Irrigation Insight

(Justified Irrigation 2016-21)

Economically sound and environmentally responsible irrigation decision-making

Summary

Irrigation Insight (2016-21) is a joint programme (Crown Research Institutes, farmers, water user groups, regulator, industry and extension professionals) funded by the Ministry of Business, Innovation and Employment (MBIE) to examine the ease and effectiveness of using high-resolution weather forecasting, production potential, and drainage estimations for on-farm water management.

A selection of pastoral farmers from the Canterbury region were engaged using a co-learning based participatory approach.

Co-learning revealed an over-lapping yet distinct understanding of the meaning of water use efficiency.

What does justified irrigation mean?

The programme has focused on co-developing knowledge and tools that include all three perspectives on water use efficiency.

Background

Uptake of irrigation management tools among New Zealand pastoral farmers has long been reported as poor, but recent studies suggest it could be improved through inclusive end-user approaches. The Irrigation Insight team aimed to co-develop irrigation decision support tools and knowledge using a participatory approach that would facilitate improved water use efficiency on irrigated pastoral farms.
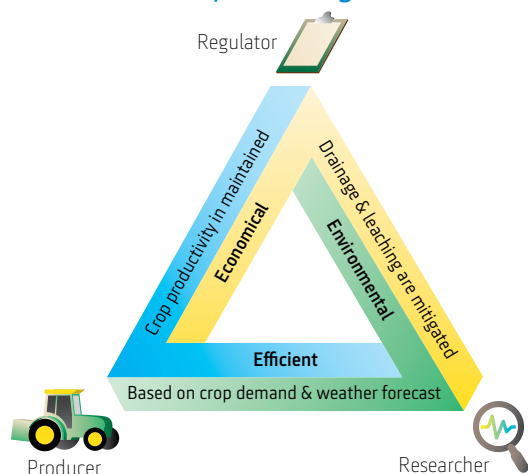
Water is identified as a vital input in MPI's Fit for a Better World initiative, which aspires for an additional $10bn export revenue in the decade. Irrigation accounts for approximately two-thirds of all consumptive water allocated in New Zealand. In 2016-17, production from irrigated agriculture accounted for 2.4% of New Zealand GDP, and this is projected to grow to 3.1% by 2021-22. There is potential to enable a significant improvement in on-farm water use efficiency by applying technology to help users make decisions that are both economically sound and environmentally responsible.

While irrigation is a stand-alone on-farm practice used to maintain soil water conditions for optimal crop growth, it needs to balance several on- and off-farm factors. Every farm and farmer is unique in their capacity and capability in managing irrigation. Optimal water use relies not only on managing the day-to-day operational decisions around when to turn on and off irrigators, but also on having the right irrigation infrastructure for the needs of the farm business and environment, and on having the confidence that a good decision has been made.

The aims of the project were twofold:

- To examine, on working irrigating dairy farms, the ease and effectiveness of using improved weather forecasting and drainage estimations for on-farm water management
- To co-develop knowledge and tools for irrigating pastoral farmers to build their confidence in better managing irrigation water use, precisely applying the water needed – where, when, and how much.
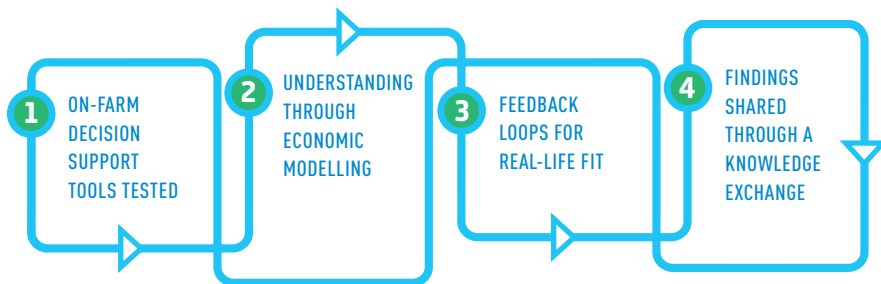
Our programme

The Irrigation Insight programme had four inter-linked components:

1. ON-FARM DECISION SUPPORT TOOLS TESTED
2. UNDERSTANDING THROUGH ECONOMIC MODELLING
3. FEEDBACK LOOPS FOR REAL-LIFE FIT
4. FINDINGS SHARED THROUGH A KNOWLEDGE EXCHANGE

Led by NIWA, in collaboration with DairyNZ, Fonterra, Perrin Ag, AgResearch, IrrigationNZ and LIC, the five-year applied research programme has focused on understanding the environmental, social and economic aspects of irrigation management, working with a collective of stakeholders to understand barriers to changing current practice. It has also quantified the potential economic and environmental benefits of improved water use efficiency from integrating high-resolution weather forecast data with on-farm soil moisture and irrigation measurements.

DIALOGUE, TRUST, LEARNING AND UNDERSTANDING

Take time to understand the problem from multiple perspectives

Apply equal value to all sources of knowledge

Remain flexible and adaptable throughout the engagement process

Provide an atmosphere that fosters learning among stakeholders

Be aware of wider problem
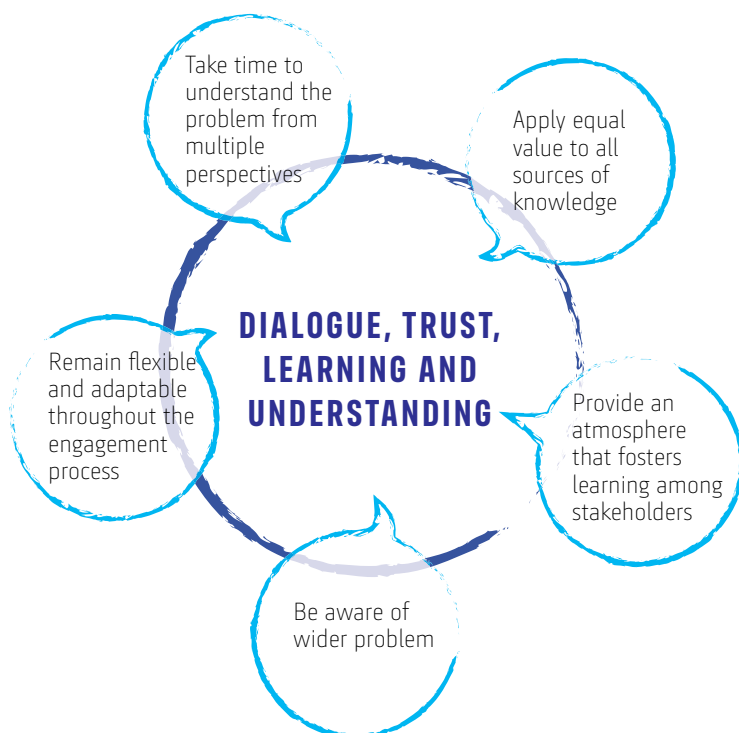
Using these principles opened a space for dialogue that allowed the participants to develop trust, articulate their values, interests and priorities and enhance learning and understanding of others.

Our findings

Perspectives matter

The co-learning process revealed an overlapping and distinct understanding of the meaning of water use efficiency:

- Researchers described water use efficiency as a practice that justifies the application of each irrigation event by considering current crop water demand and forecast rainfall (water supply)

- Regulators and land managers described it as a practice that avoids over irrigation and prevents drainage of excess irrigation water and leaching of nutrients below the root zone

- Farmers described water use efficiency as a practice that mitigates crop water stress and supports productivity.

Tools support data-based decisions

A series of farmer-friendly decision assessment and evaluation tools have been developed that brings together diverse datasets (rainfall, irrigation, solar radiation, relative humidity, wind speed, soil moisture, soil temperature, pasture production, river flow and water use) combined with knowledge of climatic, soil, specific on-farm irrigation practices, irrigation infrastructure, irrigation supply-demand dynamics, and high-resolution weather forecasting.

Behaviour change is sustainable if you easily demonstrate cause and effect

Through the Insight plot visualisation, farmers can review irrigation decisions and see the impact of those decisions on pasture growth, soil moisture and drainage. This allows farmers to see the cause and effect of their decisions and to modify future decisions if required, reviewing based on data and learning through their own experience.

Our tools

The programme developed tools to support on-farm water use decision-making.

What irrigation approach fits my farm?

IrriSET is an irrigation strategy evaluation tool that helps farmers to link soil type, water supply and irrigation infrastructure to match best irrigation infrastructure and scheduling methods now and under changing climate. It is used by farmers, usually in consultation with others such as farm consultants and bankers, to inform business strategy on the possible benefit of enhancements to irrigation scheduling and infrastructure development.

IrriSET provides farmers, banks, industry, and regulators data to understand the effectiveness of current irrigation practices under a changing climate and the level of future proofing that would be needed to enable environmentally sustainable, socially acceptable, and economically sound irrigation practice.

Should I irrigate today?

IrriMate is an operational tool that helps farmers and regulators to easily connect cause to effect (rainfall and irrigation to drainage and to pasture growth). Used daily, in the office and 'on the fly', by farm managers and staff to determine and coordinate efficient on-farm irrigation activity, it is a highly visual story of everything irrigation-related to support daily and near-future decision making.

The Insight plot from IrriMate.
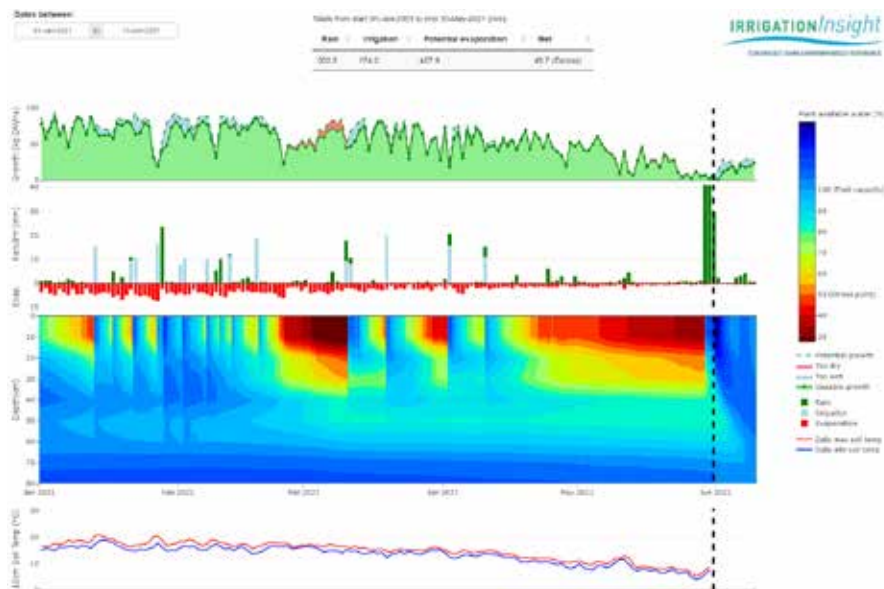
Irrimate includes a new way to visualise measured and forecast soil moisture movement, weather forecasts, and potential pasture growth data – through the Insight plot. This includes current soil moisture demand and forecast weather conditions; near-real time depiction of irrigation, soil water conditions within and below rootzone, signalling the occurrence of drainage; and modelled daily pasture growth linked to available soil water within the root zone.

This visualisation of soil moisture data alongside weather forecast and pasture production has enabled a transformative change in farmer behaviour. It offers farmers a way to understand complex information immediately; it uses real time, localised data and offers a versatility of views to inform and support decision-making. The IrriMate tool also includes long-term records that capture a farmer's irrigation behaviour over time, that can provide compelling evidence for the regulator, demonstrating best irrigation management practices.

Where to from here

The tools are designed to scale up from farm to scheme units, to enable and address water management issues at multiple scales.

For example, by combining on-farm data demand data to scheme level reticulation data, IrriMate can potentially better support the key irrigation objective of irrigating in the right place at the right time, in right amounts. We are working with both individual farms and irrigation schemes to improve their on-farm irrigation practices for the best industry outcome.

The IrriSET strategy tool is supported by MPI funding to further develop into a climate change adaption tool including:

- Extending IrriSET to all irrigated pastoral areas of New Zealand
- Including climate change functionality to the tool to simulate the changes in supply-demand relationship as controlled by climate
- Including a pasture growth model that accounts for daily weather and soil water conditions
- Developing educational and training materials to enable adaptation of IrriSET by a wider stakeholder community.

The programme team

NIWA: Dr MS Srinivasan (Programme Manager), Graham Elley, Dr Paula Blackett, Dr Trevor Carey-Smith, Richard Measures, Alex Fear, Dr Stephen FitzHerbert, Jordan Luttrell

Perrin Ag Consultants: Carla Muller

Independent Evaluator: Toni White

Scotland's Rural College (SRUC) United Kingdom: Dr Sam Beechener

DairyNZ: Mark Neal

IrrigationNZ: Vanessa Winning

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14 pilot irrigating pastoral farmers from Canterbury, Environment Canterbury.

For more information:

Visit **niwa.co.nz/irrigationinsight**

Contact MS Srinivasan
NIWA Principal Scientist – Catchment Hydrology
MS.Srinivasan@niwa.co.nz

Key outputs

Products

IrriMate: An online irrigation-drainage management tool

IrriSET: An online irrigation demand modeling tool under current and climate change conditions

SoilMate: A mobile app to spatially map and forecast soil moisture

Refereed publications

Muller, C., M. Neal, T. Carey-Smith, J. Luttrell, M.S. Srinivasan. 2021. Marginal irrigation decision making in the face of risk and uncertainty. *Australasian Journal of Water Resources*. DOI: 10.1080/13241583.2021.1936907

Srinivasan, M.S., R. Measures, C. Muller, M. Neal, C. Rajanayaka, U. Shankar, G. Elley. 2021. Comparing the water use metrics of just-in-case, just-in-time and justified irrigation strategies using a scenario-based tool. *Agricultural Water Management. 258 (2021) 107221.* https://doi.org/10.1016/j.agwat.2021.107221

Nicholas, G., M.S. Srinivasan, S. Beechener, J. Foote, M. Robson-Williams, S. FitzHerbert. 2020. Transferring the impacts of pilot-scale studies to other scales: Understanding the role of non-biophysical factors using field-based irrigation studies. *Agricultural Water Management* https://doi.org/10.1016/j.agwat.2020.106075

Srinivasan, M.S., G. Elley. 2018. The cycle of trust building, co-learning, capability development and confidence building: Application of a co-innovation approach in a multi-stakeholder project. *Case Study in the Environment* https://doi.org/10.1525/cse.2018.001255

Srinivasan, M. S., D. Bewsell, C. Jongmans, G. Elley. 2017. Just-in-case to justified irrigation: Applying co-innovation principles in an irrigation scheme. *Outlook on Agriculture* doi: 10.1177/0030727017708491

Vereijssen, J., M.S. Srinivasan, S. Dirks, S. Fielke, C. Jongmans, N.M. Agnew, L. Klerkx, J.B. Pinxterhuis, J. Moore, P. Edwards, R. Brazendale, N. Botha, J.A. Turner. 2017. Addressing complex challenges using a co-innovation approach: lessons from five case studies in the New Zealand primary sector. *Outlook on Agriculture* doi: 10.1177/0030727017712321

Webinars

Co-innovation, Co-learning & Water Management. https://youtu.be/xx7XHd5Gc9I

Data to information to impact: Co-learning from end-user engagements. Forest Ecosystem Services Forum: Planted forests, climate change, water and people connections. Scion, NZ https://www.youtube.com/watch?v=y4RIb5NIcpg&feature=youtu.be

NIWA Taihoro Nukurangi

IRRIGATION*Insight*
ECONOMICALLY SOUND & ENVIRONMENTALLY RESPONSIBLE

DairyNZ **Fonterra** **IRRIGATION NEW ZEALAND** **perrin ag** **agresearch** *āta mātai, mātai whetū*

Research partner
LIC