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Editor: Ella Stokes
Mobile 027 208 6371
Email estokes@irrigationnz.co.nz

Advertising:
Email admin@irrigationnz.co.nz

Administration & Subscriptions:
Email admin@irrigationnz.co.nz

Irrigation New Zealand
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A message from IrrigationNZ's Chair, Keri Johnston

The year of 2021 is now well and truly underway. The irrigation season so far has been as varied as the weather, and as March comes to an end, it is drier in many parts of the country than it has been for some time, and with annual volume conditions nearing exhaustion, or minimum flow reductions kicking in, managing your irrigation at this time will be critical.

The IrrigationNZ Board had its first face-to-face meeting for the year in February, with a strategy session facilitated for us by the wonderful Julia Jones of New Zealand Exchange (NZX). The session was a deep dive into what IrrigationNZ's "why" is, and what we do for our members. I cannot thank Ms Jones enough for her time and energy that helped make the day valuable and insightful.

While it has been a slower start to the political year, the team at IrrigationNZ prepared a substantial, thought-provoking and solutions-focused submission on the Water Services Bill. Many of our members are captured by the proposed legislation, and the input from affected members has added substance and robustness to the submission.

Despite the slower start, there are some rather large items on the political agenda this year including water allocation (and iwi rights and interests), nutrient allocation, the RMA reform package, and of course, implementation of the Essential Freshwater Reforms. The Food and Fibre sector CEOs, which includes our very own Vanessa Winning, have met for the year already, and the chairs met recently in the Hawke's Bay with the Prime Minister. The opportunity to participate in these forums is extremely beneficial for our sector. As well as showing a united front, we can make the best use of resources, and advocate for the entire sector on issues that are strategically important for us as separate entities. For IrrigationNZ, this is water storage and associated infrastructure, water and nutrient allocation, and Freshwater Farm Plans, and we are looking forward to leading our sector forward in these discussions.

As always, if you have any questions/comments or just want to say hello, please do not hesitate to get in touch with me.

Nga mihi nui

Keri Johnston
Chair of IrrigationNZ

Adapting to change and learning in 2021

The year 2020 was one to forget in more ways than one. 2021 was meant to be a brighter light as we moved towards the roll-out of the COVID-19 vaccine and opening our borders back up – we are yet to see this coming to fruition.

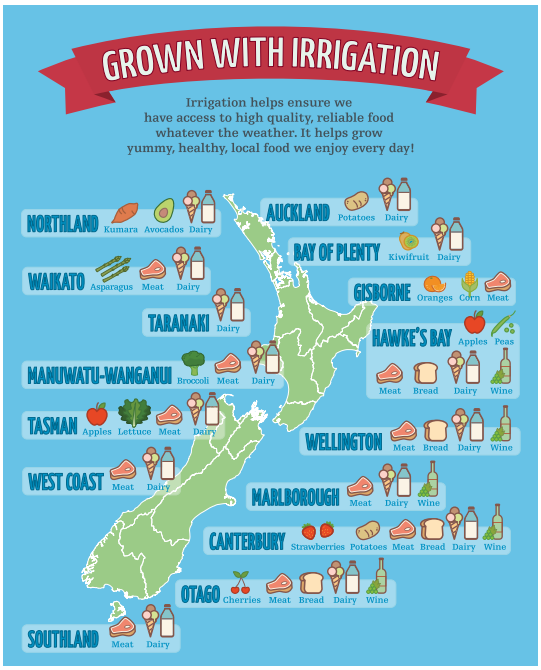
But like 2020, the productive sector of the economy – our farmers, growers, and those supporting and supplying them – are achieving gains at the same time as improving their impact. New Zealand is lucky in many ways, being an isolated series of islands, we have been able to secure our borders, and manage the virus. The same way we keep our biosecurity so high; by all being vigilant and ensuring good reporting and tracing. The ability to pivot agriculture developments has been pleasing to watch, such as the developments in *M. Bovis* testing helping when it came to human testing for COVID-19, showcasing how innovative our industry is.

Our quality of produce, quality of production and processing, ability to evolve to keep our essential workers safe while still supplying the world with much needed food, fibre, wine, and beer demonstrates the 'number-eight wire' approach we have to problems. 'Number-eight wire' does not mean cheap and dirty, it means innovative and reactive. Seeing the prices being achieved in some of our leading sectors as pure/natural food with high quality nutrition is pleasing. But we do need to keep improving our impact on the environment, keep being ahead of our consumers' demands and ensuring that we can hold our heads up high when it comes to international comparisons, including our storage and use of water. One thing I am very proud of as the chief executive of IrrigationNZ is just how careful and considered our members are when it comes to the use of water. How our irrigation companies, schemes and individuals are leading providers of solutions. They gain and keep their accredited status to ensure they support our growers and farmers to get the best most efficient use of water, designing to the latest standards, even when others who are not held to the same standard are still able to operate. How our schemes have some of the best consent audits, working for their farmers and growers and supporting them to achieve better on-farm outcomes. Being part of our industry leads to continuous improvement and ongoing development – this will pay off.

As water becomes a more restricted resource, we need to continue to improve technology. IrrigationNZ's codes of practice and projects will continue to help supply guidelines and evidence to support this. I am confident our members will continue to harness and uptake what is available to them to ensure they are as efficient with their water as possible.

Getting involved in more advocacy and collaboration with Government over the rest of this electoral term is crucial to ensure the practical application of policy is understood and where possible improvements that are outcome-based will be understood too. There is a huge amount of regulatory change coming – change that has been coming for some time under successive governments but is hitting at what feels like a tsunami right now. These changes also feel like they are outside our control, so it is important that as farmers, growers, suppliers, or supporters that you keep abreast of what is being considered and informed about what that means for you. There is a significant amount of support across the productive sector there for you – your levy bodies, your schemes if you are part of one, your regional councils, and of course IrrigationNZ. Get connected with your neighbours and your industry buddies – because mostly we do not compete, mostly we are here to support each other through the changes and help make the outcome impacts we are being asked to make. To help those farmers and growers who need to improve understand what they can do – lead them to organisations like ours, promote good consultants and industry experts to support them to improve too.

IrrigationNZ has leaned up, focused on what it can do to support you more, and provided advocacy and technical impact with regional and central Government – our focus on advocacy, credibility and leadership developed over the past year will drive us to support you. Continuous development of technical support and tools is ongoing, and key projects that can lead to technological, and insight-driven improvements will also continue. Events are unlikely unless they are topic-driven and focused given the uncertainty around ongoing COVID restrictions. Supporting our members with submissions and policy advice remains a key component of our work. Membership engagement will increase on this front with focus.



If 2020 taught us one thing, it is that change is constant and being nimble is paramount. Control what can be controlled, influence what can be influenced and work with the rest. Take advantage of the organisations that have your back, engage with them, and access the tools and support. We are all in this together.

Vanessa Winning
Chief Executive,
IrrigationNZ

IrrigationNZ farewells Elizabeth Soal

In March we sadly farewelled Elizabeth Soal from the IrrigationNZ team.

Liz has been with IrrigationNZ for two years, joining the organisation as chief executive at the start of 2019. During that time, IrrigationNZ underwent significant change, including a shift to Wellington and managing the effects of COVID-19. However, during this time we made good progress with political engagement and securing valuable relationships with a number of key national decision-makers.

A major piece of policy, the Essential Freshwater package, was introduced during this time, which IrrigationNZ was actively involved with and was able to support our members to have face-to-face discussions with both the Ministers for Primary Industries and the Environment. We also increased our public profile through our very successful "virtual field trip" event with schools around the country and won a number of branding awards, such as at the New Zealand Agricultural Show. Liz was instrumental in the launch and design of the 'Know Your Catchment' web portal, a project funded through the Sustainable Food and Fibre Futures Fund and one that will continue to grow.

It is through this work and ongoing engagement that Liz has shone and from here she will become a private consultant, starting with taking on a contract with MPI, in the freshwater policy space, including working with MPI and MFE on implementing the new NPS-FM and supporting councils with nutrient allocation and freshwater plans – something we are very keen on seeing done well, and are pleased someone of Liz's calibre is involved with. She will also be completing her PhD at the University of Otago at the same time.

Please join us in wishing her all the best. The team at IrrigationNZ will sorely miss her.

IrrigationNZ: out & about

NEW INTERIM/SET UP CE OF THE NEW WATER REGULATION BODY TAUMATA AROWAI, BILL BAYFIELD

Vanessa Winning and Ruth Spears had the pleasure of catching up with Bill Bayfield (previously CEO of Environment Canterbury) to understand the functions of the new water regulation body Taumata Arowai, and what the Department of Internal Affairs are focused on under the Three Waters framework. It was a chance to discuss the Water Services Bill and our submission prior to the oral submissions process and understand how the various water responsibilities work together. Mr Bayfield is a supporter of good irrigation, and has a huge amount of experience to draw on from local government, and this is an important cog in the wheel for infrastructure development that also impacts on the productive sector too.

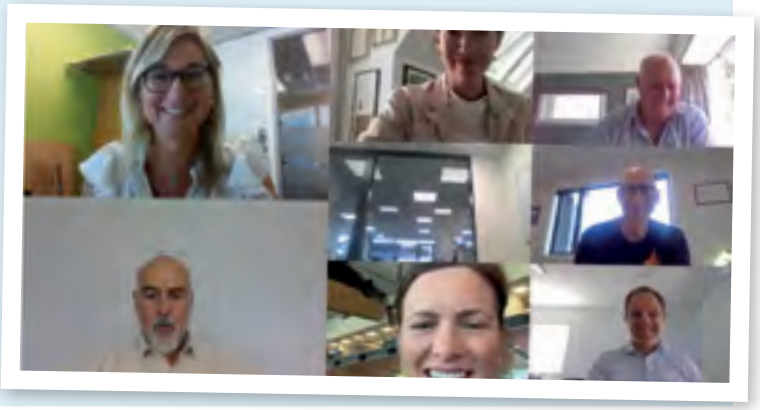
FOOD AND FIBRE LEADERS FORUM

IrrigationNZ Chair Keri Johnston attended the Food and Fibre Leaders Forum in Hawke's Bay on 12 March. The forum is made up of the chairs of the primary sector organisations.

Pictured is Chair of the Federation of Māori Authorities (FOMA) Traci Houpapa, Prime Minister Jacinda Ardern and IrrigationNZ Chair Keri Johnston. The forum was hosted by Hineuru Iwi Trust at their irrigated cherry orchard to learn more about their strategy to ensure that their people "grow, thrive and prosper".

CLIMATE CHANGE COMMISSION SUBMISSION MEETING

It was great to get some of the Canterbury and Otago schemes together for a pre-submission meeting on the climate change report – dialling in from across the country, we had a robust first conversation about the issues and opportunities the report provides for the irrigation sector. The submission will be a national one with irrigators, irrigation companies and schemes encouraged to provide their own submissions. Awesome to see collaboration, and much easier as we all get used to Zoom and Teams in our post-COVID working world.



WANAKA A&P SHOW 2021

IrrigationNZ CE Vanessa Winning was at the Wanaka Show on the 12th and 13th of March. We had our game where people must guess where the food is grown in New Zealand with irrigation to win a packet of Heartlands Chips. Ms Winning said it was a great event and opportunity to engage with members, industry representatives and the wider community. IrrigationNZ would like to make a special mention to Zimmatic and Plains Irrigators who supported us being there.

ON THE ROAD

Our Communications Manager, Ella Stokes, visited New Zealand's largest outdoor medicinal cannabis farm earlier this month on the Kekerengu coast north of Kaikoura. See the article on page 14.

Implementation of Essential Freshwater reforms

View from Here with David Parker, Minister for the Environment, Labour Party.

Since my last column in this magazine (Spring 2019) the COVID-19 pandemic has hit and New Zealand closed its borders to most non-residents while implementing some of the toughest lock-down measures in the world.

As a country we learnt a huge amount about how we can work together to solve the complex and difficult problems posed by the pandemic.

In February we again had cause to apply that knowledge, with the emergence of community cases in Auckland.

Despite the disruption from the pandemic the work on completing the Essential Freshwater package continued last year and the regulations came into effect from September 2019.

The Essential Freshwater package aims to stop further degradation of our freshwater, to start making immediate progress so quality improves within five years, and to bring our waterways and ecosystems back to a healthy state within a generation.

These are ambitious targets but align with our values as New Zealanders. We have put Te Mana o Te Wai – the life-supporting capacity of freshwater – at the centre of our decision-making for freshwater. Māori and Pākehā alike know that healthy freshwater supports healthy communities, a healthy environment and a healthy economy (oranga wai, oranga tāngata).

A strong environmental approach to dealing with freshwater issues is good for both long-term economic and community outcomes – in much the same way as a strong health response to deal with COVID-19 was also the best approach for our economy.

There should be few surprises around the details of the Essential Freshwater package – the issues were well debated with wide consultation and in-depth analysis. The focus for the primary sector now should be on finding solutions to implement what is needed to effect real change, and as quickly as practicable. The direction is clear and there is a lot of effort to provide support and advice to councils and the primary sector on what needs to be done, and by when.

The Government's recent announcement that it will reform the resource management system should not be a surprise either, following last year's report by the independent Resource Management Review Panel.

We announced formally on February 10 that the Resource Management Act 1991 will be repealed and replaced with three new acts, which will have a significant impact on irrigators and the broader farming sector. They will be the:

- Natural and Built Environments Act (NBA)
- Strategic Planning Act (SPA)
- Climate Change Adaptation Act (CAA).

The panel also recommended greater use of national direction by the Environment Minister, a more streamlined process for council plan-making, and a more efficient resource consent process.

There is urgent work needed as well to address freshwater allocation issues and climate change. The Government's aim is to have efficient and fair allocation of freshwater, taking into account all interests including existing water users and those who may want access to freshwater in the future.

The recent draft report from the Climate Change Commission, which is now open for consultation, was released around the same time that the Government announced a raft of measures to help New Zealand meet its 2050 carbon neutral target, create new jobs, and boost innovation. These actions included a commitment to a lower emitting biofuel blend across the transport sector as well as a clean car import standard to reduce average CO_2 emissions (agricultural vehicles for primary use on farms – tractors, harvesters, mowers, toppers, bailers – will be exempted).

We will continue to work with the agriculture sector through the He Waka Eke Noa partnership – supporting our farmers and growers to adapt to climate change and measure, manage and reduce emissions, while recognising sequestration opportunities from their farms.

It may take up to a generation for the improvements in freshwater quality and ecosystems to show up in monitoring results. The Essential Freshwater package is about everyone doing their bit – urban and rural – to put freshwater first and implement Te Mana o Te Wai.

Water responsibility – issues to resolve across the country

View from Here with Simon Bridges, National Party.

As a newbie to the portfolio, and first MP ever to have the title "Water" in my responsibility, I have some sense of trepidation. When you add that National is a smaller opposition now against a one-party Government at the start of a three-year term, you'll forgive me if I don't announce big policy changes or the like. Instead, what you'll get from me at this early point will be first impressions and inclinations.

That said, I think I can start with a grand pronouncement or two. National leader Judith Collins' has given me water responsibility because she recognises what a big deal it is for New Zealand, today and for our future. Secondly, it doesn't take a rocket scientist to work out that this should be a massive parliamentary term for water – it needs to be.

Every area and segment of New Zealand has a water issue at the moment. If you're an urban area, you may well have water shortages (e.g. Auckland) or decaying pipes (e.g. Wellington).

A reliable water supply for growers and farmers has major potential to boost economic growth, creating jobs and exports in the regions. A reliable source of water gives certainty and helps plan ahead and deal with droughts and dry spells. At the same time, as we know, schemes can deliver real environmental benefits by maintaining river flows and recharging groundwater aquifers.

And that's before we get to climate change, where weather changes will mean near certain need for better water management in parts of our country.

We can all agree that improved water management is needed to grow the economy while better caring for our rivers, lakes and aquifers.

In saying all this, I am still barely scratching the surface on the issues we have coming up. Iwi ownership anyone? That court case launched by Ngāi Tahu will happen sometime in the next couple of years and force the issue if Government doesn't get to it first. Water quality and the desire for better and better standards is, of course, also a government workstream.

My approach, while possibly simplistic, also has the benefit of being simple. I like to conceptualise things, so I divide water into "quality" and "quantity" issues. Serious resolution of water quality issues began under National, and we made serious progress with our NPS work. As important as these issues are though, they are under my colleagues' purview with environmental and primary production portfolios, not me.

When it comes to water quantity, however, that's definitely me, and the central issues are no news to you: how much water we have and how we store it. And how we allocate it, which involves the big issue I've already spoken of – ownership, rights and interests.

On water storage, the discussion can get caught up in so-called "dirty dairying", but this is unfair at every level. Let's remember a point I've already alluded to. Water storage isn't just required for primary production but increasingly for urbanites and regional communities and overtime for climate change reasons.

Big issues to resolve – because somewhat amazingly we haven't as a nation yet – include deciding just what exactly needs upgrading or building and how we will pay. My inclination is that we need a national project undertaken by a mix of experts to clarify where and what. There are a few, not mutually-exclusive funding options, and I am looking forward to hearing from knowledgeable Kiwis about the pros and cons. Do we do it like has been for regional highways with a financial assistance rate set depending on the ability for the locality to pay with the remainder picked by centrally? Do we use loan models to councils and/or ensure some user pays so the private sector that benefits contribute commensurate to the expected rewards? I think what we can say confidently is partnerships are the way forward. Oh, and this isn't going to be cheap, so planning now is critical. It's about getting the right rules and funding in place to support and grow our economy, while ensuring the protection of our environment.

Local Government Minister Nanaia Mahuta has indicated the Government is likely to go for a public multi-regional model where water service delivery realises the benefits of scale for communities and reflects communities of interest. There is a preference that entities will be in shared ownership of local authorities. Let's see the detail in which the devil always resides. All I would say for the moment is that the needs of urban and rural areas, say Auckland and Northland, will be very different so we need to be careful about a one size fits all approach.

On ownership, rights and interests, National's position has always been that nobody owns the water while Labour says everybody owns it (take your pick as they have the same effect). Let's all watch the fireworks.

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Irrigation with marginal quality water in Israel: boon or bane?

By Dr Alon Ben-Gal and Dr Shmuel Assouline.

Israel, a small country with a relatively solid economic base, but isolated due to geo-political reality, is unique as a water-scarce country with successful agricultural development.

The success can be credited to three central driving principles:

1. intensification and modernisation of agricultural systems;
2. development and adoption of efficient water application technologies and;
3. establishment of reliable sources for irrigation.

Water consumption from all sources and for all sectors in Israel increased tenfold from 230 Mcm (million cubic metres) in 1948 to 2,200 Mcm in 2018 (Israel Water Authority 2019). It is estimated that only 55–65 percent of the present amount of the country's water needs is renewed annually in its natural surface and groundwater resources. The remaining water supplied comes from groundwater mining, allocation of reclaimed wastewater, or by seawater desalination. While per capita consumption in the domestic and industrial sectors has remained essentially the same during these last decades, per capita water available for agricultural uses is less than half today than it was in the 1960s. Despite the reduction in water allocation, agricultural production per capita today is more than 150 percent of that produced 40 years ago (Ben-Gal, 2011; Tal, 2016).

Intensification and modernisation of agriculture were accomplished by strong research and development programs, knowledge transfer to farmers by means of a solid extension service, and strong government economic support of national strategies. Drip irrigation was developed in Israel where this inherently efficient technology is used at rates higher than anywhere else in the world. Technologies and practices promoting water efficiency have further been encouraged by national water pricing and allocation strategies (Tal, 2006). Utilisation of low-quality water has been encouraged (or compensated) through a water for irrigation pricing structure where cost to farmers goes down as irrigation water salinity increases.

The third principle stimulating success, a reliable source of water for irrigation, has been more difficult to accomplish. The NWC (National Water Carrier) has historically conveyed water from the Sea of Galilee in the north to the south of Israel, seasonally mixing it on the way with various ground and floodwater sources. Average EC of the NWC water has ranged from 0.8 to 1.1 dS/m (electricial conductivity deciSiemens per metre). Freshwater use in agriculture dropped from 950 Mcm in 1998 to around 490 Mcm today. Total water to agriculture has been maintained via the utilization of brackish and recycled water (Fig. 1).

Israel's agriculture directly uses some 80 Mcm of brackish groundwater with EC of more than 2 dS/m for irrigation, mainly in arid regions including along the Jordan Valley and the Arava and the Negev Highlands. Wastewater recycling has become a central component of Israel's water management strategy. A master plan presented in 1956 envisioned the ultimate recycling of 150 Mcm of sewage, all of which would go to agriculture. Today four times that level is recycled, representing around 85 percent of all domestic wastewater produced. Treated effluents today contribute roughly 25–30 percent of Israel's total water supply and, depending on annual rainfall, up to 45 percent

DR ALON BEN-GAL

Department of Environmental Physics and Irrigation, Institute of Soil, Water and Environmental Sciences, Gilat Research Center.

Dr Alon Ben-Gal is a senior researcher in the Department of Environmental Physics and Irrigation, Institute of Soil, Water and Environmental Sciences, The Agricultural Research Organization, Gilat Research Center. His research and expertise includes: irrigation of crops; agricultural utilisation of saline water and of recycled wastewater; optimisation of water under irrigation in arid regions; plant response to environmental stress conditions; and flow and transport of water and solutes in the vadose zone.

Alon is the author of over 130 peer reviewed journal articles and book chapters and has served as the Scientific Director of the Southern Arava Research and Development Center for the past ten years.

DR SHMUEL ASSOULINE

Department of Environmental Physics and Irrigation, Institute of Soil, Water and Environmental Sciences, ARO Volcani Center.

Dr Shmuel Assouline is a senior researcher in the Department of Environmental Physics and Irrigation, Institute of Soil, Water and Environmental Sciences, The Agricultural Research Organization – Volcani Center. His research interests include: soil hydraulic properties, irrigation practices and technologies, soil structure and compaction effects, evaporation from soils and water reservoirs, rainfall-infiltration-runoff-erosion relationships, and dynamics of soil sealing and hydraulic properties of soil surface crusts. Shmuel has over 130 peer-reviewed publications, is a Fellow of the Soil Science Society of America and the Society's 2016 winner of the Don and Betty Kirkham Soil Physics Award. Shmuel currently serves as the ARO's Associate Director for International Cooperation.

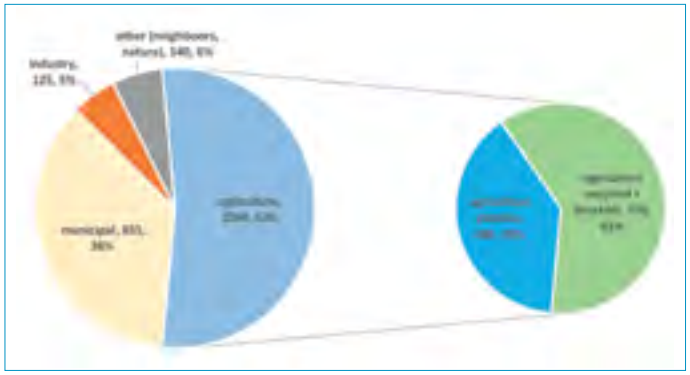

Figure 1: Average 2015–2018 annual water use (MCM, %) in Israel by sector and source. *(Source: Israel Water Authority, 2019)*

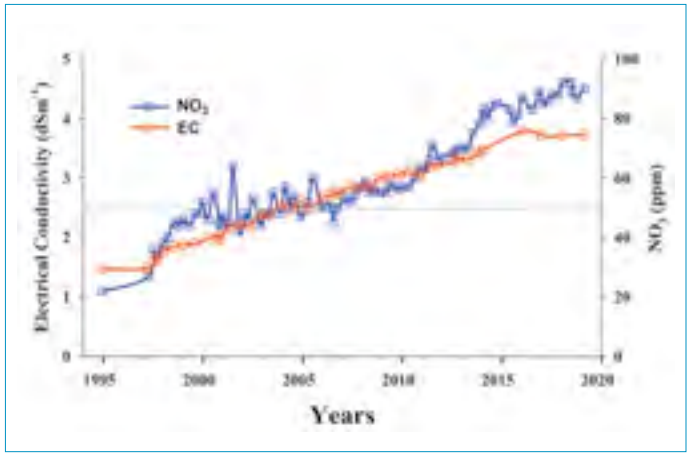

Figure 2: Electrical conductivity and nitrates (NO_3) in groundwater serving for irrigation in the Arava Valley (Hazeva) since 1995. Data provided by Dr Effi Tripler, Central Arava R&D. The horizontal grey line indicates the allowable NO_3 concentration in drinking water of 50 ppm according to the WHO (2011).

of the irrigation supply for agriculture. Salinity of recycled wastewater, depending on its type and origin, can range dramatically, but no matter what, salinity increases as the wastewater stream advances. In Israel, municipal recycled wastewater typically ranges from EC of ~1 to more than 3 dS/m (Tarchitzky et al., 2006).

Unfortunately, due to the high concentrations of salts in the irrigation water, Israel's strategy for agricultural success seems to be not sustainable. Long-term application of salts to agricultural soils in a region where seasonal rainfall is low, unpredictable, and often insufficient to systematically mobilise and remove problematic salts, must include application of water designated to leach the accumulating salts out of the root zone (Russo et al., 2009). The water applied for leaching and leaving the root zone contains not only the salts that must be leached, but also various other contaminants, found naturally in the water, added in agricultural processes (fertilisers, pesticides and herbicides), or mobilised from soil and subsoil (Ben-Gal, 2011; Ben-Gal et al., 2008, 2013).

An example of problematic sustainability stemming from policy and practice of irrigation with water high in salts is found in the Arava where brackish groundwater is used to irrigate green and nethouse protected vegetables. It is estimated that irrigation to leach salts in the region can be beneficial to yields and profits at rates as high as twice those necessary to satisfy crop evapotranspiration requirements (Ben-Gal et al. 2008, 2009). The most obvious threatening contaminant and best indicator of pollution accompanying the leaching practices is nitrates. Nitrates, as well as salinity in general, have risen from less than 20 to more than 90 ppm (parts per million) in wells of groundwater downstream from local areas of intense vegetable cultivation (Figure 2).

Regarding continued use of effluents or other salt-rich sources for irrigation water, additional indications of problems are found. These include the long-term increases in sodium adsorption ratio (SAR) and exchangeable sodium percentage (ESP) in soils (Assouline and Narkis, 2011; 2013; Segal et al., 2011; Assouline et al., 2016; Raveh and Ben-Gal 2016; Erel et al., 2019), affecting soil structure and water infiltrability, a

trend of increasing sodium and chloride found in irrigated plant tissues, and the tendency for Israeli fresh produce to have higher than international standards of sodium (Raveh and Ben-Gal, 2016). In addition, there are increasing concerns regarding possible yet undiscovered detrimental long term repercussions due to trace level (particularly persistent organic) contaminants in agricultural systems and the food chain (Goldstein et al., 2014).

In spite of all this, the latest responses of Israel to insure reliable municipal water supply to its growing population may coincidentally provide opportunity for a more sustainable solution for agriculture. Starting in 2007, Israel has added desalinated seawater to its water distribution stream. Desalination currently provides around 25 percent of Israel's total water supply, as more than 40 percent of the country's municipal water, often incidentally bringing very good quality water to agricultural areas and consistently reducing the salinity of recycled wastewater (Yermiyahu et al., 2007; Assouline et al. 2015; Raveh and Ben-Gal, 2018).

> "Israel is projecting that by 2050, two-third of its water supplies will come from treated effluent, desalinised or brackish water."

The turn to desalination as a strategy for water security is a positive opportunity to reverse the maybe dangerous and apparently non-sustainable trends consequential to irrigation with water containing high concentrations of salts (Assouline et al. 2015; Tal 2016; Raveh and Ben-Gal, 2018).

Israel is projecting that by 2050, two-third of its water supplies will come from treated effluent, desalinised or brackish water. Sustainable, healthy, economical, irrigated agriculture in Israel and other semi-arid and arid regions should be possible if the salts are taken out before application, instead of being allowed to negatively affect soils, crops, produce, and the environment (Silber et al., 2015; Raveh and Ben-Gal, 2018).

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New Zealand's largest ever medicinal cannabis crop – almost ready for harvest

North of Kaikōura, on coastal slopes under the Marlborough sun, lies a medicinal cannabis crop the size of ten rugby fields.

Wanting to be at the forefront of the industry in New Zealand, the company Puro was launched in 2018 to grow medicinal cannabis at scale.

Winston Macfarlane and his brothers are sixth-generation farmers on the 1,000 hectare sheep and beef property. Mr Macfarlane was already looking at options to diversify their land-use, so when Puro came to him with the idea, he did not hesitate to investigate doing something a bit different.

"We were approached by Puro and discussed it as a family, and we decided it was a good thing to have a go at."

Their location, being in a coastal environment and having a high number of UV light hours made for a perfect environment for growing the plants. The geographic location also meant it was suitable to meet medicinal cannabis cultivation regulations.

Mr Macfarlane is now the Site Manager of the ten hectares which Puro leased from the Macfarlane Family Trust.

The coastal environment made for great growing conditions.

It was a real change in career for Mr Macfarlane who, although originally having studied agriculture, for the past 25 years had been with Team New Zealand on several America's Cup campaigns and sailed with the Japan Sail Team.

Growing medicinal cannabis had been a steep learning curve. "It hasn't been done in New Zealand before, especially at this scale, therefore there is no handbook on how to do it … the first few years will give us incredible knowledge going forward," said Mr Macfarlane.

Mr Macfarlane said they were lucky to be surrounded by super-passionate and knowledgeable people who were making it worth it. "The people who want to do it are really passionate and it's been a great challenge".

"It's nice to work with happy people who believe in a product and the methods we are using to grow the plant … it's more than just a job."

Puro have 20 staff, both full and part time, and had another growing site in Blenheim, where cannabis is grown in an indoor facility.

In October 2017, the New Zealand Government announced a commitment to making medicinal cannabis available for people with terminal illness or chronic pain. In January 2018, a Bill was read in Parliament for the first time, and it was referred to the Health Select Committee. The Committee was unable to reach an agreement therefore

Some of the Puro team at the growing site (from left) Max Jablonski, Winston Macfarlane, Tim Aldridge.

"We are not allowed to export unless we meet the highest standards. A lot of work has gone into designing our quality management system – with extensive standard operating procedures, environmental and product testing throughout the cultivation, harvest and supply process."

did not recommend that the Bill proceed. In November 2018, the Bill was read and unchanged for a second time.

In December 2018 the Government tabled a Supplementary Order Paper (SOP) to amend the Bill and later that month the Misuse of Drugs (Medicinal Cannabis) Amendment Act 2018 came into force. In July 2019 the public consultation document on the proposed Medicinal Cannabis Scheme was released. December 2019 saw the Misuse of Drugs (Medicinal Cannabis) Regulations 2019 made under Order in Council, and in April 2020 regulations came into force and the Medicinal Cannabis Scheme commenced.[1]

A patient needs a prescription from a doctor registered to practice medicine in New Zealand before obtaining any medicinal cannabis products. A medicinal cannabis product is a dried cannabis product or a product in a pharmaceutical dosage form (e.g. tablets or capsules) containing one or more cannabis-based ingredient(s) and no other prescription medicines or controlled drugs.

"Cannabidiol" products are a type of medicinal cannabis product that have potential therapeutic value and contain little-to-no psychoactive substances (such as tetrahydrocannabinol, known as THC). These products are typically available as capsules or oral liquid.

Other medicinal cannabis products may contain psychoactive substances found in cannabis, such as THC. These products may be available as tablets or capsules, or as dried flower intended for vaporisation.[2]

Mr Macfarlane said their outdoor-grown plants contained less than one percent THC. He said he believed in medicinal cannabis and wanted to be a part of growing the industry in New Zealand.

"New Zealanders should have affordable access to medicinal cannabis."

The site, and the six different varieties of seeds used at the farm, were chosen by Puro's Melbourne-based Cultivation Director, Tom Forrest.

The crop was germinated in tunnel houses at a Blenheim facility before being trucked to their outdoor coastal home where they were transplanted into the ground.

But, not before two years of work and a lengthy process to receive a licence from the Ministry of Health.

Puro Managing Director Tim Aldridge said they originally had a licence to grow industrial hemp which they did in summer 2019/2020 for research reasons and to help build soil quality. In July 2020 Puro received its licence to import medicinal cannabis seeds and by November 2020 had them in the soil.

Mr Aldridge said COVID-19 had

Drip line irrigation was crucial for keeping the nutrients up to the plants.

1. www.health.govt.nz/our-work/regulation-health-and-disability-system/medicinal-cannabis-agency/medicinal-cannabis-agency-information-consumers
2. www.health.govt.nz/our-work/regulation-health-and-disability-system/medicinal-cannabis-agency/medicinal-cannabis-agency-background-information

caused them huge logistical delays. They were unable to get both equipment and people into the country.

"It's been a shame that people who are internationally involved haven't been able to visit the site."

They also just recently received the last piece of the puzzle for their harvesting equipment – which they were meant to have last year.

Mr Aldridge said the way the regulations have been designed means the New Zealand medicinal cannabis industry must produce a very high-quality pharmaceutical grade product.

"We are not allowed to export unless we meet the highest standards. A lot of work has gone into designing our quality management system – with extensive standard operating procedures, environmental and product testing throughout the cultivation, harvest and supply process."

"Marlborough is home to some of the most prestigious sauvignon blanc through the great growing conditions and we want to achieve that with the cannabis."

After harvest, the crop will be sold as dried milled flower in bulk to pharmaceutical companies both in New Zealand and overseas.

One of the many soil moisture monitors.

MEDICINAL CANNABIS AND FERTIGATION

Mr Macfarlane said fertigation had been crucial right from the get-go and was the best way to get nutrients to the plants.

"There is no handbook which says cannabis plants need X amount of water, however it is important … drip line is the most efficient and direct way we can do it."

Each row of plants had a drip irrigation system which was primarily used for fertigation. This was due to there not having been a previous irrigation system on farm and the location of the plantation meant water was trucked in from offsite.

Fertigation was administered every three to four days, depending on soil moisture. A soil moisture monitor was installed in each zone.

Mr Aldridge said there was plenty of research when it came to guidelines when growing indoors, but less so for outdoor.

Puro was aiming to become organically certified, therefore all products used followed these guidelines, and their main fertiliser was kelp and fish oil.

Mr Macfarlane said using fertigation allowed them to have a consistent and healthy crop. "We could grow without it, but it would be hard."

While being in a windy environment could be hard on the plants, Mr Macfarlane said the plants are resilient and the wind also meant the site wasn't the best environment for bugs and pests to grow.

"We use a foliar spray to help with pest control as well as a beneficial plant mix to combat aphids."

MEDICINAL CANNABIS IN NEW ZEALAND

The Medicinal Cannabis Scheme came into effect on 1 April 2020 with the commencement of the Misuse of Drugs (Medicinal Cannabis) Regulations 2019. The Scheme is entirely separate from the referendum on recreational cannabis.

The purpose of the Scheme is to improve access to quality medicinal cannabis products for patients.

Medicinal cannabis products are only available to patients on prescription from a doctor. Manufacturers and importers are required to provide evidence to the Medicinal Cannabis Agency that they consistently meet minimum standards of quality before they can be supplied.

Those who want to work in the industry need to hold a medicinal cannabis licence or work for a person or company that holds a licence. The licence will specify the types of activities that a licence holder may carry out, such as commercial cultivation of cannabis or manufacture and supply of medicinal cannabis products.[1,2]

1. www.health.govt.nz/our-work/regulation-health-and-disability-system/medicinal-cannabis-agency/medicinal-cannabis-agency-information-consumers. 2. www.health.govt.nz/our-work/regulation-health-and-disability-system/medicinal-cannabis-agency/medicinal-cannabis-agency-background-information

A passion for growing

Based in Blenheim, Max Jablonski is a full-time cultivation and crop technician for Puro and has worked with cannabis plants for almost ten years.

Cultivation and crop technician, Max Jablonski in his happy place.

Originally from New York, Max Jablonski moved to New Zealand in 2011 as a university student.

"I fell in love with the place and transferred my credits to complete my studies at the University of Otago."

He had also played professional basketball for the Southland Sharks.

Mr Jablonski had always had an interest in alternative medicine and moved back to the states to pursue a career in this, where he worked for an indoor cannabis company, Caliva, in California.

With the onset of COVID-19 and the rise of the medicinal cannabis industry in New Zealand, Mr Jablonski made the move back here in 2020 which saw him take up the role for Puro.

Mr Jablonski was focussed on cultivation and fertigation. "I have experience in cloning, preventative integrative pest management measures, nutrient and supplement intakes, fertigation and I also look forward to future opportunities of breeding."

"The plant is so unique – it's amazing – and we are learning all the time. It's a great environment to grow here but the plants are outside therefore can be susceptible to some conditions, but they continue to amaze me with how resilient they are."

As far as fertigation went, he said it was crucial to keep the nutrients, water being one of them, available for the plants.

Mr Jablonski said he was excited for the future of the medicinal cannabis industry in New Zealand.

"The plant is so unique – it's amazing – and we are learning all the time. It's a great environment to grow here but the plants are outside therefore can be susceptible to some conditions, but they continue to amaze me with how resilient they are."

Mr Jablonski looks at the cannabinoids through a microscope.

Water management and environment on par

There are over half a million golf players in New Zealand, with up to 400,000 rounds played per month. The Remuera Golf Course Superintendent Spencer Cooper said it is great to see Kiwis playing a sport they love in an environment that is cared for.

The Remuera Golf Course has existed since 1935 at its current site, with some small changes to the layout overtime, but the bones remained the same. Of the 70-hectare site, 15 hectares was under irrigation, home to 18 holes plus three extras to use during times of maintenance and a full driving range. Home to 35 staff, 11 of which look after the golf course including a full-time irrigation technician, plus a few seasonal extras. With 1,700 members it saw 55–60 thousand rounds of golf played a year. Mr Cooper has worked at Remuera Golf Course since 2014, however his interest in turf management started much earlier than that and is a career which has taken him around the world.

Originally from South Africa, Mr Cooper said "I grew up playing golf and loved rugby, however I broke my neck playing rugby which shifted my focus to golf."

In 1998–2000 Mr Cooper worked in South Africa and the United Kingdom (where his family were originally from) before moving to the USA in 2000 to study Turf Grass Management and Golf Club Management.

However, following the September 11 attacks, Mr Cooper's 'Greencard' was denied, and he returned to South Africa, where he continued working on courses.

This is where he said he "learnt the grass-roots of my irrigation training, in South Africa, which is an extremely water scarce country, therefore you have to be so careful with how you use it."

With a young family, a desire to live in New Zealand and a love for the All Blacks, Mr Cooper applied for the job at Remuera Golf Club, and said "I was lucky to land my dream job." With that he and wife Margie and children packed their bags and moved to New Zealand and he has been here since.

Mr Cooper said some career highlights for him included hosting a European Tour and other international events, at The Links at Fancourt in South Africa, and he also helped in getting the course to number one rated in the country.

At the same time, the course became only the second course in Africa to become environmentally (Audubon International) certified "it was exciting to see the golf course as a nature reserve and the course be recognised for this".

He said he was lucky his job had taken him to the "US, UK, South Africa and now New Zealand."

"Working in all these different places taught me a lot about different grasses and using different technologies which has been so helpful to grow my knowledge in this unique role."

Mr Cooper has always held the environmental aspect of his work close to his heart, and it has a lot to do with water management.

The Remuera Golf Course is home to 900 pop up sprinklers, each individually programmed on a Toro Central Control System and even controlled from his phone.

"Irrigation is the heart of the golf course; you can't present a consistently high-quality course without a well-designed and maintained irrigation system."

Water for irrigation of the course comes from a neighbouring housing development which was previously a rock quarry. The quarry fills up with water over time, is then pumped out to prevent flooding and pumped through the golf course of which some is used for irrigating the golf course.

The water which they receive was poor quality and so needed to be treated to correct pH and oxygen levels before it good enough to use on grass.

"We test the water quality in and out every month, including pH, coliforms, biological oxygen etc, and because these levels are not good, water goes through a treatment process. If the water you're putting on is poor quality, you're creating more problems for highly maintained turf. People underestimate just

Keeping it green thanks to irrigation at the Remuera Golf Course.

how important good water quality is for turf."

He said water began in the irrigation pond where nano-bubble technology was used to oxygenate the water to reduce bacteria, especially when water can become stagnant in the heat of summer.

The water then went through a pH correction system, "so we go from water that has a pH of about 8 ½–9 and the water is corrected to pH neutral or slightly acidic which is best for the grass."

A wetting agent is added to the water monthly when needed in summer, so as to help water penetrated the soil and be absorbed more efficiently which "saves water in the long run too," Mr Cooper said. "Wetting agents allow the water to be used by the plant before it might evaporate and evenly distributes moisture throughout the soil."

When Mr Cooper began his role seven years ago none of this was in place.

"The water quality became a serious issue, sometimes by irrigating with poor quality water we were creating more problems than solving them by irrigating, it's a whole science all on its own … we were having to apply large amounts of fungicides and acidifying fertilisers to counteract it, by doing this treatment we can use less chemicals which is better for the plant and environment."

With 1,500 direct neighbours and so many people walking over the course it was important for Spencer and his team to manage

"Realistically we can't run the golf course without chemicals and fertiliser, but it's essential however that we use as little as possible to create a healthier environment for the turf, as well as for animals and people. It's important we continue to do as much as we can to conserve and improve water for irrigation and the wider environment."

Irrigation technicians, from left, Tomas Shaw and Spencer Cooper.

the golf course to the highest environmental standards to help foster a healthier environment for everyone to live around and enjoy for recreation.

"Realistically we can't run the golf course without chemicals and fertiliser, but it's essential however that we use as little as possible to create a healthier environment for the turf, as well as for animals and people. It's important we continue to do as much as we can to conserve and improve water for irrigation and the wider environment. We also have a full weather station which helps us to not only collect data but also calculate evapotranspiration rates. By using this data, we can calculate how much water we lose through evapotranspiration and accurately irrigate accordingly. We try and keep the turf as dry as possible to make it healthier. We hand-water as much as possible to conserve water and create healthier turf that plays well for our golfers."

The course was home to 30 beehives across different sites, which were thriving Mr Cooper said, and they had an Integrated Pest Management plan in place to help avoid harming ecology of the area.

The golf course was also offered to schools as an 'outdoor classroom' to encourage environmental studies and educate the next generation about the environment and potential career opportunities involved with golf course management. This has already been taken advantage of by local schools with great feedback from students.

Irrigation on the green at the Remuera Golf Course.

Mr Cooper was currently on the board of the New Zealand Golf Course Superintendents Association which helps to educate and "provide professional development for golf course superintendents in around the country, we are all very passionate about our golf courses and are constantly trying to improve the ways in which we manage our land and resources, including water." He also said that it was often a struggle to get young people into the industry and always encouraged people to give it a go.

"I mean it's not for everyone, it's not a normal 9–5 job, however it's a passion and you get a lot of job satisfaction, it is much more than simply looking after turf."

When asked if he enjoyed playing golf on his days off Mr Cooper said "of course I love golf and always have, however, I live and breathe it and have for many years, so at times it's nice to get out and enjoy other sports or hiking and fishing in my time off."

Some of the beehives that can be found around the course.

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Walnuts with water

From bare land to a thriving walnut orchard – over the years a Canterbury pair have become nuts about nuts.

Colin and Karen Prebble are the owners of Nut Tree Farm just out of Christchurch – where they grow a variety of walnuts.

Their ten-hectare block is home to over 800 walnut trees which they planted in 1999 after purchasing the property.

Mr Prebble said when they bought the block it was used for dairy support and originally thought they would grow chestnuts.

"However, after investigation we changed our mind to walnuts, we're lucky to be on silt loam soil, perfect for growing trees. Having the right soil for the right crop has proven to be valid in the long term."

Although they planted the trees in 1999 it was not for another eight years until they had their first commercial harvest.

"It was a long wait," Mrs Prebble said.

She said she still remembered it as "so exciting, we had an 8x4 trailer filled with four tonnes of nuts, however now we get up to 15 tonnes of nuts at harvest and have our own washing and drying plant".

Mr Prebble said irrigation had been crucial right from the beginning from growing the trees to continuing to have a successful crop.

"If we didn't have irrigation, we would have struggled to have a successful harvest let alone have grown the trees in the first place, without it the trees would've become unhealthy and stunted, water is the most important input, it was also crucial for us growing the shelter trees."

They sourced water from a bore that was previously on the property and had a three-zone irrigation system. Irrigation was run between November and May, give or take dependant on the season. Harvest was generally in the last week of March and went for a six-to-eight-week window.

Karen and Colin Prebble at home in their walnut orchard, Nut Tree Farm.

"We have the soil moisture at about 17.5 to 25 percent and each tree has a sprinkler beside it, as the tree grows we increase the nozzle size to make sure it gets enough water, we have a soil moisture probe in the orchard measuring from 200 millimetres below the surface to 900 millimetres to make sure we are best using our water," Mr Prebble said.

They supplied to the Walnut NZ Co-Operative with the Nut Tree brand and Countdown. Six years ago, the couple made the shift to organic growing and became BioGro Organically Certified.

"We didn't want to use glyphosate and wanted to restrict chemical use as well as economically organic walnuts fetch a higher premium being organic," Mrs Prebble said.

Becoming certified meant alternative controls in the orchard as well as restricted products for nutrition. The trees' nutrition was monitored through leaf and soil samples.

She said, "instead of traditional fertiliser we

"If we didn't have irrigation, we would have struggled to have a successful harvest let alone have grown the trees in the first place, without it the trees would've become unhealthy and stunted, water is the most important input, it was also crucial for us growing the shelter trees."

shifted to organic compost and lime."

During harvest nuts fell to the ground and were mechanically harvested then washed and sorted and dried to nine percent moisture.

Mr and Mrs Prebble agreed they have had many challenges and learnings while being walnut growers.

Some of their biggest challenges had been weather events.

"In 2018 there was a very wet spring which resulted in high incidence of walnut blight which ruins the nut. 2019 was looking to be a record year however, Nut Tree Farm was in the direct path of the worst hail storm we had seen in 20 years and left the nuts damaged. 2020 saw a -9.2 degree frost just as the early variety was getting it's fruit. Despite three years of unfortunate events the trees are healthy and resilient, just like we as growers have to be."

They said New Zealand imported 90 percent of its walnuts, and it was an ongoing challenge to compete with this to keep prices low but also still cover costs.

"You always become more knowledgeable after trial and error," Mrs Prebble said, "you never stop learning."

When asked if they liked walnuts themselves, they said they had not got sick of them, in fact Mrs Prebble said they ate them all the time.

"We eat a lot of them ourselves … it is very rewarding producing a healthy product for eating and hearing the bird song in the orchard … you can certainly taste the difference between a good and a bad walnut when you have eaten as many as we have."

Growing the trees was a bit of a lifetime commitment they said and when the trees were fully matured over the next ten years, they hoped to get up to 30 tonne of walnuts at harvest.

Irrigation crucial to have successful growing conditions.

Growing opportunity in Northland

The recently formed Te Tai Tokerau Water Trust is creating water storage and distribution schemes in Northland that will allow commercial-scale horticultural development.

While summer 2021 has not seen the same level of water scarcity in Northland as was the case the year before, when major towns in the region almost ran out of water, the fact remains that access to reliable water is still not secure for many in the region.

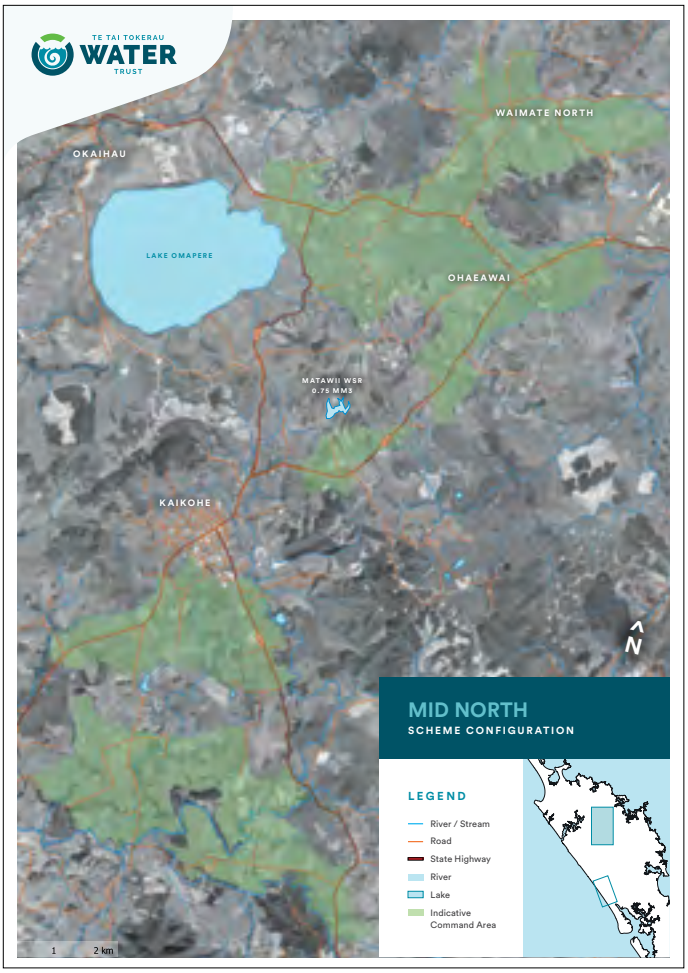
Plans by Te Tai Tokerau Water Trust aim to create water schemes in two different areas within the province, in the Mid North near Kaikohe and on the northern Pouto peninsula in Kaipara, could see as much as 7,000 hectares of land potentially become viable for horticultural development.

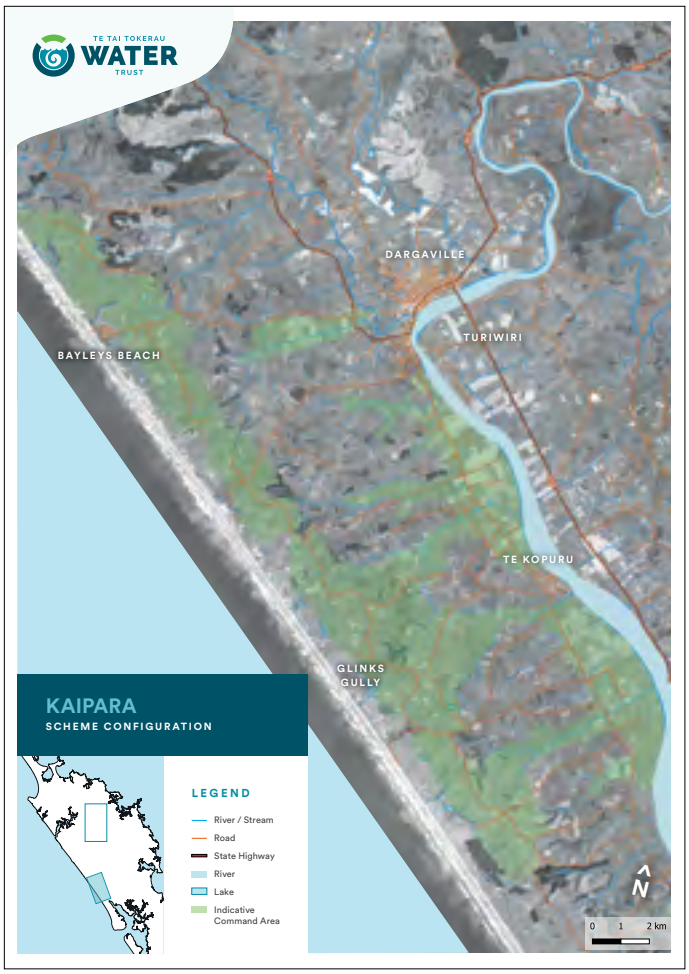
"Once these schemes are up and running, it will be a game-changer for the region," said horticultural consultant Dr Bruce Campbell. "Having a reliable source of water available in areas where there are fertile, free-draining soils, such as in the two areas the Trust is operating in, de-risks the opportunity for horticulture."

The wheels are already turning and the Trust is calling for landowners and investors interested in joining the proposed water schemes to get in touch.

The first reservoir to be developed, called Matawii near Kaikohe, was the first project to be consented under the new COVID Fast Track consenting legislation and is due to begin construction before winter whilst investigations and consent applications at other sites in the Mid North are advanced.

Plans are also well underway in the Kaipara where the Trust has





The areas the new water scheme hopes to deliver water to.

secured access to a farm block as part of acquiring land for its first reservoir site in the region. Approximately half of this is considered suitable for horticulture and the Trust is seeking investment partners to develop the property.

"The goal is to build a series of reservoirs and reticulation networks in both the Mid North and the Kaipara that can supply water for horticulture via a water supply scheme, as well as offering water for town supply. Collectively, they represent one of the largest infrastructure projects seen in Northland for decades," Trust project manager Andrew Carvell said.

"We have gone for a distributed storage option to deliver the objectives rather than building a single large reservoir in each region. This spreads the scheme development and implementation over time to align with demand for the water.

"The funding agreements we have with government predominantly come in the form of loans which will of course need to be repaid, so it's important we don't develop too much, too fast, without customers on board."

You only have to look as far as Kerikeri to see what can be achieved in the subtropical Northland environment. More than 1,000 hectares of new avocado orchards alone have gone in in the region in the last three years.

"The growing conditions in Northland are awesome, especially for avocado", Dr Campbell explains. "It's a sub-tropical region that is forecast to get warmer under climate change. If you have access to a reliable, sustainable supply of water, that creates exciting options for growers to increase productivity and quality."

Dr Campbell said the Trust's plan to harvest water during periods of high rainfall and flow during winter is another key aspect of the schemes' design.

"Northland actually gets plentiful rain, but it comes in pronounced peaks and troughs. Capturing a small proportion of these overland flows in the excess periods and storing it for use later can even out water supply and water security compared with other sources of water. This de-risks the investment opportunities for growers and the community."

The Trust is currently in the process of creating two water companies, one for each geographic area, which will ultimately be owned by the water users as shareholders.

Registration of Interest forms can be found on the Te Tai Tokerau Water Trust's website: www.taitokerauwater.com

What is required for agriculture to move up the value chain?

By Ivan Knauf, Hawke's Bay Dairy Farmer and IrrigationNZ Board Member.

It is estimated that 2,000 hectares of pasture will be converted to intensive horticulture every year for the next ten years. This has certainly been occurring in Hawke's Bay with pasture land being converted to apple orchards and vineyards. New Zealand currently has approximately 100,000 hectares planted in these crops.

High value horticultural products include crops like kiwifruit, avocados, apples, cherries, wine and vegetable crops to name a few. Product volumes required are demand driven and oversupply has devastated some of these industries in the past. These crops will require some of our best agricultural land, and have specific requirements, there is a limited supply of suitable land.

These crops have very specific soil, climate, sunshine hour requirements so not all land is equal. Some regions are more prone to drought, hail, frosts, snow or heavy rain which increases the risk of damage to crops. Canopy structures can protect crops from the elements but add to development costs and shelter trees take time to grow.

One frost can wipe a whole seasons crop out in one night, frost protection requires high volumes of water therefore generally needs to be sourced from storage. Hail can damage fruit leading to total loss or down grades. Dry weather can either reduce yields or reduced size down grades or kill the plant that has taken years to grow. The per hectare development costs for these high value crops are eye watering and it takes three to five years to reach full production and receive economic returns. They may not need a lot of irrigation water but their overheads mean they cannot afford to have crop failures or product downgrades due to lack of water. Though average rainfall may seem reasonable in these regions water availability is crucial.

> "Isn't it time we starting planning and developing storage for both sectors to accommodate expected growth rather than fighting over a diminishing resource?"

Some of our highest value horticultural land is being sub-divided into housing forcing these crops into new and sometimes less suitable regions increasing the risk for growers.

Urban drinking water demand is increasing rapidly and has priority over irrigation water, so crop irrigation water will come under increasing threat in some regions.

Isn't it time we starting planning and developing storage for both sectors to accommodate expected growth rather than fighting over a diminishing resource?

With urban growth comes an increased volume of storm water which currently is just dumped into our rivers and estuaries with little or no treatment. This needs to change with many beaches closed in our major cities throughout summer due to the poor water quality of storm water runoff with contamination of inshore shellfish beds, putting food gathering at risk and recreational areas unusable.

Storm water quality emanating from industrial areas in our cities is appalling and has gone under the environmental radar for too long, this needs to change. Once treated sufficiently this water could be stored and used for irrigation water or recycled as drinking water. Some would say why use possibly contaminated water for irrigating valuable crops. If the water quality is not suitable for our highest value crops or for drinking water, why is it acceptable to put that water into our marine environment?

Our consumers and descendants will be the judges of how well we have done. Admittedly not all land requiring irrigation is located near metropolitan areas but where it is, let's get smart.

If we as a nation want to climb the value ladder for agricultural goods we need to:

- Strategically plan what soils need protection from inappropriate land use like housing, roads and container parks,
- integrate irrigation water, storm water, sewage and drinking water into an overall strategic plan,
- provide the capital to make it happen.

The current lack of foresight and planning is astounding and will affect whether we climb the value chain or not.

In New Zealand we seem to do the development first and then plan and build the infrastructure to service that development later, maybe it is time to change our approach.

Irrigation Leader

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Can Catchment Groups foster an ethic of care for our waterways?

Policy aimed at changing practices on individual farms isn't working, writes Jim Sinner from Cawthorne Institute Collective Responsibility research team. Could collective management, through catchment groups, achieve better outcomes for our waterways?

Over the past several years, I've had a growing sense that our policy approaches for improving freshwater health are not working and not going to work. We have cajoled, shamed, subsidised and regulated farmers and foresters to take action on their individual properties, largely ignoring the ecological reality that the health of a waterway is determined by the cumulative effects of all land within a catchment.

In some cases, we have tried to deal with cumulative effects by estimating how much of a given contaminant a waterway can cope with. For Lake Taupō, for example, shares of the total allowable nitrogen runoff were allocated to individual properties and land users are now required to operate within these allocations.

That might be appropriate in places like Lake Taupō where one contaminant is the main concern – at least for now.

Most of New Zealand's rivers, lakes, streams, wetlands and aquifers are ecologically complex. We could never hope to calculate 'sustainable limits' of nitrogen, phosphorus, sediment, bacteria and water takes for every waterway in New Zealand. To do this well, we would have to understand how these contaminants all interact with physical habitat to affect diverse values such as mauri, mahinga kai, swimming, kayaking, wildlife, and drinking water for people and animals.

That is an impossibly complicated task, so instead, policy tends to default to rules about 'good management practice' – directing land users what to do on their property. These regulations need to be broadly applicable to all properties of the same type, so they are typically set at a low bar: the lowest common denominator.

> "Regulation of farming practices is seen by many land users as blunt, one-size-fits-all, and not appropriate for their situation. This stirs resentment rather than fostering an ethic of care for our waterways, for our special places and for each other."

As a result, the sum effect of good management practices on individual properties is often insufficient to address the local, cumulative effects on a given waterway and community. Hence we make little progress, as improved practice struggles to keep up with on-going intensification.

FROM AN INDIVIDUAL TO A COMMUNITY APPROACH

I've also been concerned about how the current approach, regulating each property separately, fosters a 'tick the box' compliance mentality.

Regulation of farming practices is seen by many land users as blunt, one-size-fits-all, and not appropriate for their situation. This stirs resentment rather than fostering an ethic of care for our waterways, for our special places and for each other.

Rather than hoping that standardised good management practices and individual property regulation will solve most problems in most places, I have wondered: could collective management – through catchment groups – build upon local knowledge and ecology to achieve better outcomes for our waterways? Would collective management help to instil an ethic of care for waterways and support for each other as neighbours?

COLLECTIVE MANAGEMENT HAS A LONG HISTORY

Collective management of natural resources is not a new idea. In many countries, communities have been collectively managing forests, fisheries and irrigation schemes for centuries. In New Zealand, there are collectively managed irrigation schemes and pest control schemes.

As Nobel Prize winner Elinor Ostrom has shown, communities can manage their resources effectively when conditions are right:

- when users depend on the resource for their livelihood,
- when local knowledge can improve decision-making,
- when users monitor the resource and each other, and
- when social pressure is used to encourage compliance with group rules.

Waterways (streams, rivers, aquifers) are sometimes collectively managed as irrigation resources, but collective management for ecosystem health is different.

In particular, the effects of water use and runoff go far beyond those who are directly benefiting from land and water use. So we cannot rely on users' self-interest to motivate protection of waterways, especially when the

View of Mount Maunganamu Hill and Lake Taupo.

effects of individual use are largely invisible, only becoming apparent downstream (Amblard, 2019; Knook et al., 2020).

That's a key reason why we've seen the health of our waterways decline steadily over the past 50 years (Ministry for the Environment, 2020).

COLLECTIVE MANAGEMENT – A NEW OPPORTUNITY?

Through public pressure and legislative changes, tangata whenua and the wider community have made it clear that we must do better for our waterways.

The National Policy Statement for Freshwater Management 2020 (NPS) has formalised this through 22 attributes (i.e. water quality standards) and through the principles of Te Mana o Te Wai, alongside new regulations on winter grazing, fertiliser use, wetlands, fish passage and excluding stock from waterways.

Now, regional councils must develop or change plans to give effect to the latest version of the NPS, including identifying specific outcomes for every water body, and how they will be achieved.

The question is, how we will achieve these outcomes. Will we use the same approach as before, focusing on actions by individual land users? Or do catchment groups offer a better way to improve freshwater health, deliver on Te Mana o Te Wai, and build stronger communities?

WHAT CAN BE DONE NOW?

In a previous article, our research team argued that catchment groups offer a better way. We suggested four actions for catchment groups wanting to improve freshwater:

1. identify specific objectives for each sub-catchment,
2. prepare a sub-catchment plan that identifies priority actions,
3. partner with tangata whenua, and
4. monitor and adapt plans over time.

Now, given that regional councils are meant to identify outcomes for each waterway and set targets for 22 attributes, should catchment groups wait for this to happen before developing local outcomes and action plans at sub-catchment scales? That could take several years, during which valuable time would be lost.

CONNECT WITH COUNCILS AND TANGATA WHENUA

Regional councils and tangata whenua already have a lot of understanding and information on most waterways in New Zealand.

Councils can advise catchment groups on how the current health of waterways compares with the NPS standards, what the main stressors or problems are, and the type of actions that are most likely to improve the health of waterways.

While we should aim to improve all attributes, the attributes that are most stressed are likely to be what needs to be addressed first to improve ecosystem health and other values.

Tangata whenua often bring a different perspective and specific objectives, reflecting their history with the land and waterways. Tangata whenua have local mātauranga (knowledge) about how the river behaves (e.g., in floods or droughts), about treasured species, and about the location of wāhi tāpu (sacred sites) that warrant special protection.

Tangata whenua also bring a sense of the waterway as a whole entity – mountains to the sea – and awareness of what is important to them, such as mahinga kai and native species. This perspective is a useful counterpoint to reductionist approaches that focus on individual attributes.

IDENTIFY WHAT MATTERS MOST

Ultimately, what matters is not the concentration of nitrogen or how much sediment there is on the streambed, but whether the waterway is itself healthy and is a healthy place for aquatic life and for humans.

It is also important to look downstream, beyond the sub-catchment, and make sure a tributary is not contributing to the degradation of lakes, estuaries or the coastal environment.

Drawing upon attributes in the NPS and discussions with regional council staff and tangata whenua, catchment groups can identify interim outcomes and objectives for their waterways, without waiting for finalisation of formal regional plans.

Outcomes should be based on the key values to be maintained or enhanced in the catchment, and be something that everyone can be proud of, such as protection of a rare or threatened species, a popular swimming spot, or a site of historical and cultural significance.

GOOD RELATIONSHIPS ARE A GREAT PLACE TO START

This approach will also be a good start to giving effect to Te Mana o Te Wai, which requires putting the health of waterways ahead of human uses. What this means in practice needs to be worked out with tangata whenua and community in each place, so developing good relationships between land managers and tangata whenua is a great place to start.

At a recent Our Land and Water webinar, Kēpa Morgan commented: "Iwi and Hapū are most concerned with how genuine the relationship is and the intentions of forming it… Best is to visit the local marae and establish a relationship that is not outcome-driven, but that will allow you to get to know who with and when to raise issues that concern you, and ask what the priorities for iwi and hapū are." (Written comment submitted at webinar on 14 December 2020.)

There is much to be gained from tangata whenua and land users getting to know and understand each other's histories and points of view, before the issues take on a legal character through formal submissions and hearings.

Also important is for neighbouring land users to hear each other's perspectives and consider how they could work together.

There are some catchments in New Zealand where existing mitigation options are not enough to return waterways to a healthy state – land use change will be required. In these situations, catchment groups could find it difficult to agree on an action plan to achieve the long-term objectives. Yet even here, having these early conversations helps prepare everyone for the tough decisions ahead.

Catchment groups may have a wide range of objectives – these groups don't exist just to implement government policy. Having said that, there is an opportunity for catchment groups to address freshwater issues in a way that advances the interests of farmers and foresters, as well as tangata whenua and community interests, and puts the waterways first.

Ultimately, to support an ethic of care – for the land, waterways, and our neighbours – we need strong relationships between tangata whenua and land users.

Many questions remain about how to nurture catchment communities of care. We hope to offer more guidance over the next two years as we explore these questions in our research with farming leaders and tangata whenua in four catchments around New Zealand.

Author, Jim Sinner, is a senior coastal and freshwater scientist at the Cawthron Institute and leader of the New Models of Collective Responsibility research programme, with co-authors Marc Tadaki, Margaret Kilvington, Ed Challies and Hirini Tane from the New Models of Collective Responsibility programme team.

More information:
■ New Models of Collective Responsibility research programme. ■ Amblard L (2019) Collective action for water quality management in agriculture: The case of drinking water source protection in France. Global Environmental Change 58: 101970. ■ Knook J, Dynes R, Pinxterhuis I, et al. (2020) Policy and Practice Certainty for Effective Uptake of Diffuse Pollution Practices in A Light-Touch Regulated Country. Environmental management 65(2): 243-256. ■ Ministry for the Environment (2020) Our Freshwater 2020: Summary.

Investigating how to improve fish screens – Year 1 lab trial report

In late 2019, IrrigationNZ (on behalf of the New Zealand Fish Screen Working Group*) received a grant from the Ministry for Primary Industries Sustainable Food and Fibre Futures fund to further research fish screen design criteria. The aim of the research is to provide clear and simple guidance on fish screen requirements and provide solutions and guidance on existing fish screen deficiencies.

This work is helping to develop more effective fish screen designs by getting a better understanding of fish behaviour at intakes, improving design guidance and informing the development of appropriate future consent conditions.

To date the following has been completed:

- A report summarising the current status of fish screening regulations across New Zealand — these regulations are produced by Regional Councils so can vary depending on where you farm. This report also identified gaps still to address since the original 2007 Fish Screening guidelines were published.
- Identification of three sites suitable to address compliant design. These sites cover 'typical intake locations' and represent a range of flows and challenges. They are small to medium in size and exclude large takes. Agreement with landowners of the three sites to participate in the project has been achieved, options reports have been completed and the technical design of the water intake for each location is due for completion mid 2021.
- Field and Laboratory trial scope and design methodologies have been defined.
- Year 1 Lab Trials have been completed with Year 2 trials underway. Fish screen Lab Trial report – Year 1. See the report summary below or more at www.irrigationnz.co.nz/KnowledgeResources/FishScreens.

The Year 1 lab trial report was completed by Dr Phil Jellyman, NIWA.

DR PHIL JELLYMAN

Dr Jellyman is a freshwater fisheries scientist with a PhD from the University of Canterbury.

He first worked with NIWA in 2005–2007 and has been back as a scientist since 2012 specialising in freshwater resource management and conducting research on freshwater fisheries. He has previously led the freshwater fisheries research within NIWA's Environmental Flows Programme. Prior to becoming Assistant Regional Manager in 2018 he managed the Freshwater Ecology Group in Christchurch.

The Rangitata South Irrigation Scheme intake. *(Photo: RWL/NIWA)*

REPORT SUMMARY

Water for irrigation is the largest water use sector, currently accounting for about 70 percent of global water withdrawals. Surface waters are abstracted to varying degrees to meet human needs such as agriculture, drinking water, urban water supply, industry and electricity generation and New Zealand is no exception. When surface water diversions are not properly screened, they can result in the physical removal of fish from rivers. In New Zealand, regional councils issue the consents for the taking of surface waters in consultation with agencies that have statutory responsibilities for managing native and sports fish populations. A recent review of council plans highlighted that regulations pertaining to fish screening are highly variable across New Zealand and that the greatest source of variation in plans was related to the aperture size of suitable screening materials. Thus, this report designed research to address inconsistencies relating to both the aperture size of screens and also the type of fish screens being consented.

This research conducted two types of experiments: indoor flume experiments to examine the effectiveness of different types of fish screens and outdoor experiments in a 'stream simulator' to refine how altering screen aperture and approach velocity influenced screen penetration, bypass use and screen contacts by fish. Flume experiments tested five fish species (bluegill bully, common bully, Canterbury galaxias, shortfin eel, rainbow trout) against two rock screens (50–100mm and 100–200mm), 3mm woven-wire mesh, 3mm wedge-wire and a no screen 'control'. Rock screens were tested because they are a novel screen design that has been consented at large water intakes, particularly on the South Island's east coast, but for which almost no quantitative information is available. Each experiment had five replicates (five fish per replicate) and a duration of 30 minutes with the location/zone each fish was present in noted at six-minute intervals (zones were: upstream of the screen, within the screen,

downstream of the screen or on the back of the exclusion screen). Stream simulator experiments examined the effectiveness of two mesh sizes, for the leading screen type, under two 'approach' velocity treatments (0.12 and 0.24 m/s). These experiments examined the same species, except rainbow trout, as in the flume experiments and lasted 15 minutes. In flume experiments, the presence of a screen significantly reduced the proportion of fish present in the upstream zone. Rock-bund screens had a high proportion of bluegill bullies that had penetrated through both sizes of rock screen, with 60 percent penetration of the 50–100mm rock screen. Screen penetration (i.e., entering the upstream zone) was low for shortfin eel and Canterbury galaxias, however, this was because both species were instead spending most of the time in the rock-bunds.

For example, screen penetration of 100–200mm and 50–100mm rock screens by shortfin eels was 4 percent and 0 percent, respectively but shortfins spent 63 percent of their time in the larger rock screens and 71 percent of their time in the 50–100mm screens where no penetration was recorded. The 3mm woven wire mesh screen had no penetration by Canterbury galaxias, common bully or rainbow trout but there was reasonable penetration (40%) by shortfin eels and a single bluegill bully made it through the screen.

Apart from shortfin eels, there was no penetration of the 3mm wedge-wire screen. The more flexible body shape of shortfins meant the slot shape was easier to penetrate than the square grid of the 3mm woven-wire screen and shortfins were able to weave their bodies through the wedge-wire and use the screen as refuge habitat. Based on the results of the flume experiments, wedge-wire screens were selected for refinement experiments in the outdoor stream simulator. Both the 2mm and 3mm wedge-wire excluded all bluegill bullies, common bullies and Canterbury galaxias when tested in the stream simulator, however a proportion of shortfin eels penetrated both screens. Eleven elvers (22%) penetrated the 3mm screen ranging in size from 75–85mm, whereas only two elvers (4%) that were 77 and 80mm.

Effectiveness trials for different fish screen materials penetrated the 2mm screen. More shortfin eels penetrated the wedge-wire screens in the higher velocity (0.24 m/s) treatment, although this difference was not statistically significant due to high variability between replicates. No impingements were noted for any species in either velocity treatment although video analysis also suggested that the setup had an appropriate sweep velocity that minimised the risk of impingement as individuals of all species were observed being swept along the screen, rather than being impinged onto it. Shortfin eels and Canterbury galaxias were more active than the bully species in the stream simulator experiments and consequently had the most contacts with the screens and the highest bypass use.

**The New Zealand Fish Screen Working Group is a subgroup of the Canterbury Water Management Strategy and consists of representatives from the following:*

- *Environment Canterbury*
- *IrrigationNZ*
- *Fish and Game*
- *Service Industry*
- *Department of Conservation*
- *Salmon Anglers Association*
- *NIWA*
- *Otago Regional Council*
- *Irrigation Schemes*
- *Ngāi Tahu.*

Shortfin eels would weave their bodies through the 3mm wedge-wire as a spot to rest or to utilise as cover in the flume experiments. *(Photo: NIWA)*

Based on the results of the flume experiments it was concluded that:

- rock-bund screens should be effective at excluding salmonids, provided preferential flow paths through screens are not available;
- rock-bund screens are an ineffective fish screen for several native fish species tested, particularly bluegill bully, shortfin eel and Canterbury galaxias. Note, the species tested were anticipated to be representative of wider groups of fish, for example, results for shortfin eels should be highly applicable to longfin eels. Canterbury galaxias results should be applicable to other flathead and roundhead Galaxias species. It is acknowledged that rock-bund screens could become a screen for larger adult eels above a certain body length although the length at which a rock-bund becomes a screen will be relative to the size of rock used;
- woven-wire screens, when new, are likely to be a relatively effective screening material but because aperture size can change over time (i.e., within an irrigation season), there is concern about the potential for variable effectiveness with this screening material;
- with the potential exception of shortfin eels, wedge-wire was the most effective screening material and it had a number of advantages over woven-wire mesh as a screening material..

This summary is limited to the flume experiments. The Year 1 refinement experiments are not summarised because further testing in the stream simulator during Year 2 will result in a 'package' of recommendations from these experiments. Thus, all recommendations relating to the refinement experiments will be included in the Year 2 report scheduled for release in July 2021.

World-class fish screens for Canterbury

One of the world's largest irrigation fish exclusion screen solutions of its type will be operational in Mid-Canterbury early next year.

Rangitata Diversion Race Management Ltd (RDRML) has consent to divert water from the Rangitata River into the 67km long canal system, to be used for irrigation, stock water and hydropower generation. The scheme has been in operation for over 75 years however previous attempts to prevent fish from entering the scheme have proved unsuccessful and a new initiative is underway to provide better protection for the iconic river's sport and native fisheries.

A $17.2 million project is currently underway to design and construct a new fish-friendly screen solution to ensure native and sporting fish are prevented from entering the canal system and returned safely to the river system. The new facility is expected to be commissioned in May 2022.

Tony McCormick, RDRML's CEO, stated "It is great to be installing a facility that we have confidence will perform as intended and to know that confidence is shared by the many stakeholders representing the interests in the Rangitata River. We are committed to minimising any adverse impacts of our operation on the river and we're proud that this project is a bold demonstration of that commitment".

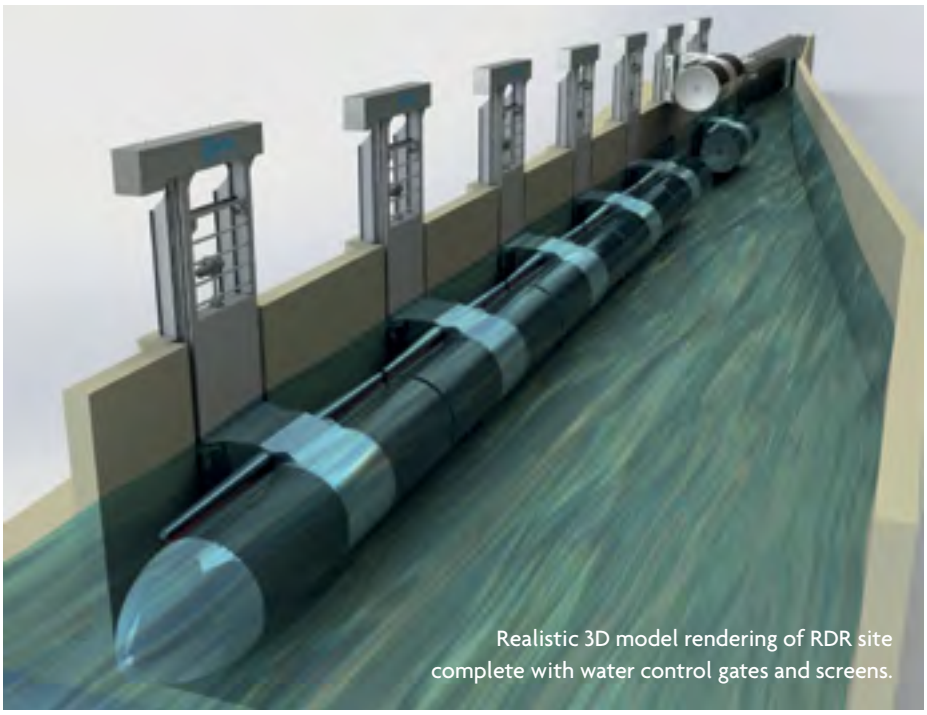
Internationally experienced, Australian-based company, AWMA Water Control Solutions were tasked the design and construct contract for the facility's water control gates and screens.

An Early Contractor Involvement (ECI) process was adopted by RDRML to develop the solution with AWMA over a number of years. When there is minimal precedent and when sites are unique, the early involvement of the screen designer and manufacturer is essential to develop sustainable, bespoke solutions.

Mr McCormick made comment that "AWMA have been part of our project from a very early stage and have contributed tremendously as we have endeavoured to design a facility of a scale unprecedented in New Zealand. We have been very impressed and appreciative of the support from AWMA and their contribution to the

AWMA in-house factory acceptance testing of fish exclusion screen, retrieval system and isolation gate as part of the quality management system, required prior to dispatch.

"It is great to be installing a facility that we have confidence will perform as intended and to know that confidence is shared by the many stake-holders representing the interests in the Rangitata River."



Realistic 3D model rendering of RDR site complete with water control gates and screens.

design development, to ensure that the facility we build represents the very best technology and knowledge available to help protect the river environment and maintain our valuable contribution to the local region. AWMA have already delivered the first two T-screens on time and are well into the manufacturing programme for the remaining screens to be delivered progressively through 2021."

Due to the volume of water carried in the RDR canal and the specifications vital to meet best practice fish screening guidelines, a custom design and construct solution was required.

The site's large flows exceed 33m^3/s. This requires seven AWMA Cylindrical T-Screens as well as 30m of flat screens. The T-Screens are 2.1m in diameter, 8m in length and weigh 6 tonne each. Combined with the flat screen, the AWMA infrastructure provides 374m^2 of screening surface over a stretch of nearly 100m, weighing in excess of 100 tonne.

All components were manufactured from stainless steel to ensure strength, durability and longevity. Stainless steel wedge wire with 2mm slot width is utilised as the screen medium as it poses the least risk to aquatic life, with the strength to withstand debris.

The three most critical design features required for successfully operating fish exclusion screens are: aperture size, approach velocity, and self-cleaning functionality.

1. **Aperture size:** Wedge Wire 'screen mesh' is available in a variety of slot sizes. The aperture size required for any particular site is based on the aquatic life present (in order to screen all stages of aquatic life cycles) and will be dictated by local specification. RDRML's resource consent specifies a 2mm maximum slot width which will exclude the native and sport fish species present.
2. **Approach velocity:** The velocity of water passing, through the screen must be as low as practicable. It must also be very evenly spread across the entire screen area. This prevents the entrainment and impingement of both fish and debris onto the screen surface. Low approach velocities also reduce head loss. RDRML's resource consent requires an average approach velocity of less than 0.12 m/s.
3. **Self-cleaning functionality:** It is imperative fish and debris screens are self-cleaning to ensure safe and efficient operation and fish protection, without compromising flow. Additionally, when a diversion is pumped, a sustainably clean screen improves pump efficiency reducing energy consumption. All the screens on the RDR facility have been designed with automated, self-cleaning systems.

A fish exclusion screen cannot be passive (not cleaned), nor can it be a manual process if it is to conform to relevant guidelines. It must be an automated process to ensure the screen stays clean and the designed approach velocities are conforming at all times regardless of regular maintenance or attendance to site.

A well-designed fish exclusion screen typically requires very low duty cycles for screen cleaning, often only once a day for a few minutes. This does depend on the screen cleaning type and the operating environment. A low cleaning duty cycle will reduce fish exclusion screen maintenance and whole-of-life costs.

Cleaning of the screen should be considered when the diversion is in and out of use. Long periods of stagnation can still see the screen being blocked by algae and other contaminates making start up difficult. A maintenance regime should be employed in an off-season or during prolonged times of non-use. This will typically be the same cycle but less regular. Keeping screens clean not only protects aquatic life it also ensures efficient, high quality water delivery and pump efficiency, therefore reduced maintenance of infrastructure and lower energy costs.

These design principles apply to self-cleaning fish exclusion screens of all sizes.

Screen inspection and maintenance is an important part of ensuring sustainable fish protection and compliance with consent conditions. The RDR screen system includes a retrieval system for each screen. This allows the orifice to be isolated using a control gate and the screen to be raised above the water line using an electric winch and rail system. Once raised the screen can be safely and easily accessed for inspection and maintenance if required.

There are a number of different retrieval systems available to suit various installation configurations.

An effective fish exclusion screen will require very little maintenance and have a low whole-of-life cost.

AWMA's range of fish and debris exclusion screens typically accommodate flows from 35L/s to 35,000L/s. This range is suitable for all water control applications including municipal raw water intakes, irrigation pumps, gravity diversions and hydropower intakes.

SELF-CLEANING FISH & DEBRIS EXCLUSION SCREENS

- FLOW CAPACITY; typically ranging from 35L/s to 35,000L/s
- SELF-CLEANING FUNCTIONALITY; low cost self-propelled or powered operation
- DUAL BRUSH SYSTEM; with internal and external cleaning mechanisms
- LOW VELOCITY DESIGN; ensures debris and fish are not impinged or entrained through the screen
- STAINLESS STEEL WEDGE WIRE SCREEN; manufactured for strength and longevity
- CUSTOM OR STANDARD DESIGNS; designed to suit flow, configuration and environment
- OPTIONAL RETRIEVAL SYSTEMS; various customised screen retrieval systems available for ease of maintenance and inspection

COMPLIANT WITH NEW ZEALAND'S FISH SCREENING GUIDELINES

AWMA specialise in the design and manufacture of water control infrastructure including Penstocks, Stopboards, Flood Barriers and Screens.

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Joining the dots between irrigation science and application

Can soil moisture and weather forecast data be delivered to irrigating dairy farmers in a way that supports water use decision making, that is both economically sound and environmentally responsible? The Irrigation Insight programme aims to find out, by supporting farmers to move towards informed irrigation decision making that considers both current supply and future demand.

The Irrigation Insight programme began in 2016 – focusing on developing the knowledge and tools needed to give dairy farmers the confidence to better manage their irrigation practice, precisely applying the water needed, when, where and how much. It is a joint industry-CRI programme, funded by the Ministry of Business Innovation and Employment and led by NIWA, in collaboration with IrrigationNZ, DairyNZ, Fonterra and AgResearch.

Programme lead and NIWA Principal Scientist of Catchment Hydrology Dr MS Srinivasan said the programme team never attempted to tell farmers when to irrigate. "Our challenge was to discover what information farmers needed and how it should be presented to them, for better on-farm water use decisions."

"The Irrigation Insight team has worked hard throughout the project to deliver information to farmers that is decision-ready."

NIWA Principal Scientist of Environmental Monitoring Graham Elley has been working with water resources from hydro power, water energy monitoring, irrigation and more for over 40 years.

"Over my time working here there has been significant changes in the way water is monitored and used," he said. The pair wanted to create a way that state-of-the-art NIWA weather forecasting technology could be combined with evolving sources of on-farm data and used by farmers to make better irrigation decisions.

"We want to help people be confident in their decisions rather than thinking it's near enough; to create a business support tool so people could use water in a way that was right for the farm business, the community and for Mother Nature," Mr Elley said.

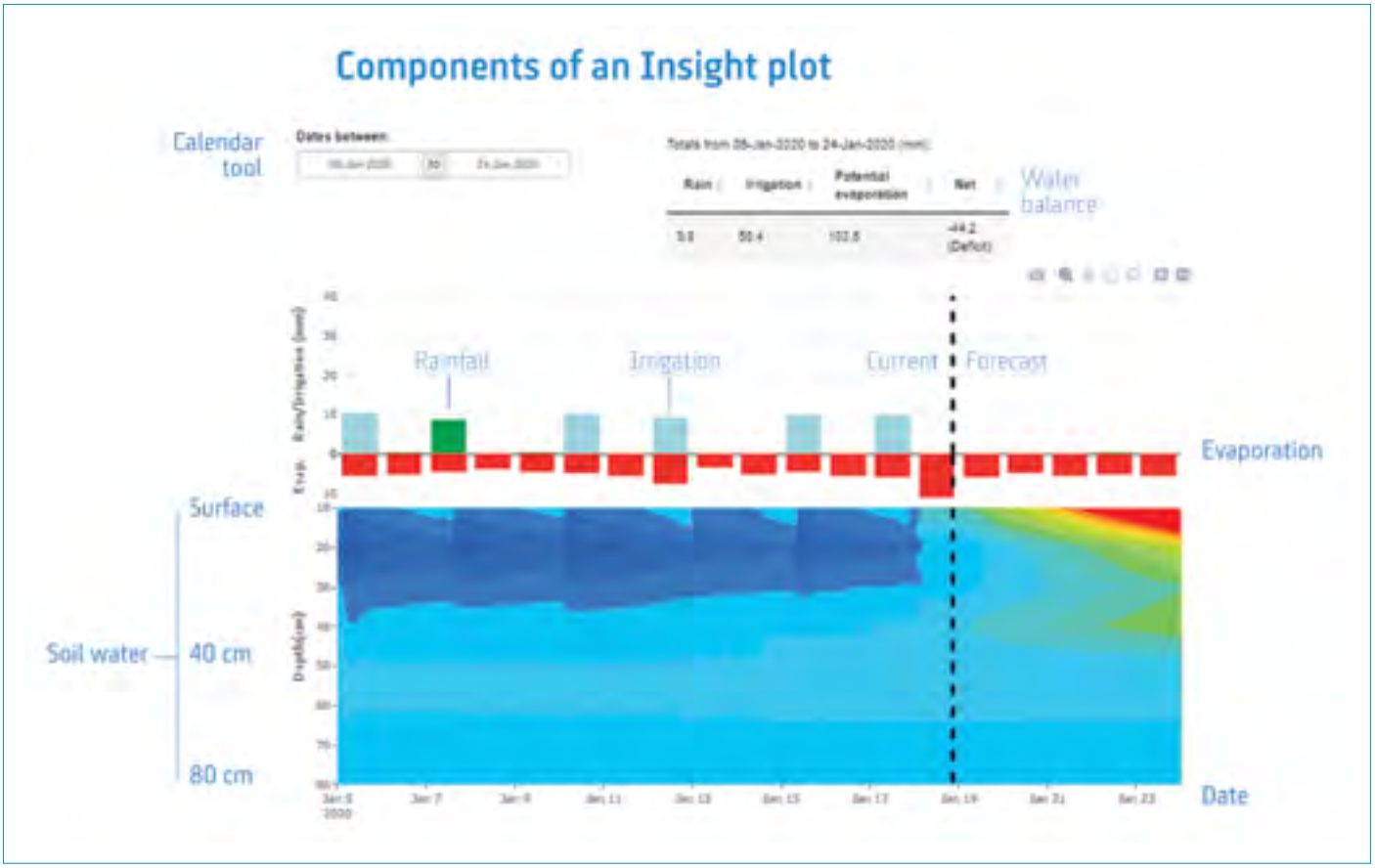
MS Srinivasan.

Graham Elley.

What has been created with the help of a range of industry experts and farmers, includes a user-friendly interactive irrigation support dashboard.

The Irrigation Insight project team identi-

Graham Elley with Bruce Baggot, one of the farmers involved with the pilot study.



The Insight plot: found within the Irrimate tool the Insight plot is helping farmers visually understand how water is moving through the grass root zone and what the consequences are of their irrigation decisions.

fied Canterbury as a focus area and got a group of 11 irrigated dairy farms from the Cust area to join the programme in late 2016. Dr Srinivasan said this farmer involvement was crucial in helping to define the gaps in current knowledge and to scope the required irrigation support tools.

The Irrimate dashboard developed by the programme, provides a farm-specific water balance model that informs farmers and growers of current irrigation status and demand and about future water supplies.

It utilises NIWA's state-of-the-art weather prediction systems including forecasts from a high resolution global model, which can accurately describe the evolution of weather systems that affect New Zealand, and a high-resolution terrain resolving weather model to ensure the estimates of rainfall, temperature and wind are as precise as possible, even in complex terrain. These place-specific forecasts include estimates of the reliability of the predictions and are bias-corrected using locally collected weather data.

To provide local data a chosen irrigated paddock on each farm had a soil moisture sensor and rain gauge installed. Data from these instruments is telemetered in near-real time and combined with up-to-date high-resolution weather forecasts to present a snap-shot of past, current and future soil moisture demands and forecast rainfall and evaporation. This is presented to the farmer within the newly developed Insight plot – a new way to interact with data, support decision making and review what those decisions mean to the farm business.

To increase farmers understanding of the potential benefits of efficient irrigation management the Irrigation Insight programme added an economics component that uses modelled and actual on-farm data to easily understand the economic impacts of differing irrigation management choices.

"Farmers are business owners," said Dr Srinivasan. "By including economics derived from their own farm data we are talking to them in their language and demonstrating the impacts of decisions in a way that can be easily understood."

Interviews and workshops with farmers and other relevant stakeholders also ensured understanding of real-life application.

"We never would've got to this point without the valuable contributions, feedback and innovation from our pilot farmers and the wider stakeholder group," said Mr Srinivasan.

One of the pilot farms with 222 hectares effective and 860 peak cows with a mix of heavy and light soils had the same irrigator going over two different types of soil. With the new information provided by the Irrigation Insight programme they found a water balance approach of just accounting for metered water at the irrigator would not capture the differences between the soil types.

The Insight soil moisture plot showed the difference in soil moisture response to irrigation or rainfall between the light and heavy soils. They have now programmed the irrigator to adjust the application rate for each soil type.

Mr Elley and Dr Srinivasan agreed that one of the biggest challenges had been the *Mycoplasma Bovis* outbreak in 2017.

"The outbreak meant it was a lot harder to get onto farms, and farmers, especially dairy farmers, had a lot of added stress," Dr Srinivasan said.

"Working through these issues allowed us to bring on a new research partner, Livestock Improvement Corporation (LIC). By using their SPACE™, pastures from space service, we were able to give farmers additional pasture growth information while removing the risks associated with team members moving between farms while completing manual plate meter-based pasture walks.

The Irrigation Insight project is ending in September 2021 with the last annual farmers meeting being held in Canterbury mid-2021.

Mr Elley wants to see the programme's knowledge and tools used more by farmers around the country. Although they had focused on dairy-based systems, he said many elements could be used in a range of irrigation systems.

"We are looking at all opportunities to commercialise this – it would be great to see it used more and more for years to come."

IRRIGATION*Insight*

ECONOMICALLY SOUND & ENVIRONMENTALLY RESPONSIBLE

The Irrigation Insight programme is examining the ease and effectiveness of using improved weather forecasting and soil moisture measurements for on-farm water management.

Find out more about the project and how the pilot farmers are using the tools and knowledge developed at: **irrigationinsight.co.nz**

"I thought all I'd ever get out of this was a weather station, but it has developed into all these tools and has been just amazing"

Julie Bradshaw

"I can't thank you enough for having me in this project. The amount it has, and is, helping me with what I do day to day is huge"

Ben Abernethy

"It gives us confidence in the decisions we are making"

Stuart Bailey

NIWA Taihoro Nukurangi | DairyNZ | Fonterra | IRRIGATION NEW ZEALAND |

Research Partner LIC

Avoid lost productivity when you 'Point, Park, and Anchor'

Advice from FMG, IrrigationNZ's Risk Partner.

The impacts of high winds and storms are well known to New Zealand's farmers and growers. While the winds or the storm may pass and insurance claims are paid, it's never under-estimated the on-going impacts they can have, not to mention loss of productive time.

Less than six months ago (September 2020) a windstorm hit Culverden in North Canterbury, said FMG's Manager Advice Services, Stephen Cantwell.

"This storm resulted in damage to 25 irrigators and FMG settled over $1.5 million in claims from that one event. Although over $1.5 million is the cost to the Mutual, the loss of production and farmers' time diverted to resolve the issue would far exceed that."

Mr Cantwell in many of those cases the damage was caused either by the wind tipping them over or causing branches and trees to fall on the irrigators.

"It's a reminder to farmers with irrigators the real benefit that can come from the 'Point, Park and Anchor' advice.

"Most of the irrigators that tipped over weren't pointed into the wind. This reiterates the importance of 'Point, Park, and Anchor' but also the need to have a plan so that when high winds are forecast, owners and their staff know exactly what to do. Also, parking irrigators up against hedges in windstorms does put the irrigator at risk of having trees or branches falling on the irrigator."

"The 2013 Canterbury windstorms may seem like a distant memory, but these recent windstorms serve as a reminder of the risk that wind has on irrigators," said Mr Cantwell.

1. POINT
Pointing your irrigator either into or away from the wind (if possible) remains an effective way to reduce damage to your irrigator in high winds.

2. PARK
Once it's pointing into the prevailing wind, park it there until the winds dissipate.

3. ANCHOR
Look at the guide to find advice on how to anchor your irrigator effectively.

Head to www.fmg.co.nz/advice/irrigators for more information, including access to the free Irrigator Guide to help protect your irrigators.

Make sure you protect your irrigators from being harmed by high winds.

Fertigation project assistant Tommy Ley, at the plot sight at Lincoln University where he has been examining the difference in growth patterns in response to liquid and solid fertiliser.

Gauging a clearer understanding of fertigation

Driven by a passion of wanting to continue to swim in New Zealand rivers, Tommy Ley has been investigating what impact fertigation could have on New Zealand farming systems as part of the IrrigationNZ Fertigation Project.

Fertigation is a way of applying liquid fertiliser in small quantities through irrigation systems at the same time as water. In 2019 IrrigationNZ entered into a two year Sustainable Farming Fund project with the Ministry of Primary Industries with the aim of the project being able to provide answers to the following questions: What is the efficacy of fertilisers applied through fertigation techniques? What are the environmental benefits from the adoption of fertigation? What are the equipment options for fertigation and to which irrigation system types are they best suited? The Fertigation Project was also supported by Fertigation Systems, Pamu Farms and Ballance Agri-Nutrients.

Mr Ley joined the Fertigation Project in 2019 as part of his thesis looking at how fertigation could increase nitrogen efficiency in New Zealand dairy pastures.

"I wanted to understand a functional way we could help alleviate nitrate pressures on waterways. Fertigation has been adopted and researched around the world but not specifically in New Zealand on pasture-based systems, I hope my research can represent something for New Zealand farming systems."

Mr Ley is not shy of study, having completed his Bachelor of Agriculture Science with Honours completing it in 2017, with the honours' dissertation on Caucasian clover rhizobia in high country soils.

In 2018 he worked on a vegetable seed farm before returning to complete his master's degree and securing the role as part of the Fertigation Project.

"I wanted to do some practical learning that could help the future of farming in New Zealand, for both people and the natural environment."

From 2019 until June 2020 Mr Ley completed a number of trials – all going towards his thesis – which compared liquid fertiliser to solid fertiliser with controls.

The initial phase was two experiments.

Experiment one was four treatments. Firstly solid nitrogen was used with immediate irrigation after application, secondly nitrogen dissolved in water (fertigation) applied through watering and irrigated immediately afterwards, thirdly, solid fertiliser with a two-day delay in irrigation after nitrogen application to simulate the maximum amount of time it takes for a centre pivot irrigator to complete its circuit and lastly a no applied nitrogen control.

Experiment two saw three treatments; firstly, no nitrogen control, secondly nitrogen dissolved in water and applied once per week (four even applications totalling 25kgN/ha/month) and lastly nitrogen dissolved in water and applied once per month (25kgN/ha/month).

The total fertiliser used at each of the nitrogen treatments plots per month was 25kgN/ha.

Each of the treatments had six reps and was repeated over two field sites.

"It's very exciting doing independent research, whether the results are what you expect or not it's still exciting. It's been good for my time management skills to be reliant on my own processes and research. Science is very interesting and it's exciting to be the one out there doing it."

Mr Ley was currently working on the year one trial report which was soon to be published. Keep an eye out for this on the

IrrigationNZ website: www.irrigationz.co.nz.

Mr Ley said that while there were similar findings between the two forms of fertiliser, he saw some benefits of using fertigation.

"The important part of it applied as a liquid is that it can be applied in smaller quantities more frequently as opposed to all at once. This means that in the case of a significant rain event only a small amount of fertiliser will be lost through leaching as opposed to a large amount. The smaller quantity of nitrogen fertiliser applied also means that it doesn't exceed plant maximum uptake at the time of application, lessening nitrogen losses."

He said he believed fertigation was a better management tool for precision agriculture on New Zealand farms in the future.

"You don't get the same soil compaction to having a fert truck driving over your property, you know exactly where your fertiliser is going as there is less margin for error and you have more flexibility to adjust to weather events."

The project began in October 2019 and will end in May 2021.

For this round of trials there would again be two experiments. However, experiment one would have five treatments; firstly solid with delayed irrigation, secondly, dissolved urea with immediate irrigation, thirdly, dissolved nitrogen for the first and last two months of the trial (four months total), fourthly, solid nitrogen with delayed irrigation for the first and lastly last two months of the trial (four months total). No nitrogen control.

Nitrogen only applied at a rate of 24kgN/ha to meet new 190kgN/ha limitation.

"The idea with the shoulder season application is to give the pasture a boost at the start and end of the season while letting the clover supply the nitrogen during the middle of the season."

Experiment two with four treatments, all as fertigation 24kgN/ha, 20kgN/ha and 16kgN/ha.

"Essentially it's to see what rate production drops off at so we can apply the lowest nitrogen rate for maximum production," Mr Ley said.

"I am looking forward to what the next lot of trials show."

Tommy applies urea dissolved in water to one of the field plots.

Climate change: the need for more efficient production

By Susan Kilsby, ANZ Rural Economist.

Climate change is resulting in hotter temperatures and more frequent extreme weather events. This will change where we can grow crops and how we farm, providing both opportunities and challenges along the way. Two key ingredients required to grow virtually anything are warmth and moisture. As temperatures get hotter, plants that thrive in hot temperatures will be able to be grown further south, providing there is sufficient water available.

Climate change will also bring more frequent extreme weather events – including droughts. This will increase the need for irrigation but at the same time potentially decrease the quantity of water available. Investment in water storage, and ways to apply water more efficiently, are paramount if we want to increase the return from our natural assets whilst also operating in a more sustainable manner.

New Zealand is not currently on track to meet its climate change obligations, but the latest report from the Climate Change Commission (CCC) outlines a path to get us there. To achieve our objective of limiting warming to 1.5 degrees major changes are required across several sectors.

Aside from reducing emissions, for our primary sectors to be sustainable we also need to increase returns being generated – partially to offset the costs of emissions. To do this we need to either increase the value of our produce or become more efficient. Efficiency measures have traditionally been associated with financial returns, such as reducing the cost of production. Looking forward, efficiency measures also need to consider the impact on the environment, such as methane emissions per unit of meat or milk produced.

If all long-term environmental costs were priced in, it would be easier to compare the value of different land uses. Agriculture is schemed to join the Emissions Trading Scheme in 2025, at which time the sector will be required to pay five percent of its emission costs.

Significant productivity gains from livestock will be required to reduce methane gas emissions whilst also maintaining milk and meat outputs.

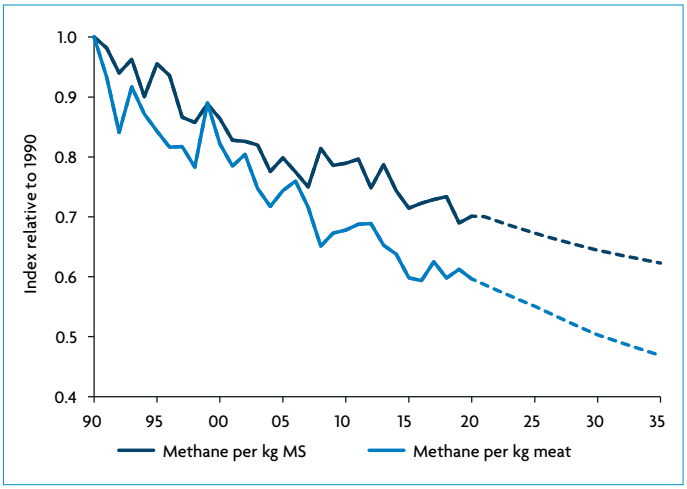


Figure 1: Changes in emissions relative to production. *(Source: Climate Commission)*

The latest report from the Climate Change Commission calculates a 15 percent reduction in the number of sheep and cattle farmed by 2030 (from 2018 numbers), along with reduced emissions from other sectors, is needed to get us on track to meet our climate change objectives. That equates to about 950,000 fewer dairy cattle (including young stock), 560,000 fewer beef cattle and about four million fewer sheep.

The CCC believes it is possible for output of meat and milk to be maintained with less land dedicated to livestock production and lower stocking rates.

Both the dairy and the sheep and beef industries have made significant productivity gains in the past 20–30 years and it has been assumed productivity gains will continue at a similar rate in the future (Figure 1).

The latest provisional livestock numbers show that the past decade sheep numbers have already fallen 20 percent. The quantity of meat produced per animal has virtually doubled in the past 30 years while methane output per kg of meat produced has decreased by 40 percent.

The productivity gains in the dairy sector have been a little lower but have also been substantial. Milk output per cow has increased by 66 percent and methane emissions per kg milksolid (MS) have fallen by 30 percent. As this data indicates, the relationship between livestock numbers and emissions is not linear. It is also impacted by the quantity, quality and type of feeds used.

Whether or not these productivity and efficiency gains can continue to be achieved at a similar rate to history is debatable, as we may hit some practical limits. Productivity gains are attained through a combination of improved genetics, feed quality and quantity, and farm management practices. There is also a linkage between the quantity of feed consumed and emissions. Therefore, if fewer animals consume the same quantity (and quality) of pasture previously fed to a larger number of animals there may in fact be little change in emissions.

However, we already know there is a wide range in emission efficiency levels driven by genetic differences, the type of feed being used, and management practices. So, a large part of the challenge is figuring out exactly what can be changed on farm to reduce emissions whilst limiting any negative impact on production.

The path proposed by the CCC, which assumes a 15 percent reduction in livestock, is expected to be sufficient to achieve the lower end of the 24–47 percent reduction in biogenic methane emissions budgeted for. Other scientific solutions, or a greater reduction in stocking rates, would be required if we want to get near the upper end of the forecast range.

While scientific solutions are being rapidly developed, and some of these solutions are looking promising, they are unlikely to deliver the changes required in the shorter term. There are some exciting developments in terms of feed types and feed additives which may provide some shorter-term solutions, but these are still either being proven or not yet available at scale.

On the other hand, productivity gains are a tangible solution that can deliver lower emissions and have the potential to deliver improved economic returns. Productivity gain is all about producing more from

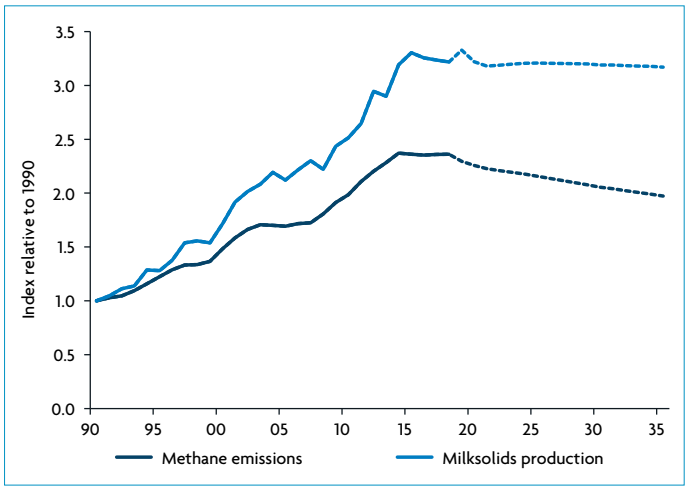


Figure 2a: Methane emissions vs production – Dairy.
(Source: Climate Commission, ANZ Research)

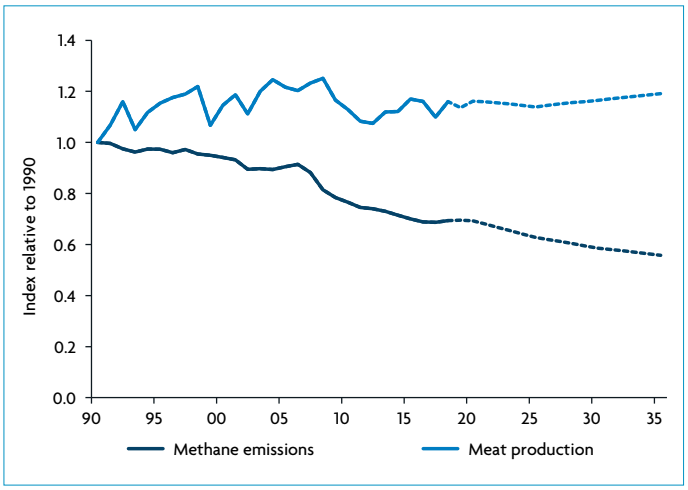


Figure 2b: Methane emissions vs production – Sheep and Beef.
(Source: Climate Commission, ANZ Research)

less. In terms of meat production this can be achieved by increased lambing/calving percentages, growing animals more quickly, and/or killing them at heavier weights. In terms of dairy production, important metrics include MS per cow, feed conversion ratios, and timing of culling.

In simple terms it is about having sufficient quality feed of the right type on hand so that we can feed our animals better. Now that is much easier said than done! Particularly when the weather does not deliver the conditions required for optimal pasture production.

Further investment in irrigation infrastructure and water storage will therefore be a key part of the solution for both improving emission efficiencies and mitigating the risk of hotter temperatures and drier soils negatively impacting primary sector production. Irrigation will also be key to achieving higher returns from either improving outputs (for the likes of milk and meat), or changing to more intensive land uses such as horticulture.

The CCC's forecast path includes 2,000 hectares of dairy land being converted to horticultural use per year from 2025. This would see the area used for dairy reduced back to 2012 levels by 2035 – so not a massive change. Higher-value land uses tend to need access to water at specific times of the season and this water often needs to be applied in a precise manner. Horticultural investments tend to be more intensive and can generate high returns from relatively small areas of land. However, they also have higher cost structures and often carry more risk in terms of production, storage and market risks than pasture-based farming systems.

Access to reliable water is one of the major factors that determine whether a horticultural operation will be viable. Water is increasingly become a limiting factor in the expansion of many of our successful horticultural operations. Some areas of land are not able to access water due to the region already being over allocated, whilst in other areas the cost of accessing water is prohibitive or there simply is not sufficient security of future supply to warrant investment in an orchard.

Rising temperatures, increased climate volatility (including more droughts), changing land uses to more intensive uses, and increasing productivity gains all indicate demand more investment is needed in water storage and the water we do have will need to be used more efficiently in the future.

Senninger: improving irrigation efficiency

ABOUT SENNINGER

As a member of the Hunter Industries family of companies, Senninger Irrigation is a leading designer and manufacturer of quality irrigation solutions for agricultural, horticultural, and industrial applications. With over 58 years of experience in more than 50 countries worldwide, Senninger is one of the most trusted names in the irrigation industry.

Products are manufactured in the USA, ensuring the highest quality standards are adhered to. Products undergo repeated, rigorous testing in the field and in our facilities before they make it to shelves. These testing procedures and attention to detail mean that our customers can count on the consistency and quality they demand of all our products.

IMPROVING IRRIGATION EFFICIENCY WITH LOW-PRESSURE WOBBLER® SPRINKLERS

Some of the water systems that prove most beneficial worldwide are those with low-pressure sprinklers and pressure regulators. They provide significant savings in energy and water costs and, in many cases, can improve crop quality and increase yields. These benefits explain why low-pressure irrigation systems have gained popularity among farmers challenged by low water availability, high energy costs, and the growing need to produce more food and fibre.

Senninger Wobbler sprinklers are among the low-pressure sprinklers that irrigators across the globe have used to get the most out of their irrigation systems. Many growers have been changing high-pressure sprinklers to use Senninger heads and pressure regulators and are getting multiple returns.

HOW WOBBLER SPRINKLERS CAN HELP

Wobbler technology has proved to be one of the most effective irrigation solutions for pivot and solid set installations. Senninger Wobbler sprinklers are designed for low pressure operation (10 psi or 0.41 bar), which lowers total pumping costs by reducing horsepower requirements and energy consumption.

Energy savings vary depending on the specific irrigation system, hours of operation, flow, and pressure used. Still, farmers can expect to see energy savings of about 50 percent with the low-pressure Wobbler sprinklers.

Wobbler sprinklers instantly and uniformly cover their entire wetted diameter thanks to a unique off-centre rotary motion of grooved deflectors. This technology helps maintain the integrity of the sprinkler's application pattern against wind-drift and evaporation.

Wobbler sprinklers apply a 360-degree wetted pattern over a larger area to reduce the instantaneous application rate. Their lower application intensity onto the soil helps maintain the soil's infiltration capabilities to minimise soil compaction and runoff.

Senninger's pivot irrigation line includes three Wobbler sprinklers: the i-Wob2, the Xi-Wob, and the Xcel-Wobbler TOP. All three models have similar low pressure, high-performance benefits, but each model is best suited for a different type of installation.

I-WOB®2: THE LATEST IN WOBBLER TECHNOLOGY

The i-Wob2 is the next generation of Senninger Wobbler sprinklers for pivot irrigation. Senninger improved on the i-Wob UP3's design to make the i-Wob2 last longer and capable of better withstanding harsh operating conditions. It comes backed by the longest warranty in the industry – three years on materials, workmanship, and performance.

The i-Wob2 features a shroud that protects its wear surface against the splashing of adjacent sprinklers, grit, and the effects of direct UV. The protective shroud also doubles as a nozzle carrier of two additional UP3 nozzles to allow growers to change their flow as needed.

With four different models that produce multiple droplet sizes and trajectories, the i-Wob2 is designed for use on flexible hose drops and is suitable for virtually any field or situation, including windy conditions, difficult soils, high profile crops, and more.

XI-WOB™

The Xi-Wob is ideal for installing on semi-rigid PE & steel drops due to its counter-balance design and can even be installed on flexible hose drops with a Senninger weight. Growers can tailor the droplet size of the Xi-Wob to the soil's needs by selecting proper deflectors and operating pressures. Like the i-Wob2, it provides low operating pressure and a wide coverage area to reduce application intensity.

XCEL-WOBBLER™ TOP

The Xcel-Wobbler TOP can be mounted along the centre pivot's entire length using nozzles from #6 through #26. It provides a gentle rain-like application over a large area suitable for all soils and various terrains. A sprinkler package with the Xcel-Wobbler UP3 TOP and the 10-psi PSR2 pressure regulator can be more economical than typical top-of-pipe solutions.

Carp taking care

After struggling with unwanted weeds in their irrigation lake a Canterbury farmer introduced grass carp to its water three years ago and hasn't had any trouble with it since.

Paul Wright from Sheffield farms with brother Steven and their father Donald. They have an integrated arable, sheep and beef property of 600 hectares with approximately 540 hectares under irrigation.

Mr Wright has worked on his family property for over 27 years which has had irrigation for 13 years.

"Irrigation is so important to what we do, we would really struggle without it and we are lucky to have our own storage which we can utilise."

Originally the farm sourced its own water for irrigation, and then built their own storage lake. The introduction of Central Plains Water Scheme in 2015 allowed them to become part of the scheme.

However, overtime Mr Wright noticed more and more aquatic weed growing in their irrigation water storage lake.

"It was starting to become an issue, and having the weed in their reduces the water holding capacity … it just didn't sit well with us that we had to spray it, I didn't like the idea of having to spray the water that then goes onto our crops and grazing pasture."

After seeing an ad for Grass Carp in the IrrigationNZ News magazine three years ago, Mr Wright contacted, Gray Jamieson of New Zealand Waterways Restoration, he soon had around 50 grass carp in his lake.

"We had to get consent from the Department of Conservation and of course have a screen so the fish can't re-locate."

"The weed is there but it doesn't get out of control, the great thing about it is we just put them in there then walk away they just do their thing, and we leave them to it … you can see them in the lake, and they have grown to be very big fish."

Mr Wright said they are a very effective tool and if you had a weed problem, he would encourage people to do the same.

"It's something a bit different, but it has worked well for us, ultimately we aren't having to use any chemical or manpower to control it, it's a win win."

WHITE AMUR: GRASS CARP

White Amur, more commonly known as Grass Carp are an herbivorous species of fish which are native to Eastern Asia. The New Zealand Government introduced them to the country in 1969, however following several trials they were not used commercially until 1991. Although they are an introduced species they are classified as a restricted fish not a pest fish, as they cannot breed naturally in New Zealand waterways and had to be bred in special hatcheries. The carp only eat aquatic vegetation, so they pose no risk to other species.

New Zealand Waterways Restoration (NZWR) Ltd managing director Gray Jamieson breeds and sells the carp fish. He said, since 1992 when NZWR started supplying the carp they have been placed in 13 lakes both public and private, 10 water-ski lakes, 90 detention ponds, 20 golf courses and over 300 private waterways. The carp were preferential eaters, Mr Jamieson said, as they didn't like native weeds and preferred to eat exotic pest weeds.

"A huge problem for irrigation dams, ponds and lakes in New Zealand is getting chocked with Canadian Pond Weed, this can result in loss of up to 20 percent storage capacity." The removal of invasive exotic weed species also allows for native species to re-establish.

Mr Jamieson said the carp tended to live for around 15 years, however there were records of some living until 30.

Paul Wright stands in front of their water storage lake in Sheffield, Canterbury. Beneath the surface home to White Amur, Grass Carp.

PRODUCT & SERVICES DIRECTORY

Intensive winter grazing – what are the changes?

Temporary delays to intensive winter grazing rules were announced in March. They were welcomed by some but IrrigationNZ advises it is not an opportunity to disregard the changes, however an opportunity to adapt and improve.

Intensive winter grazing (IWG) is a farming practice where stock are confined to outdoor feeding areas planted with fodder crops.

In announcing the temporary delay to May 1 2022 of IWG rules taking effect, Environment Minister David Parker has recognised there were issues with the workability of the changes.

"The one year deferment will enable an IWG farm plan 'module' to be rapidly developed, tested and deployed ready for formal incorporation into wider certified freshwater farm plans in 2022," Mr Parker said.

IrrigationNZ chief executive, Vanessa Winning, said like many components in the farming and growing environment, correct management was crucial now more than ever, and IWG was an example of that.

If done poorly, IWG can have serious effects on animal welfare and the environment particularly freshwater health and estuaries, however Ms Winning said with effective realistic management it could also be successful.

Although the Government has deferred the introduction of IWG practice regulations for a year until May 2022, preventing the expansion of IWG will still apply.

The Government will work with the farming sector to improve on-the-ground IWG practices for the benefit of freshwater quality and animal welfare.

David Parker and Agriculture Minister Damien O'Connor have always seen the freshwater farm plan regime as the key to achieving improvements in IWG practices.

Damien O'Connor said the direction of travel is known to all involved. "This decision provides certainty of direction and timeframe. We can get on and put farm plans into place as quickly as possible across all farming operations."

"Immediate improvements in IWG practices this season are required, and I have set out my expectations to both councils and industry bodies," Mr Parker said.

"Increased monitoring and reporting by councils will also ensure measurable improvements in IWG by May 2022. This will include quarterly reports to me," Mr Parker said.

Ms Winning said although it allowed farmers more time it wasn't an opportunity to take a step back, but an opportunity to innovate and harness change.

Irrigation is feeding the world

Food grows where water flows

Irrigation is used to grow **40%** of the world's food
on **20%** of the world's agricultural land.

275 million hectares
of land is irrigated worldwide

The irrigated land area in Asia went from 26% in 1970 to **41%** today. Undernourishment in Asia has fallen as irrigated land has expanded

Irrigation has been used for **at least 4,000 years.** Mesopotamia, Egypt, and Mongolia were some the ancient civilizations which used irrigation.

If we didn't use irrigation, the UN estimates we would need **500 million more hectares** of land in order to produce the amount of food we do now.

SOURCE: All data sourced from: Food and Agriculture Organization of the United Nations

Future world population growth

2020	2030	2050
7.8 billion	8.5 billion	9.9 billion

SOURCE: United Nations

To share this picture you can visit Irrigation New Zealand on Facebook and select the photos tab.

Seasonal climate outlook March–May 2021

OUTLOOK SUMMARY

During autumn, New Zealand's climate patterns are expected to become more variable as the impact from a non-traditional central Pacific La Niña starts to ease. Temperatures are most likely to be near average in the north and east of the South Island and east of the North Island and about equally likely to be near average or above average in all other regions. Cool spells are also likely to occur from time to time, such as during the first half of March. Rainfall is about equally likely to be near normal or below normal in the west of the South Island. Near normal rainfall is most likely in all other regions as low-pressure systems become more common in the New Zealand region.

The tropical Southwest Pacific may feature cyclone activity during the first half of March. Should one of these features or their moisture affect New Zealand, heavy rainfall that can cause flooding would be possible for some regions, but it is not possible to predict where it would happen weeks in advance.

Coastal sea surface temperatures (SSTs) ranged from -0.8°C below average to near average during February.

Soil moisture levels are most likely to be below normal in the north of the North Island, near normal in the east of both islands, and about equally likely to be near normal or below normal in all other regions.

River flows are most likely to be below normal in the north of the North Island and west of the South Island, near normal in the east of the South Island, and about equally likely to be near normal or below normal in all other regions.

REGIONAL PREDICTIONS FOR MARCH TO MAY 2021

Probabilities are assigned in three categories: above average, near average, and below average.

Northland, Auckland, Waikato, Bay of Plenty

- Temperatures are about equally likely to be near average (40% chance) or above average (40% chance).
- Rainfall totals are most likely to be near normal (45% chance).
- Abnormally dry conditions are occurring across much of the region according to NIWA's New Zealand Drought Index.
- Soil moisture levels and river flows are most likely to be below normal (45–50% chance).

Central North Island, Taranaki, Whanganui, Manawatu, Wellington

- Temperatures are about equally likely to be near average (40% chance) or above average (40% chance).
- Rainfall totals are most likely to be near normal (45% chance).
- Soil moisture levels and river flows are about equally likely to be near normal (40% chance) or below normal (40% chance).

Gisborne, Hawke's Bay, Wairarapa

- Temperatures are most likely to be near average (45% chance).
- Rainfall totals are most likely to be near normal (45% chance).
- Abnormally dry conditions are occurring across Gisborne, Hawke's Bay, and Wairarapa according to NIWA's New Zealand Drought Index. Meteorological drought is occurring in East Cape.
- Soil moisture levels are most likely to be near normal (45% chance) while river flows are equally likely to be near normal (40% chance) or below normal (40% chance).

Tasman, Nelson, Marlborough, Buller

- Temperatures are most likely to be near average (45% chance).
- Rainfall totals are most likely to be near normal (45% chance).
- Abnormally dry conditions are occurring across Marlborough, Nelson, and western Tasman according to NIWA's New Zealand Drought Index.
- Soil moisture levels and river flows are about equally likely to be near normal (40% chance) or below normal (35% chance).

West Coast, Alps and foothills, inland Otago, Southland

- Temperatures are about equally likely to be near average (40% chance) or above average (35% chance).
- Rainfall totals are about equally likely to be near normal (40% chance) or below normal (35% chance).
- Soil moisture levels are equally likely to be near normal (40% chance) or below normal (40% chance) while river flows are most likely to be below normal (45% chance).

Coastal Canterbury, east Otago

- Temperatures are most likely to be near average (45% chance).
- Rainfall totals are most likely to be near normal (45% chance).
- Abnormally dry conditions are occurring in parts of mid and north Canterbury according to NIWA's New Zealand Drought Index.
- Soil moisture levels and river flows are most likely to be near normal (40% chance).

This is an extract of the Seasonal Climate Outlook published by NIWA.

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