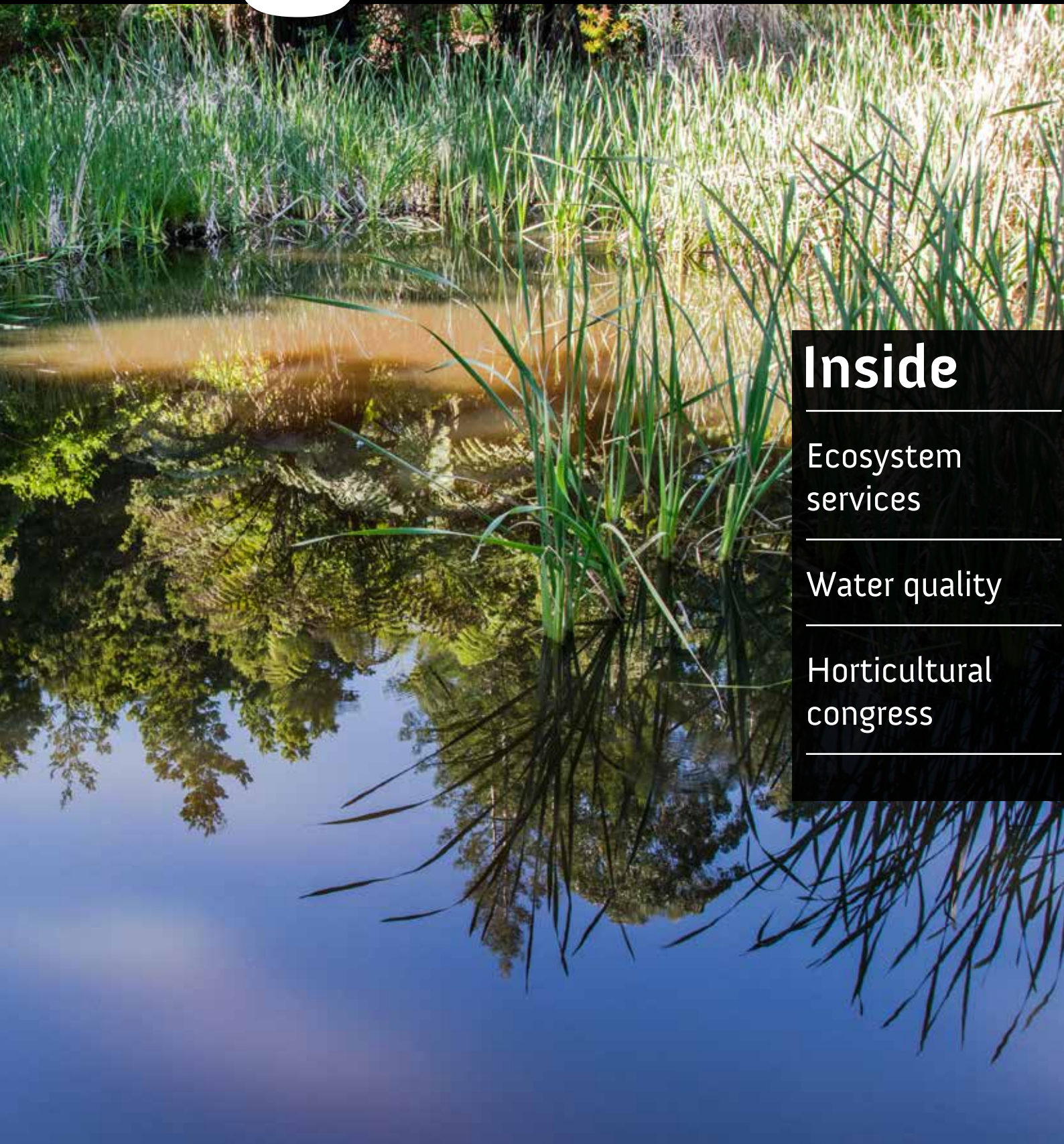


AgScience



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Identify the desired outcome - solutions to get there will vary!

WELCOME TO THE FIRST edition of AgScience for 2015, a slightly extended version including summaries from our two forums in 2014. Both forums considered topics on the use of our natural resources. One looked at how we value and measure the different services that those resources provide; the other looked at how we develop workable long-term solutions for different groups which are using a particular resource. Both forums were well attended and provoked interest and debate. It was pleasing that the attendees came from many different fields, reinforcing the role NZIAHS plays as an independent group that can ask questions without being seen to have vested interests but also as a group with links across different parts of our community.

The ideas for the forums initially arose from what has been a very topical issue nationally, that of water quality. We cannot get away from the fact that human activity is impacting on our environment and we are reaching the limits whereby use of a resource for one purpose either prevents it being used for another activity or its quality is downgraded so that it is no longer suitable for other uses. The initial discussion may have been around water but land use was quickly included and there was acknowledgement that the discussion must embrace a range of factors that are closely linked. The inter-connectivity goes fairly wide, even into the debate about housing shortages and land availability. A colleague commented that some years ago the focus was on whether we are doing enough to protect our elite soils. Hence the general nature of the debate is not new and while that particular question seems to have gone down the list somewhat, it is still very pertinent. At times, all of this can seem too hard. The positive message from both forums was that methods are being developed to respond to these hard questions and systems and solutions exist for us to use and learn from.

In Palmerston North, the topic was “Natural Capital and Ecosystem Services

– New Science for Better Land & Water Policy”. A number of speakers noted that the calculation of Natural Capital and Ecosystem Services is not the answer in itself. Rather, it is a way to produce information that then allows us to make decisions about how resources are used. The information developed allows a more holistic view to be developed about what might be lost as well as what might be gained. That information is relevant at a number of levels, for an individual property, a region or nationally when for instance the Ministry of Primary Industries is setting policy. An important point from one speaker was that ultimately the models have to work to farm level, so that solutions can be derived. Changes to farming or other land use practices still require that value can be gained from those practices.

At Lincoln the topic was “Enduring Agricultural Solutions for Improving Water Quality”. Water use and quality in Canterbury has had extensive coverage. To someone from outside the region it was mainly about a series of ongoing problems. After the Canterbury forum, I came away with an impression of a process that was being worked through, and while clearly there had been bumps along the way, the debate had been useful, had engendered a level of respect and goodwill and ultimately was having a useful outcome. A very clear message was that communication and discussion was vital. It wasn’t necessarily fun and took time but the solutions being developed were workable.

The solutions around water use and quality often involve compromise and it’s not just about farming. Urban water use and waste also have to be considered. We do have to look at how cities develop and the infrastructure required. Other factors such as deforestation can be important and so carbon credits and incentives for forest plantings come into discussions of land and water management. Clearly there will be financial impacts. Profitability of the Lincoln

University dairy farm dropped substantially when the farm was required to meet specific nutrient outputs. Relatively drastic measures had proved necessary halfway through the season, when it was clear these targets would not otherwise be met. It will be interesting to see how this is worked through in future years.

One strategy is that of providing incentives to direct the focus on the outcome, in preference to a regulatory body prescribing what users can and can’t do. It may be that more intensive agriculture is possible but that then depends on how the outputs are managed. A similar theme came through from the forum on Natural Capital and discussions about the One Plan in the Manawatu: if outcomes are defined then activities can be planned around that. This is where the input of those involved in science is important, providing some of those solutions.

I believe that 2014 was a good year for the Institute. We held two very successful forums and were very involved with the International Horticultural Congress in Brisbane. I felt privileged to represent NZIAHS and the Congress emphasised to me the importance of our role in promoting Agricultural and Horticultural Science and in recognising achievement and excellence. I really enjoyed the Massey Agriculture Awards Dinner. It was great to see the increased numbers of students in agriculture and horticulture and to learn that those students are in demand with industry. It was also enlightening for me to see how much the NZIAHS awards, made during the course of the year, meant to the recipients. So be aware of the awards for 2015. The council very much relies on your involvement in making nominations. Further than that, help us make the Institute relevant, get involved and I ask you to recommend the Institute to your colleagues, ensuring that we stay strong and active.

David Lewis
President



International Horticultural Congress in Brisbane



The main stage in the Great Hall for the 29th International Horticultural Congress, Brisbane 2014.

THE INTERNATIONAL HORTICULTURAL CONGRESS 2014 is the major event of the International Society for Horticultural Science, and has been held every four years since 1864 (with a few breaks for major world events). The 2014 conference was held in Brisbane last August, only the second time it has been held in the southern hemisphere. NZIAHS was proud to be one of the host societies along with the Australian Society for Horticultural Science and the Secretariat for the South Pacific.

After years of planning by the organising committee, it was great to see the Congress under way and the dream to present a great congress turned into reality. The congress was a success on many levels:

- **Attendance** – 3,290 delegates from 97 countries;
- **Financially** – within budget;
- **The venue** – big enough for 3,000 in the Great Hall but also able to cater for 50 people to hear a talk on how roof-top gardens allow people to enjoy green space in condensed housing situations;
- **The volunteer helpers** – wonderful work;
- **The response** – the overall tone and feeling that came from the delegates was of people engaged and enjoying themselves.

The effort put in by NZIAHS to the congress proved very worthwhile. Simply to be acknowledged as one of the host societies and being part of such an excellent event has been beneficial.

Overall, New Zealand was well represented with the attendance of some 120 delegates from research institutes, universities and commercial companies. We were pleased to help seven young scientists to attend an event that was important in terms of their career development. We also made the congress more accessible and inviting to New Zealanders by providing a hub in the Exhibition Hall and a social event that facilitated contact and a feeling of belonging and involvement.

NZIAHS shared an island booth within the exhibition area with Plant & Food Research, The College of Health from Massey University and Zespri. We treated the booth as 'Kiwi Corner' and a hub for the New Zealand delegates to use. This concept proved very successful, based on how the booth was used and visitor numbers. The New Zealand produce also proved popular with delegates from around the world and Zespri staff commented "that the exhibition site was serving thousands of kiwifruit to a whole new group of expert consumers and it was lovely to hear people describing their kiwifruit addiction by the end of the week".

The scientific programme was huge with 23 different science symposia running over the course of the congress, covering everything from plant propagation and orchard management to turf culture and landscape architecture. Two of the plenary speakers who

impressed me were Julian Cribb, an Australian journalist and commentator who spoke on "Meeting the 21st Century Food Challenge", and Malcolm Smith, an Australian architect based in the UK, who spoke on "Food Forming Places – Horticulture and the Contemporary City". Both presentations focused on the size of the world population and what this means for our living and where we grow our food.

Julian Cribb focused more on the challenges – recycling nutrients, how our diet has to change, the likely impact of climate change and the development of super cities. Malcolm Smith focussed on our urban planning, what our cities will look like and how they will accommodate horticulture. A link between the two was that we will still need to grow food locally: we would become too vulnerable to a crisis if all food was imported over long distances. This was illustrated by shortages of some items on supermarket shelves in London within days of the 2010 eruptions of the Eyjafjallajökull volcano and the suspension of flights over much of Europe.

One feature that sparked some debate was the use of electronic posters, instead of a standard printed scientific poster. Presenters were given a five-minute slot to present a summary of their work using 5-6 power point slides. Some people felt they missed some posters and that the format did not allow people to meet and interact. Others felt the format worked well, you could access posters you had missed by WiFi and the setup was not as daunting as rows and rows of posters. I think the format will work but we need to become familiar with the technology.

So a very successful event, showcasing New Zealand science and technology to the world and one that NZIAHS was pleased to be part of. 📧

– David Lewis



Science posters presented using large video monitors, a change of format that seemed to work well.



The NZIAHS exhibition booth at the Congress was part of "Kiwi Corner", with Plant & Food Research, Zespri and Massey University.

Enduring Agricultural Solutions For Improving Water Quality

NEW ZEALAND FARMERS AND growers have a tough assignment – helping the country to meet the Government’s target of doubling export earnings by 2025 while meeting public, market and regulatory demands to reduce the impacts of their businesses on the environment. All in all, they are being asked to produce more product, of a greater value, using fewer inputs.

Is it possible? How can science help? These questions were addressed at the NZIAHS Canterbury Section’s 2014 Forum, at Lincoln University last year.

The subject matter was clearly on-trend, as the forum attracted a record audience. The programme was varied too, with experts covering everything from community consultation and computer models to mitigation approaches for nitrogen, phosphorus and animal waste.

The morning session focused on policy, regulation and process, with speakers outlining how and why decisions were made and implemented, while the afternoon session looked more closely at the role of science in developing mitigation tools. The audience had to deal with a barrage of watery acronyms, most importantly NPS-FM (National Policy Statement for Freshwater Management); NOF (the National Objectives Framework); LWF (the Land and Water Forum); CWMS (the Canterbury Water Management Strategy); and GMP (Good Management Practice). At the end of the day they gained a clearer understanding of the issues involved in trying to meet environmental, social, economic and cultural goals, and of science’s role in developing enduring agricultural solutions.

A WIN-WIN MODEL FOR LIMIT SETTING

First up for the day was Guy Salmon, Executive Director of Ecologic, who outlined some of the challenges around reducing environmental impacts while intensifying land use. He also compared the environmental focus of farmers with that of corporates.

“Corporates are focused on dollar returns, and as such are less concerned about environmental impacts,” he said. “Farmers, on the other hand, have multiple objectives, genuine community connections and they do care about the land, even though traditionally they have used their political power to avoid taking responsibility for their environmental impacts.”

Salmon said the key to creating enduring solutions lay in communication and collaboration.

Referring to the pan-industry Land and Water Forum, the Canterbury Zone Committees and individual catchment groups, he said he was “optimistic that we are starting to know what we are doing”.

“Collaboration shifts stark choices to specific catchment contexts and time frames where varied answers will be found. Good water quality is not easy to deliver without farmer co-operation, as it needs on-farm investment and detailed practice improvements. Industry buy-in has provided a fantastic step forward in mitigation. However it is clear

that for collaboration to succeed, key leaders must be on the inside not the outside; their agreement must follow, not precede, public consultation, and that deals, once set, must be respected. Collaboration, practiced well, enables us to discover the win-wins, accept the limits, and elicit the commitment to improve practices.”

ENVIRONMENT CANTERBURY AND N CAPS

Environment Canterbury Commissioner David Caygill was clear about why his council was imposing nitrogen limits – it’s because Canterbury has a nitrate problem. “In much of Canterbury we are not meeting the national drinking water standards in respect of nitrate, and some places where people used to swim are now unsafe, although typically more than nitrate is involved.”

Caygill was equally direct about the pros and cons of land use intensification. More intensive land use was putting greater strains on the environment but was generating greater economic and social benefits such as increased employment and school rolls. Efficiency gains, new infrastructure and science were all important aspects of Canterbury’s approach to dealing with the paradox.

Caygill said water storage proposals were often questioned because of concerns that in facilitating more intense land use they will add to pressure on the environment. He felt that by establishing limits on the discharge of nitrates, but not prescribing land use or input controls, ECan was incentivising rather than imposing particular solutions.

“We are providing answers to the challenges posed to developers of water infrastructure,” he said. “But we have left landowners to make their own investment decisions. We have also largely applied nutrient limits at the farm level, implicitly ‘allocating’ the total load that we think each catchment can safely bear (as required by the NPS-FM). That way landowners know exactly what is expected of them. We are also encouraging better management, as this is complementary to the imposition of outright nitrate discharge limits.”

Highlighting the role of science and technology in mitigation, Caygill listed plant and animal breeding, the routine use of soil moisture monitoring and targeted fertiliser application as current and future tools.

IMPLEMENTING THE CANTERBURY LAND AND WATER REGIONAL PLAN

Following on from Caygill’s presentation on the whys of imposing nitrogen caps, ECan’s Principal Planning Advisor, Leo Fiejte,

outlined how the council was doing it. He said he had yet to meet the farmer who didn’t care about water quality and didn’t want to leave their farm in better shape for the next generation. He believed there was broad acceptance of the need for action, and that it was vital for farmers and businesses to regard water quality management as an integrated part of their business – not as an add-on.

Despite concerns about its fitness for purpose, several regional



councils specify the use of the OVERSEER® computer model for recording estimated nutrient discharges from individual properties. Fiejte justified ECan and other council's continued reliance on the model on the grounds that problems associated with its predictive accuracy, version changes and inconsistent use could all be managed through increased investment, policy frameworks and the adoption of national input standards.

Like Salmon, he saw the collaborative approach as the best way of ensuring that allocations were fair, citing the Lower Waitaki-South Coastal Canterbury catchment agreement as a trailblazer.

He concluded by emphasising the need to look ahead.

"What's the big picture? Where do we want to be in 5, 10 or 25 years? What behaviours need changing to get there? How do I position my business to keep ahead and ensure a resilient future? How do we integrate our efforts?"

HAVING YOUR RIVER AND SWIMMING IN IT TOO...

Compromise was also the theme of the presentation by Lincoln University's Dr Ken Hughey, who discussed the Hurunui-Waiiau Zone. He explained social construction theory which suggests that an individual's world view is informed by values and context, and that these views in turn will inform their policy ideals.

"There is no one view of an ideal river," he said. "Farmers, kayakers, tangata whenua or fishermen all have a different picture, so to reach an agreement, these groups and others, need to come together, define and prioritise their desired outcomes. This is what happens in zone committees whose members represent diverse value sets."

Hughey explained that the Hurunui-Waiiau Zone Implementation Plan and Regional Plan had defined key values and desired outcomes, required flows and water quality needs. The process now requires sustaining those requirements while trying to meet the economic, social and cultural aims of the Canterbury Water Management Strategy. This, he said, was the tricky bit.

"The 'grand parenting' approach basically lets the highly developed, generally irrigated properties retain the right to discharge large amounts of N and P while over time allowing others to intensify slowly. This protects the status quo and existing investment, but limits others' opportunities to develop and is therefore seen as inequitable. This means the solution will need to involve those developed properties having limits set, while dryland and other properties will need to understand there are limits to development."

Hughey said any solution for Waiiau-Hurunui would be a compromise, but it would still provide a net gain to the four well-beings: environmental, cultural, economic and social. Moreover the community would be in a far better position, overall, than it would have been under the much more litigious pre-CWMS approach.



THE CHALLENGES OF USING OVERSEER®

"All models are wrong, but some are useful", contended OVERSEER® General Manager Dr Caroline Read, who provided a checklist for the successful use of models in a regulatory capacity. Choosing the right model for the job was high on the list.

"This requires a clear understanding of what the model does, why it was developed, who developed it and its history," Read said. "Scientists and stakeholders need to understand how assumptions and outputs are linked, and complexity and usability need to be balanced to manage the repeatability of the model outputs. If stakeholders cannot make sense of the model, acceptance and behaviour change are unlikely."

"A key challenge for Overseer is in collecting robust data to calibrate the model. The extrapolation methods used in the model where there are gaps in real data need to be clearly understood and re-calibration should be ongoing as new information becomes available. Effective quality assurance is another challenge. Peer review needs to be thorough and ongoing so that non-experts can be assured of the quality and accept the science represented in the model. Understanding uncertainties helps regulators set appropriate policy around implementation."

Read concluded that models used in regulation require significantly more validation and transparency than non-regulatory models. Because OVERSEER® was now being used in this way, a significant development programme is needed to ensure it is fit for purpose. This programme would need to include uncertainty analysis, a peer review programme, re-calibration and ongoing maintenance, and greater knowledge transfer and training for stakeholders and users. All in all this would require investment well beyond business as usual.

THE FARMERS' VIEW

Ian Mackenzie, from Federated Farmers, provided the farmer perspective on land and water issues. He accepted that nitrate levels are an issue but reminded the audience that some of New Zealand's worst water pollution is associated with towns and cities, deforestation, poor riparian management and flood control measures.

He emphasised that any process for managing nutrients needs to treat all land uses fairly and protect the maximum possible flexibility of land use rather than undermine the viability of farm systems. He said nutrient management guidelines can work, as has been illustrated by the South Canterbury Coastal Streams zone.

Engaging with farmers was vital to the development of successful solutions, McKenzie said.

"These applied agricultural and horticultural scientists will own the solution and are far more likely to engage in the success of the process... we are the implementers. We are more

likely to use facts rather than opinion to inform the community catchment decision-making process."

Farmers were committed to finding enduring agricultural solutions for water, he concluded.

"We may not get everything right but we are going in the right direction and we are here for the long haul!"

FARMING UNDER A PREDICTED NUTRIENT CAP

Mackenzie's concerns about undermining businesses were illustrated in a case study from Ron Pellow, Executive Director of the South Island Dairying Development Centre.

Last year the Lincoln University Dairy Farm was managed to meet a nutrient cap of 30kg/ha using an OVERSEER® prediction. The target was met by culling cows early, thus reducing production by 26,000kg of milk solids (8%). This resulted in \$84,000 of lost income, yet it is nowhere near the reduction that will be required by 2022 in the Selwyn Waihora Catchment or by 2025 in Hinds.

So what are the options? Pellow suggested either investing in infrastructure, such as indoor housing, or working with a nil-infrastructure, low input system, such as that being investigated in the Pastoral 21 project.

Either way, he predicted a change in mind-set and in dairy production terminology in the coming years. "At present, farmers talk about 'production per cow or per hectare' and calculate profit based on 'farm working expenses per kg milk solids'," he said. "I think this will change to 'profit or productivity per kg of N lost' and the 'catchment N-load per kg of milk solids.'"

FOOD SECURITY, CROPS AND WATER

Allister Holmes, from the Foundation for Arable Research, reminded the audience of why solutions are needed, citing our planet's ever-growing human population and the need for food security, and noting that while global grain production had increased markedly in recent decades, the amount being grown per capita had fallen.

"New Zealand feeds up to 50 million people every year, but this is only about one percent of the world's population, and that population is growing," Holmes said. "We need to work out how to increase food production without wasting precious natural resources."

Outlining how much water is required to produce different types of food – 900 litres for a kilo of potatoes, 1,300 litres for cereals and 5,000 litres for cheese – Holmes said water use efficiency was becoming more and more important. He discussed research into areas such as crop establishment, plant uptake, different irrigation



systems and precision agriculture, all of which can influence efficiency.

MITIGATING N LOSSES

Lincoln University's Professor Keith Cameron gave the audience a swift reminder of the N cycle, highlighting plant uptake, animal urine-N, farm systems and inputs, effluent management and nitrification as potential intervention points for reducing N losses. He then outlined a range of projects investigating mitigation options.

Some plant species take up more N than others, meaning that pasture species selection can impact on N losses. Cameron noted that plant N uptake rates in late-autumn and winter are important because that is when most leaching occurs. Catch crops such as oats are another option being investigated. The impact of pasture species mixes and crops, such as fodder beet and kale, on the N content of animal urine is being investigated, along with the economic viability of lower input systems. Stocking rates are another variable, as the more animals on a piece of land, the more urine-N will be received by that land. This in turn leads to the consideration of stand-off pads and cow housing, and the role of effluent as a replacement for artificial fertiliser when establishing some crops.

The final option discussed by Cameron was the use of nitrification inhibitors. He cited a FertResearch

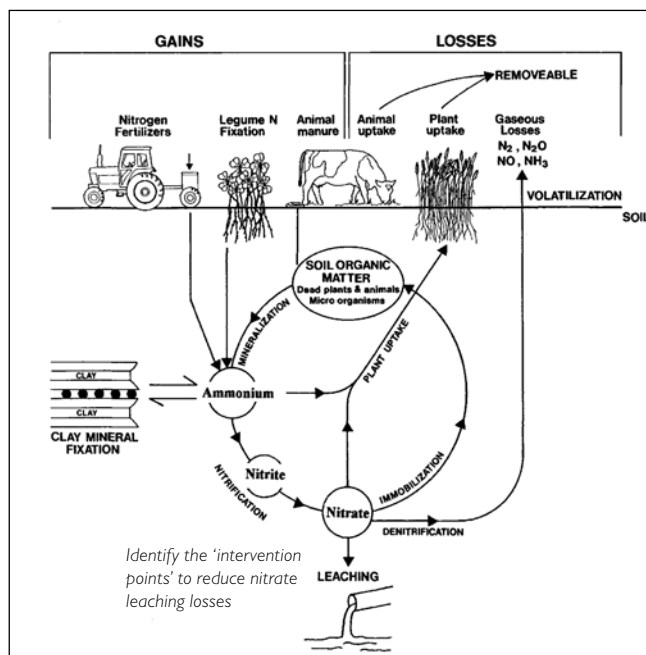
factsheet which stated that paddock scale reduction in nitrate leaching per ha/year with DCD (dicyandiamide) ranged from 10-30% in the North Island and 25-40% in the South Island.

Having shown that there are multiple intervention points for reducing N losses, Cameron emphasized the importance of multi-disciplinary science teams in seeking enduring solutions.

MITIGATING FAECAL CONTAMINATION IN DAIRY SYSTEMS

Faecal contamination of fresh water, measured by monitoring E. coli concentrations, is another focus of the NPS-FM. AgResearch's Richard Muirhead explained the NPS-FM categorises two types of recreational contact with water – primary contact, such as full emersion, head-under-the-water swimming, and secondary contact, where there is no intentional emersion, such as boating and fishing. Each has different E. coli limits.

"Under the NPS-FM regional councils need to set freshwater management units in consultation with the community, Muirhead said. "Generally, meeting secondary contact requirements is not a problem, but getting all rivers and lakes up to primary contact standards, a key community value, by 2025 will be very difficult."



Muirhead said four things have the most impact on base-flow animal faecal contamination of waterways. They are direct inputs from cows, stream crossings, effluent management and irrigation. These can be mitigated through fencing and riparian planting, culverts and bridges, improved dairy effluent management systems and more precise application of irrigation.

E. coli mitigation systems are generally similar to those for N and P mitigation and water use efficiency. For this reason, decision support systems around water quality should cover all these risks, Muirhead said, because “farmers do not want to be dealing with 10 different types of technology”.

MITIGATING P LOSSES IN THE DAIRY INDUSTRY

The third contaminant discussed was phosphorus, which generally moves into waterways as wind or waterborne soil particles and sediments. Professor Rich McDowell, from AgResearch, said around 80% of P losses come from just 20% of the farm. Concentrating mitigation and P use efficiency on these critical source areas is the most cost-effective method of reaching an environmental target.

“Phosphorus in the farm system comes from fertiliser, manure, grazing and soil,” McDowell said. “Mitigation is possible for each of these factors. Fertiliser choice, rate and timing influence the amount of P available should an erosion event occur. Restricting grazing, especially on wet soils, can also help, as it reduces soil disturbance (disturbed soil is more likely to be swept away in wet or windy conditions).”

Fencing off and/or planting gullies, creek edges and other wet areas was another good option. Once again, disturbance would be reduced and the vegetation could trap sediment, lowering the amount of P being carried into streams and lakes.

Having listed the mitigation approaches, McDowell noted that soil hydrology could be an overriding factor in controlling P losses.

MANAGING LAND-WATER INTERFACES

The final presentation for the day came from NIWA’s John Quinn, who outlined research into managing wetland and riparian areas to enhance in stream and downstream values.

“Riparian buffer options include e-fences which exclude only cows, traditional wire fences which keep out all stock, bank-stabilising trees, production trees, permanent native plantings, managed grass filter strips, wetland protection or a tiered combination of the above,” Quinn said. “The best option will be the one which matches land and



2004

2009 – after fencing



periphyton levels, benefiting stream biodiversity. However, it can lead to stream bed widening and also the release of legacy sediment.”

DISCUSSION

The forum concluded with a panel discussion of issues which had arisen during the day.

Lag times were a concern to Federated Farmers’ chairman William Rolleston. David Caygill agreed that changes in management could not be expected to produce results overnight. “If we want development and environmental improvement, there must be a lag.”

The issue of incentivising farmers to shift toward GMP was also raised. Market forces were considered to be effective, but Rolleston also stressed the importance of the collaborative systems discussed earlier in the day.

Finally, the cost of who should pay for mitigation was raised. Rolleston pointed out that riparian buffers of up to 10 metres on either side of streams constitute a large loss of productive land and income on many properties. Caygill agreed it was an issue which required further consideration and communication, noting that in the Selwyn Waihora Zone, riparian planting would be the largest individual cost to landowners.

Hughey said he believed mitigation costs should be shared. “This problem has accumulated over many decades and current landowners have literally bought previous owners’ problems. Yes, exacerbators should pay, but so should the public.”

The panel agreed that science had a huge role to play in developing enduring agricultural solutions for improving water quality. Key areas of focus should be on soil management and plant breeding and selection. ☑



Natural Capital and Ecosystem New Science For Better Land & Water Policy

The assessment and quantification of ecosystem services provided by natural capital is an emerging area of research which attempts to recognise the direct benefits provided by the natural environment for human enterprise and well-being. These benefits incorporate – but also go beyond – the traditionally recognised production of food and fibre to areas such as the provision of fresh water, minerals and energy and the regulation of climate and disease.

This work is of direct relevance to future natural resource policy development as it integrates existing knowledge from a number of disciplines to give a whole-system perspective on the impacts of human decision-making on service provision in the context of environmental change.

Development of concepts is well advanced in the international literature but frameworks for practical application are still in their infancy. New Zealand is fortunate to have a number of researchers taking a leading role in this area.

Because The New Zealand Institute of Agricultural and Horticultural Science is keen to profile emerging disciplines of relevance to the primary sector we decided to hold a one-day seminar on the topic, entitled “Natural Capital and Ecosystem Services – New Science for Better Land & Water Policy”. Our objectives were to foster a wider understanding of the discipline and its approaches across the primary sector and to encourage robust debate about its merits and potential, given that we have entered a highly volatile phase in natural resource management throughout the country. The seminar was held at Massey University in July 2014. Active members of the New Zealand research community outlined the thinking behind the natural capital-ecosystem services approach and speakers from both central and local government described how the approach is being applied to recently developed natural resource policy.



Services -

SOIL AS NATURAL CAPITAL: FROM THE FARM TO THE COURT

New Zealand's diverse farmlands comprise interconnected ecological infrastructures that underpin the production of our premium foods and fibres. Rural lands are valuable natural capital assets comprising stocks of soil, water, biodiversity and climate. From these natural capital stocks flow ecosystem services that are valuable not only to farmers, but also to the wider community. The whole community benefits because these natural capital stocks are connected by surface and groundwater linkages so that the ecosystem services that flow from our lands and waters have complex spatial and temporal patterns.

The Millennium Ecosystem Assessment in 2005 classified ecosystem services into four typologies: the supporting services of soil formation and nutrient cycling; the provisioning service of food, feed, fuel and fibre production; the regulating services that buffer and filter water, solutes, carbon and gases; plus the cultural services of heritage, recreation and spiritual well-being. Certainly there is valuable bounty coming from the provisioning services of the farms of New Zealand's diverse regional landscapes.

But the three other types of ecosystem services – the supporting services, regulating services and cultural services – are also very valuable, even though no one pays for them directly. A key regulating service provided by soil is the buffering and filtering of nutrients.

In developing the nutrient policy for the One Plan of Horizons Regional Council in 2007, the science team from the multi-CRI Sustainable Land Use Research Initiative (SLURI) used the Land Use Capability (LUC) classification as a proxy for natural capital. From this they were able to assign a sustainable leaching loss of nitrogen for a farm by summing the losses from the various LUC parcels of land comprising the enterprise.

In the decision from the appeal hearings of the One Plan, the judge and commissioners noted that as a proxy of natural capital "...the LUC classification should be used as a basis for leaching limits", and "...we have considered throughout the importance of farming to the region. We are satisfied that our decision properly recognises and deals with the tensions between the social and economic wellbeing of the affected people... and slowing the decline of the region's water quality".

More recently, in its final decision, the Board of Inquiry for the Tukituki Catchment Proposal considered that as an approach of using natural capital to infer nutrient discharge allowances for farms "...the LUC system is well established and takes into account the particular characteristics of the various land use classes in terms of contour, soil type, and other physical characteristics. It is relatively simple and easy to follow." The board concluded that "... finally, it has an inherent logic because it is based on the actual natural capital of the soils which reflects the uses that are likely to be made of the relevant land in the future."

We conclude here by noting that an approach based on ecosystem services can also be used in judicial hearings to protect peri-urban orchards from encroachment by city expansion. Horticulture generates \$3.65 billion of export revenues for New Zealand annually and this sustains a \$3 billion domestic economy. All of this provisioning service comes from just 120,000 hectares of orchards and vineyards. Yet every year, some 40,000 of productive land is lost by city expansion at the peri-urban fringe. An ecosystem services interpretation of the District Plan for the Heretaunga Plains was successfully used by the Hastings District Council in a hearing to prevent the construction

of a "big-box" hardware store on Pakowhai Road on the outskirts of the city.

So we consider that viewing our natural estate and productive lands through the lens of "natural capital and ecosystem services" will not only lead to better management of our farms but also better policy to govern and sustain our landscapes.

– Dr Brent Clothier, Plant & Food Research

NATURAL CAPITAL AND ECOSYSTEMS SERVICES: AN MPI VIEW

The Government has an ambitious strategy to meet the target of 40% for the share of exports and imports to GDP by 2025 (currently 30%). This means that the value of our exports will need to almost double in real terms. With over 70% of New Zealand's exports coming from primary sectors, growth in these industries will be critical in lifting New Zealand's economic performance. Such growth will need to be within current and future environmental and social constraints, suggesting an increased need for smart production practices, biotechnology uptake, and increased quantification and valuation of our resources.

Natural capital assessment and evaluation of ecosystem services is therefore a valuable framework for assessing the impact of proposed increases in productivity. It provides a measure of the impact of primary production growth and intensification, assessment of relative values, and integration of economic, environmental and social capital and impacts, a view of trade-offs and collateral damage, facilitates an integrated view of production and natural estates, and informs decision making on land use, technology uptake, sector development and balance, and associated limits and constraints.

Natural capital assessment also has the potential to improve risk



identification for both marine and land-based primary industries, and to support the Ministry for Primary Industries' regulatory role in natural resource use and management from an ecosystems perspective.

It is essential that our view of natural capital and ecosystem services is broad, encompassing marine environments, biodiversity and social services, along with soil-based provisioning in relation to primary production.

– Dr Ian Ferguson, Departmental Science Advisor, MPI

ECOSYSTEM SERVICES AS A POLICY TOOL

We can only manage what we know. The core business of regional councils is the sustainable management of natural resources, but good information about our key assets – our land and soils, our rivers and lakes, our coasts, our forests, our ecosystems – is often missing. The stocks of our natural capital and the associated flows of ecosystem services is largely absent in our balance sheets.

As nature's limits and constraints become increasingly apparent we start to realise that economic indicators such as GDP are inadequate to measure the success and wellbeing of our communities. Concepts such as accounting for and valuing our stocks of natural capital and the associated flows of services are urgently needed to establish true and enduring links between the environment, our economy and community wellbeing.

The most widely used definition of "ecosystem services" is from the pioneering work of the Millennium Ecosystem Assessment, 2005: "Ecosystem services are the benefits people obtain from ecosystems." An operational definition and classification system of ecosystem services that is meaningful to scientists, economists, social researchers and the public is, however, imperative to move from concept to practice.

Many ecosystem services, such as biodiversity, recreation, landscapes and amenity values, cultural and spiritual ecosystem services, are not traded in the market economy. Therefore there is often no incentive for maintaining, enhancing or protecting them.

But the ecosystem services concept provides a timely opportunity for New Zealand – especially regional councils – to better connect environmental management to the economy and community wellbeing. The challenge we face is to live and progress within our means.

Based on the seminal work of Robert Costanza *et al* published 1997 in *Nature*, the Waikato Regional Council undertook a benefit transfer study to estimate the monetary value of ecosystem services provided in the Waikato region. The key message was that the combined value of all the regional ecosystem services was of similar magnitude to the regional GDP. This clearly illustrates that GDP tells only half the story – there is a significant hidden economy.

How can the ecosystem services concept be translated into policies and actions? The Waikato Regional Council has identified the declining state of our natural resources, including ecosystem services, as a significant regional issue and included a specific objective in its proposed Regional Policy Statement: "The range of ecosystem services associated with natural resources are recognised and maintained or enhanced to enable their ongoing contribution to regional wellbeing."

Work has started to develop a framework to evaluate and prioritise ecosystem services and make recommendations for further work, including:

- 1 Information: Improving the evidence base (characterising, describing and mapping ecosystem services; understanding and developing models for key ecosystem services and including these in the regional spatial WISE simulation model.
- 2 Policy: Providing guidance on policy development and implementation for ecosystem services (policy frameworks,

methods and practical examples of use in New Zealand and overseas)

- 3 Regulatory: Develop a checklist (for each relevant consent type/activity) to consider ecosystem services for consent applications.

The ecosystem services concept benefits regional councils in several ways:

- Raising awareness of the values of ecosystem services to the economy and community wellbeing.
- Providing improved evidence base and practical tools – ecosystem services valuation, policy guidance and models, for example.
- Linking western science to Mātauranga Māori to support Māori co-governance.
- Providing more consistency in the national classification and framework to assess and value ecosystem services.
- Creating collaborative and strategic partnerships between central and local government, between multi-disciplinary research teams, and with business (such as the Natural Capital Assessment project).

Challenges are opened and opportunities provided, too. Ecosystem services provide a meaningful conceptual framework for policy and action. There is a lack of knowledge and measurable limits or thresholds to ensure ecosystems can function effectively and provide their services.

Mainstreaming ecosystem services requires multi-disciplinary approaches, especially across the environment and the economy. Whereas monetary valuation does not always make sense, ecosystem services are valued for a variety of qualities.

– Dr Beat Huser, Waikato Regional Council

VALUING OUR NATURAL CAPITAL

The central government Natural Resources Sector is considering ways we can better determine the value of our natural capital with a view to supporting our future prosperity and the well-being of all New Zealanders.

It's a big shift in how we think about our land, water, and our native plants and animals. It means no longer setting conservation apart from the day-to-day business of our economy. It also means looking at the value of ecosystem services, such as climate regulation and flood protection, in terms of our way of life. It's a shift that's occurring around the world, with more and more consumers demanding that the products they purchase are grown and manufactured in environmentally sustainable and socially responsible ways.

To ensure a natural capital assessment is robust will require input from iwi, economists, business leaders, scientists, natural resource managers, local government, and communities. The intent is not for an assessment to stand alone; instead it should become an integral part of a toolbox that communities and decision-makers use for planning and policy-making.

To ensure success, the government is determining the best way to proceed with a Natural Capital Assessment project. In the coming months, we will communicate how the assessment will be carried out and what opportunities there will be for people to contribute to this important work.

– Rebecca Bird, Project Director, Natural Capital Assessment, Natural Resources Sector Network, Ministry for the Environment



VALUING GREEN SERVICES

Putting a value on green services on farms is an opportunity that needs exploiting. Farmers have been familiar with sediment and soil loss issues for a long time but only recently have become conversant with issues around nitrate leaching. When we consider the concept of natural capital and ecosystem services and apply it at the farm level we are talking about something with much greater ramifications.

Fifty years ago we were thinking about stopping hills falling down and the protection of our lowlands. We got much more into integrated landscapes in the 1980s and in the 2000s we were thinking about more space – tree planting, shade, fodder and land stabilisation.

In 1967 we were thinking about the Resource Management Act. In the past decade thinking was focused on water and water quality. Now we are starting to think around natural capital and the range of environmental services that the landscape provides. This notion of environmental services nevertheless has been with us for a long time. It is there in the RMA and in the more recent documents put out on National Policy Statement on Fresh Water Management, guiding us on how we should be thinking.

There are different ways of categorising these services and putting an economic value on what some of these services contribute. In 2014 Dr Estelle Dominati and Dr Alec Mackay from AgResearch, looked at the effects of a sub-tropical storm that occurred in April 2011 on a sheep and beef farm in the Hawkes Bay. The research examined the difference in performance of land that had been degraded by the storm event compared to land that was not. Land that had been severely degraded had less food production. It was less effective in flood mitigation and less effective in filtering and retaining sediments within the landscape.

Being able to describe economic losses and benefits helps us to value and think about the market and non-market benefits of environmental services and how they can make positive contributions.

Hence service providers must start shifting the way they think to market their services by helping land managers and owners to

appreciate the benefits of what they can do. In some cases there may be a major public good benefit. This should prompt thinking about how the land manager/owner can gain some recognition and reward from the provision of public good services.

The fact that farmers can graze their stock on the land means they don't need barns. The ability to graze livestock in paddocks without causing damage is an important environment service. We need to be putting a value on that.

A range of environmental services could provide income streams on a dairy support farm – cut and carry forage, grain, straws, bio-energy, water-take trade, ETS credits, methane and NO₂, odour mitigation and crop yield.

A Canterbury farm defined as a dairy support property is selling forages, grain (wheat & barley) and straw primarily into the dairy industry. It provides other services for which no value is attributed, such as taking cows and grazing them on their paddocks for 10 weeks in the winter and providing a grazing platform. The dung and urine provides a nitrogen assimilation service for the dairy farmer which, if it was occurring on the dairy farm, would have serious implications from nitrogen leaching.

Another example is a farm supporting dairy farms with a storage facility, able to feed 2,000 cows on brassica. Effluent gets pumped on to the support farm and goes into a big tank which is attached to a methane digester. This support farm is providing environmental services for other dairy farms which are charged.

The methane digester can get rid of odour (a public good benefit) and provide a benefit from the emission trading scheme for its treatment of the effluent.

If farms moved to a cut and carry fodder system then effluent from dairy farms could be exported to the support property, stored and applied in a much more controlled manner. Stored effluent creates methane which creates an opportunity for bio energy production.

– Tony Rhodes

Agricultural Consultant, PGG Wrightson



Sustainable Farming Systems for the Future

NZIAHS Forum
Canterbury Section
Wednesday 21st October 2015
9.00am – 4.00pm
Lincoln University, Canterbury

Morning session:
Intensive irrigated agriculture

Afternoon session:
Dry land farming



NZIAHS/NZSPB 2015 Plant Biology Conference

30th June to 2nd July 2015
Massey University
Palmerston North



Why Change is Needed

FOR MUCH OF THE last year or so the New Zealand public have been subjected to a barrage of positive comments largely from bank economists about our “rock star economy” with an annual GDP growth rate forecast to hit 4%. But this figure (before the collapse of dairy prices) included the Christchurch re-build and a rare huge spike in commodity prices of two of our major exports, dairy products and logs. If these were excluded New Zealand’s growth rate was much closer to our 30 year average of just over 2%. This historical average of a very low growth rate is the reason why we have slid down the OECD rankings so that we are now a relatively poor country.

It is a nonsense, of course, to argue that our levels of inequality have remained unchanged for 20-30 years because 40-50 years ago we were among the least unequal countries in the OECD whereas now we are the seventh most unequal. This major change is largely due to our low growth rates and neo-liberal policies introduced by Roger Douglas in the 1980s.

New Zealand’s ongoing problem is that we largely sell commodities cheaply and buy in very expensive capital equipment and consumer goods resulting in a continuous problem of deficits. The backbone of what can only be regarded as a failed economy is still the primary sector which accounts for 75% of merchandise exports. It is not often realised that the average return on capital over many years in the beef and sheep sector is around 1% and even in dairying is only about 4-5% and thus money in the bank would generally be at least as profitable. The only reason most farming continues is the massive increase in land values which have occurred in recent years which can be capitalised when the farm is sold. It is perhaps surprising that the Government is pouring hundreds of millions of dollars into the Primary Growth Partnership scheme for the pastoral sector which, given the current state of returns in the industry, is little better than an investment in real estate. Federated Farmers want over \$600 million more invested in R&D for the farming sector while government wants to double the value of primary sector exports by 2025 (reduced from an initial target to triple the value).

Despite a lot of talk on added value the emphasis is still very much on increasing production with Fonterra apparently still having a target of 3% production increase annually for many years into the future.

This concept of added value in the primary sector has been talked about for at least 50 years by many respected commentators, academics and enlightened producers but with the exception of a few progressive small companies such as Tatua and Synlait in the dairy industry little changes. One overseas report last year pointed out the huge opportunities for added value in our seafood industry but the emphasis still seems to be on increasing quotas and mostly low-value products.

Many reports over the past 10 years have recommended changes of emphasis from raw logs to more sophisticated products in the timber industry, but progress is very slow and recent export log prices have been so high that local processors and producers of added value products cannot compete for the raw product.

Unless the primary sector changes to more added-value products the New Zealand economy will continue its recent fairly rapid decline. Because of its size the primary sector cannot be totally replaced by new high-tech and high value industries or even tourism which is another low-value industry. Therefore it has to change. The government must target ‘added value’ in the sectors rather than permutations to bring low producers up to the level of the best. Do we really need more production with its increased environmental cost? A better target would be greater value per unit of production which could be a win/win in terms of the environment. Finally, a capital gains tax on sales of farm land could provide an incentive for farmers to demand higher prices for their product as the prospect of selling land at excessive prices would be removed. ☒

by John Lancashire



New members We welcome

Sarah Joblin (Auckland)
Ben Smith (Auckland)
Alicia Taylor (Auckland)
Mary Black (Bay of Plenty)
Thomas Maxwell (Canterbury)

Corporate members

- AGMARDT
- AgResearch
- Ballance Agri-Nutrients
- Catalyst R&D
- Plant & Food Research
- DairyNZ
- Federated Farmers of New Zealand
- Horticulture New Zealand
- Lincoln University
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- PGG Wrightson Seeds
- Ravensdown Fertiliser Co-op
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