muscles.

Scientists at Plant & Food Research have conducted a number of human intervention studies. In findings published in 2009 a commercial blackcurrant powder extract was fed to a group of healthy everyday people who exercised regularly. Biochemical indicators to assess the effect of taking blackcurrant before exercise were measured. As a moderate exercise for that study, a 30-minute row at a given intensity was selected. Subjects were given a total of four capsules that contained the blackcurrant extract, approximately equivalent to 48 grams of fruit. Each individual consumed a total of 240 mg of anthocyanins, and a sugar placebo acted as a control.

Measures of biomarkers for control of exercise-induced oxidative stress and muscle damage were made as well as the ability to modulate the immune function. *Figure 1* shows a key piece of data – when subjects exercised and ingested a sugar placebo there was a temporary exercise-induced oxidative stress as measured by a 1.4-fold rise in plasma protein carbonyl levels (as a biomarker of oxidative stress) at 0.5 hours. Consuming the blackcurrant fruit extract prevented the increase of exercise-induced oxidative stress as indicated by a reduced plasma protein carbonyl level compared to the placebo.

These biochemical findings lead to the conclusion that blackcurrant anthocyanins likely acted as effective antioxidants

By Prof Roger Hurst, Dr Suzanne Hurst, Kirsty Lyall
Food & Wellness Group, Plant & Food Research

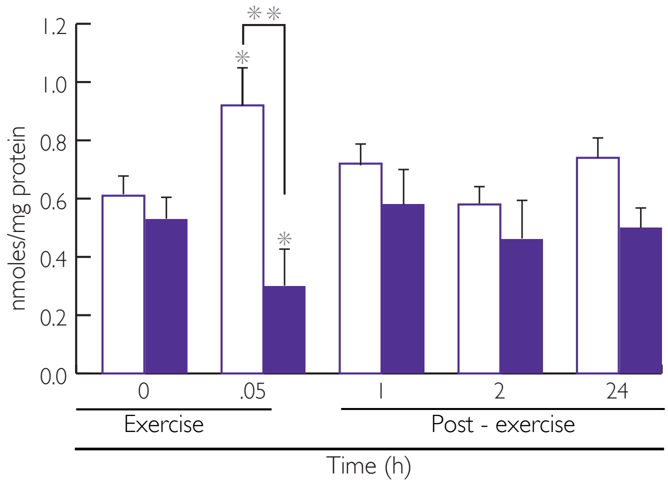

Figure 1. Protein carbonyls, a biochemical marker of exercise-induced oxidative stress, was reduced in samples of plasma from subjects receiving the blackcurrant fruit extract. Healthy untrained subjects were given a placebo (white bars) or a New Zealand blackcurrant extract (black bars) prior to and immediately after a 30-min row (80% VO_2 max). Blood samples were taken and protein carbonyl levels measured.
** Represents statistical significance (P<0.05) between pre-exercise and post-exercise time points for both placebo and blackcurrant extract groups.*
*** Represents statistical significance (P<0.05) between placebo and blackcurrant extract groups. Reproduced from Lyall, K.A. et al., (2009).*

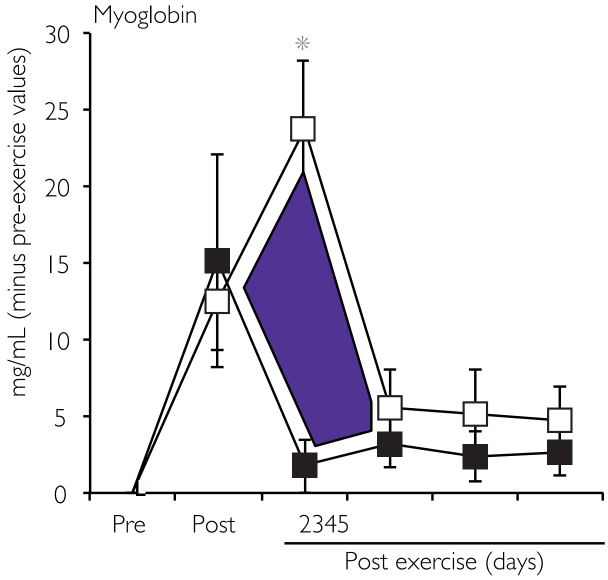

Figure 2. Consumption of blackcurrant modulates a plasma biomarker of muscle damage. Subjects underwent repetitive eccentric quadriceps contractions designed to cause muscle damage after the ingestion of either a placebo (open squares) or a New Zealand blackcurrant extract (solid squares, total 240 mg anthocyanins). The degree of muscle damage was assessed by measuring plasma myoglobin levels.
** Represents statistical significance (P<0.05) between treatments at the specified time post eccentric exercise. Figure based on data reported in Hurst, S.M. & Hurst, R.D. (2013).*

against the oxidative stress induced by the 30-minute row *(Figure 1)*. Furthermore in other exercise studies the blackcurrant extract prevented muscle damage as shown by reducing the release of the muscle molecule myoglobin into plasma after exercise *(Figure 2)*. The effect of the blackcurrant extract on the functionality of the immune system before and after exercise has also been examined at Plant & Food Research. Using blood plasma from subjects on immune cells in the laboratory it was demonstrated that the blackcurrant extract modulated pro-inflammatory events resulting in an enhanced exercise-induced acute inflammatory response. These findings suggest an enhancement in immunity which may aid in repair of damaged tissue.

Very recent research from scientists in the UK have supported and extended these earlier findings. They examined the effect of New Zealand blackcurrant extracts on high-intensity intermittent running, post-running lactate responses (lactate being a metabolite that has a role in exercise fatigue) and cardiovascular function. They concluded that New Zealand blackcurrant may enhance performance and assist lactate removal in recovery from sports characterised by high-intensity intermittent exercise as greater distances were covered with repeated sprints.

These results overall show that those who took the New Zealand blackcurrants in these studies exhibited indications of improved performance. Blackcurrant mediated a reduction in markers for oxidative stress linked to muscle damage and inflammation, assisted the clearance of the fatigue marker lactate, as well as increased cellular activity linked to immune responsiveness. These cell and tissue processes induced by blackcurrant may be important initial responses that must occur to enable follow-on repair mechanisms to kick in. They may also be a prelude to the adaptive mechanism that enhances the human body's immune system so we are better prepared for any future similar events. It looks like natural compounds in blackcurrant improve the benefits gained from moderate exercise by complementing the body's natural way of coping, adapting and repairing itself following moderate exercise.

Of course, the research is preliminary and there is still a great deal to discover about the compounds in blackcurrants and the mechanisms offering these and other health benefits. The potential is there however. Through this and further research the knowledge gained can be used by the New Zealand food industry to both validate health claims and develop new functional foods and beverages that consumers can benefit from to enhance and complement our body's natural activity to maintain our physical fitness and overall health.

Biographical note: Prof Roger Hurst of Plant & Food Research leads a Food & Wellness Group that investigates the role of plant compounds in inflammation and immunity – physical fitness, mental performance and airway, skin inflammation.

This article along with research references can be found on the AgScience website www.agscience.org.nz

Welcome
Dr John Hay, Interim Vice-Chancellor, Lincoln University

Overview of sustainable farming systems for the future
Hayley Moynahan, Direct Dairy Research, Rabobank

Climbing the value chain to increase the economic and environmental sustainability of farming systems in Canterbury
Prof Keith Woodford, Lincoln University

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Andy Macfarlane, Macfarlane Rural Business

Real sustainability – understanding the value of nature on farms
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The Central Plains Water Scheme: Impacts on the productivity, sustainability and land use diversity of Canterbury agriculture
Susan Goodfellow, Central Plains Water Ltd

Horticulture in the Greater Canterbury region
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Current and future technologies and practices will define sustainable dairying in Canterbury in the future
Dr Grant Edwards, Lincoln University & Ron Pellow, South Island Dairy Development Centre

Sustainable farming for the Canterbury sheep and beef farmer
James Hoban, Farmer

Crops – adding sustainability to farming systems
Nick Pyke, Foundation for Arable Research

Plant species, systems and practices for tomorrow's dryland pastoral agriculture
Prof Derrick Moot, Lincoln University

Key forces that will shape future land use diversity in Canterbury
Prof Jacqueline Rowarth, Waikato University

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