LandWISE
Promoting Sustainable Production

2019

Future Proofing Vegetable Production - Milestone Report 4

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6/17/2019

PAGEBLOOMER
ASSOCIATES LIMITED

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Report prepared for LandWISE Inc by Page Bloomer Associates Ltd

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1. Executive Summary

This report summarises progress made, and deliverables met for Milestone 4, from work done between March 31st and June 14th, 2019.

1.1 Key Deliverables

- **Catchment group and individual farmers supported to build capacity and capability**
  - Overseer nutrient budgets of sample blocks (1 – 12ha) completed for 5 growers, 1 more in progress, another planned.
  - Nutrient budgets discussed and alternative management strategies considered – small scale trials agreed to by 5 growers
  - Nitrogen fertiliser trial at the MicroFarm will investigate efficacy of liquid N fertilisers and split applications for winter-planted Broccoli

- **Field Day for Arawhata growers**
  - TBC
  - Will cover how to soil sample, nitrate test strip demonstration, and determining fertiliser requirements with recommendations from Nutrient Management for Vegetable Cropping in NZ (Reid & Morton, 2019)

- **Workshop in another region**
  - TBC
  - Will be held in Gisborne and assist growers with fertiliser applicator calibration

- **Presentations made at annual LandWISE Conference**
  - Dan Bloomer, Pip McVeagh, and Georgia O'Brien presented on various topics within Future Proofing Vegetable Production.
  - Brandon Goeller (NIWA), Rebecca Eivers (Streamlined Environmental), Brad Bernhard (University of Illinois) Alastair Taylor (Overseer Ltd.) presented on related nitrogen management and mitigation topics.

- **Project team meeting held**
  - Levin: 9th April

2. Introduction

This report has been prepared to communicate progress on the deliverables on Milestone 4 of SFF 405649 "Future Proofing Vegetable Production" (FPVP) – due 30th June 2019. The report covers work undertaken from 31st March 2019 to 15th June 2019 and includes evidence of progress towards but not completion of an Arawhata Field Day and Workshop in one other region (Gisborne) (see Section 4). Evidence of grower support and capability growth can be found in Section 3, conference proceedings relevant to FPVP in section 5, Drainage Nitrate Sampling in Section 6 and meeting minutes from the Project Team Meeting (held on 9th April in Levin) in Section 7.

3. Grower Support and Capability

3.1 Overseer Consultations and Analysis

Growers have been supported and assisted to grow their capabilities through a series of Overseer consultations. In the first round of meetings, growers were asked to provide 2 years' worth of data for one or two particular paddocks (ranging in size from 1 – 12ha each). The consultation involved discussing the area cropped, crop rotations, fertiliser applications, products applied, yield estimates, irrigation and the multiple other detailed factors about their growing system and nutrient management. An example of the document sent to growers to prepare their information is attached in Appendix 1.

Once the input information was gathered, the analysis could be created, and results derived. For most consults, the analysis had to be done at the office, after the initial meeting, as the complex systems were time-consuming to do, and help was sought from the Overseer helpdesk at times. The first consult meetings were extremely useful to better understanding each grower's specific system and constraints, which created meaningful interactions and supported later nutrient management suggestions and discussions. Growers were emailed preliminary results before a follow up meeting.

In the second meeting, the analyses were presented and explained. Overseer entries that were different to those from the initial discussion were explained, and any changes in N or P loss discussed. This session was particularly useful to determining what changes growers were prepared to trial, as the original Overseer analysis was presented alongside some changes in nutrient management practice that would reduce the N loss number. Options included reducing fertiliser rate applied, splitting up applications of N, or removing a pastoral phase. Because prior interactions with growers had established trust and rapport, recommendations for trials were tailored to the individual and most had positive reactions towards trialling these practices. One grower who was reluctant to attempt a reduced rate of fertiliser, could still recognise that in instances where fertiliser had been accidentally applied at a lower rate to a cabbage crop there was anecdotally no effect on yield, and so was willing to trial this example in a measured and objective way.

Most growers were shocked by the initial N loss number from their analyses (ranging from 46 – 170kg N/ha). However, by being a part of the process and given the opportunity to ask questions and query inputs that were incorrectly recorded growers had ownership of their N loss result – and were motivated to do something about it. Throughout the process Page Bloomer staff were honest and transparent about problems with the Overseer model and explained that there are uncertainties in the way it calculates N loss which mean its numbers are not indicative of actual or measurable losses. Despite this, growers were still proactive about taking mitigative steps towards reducing N loss.

Table 1. Diary of Grower Meetings (regarding Overseer).

Date	Grower	Meeting Purpose	Outcome
28/2/19	Chris Pescini	Gather information for Overseer	• Overseer analysis completed in office – number reported to Chris
18/3/19	Jeffery Wong	Gather information for Overseer	• Overseer analysis completed in the office
18/3/19	Travis Sue	Gather information for Overseer	• Overseer analysis completed in office
19/3/19	Chung Su	Gather information for Overseer	• Prelim Overseer analysis completed on the day, • Final version in office
9/4/19	Tony Jung	Gather information for Overseer	• Prelim Overseer analysis completed on the day, • Final version in the office • Considering trial of reduced rate
6/5/19	Jeffery Wong	Confirm Overseer inputs, report/explain results (N leaching loss), and model additional scenario	• Final analysis validated, results presented and explained, • Additional Overseer scenario completed (more farm area represented), • Trial considered
6/5/19	Travis Sue	Confirm Overseer inputs, and report/explain results (N leaching loss)	• Final analysis validated, results presented and discussed, • More information gathered about crop rotations, and fertiliser practices, • Trial considered
7/5/19	Karen Silva (Woodhaven)	Gather information for Overseer	• Overseer analysis completed in the office • Gained more understanding of how complex Woodhaven's growing systems are • Developed ideas for how input structure could change to simplify process
6/5/19	Chris Pescini	Confirm Overseer inputs, and report/explain results (N leaching loss)	• Some inputs changed to better represent growing systems • Reduced rate trial considered • Discussion about side-dressing re: Overseer
15/5/19	Chung Su	Confirm Overseer inputs, and report/explain results (N leaching loss)	• Final analysis validated, results presented and discussed, • Chung wants to record more information to improve the accuracy of future analyses • Discussion about trials they've done before and several LandWISE trials considered
22/6/19	Nick Pollock (Leaderbrand)	Gather information for Overseer	• To be completed at time of writing
TBC	Karen Silva (Woodhaven)	Confirm Overseer inputs, and report/explain results (N leaching loss)	• To be completed at time of writing
TBC	Nick Pollock (Leaderbrand)	Confirm Overseer inputs, and report/explain results (N leaching loss)	• To be completed at time of writing

3.2 Broccoli Trial at the MicroFarm

On the 20th of April 0.11 hectares of Broccoli was planted at the MicroFarm initiating the liquid fertiliser trial that will continue for the next 3 months. The aim of this trial is to test the efficacy of liquid fertiliser products applied to the base of the crop row on yield, as this method has greater suitability to multi-row side-dressing which could improve the uptake of split fertiliser applications by growers.

Figure 1 shows the trial layout, which includes 5 treatments each with 4 replicates. The treatments are described in Table 2.

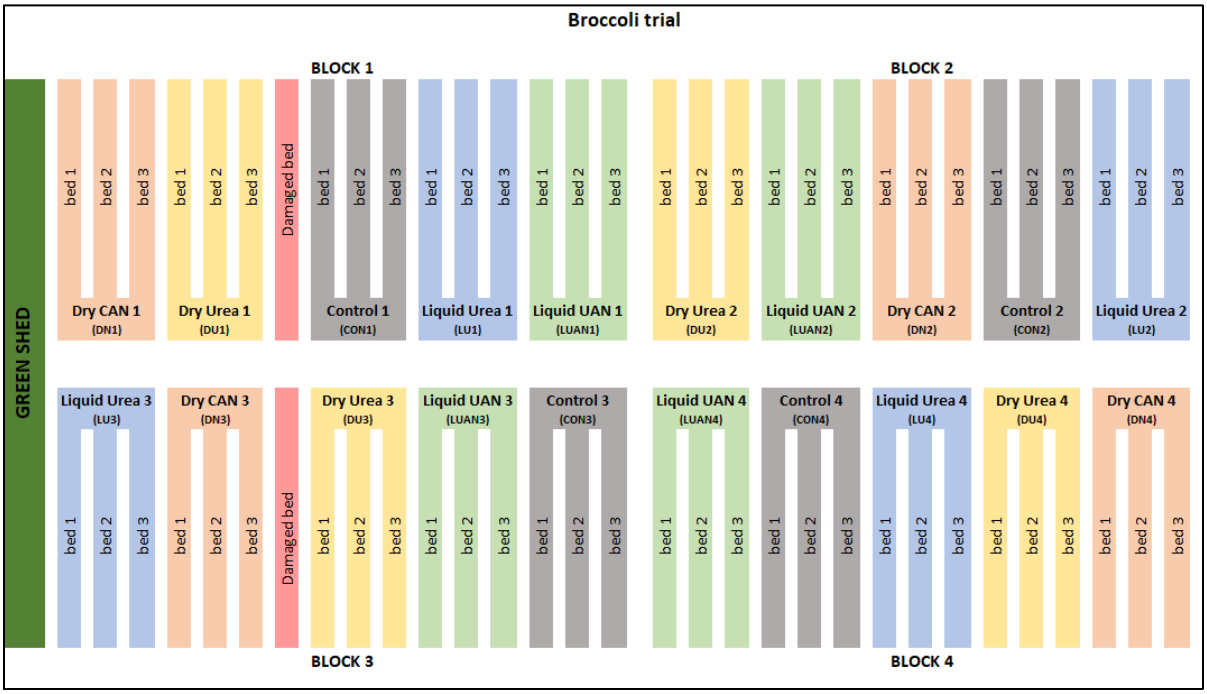


Figure 1. Broccoli Trial Layout at the MicroFarm.

Table 2. Broccoli Fertiliser Trial Treatments.

Treatment	Fertiliser Applied (kg/ha)			Nitrogen Applied (kg/ha)		
	Application 1 5/6/19 – 7 weeks post-transplant	Application 2	Application 3	Application 1 5/6/19 – 7 weeks post-transplant	Application 2	Application 3
Dry CAN	370	0	0	100	0	0
Liquid UAN	123	123	123	33	33	33
Dry Urea	217	0	0	100	0	0
Liquid Urea	72	72	72	33	33	33
Control	0	0	0	0	0	0

The rates for each treatment were informed by soil testing done by Jono Ritchie from Ballance and analysed through wet chemistry at Hill Laboratories, the Nutrient Management Guidelines for Vegetable Crops in New Zealand (2019), as well as standard grower practice. In addition to detailed soil sampling of the trial area (20 cores at two depths (0 – 300mm and 300 – 600mm)) for Mineral-N, the N test strips were used to estimate available soil nitrogen.

0 – 300mm Depth

- Mineral-N (sum of Nitrate-N and Ammonium-N) varied from 12 – 20mg/kg soil based on the samples taken on 27th May and analysed at Hill Laboratories.
- Nitrate-N varied from 35 – 67kg/ha according to the Nitrate test strips measured on the 27th and 28th May.

It is not yet clear if these two test values can be directly compared, however they provide a starting point for available soil nitrogen to observe variation and assess application treatment efficiency.

Each treatment will receive 100kg N/ha with total fertiliser applied varying due to the different N % formulas. Calcium Ammonium Nitrate (CAN) has a 27% N content, and Urea is 46% N (hence more CAN applied to achieve the 100kg N/ha rate).

The Liquid Urea and CAN treatments also receive 100kg N/ha total, however unlike the Dry treatments, they will be spread out over 3 equal rate applications of 33 kg N/ha. The liquid products were mixed at a rate of 12% by weight for Urea, and 20% by weight for CAN – both liquid treatments received 1.2L of water per bed, which is a rate of 614 L/ha (the liquid was applied in a small band dribbled close to the plant row, similar to the dry fertiliser banding).

Figure 2. A closeup of a bed from Dry Urea 2 (DU2) in the broccoli trial at the MicroFarm after fertiliser was applied.

When the trial is harvested, there will be an objective (weight, head size) and subjective (blind grower grading) yield assessment to determine how the fertiliser treatments have affected growth. The intent is to provide growers with independent information with which to make informed decisions about liquid products, and their role in reducing large upfront applications of fertiliser which are at a greater risk of leaching.

3.3 Drainage Water Nitrate Monitoring

In conjunction with Horizons Regional Council and Levin growers we have set up a system to monitor nitrate levels in drainage through the Arawhata Catchment. Horizons is to undertake two State of Environment water quality test runs, one at high flow and one at low flow. Growers will monitor nitrate levels using sensitive test strips (10 x the sensitivity of the soil test strips) after rain events.

The proposed sites are shown in Figure 4:

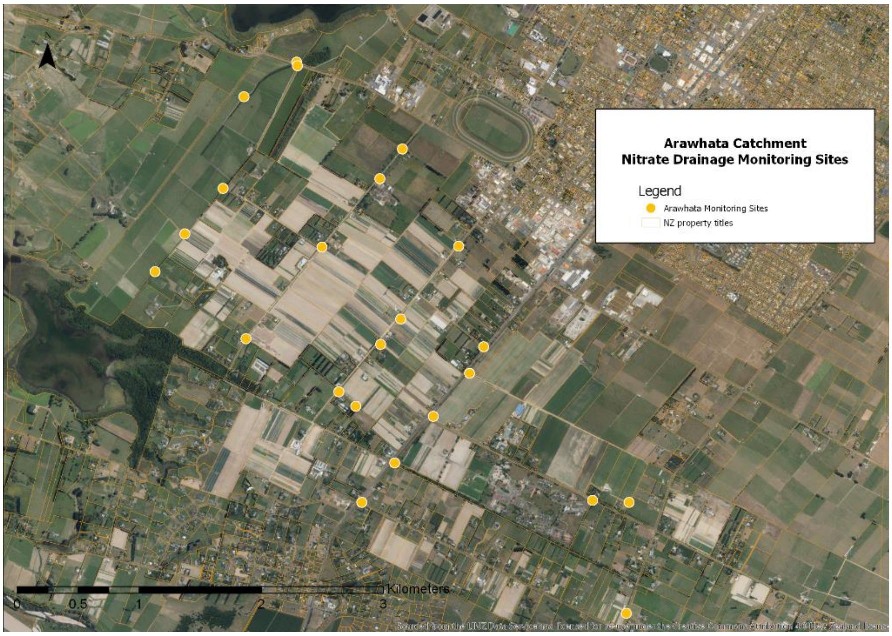


Figure 4. Arawhata Catchment Nitrate Drainage Monitoring Sites

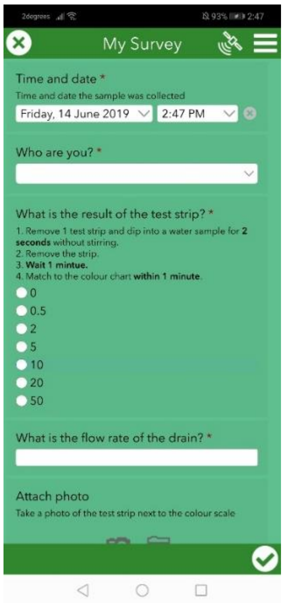


Figure 3. Screen shot of the Survey 123 app for collection of data from grower drainage water monitoring

To collect the data from growers, we have developed a Survey 123 form that acts as an app on their phones, into which they enter data as the do the tests. This will return all data directly to our Hastings offices, so the full set is captured immediately. Any missing data can be quickly identified and addressed.

In Gisborne, we are working with Gisborne District Council and growers to monitor nitrate in tile drain discharges. Because higher nitrate levels recently appear in State of Environment monitoring, but no obvious hotspots were identified, we are interested to consider tiles as possible sources. An Iowa "Corn and Soybean Digest" article is reproduced as Appendix 7.2.

We have installed two Wetting Front Detectors in the Hastings broccoli trial to observe their use and results. We noted our installation was too late as we damaged many roots preparing the hole in which the detectors are established. The detectors capture drainage water via a buried funnel allowing it to be extracted by syringe. The extract can be tested using conventional wet chemistry or with test strips such as we are using for soil and drainage water monitoring. A paper is attached as Appendix 7.3.

4. Arawhata Field Day and Gisborne Workshop

Workshops covering soil sampling, soil test results and fertiliser will be held in Gisborne and Levin. Conversations with growers and examining their soil test results has highlighted an opportunity to improve nutrient use through covering some key principles and concepts.

A brief run sheet of topics, learning outcomes and activities:

- Soil sampling
    - *Learning outcome*: Growers are aware of the key steps to collecting representative soil samples (transects, no. of cores, timing, core depth, variability, areas to avoid etc.)
- Sending samples away for laboratory analysis
    - *Learning outcome*: Growers understand the key steps to ensuring their soil samples reach the laboratory in a state suitable for soil nitrogen testing
- Soil testing with nitrate test kits
    - *Activity*: collect a soil sample, prepare and analyse
    - *Learning outcome*: Growers can confidently collect, prepare and analyse a soil test using the nitrate test kits
- Interpreting soil test results
- Soil test trends over time
    - *Activity:* Discussion around soil test values from one grower's paddock over several years – having a soil fertility strategy/plan
- Correcting deficiencies and excesses
    - *Learning outcome:* Growers have sufficient understanding of optimum fertility ranges and how they vary between crops.
- The recently published Vegetable Nutrient Guidelines
    - *Learning outcome*: Growers are aware of the newly published vegetable nutrient guidelines, the basic content that can be found within the book.
- Fertiliser planning
    - *Learning outcome*: Growers gain knowledge and are empowered to discuss and ask questions regarding recommendations provided by fertiliser representatives.

5. LandWISE Conference Proceedings

Future Proofing Vegetable Production was well represented at LandWISE 19 "Rethinking Best Practice" held in Havelock North over 22nd – 23rd May. Three presentations were given with regards to work completed for LandWISE as part of FPVP – A Progress Update from Year 1 (by Dan Bloomer), OverseerFM Modelling for Vegetable Production (by Georgia O'Brien), and The Treatment Train (by Pip McVeagh). All three presentations received positive feedback, with the post conference survey indicating 59%, 64%, and 71% of respondents enjoyed these respective topics. The abstracts for the presentations are given in the following sections, 5.1, 5.2, and 0. An additional five related presentations addressed Overseer, nutrient recommendations and loss mitigation.

5.1 Abstract: Future Proofing Vegetable Production – Progress Year 1

Dan Bloomer, LandWISE

Future proofing vegetable production requires ongoing rapid change in farm practice to meet cost pressures and increasingly stringent demands from regulators and markets for enhanced environmental performance and water quality.

LandWISE is partnering with growers and our funders to develop and test new production and nitrogen mitigation techniques. The project draws on and supplements recent and current research to develop new generation good management practices.

We have four main areas of focus:

- precise nutrient prescription (how much is required)
- precise application (is it going where it is needed when it is needed)
- maximising retention (ensuring leaching is minimised)
- recapturing nitrates that move beyond the root zone (constructed wetlands and wood-chip bioreactors)

Year 1 has been focused on establishing benchmarks of current practice and, where possible, effects.

Growers were interviewed on current nutrient management practices using a survey based on the Code of Practice for Nutrient Management. While no vegetable growers reported using documented calculations to plan nutrient applications, most took into account the various factors that contribute to such decisions. Fertiliser transport, storage and application are undertaken to code.

Placement and broadcast fertiliser application machines were tested. The placement machines had very high application uniformity, although there is some question about the rates applied as hoppers empty. This will be retested as growers ready for the next season.

Considerable effort has been spent collecting information and completing exemplar Overseer budgets. This proves difficult for fresh vegetable systems, particularly because cropped areas change regularly and do not fit a neat two-year cycle. In addition, there are very many individual budgets to complete for any farm. This is dealt with in detail in a separate presentation.

The project also investigates recapture of nitrates that may leach to prevent them reaching sensitive waterways. The key is to identify suitable locations for treatment interventions. This is also covered in a separate presentation.

5.2 Abstract: Future Proofing Vegetable Production – OverseerFM Modelling for Vegetable Cropping

Georgia O'Brien, LandWISE

In order to obtain a consent to farm, vegetable growers in the Horowhenua catchment are required to meet a Nitrogen Loss Limit of 27kg N/ha in accordance with Horizon's One Plan. As part of our Future Proofing Vegetables Project we set out to do Overseer Nutrient Budgets with these growers, and then combine them to understand Horowhenua's catchment load of nitrogen leaching.

Vegetable cropping systems are complex, and it became clear early on that modelling growers' whole farms would be very time consuming. To overcome this, representative sample blocks were chosen from each grower's farm, which led to 10 crops being modelled on blocks ranging in size from 1 – 12 ha. The unique combination of management factors, crop rotation, and land use history resulted in leaching loss of N ranging from 46kg/ha to 170kg/ha. Therefore, the catchment load of N from Horowhenua vegetable growers is highly variable according to the OverseerFM sample block analyses. We are working with Overseer to improve the software input structure so that the nutrient budgeting process can be simplified, and we can figure out the best way to estimate the catchment N load.

Growers were engaged with Overseer, and the software has been a useful tool to start conversations about nutrient management practices. We are now in the process of designing small trials with growers to test some N loss mitigation strategies.

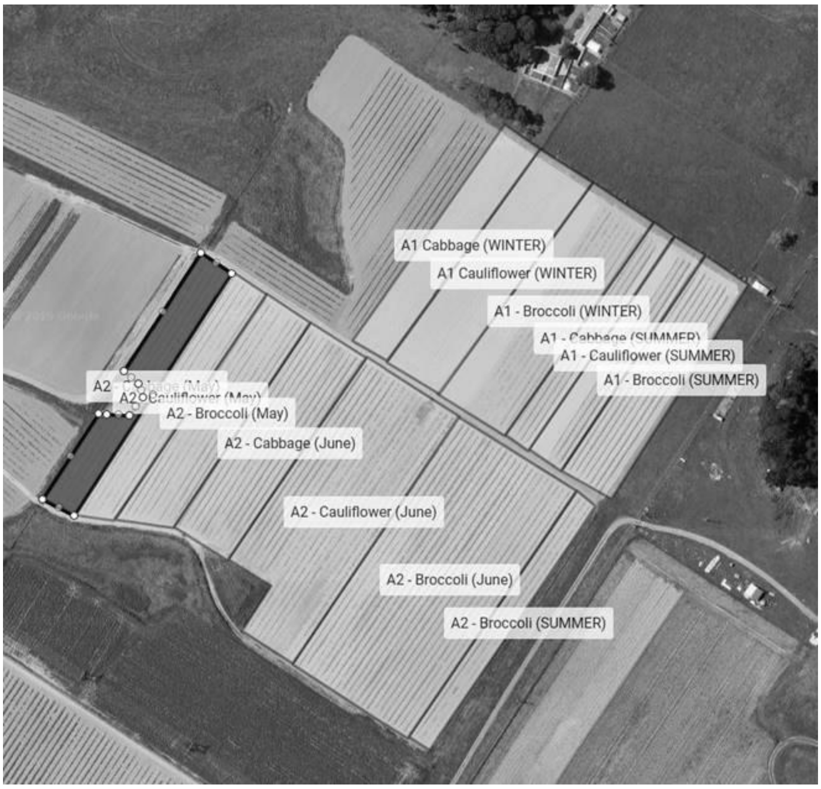


Figure 5. Example of OverseerFM blocks created to model a 7ha area.

5.3 Abstract: The Treatment Train – opportunities to reduce nitrate losses from drainage water under intensive vegetable production systems

Pip McVeagh, LandWISE

Vegetable growers are facing major challenges regarding nutrient use in their systems – particularly for nitrogen. Future Proofing Vegetable Production aims to work with vegetable growers in Arawhata and on the Poverty Bay Flats to reduce nitrate leaching in their catchments. The project focuses on four areas: precise prescription, precise application, management practices that maximise retention of nutrients and soil, and introducing ways to mitigate losses through downstream capture.

While nitrate leaching can be reduced, some level of leaching will be inevitable under current intensive vegetable production systems. Options to capture nutrients lost to drainage water include wetlands and bioreactors. Wetlands are already under construction on some blocks in the Arawhata catchment and more are planned. The use of bioreactors are also being considered as part of this project, with sites and designs currently being investigated.

Wetlands and bioreactors are being used to mitigate nitrate loses in sensitive catchments in New Zealand, Australia and the United States. Monitoring nitrate removal in these systems has shown results of up to 90%. A forum was recently held in Townsville, Queensland where researchers shared information and lessons learnt from their installations.

Monitoring of nitrate levels throughout the catchment and work previously completed developing a catchment wide drainage plan will help identify suitable sites for mitigation strategies. Regional councils are working together with growers to monitor nitrate levels in drainage water.

The project aims to work at a catchment scale, with grower input from the outset. This involves examining nutrients in these systems – their use and movement both spatially and temporally. Making changes to minimise nutrient loss in growing systems and implementing mitigation strategies, all help to reduce nitrate losses to waterways. This combined approach is known as the 'treatment train'.

5.4 Abstract: Constructed Treatment Wetlands as tools to mitigate nutrient and sediment runoff from farms

Dr Rebecca Eivers, Streamlined Environmental, Hamilton

Constructed treatment wetlands (CTWs) are being used in New Zealand and globally as mitigation tools to manage diffuse pollution from intensive agricultural catchments. My research investigated CTW efficacy and evaluated different predictors of their performance, exploring morphological and environmental variables which influence treatment efficiency. The CTWs studied were comprised of a surface-flow sedimentation pond 'module' (Figure 1), with around half including subsurface-flow shallow wetland-modules (Figure 2) planted with native species, and three with additional sedimentation pond-modules.

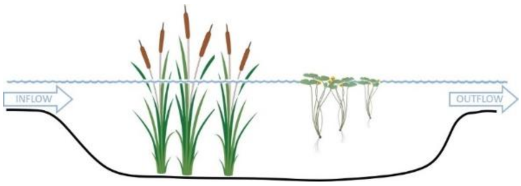


Figure 1. Free water surface flow CTW

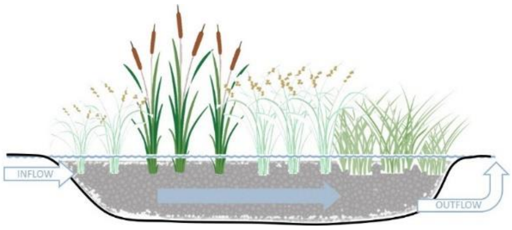


Figure 2. Horizontal subsurface flow CTW

The inflows were surface-flow drains, and the outflows were either surface-flow (through drainage channels or culverts), or filtration (through vegetated riparian margins). Morphological performance variables included:

- CTW area (range 7 – 1950 m²);
- CTW depth (range 0.2 – 2.1 m);
- CTW volume (range 12 – 2030 m³);
- Wetland to Catchment Area Ratio (WCAR; range 0.01 – 1.18);
- Hydraulic retention time (HRT; range 0.2 – 37.2 h);
- Hydraulic loading rate (HLR; range 0.4 – 130 m/d);
- Presence/absence of macrophytes (aquatic plants);
- Outlet type (surface flow or filtration); and
- Number of CTW modules (1, 2 or 3 modules).

Reductions in nitrogen (N), phosphorus (P) and suspended sediments (SS) varied, driven by variable inflowing concentrations, different ‘forms’ of N, P, and SS, and CTW morphologies.

Generally, CTWs with larger areas and volumes improved removal performance of nitrate, total N and coarse sediments, while deeper CTWs more effectively reduced particulate N and fine organic suspended sediments. Macrophytes improved removal of nitrate and P, whereas CTW with filtration-outlets frequently increased ammonium. Greater depths of accumulated sediment significantly reduced P removal efficiency, signifying the importance of CTW maintenance. Increasing the number of CTW modules largely improved performance, thus implementing treatment-train CTW designs is recommended.

5.5 Abstract: Woodchip bioreactors for mitigating water quality and improving stream health

Dr Brandon Goeller, NIWA

The mitigation of agricultural contaminants with edge-of-field tools is an effective approach to protect and rehabilitate aquatic ecosystem values and functions, while reducing costs and maintaining agricultural outputs.

A variety of edge-of-field nutrient attenuation tools are suitable for targeting surface and subsurface drainage discharges, including riparian fencing and vegetated buffers, constructed wetlands, denitrifying bioreactors, and filamentous algae nutrient scrubbers (FANS). The design and landscape fit of these tools should intercept the hydraulic pathways (flow paths) of nutrient delivery and provide conditions to enhance nutrient attenuation in riparian zones and within receiving waterways.

The increased implementation of edge-of-field mitigation tools has the potential to protect waterways from degradation and provide benefits to ensure the ecological health of receiving streams, lakes, and estuaries. However, the positive and negative impacts of edge-of-field mitigation tools on waterway health are not well-understood or accounted for in management, particularly for newer tools such as denitrifying bioreactors.

The pollution mitigation efficiencies of these tools, as well as their implementation costs, can vary due to challenges associated with treating variable drainage discharges and fluctuating nutrient loads common throughout New Zealand. Therefore, besides overcoming the administrative, socio-economic, and technical barriers to implementation, enhancing the uptake of edge-of-field contaminant mitigation tools also requires practical knowledge to inform how existing and newer tools can impact the water quality and cultural values of waterways.

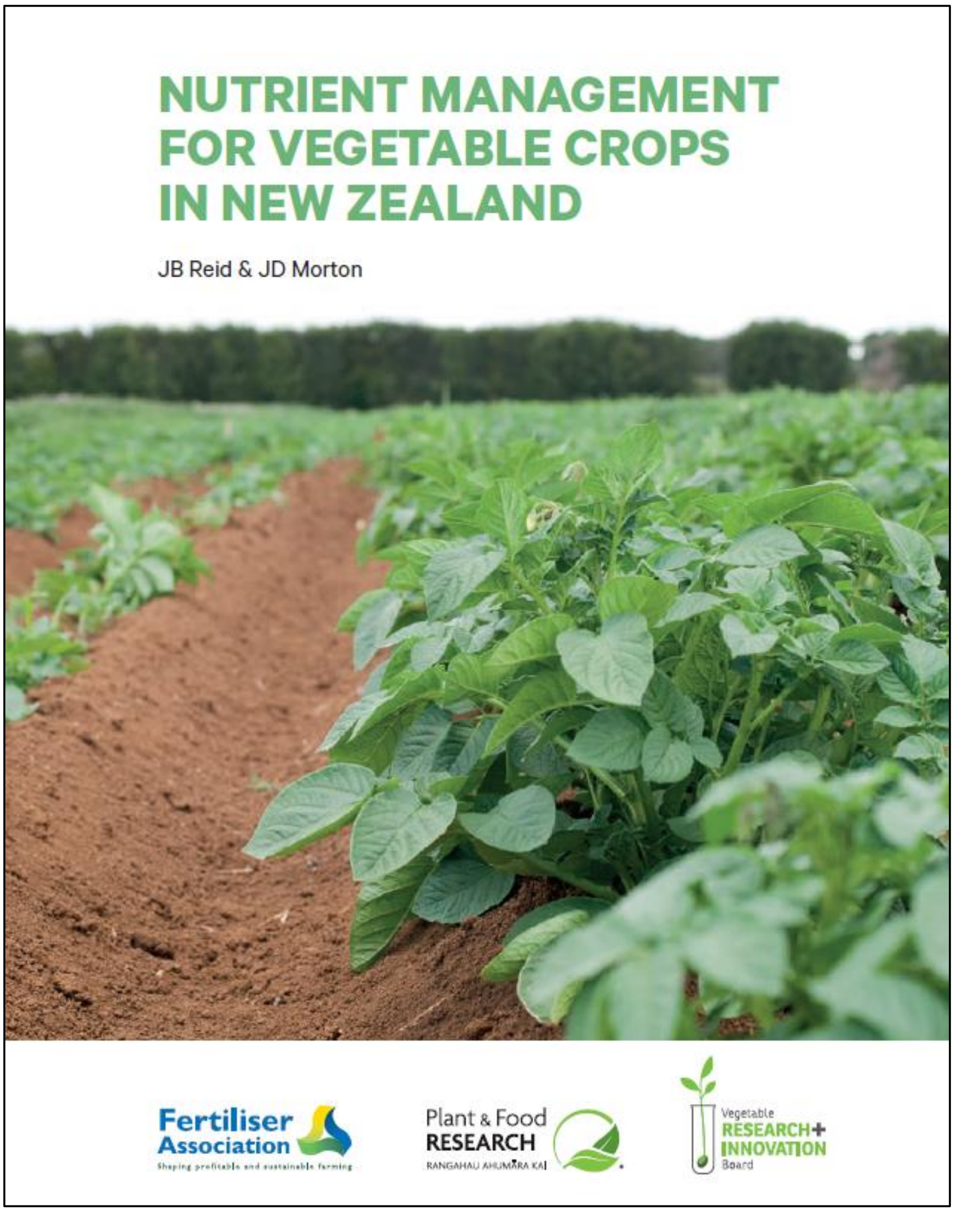
Besides improving water quality, these mitigation tools will likely help to improve the ecosystem health of receiving waterways, thereby ensuring that farming can be sustainable and economically viable within the new paradigm of “farming within limits”.

5.6 Nutrient Management for Vegetable Crops in New Zealand

Jeff Reid and Jeff Morton, Plant & Food Research Limited, *MortonAg, Napier*

Since 1986 a single chapter in the book, Fertiliser Recommendations for Horticultural Crops, has been the standard source of nutrient management guidelines for vegetable growers in NZ. In recent years there have been major changes in the scientific, social and business environment of vegetable production.

Recognising those changes, we have produced a new book Nutrient management for vegetable crops in NZ. This is intended to be a resource of scientifically-defensible best practices. Here we describe the major differences in approach and recommendations from the 1986 book. We also outline the opportunities and challenges that have been prompted by preparing the new recommendations.



5.7 Nitrogen Management to Increase Corn Yield and Nutrient Use Efficiency

Dr Brad Bernhard, University of Illinois

Assuring adequate nitrogen (N) availability during key stages of plant growth is a major factor affecting yield and profitability of corn. Nitrogen uptake by modern corn hybrids follows a sigmoidal pattern over time with limited uptake before the V8 growth stage (Figure 1). Between V8 and flowering two thirds of total plant N uptake occurs, equal to a rate of 8 kg of N per acre per day for a period of at least 21 continuous days. Side-dressing N to coincide with this period of maximum uptake is a logical approach to assure adequate N availability, while limiting its potential for loss. A relatively new technology known as the Y-drop, allows for placement of side-dressed N directly next to the crop row, where proximity to roots and stem flow of water helps to assure availability by creating a zone of high N concentration directly in the plant's rooting zone. Alternatively, controlled release sources such as Environmentally Smart Nitrogen (ESN), a polymer coated urea, and banding of the fertilizer are other ways to assure adequate N availability at the right time and in the right place.

Choices for N Fertilization

Different combinations of N fertilizer source, timing of application, and placement were evaluated at three location in Illinois in 2017 and 2018. All treatments received a total of 200 kg N per hectare. Treatments included supplying all N upfront, either broadcasted as urea or ESN, or banded as ESN 15 cm deep directly below the crop row using RTK guidance preplant. Additionally, spilt applications received 100 kg of N preplant as broadcasted urea and 100 kg of N side-dressed at the V8 growth stage. Side-dress applications included broadcasted urea, Urea Ammonium Nitrate (UAN) down the centre of the row, or UAN placed next to the row using a Y-drop technique (Figure 2). Soil N availability throughout the season was estimated by comparing yield results of the fertilized treatments to unfertilized check plots, which indicated whether the growing season created conditions where the best N application timing was all upfront or split-applied.

What Worked Best

When the N availability supplied from the soil was deficient (as indicated by a low check plot yield), more N was needed upfront during the critical growth stages of kernel number and yield potential. However, in environments with high initial soil N availability, split applications increased yield, and the Y-drop method was the best way to side-dress. Supplying only half the N fertilizer in a concentrated band directly in the root zone provided enough N for the corn plant through the side-dress application timing. When broadcasting all the N upfront, ESN resulted in greater yields than urea.

Summary

Because sufficient N is needed too early in the plant's development to set yield potential, an understanding of environmental and soil conditions is important when choosing the best management practices for N fertilization of corn.

5.8 OverseerFM – innovative new software that provides insights beyond numbers

Alastair Taylor, Overseer Ltd.

The launch of OverseerFM software in June 2018 marked a significant change in Overseer's development history, which has been one of relentless improvement. Since it was first established to support good nutrient management decisions, Overseer has steadily evolved as new science has become available and in response to a growing interest in understanding the nutrient losses from agriculture into the environment.

OverseerFM is an innovative new cloud-based software service which enables growers and their advisors to maximise the value of the extensive science modelling. It takes Overseer to the next level in terms of usability – for farmers, growers, advisors and regulators.

Compared to the legacy OVERSEER software, the data entry system is significantly more streamlined, making it much faster and easier to capture better quality farm management data. The farm account allows you to easily share information with others, so they don't need to re-enter data, it also improves farmer control of data, and takes away the confusion of numbers changing when the model versions change.

Informative reporting includes trend analyses and block comparisons, enabling users to visualise the effect of management and system changes over time and within the farm, supporting better interpretation of the model results, and integrating into Farm Environment Plan processes.

As New Zealand's only tool for estimating farm-specific nutrient losses, including Nitrate leaching and Greenhouse Gas emissions, we work with the policy developers and Regional Councils to help them understand how the software can best be used to support farmers' efforts to operate sustainably within environmental limits.

Overseer will continue to evolve as we look to improve the usability of the software and include a broader range of crops and mitigation options.

6. Project Team Meeting

Levin Project Meeting

Date: Tuesday 9th April 2019
Time: 1:30 – 3:00 pm
Venue: Woodhaven Gardens Board Room, Levin

Attendees: Dan Bloomer and Pip McVeagh (Page Bloomer Associates), Adam Jory (Woodhaven Gardens), Chung Su (Garden of York), Jeffery Wong, Chris Pescini (Pescini Bros) and Fernando Avendano (Massey University)

Topics covered:

1. Soil nitrate test strips

Woodhaven initiated some discussion around use of soil N test strips. The test strips are now being routinely collected and analysed by their agronomists. They have invested in a shaker to process the large numbers of samples they are collecting. Their team is gaining understanding and confidence in the use of the test strips which they are now using to aid N fertiliser decisions. They have reduced the number of fertiliser spreaders in action dramatically.

2. Introduction of Fernando Avendano

Fernando Avendano was introduced to the Levin growers. Fernando has recently begun his PhD study at Massey University and his PhD will run in parallel to the SFF project. Fernando will be supervised primarily by Dave Horne and will focus on nitrate leaching in the vegetable growing area of Levin. Fernando's masters degree in Chile investigated the use of narrow vegetation strips as buffers to waterways to reduce nitrate entering the waterways.

3. Drainage water nitrate testing

The proposed sites for water monitoring by Horizons Regional Council was put in front of the growers along with the drainage network for the area. Growers advised of where drains have been recorded incorrectly or added. Each of the 25 sites were discussed and the growers agreed with the majority of sites. Growers have agreed to monitor a few sites (to be allocated) during rain events and some low flow measurements. An app created using ESRI's Survey123 was demonstrated where growers can record their measurements and this will be stored in a single database at LandWISE.

4. Actions

The next steps for the project include:

- Finalising drainage monitoring sites with Horizons
- Assisting growers to collect and record their first drainage water sample
- Plan and design trials with growers to improve nutrient use efficiency while maintaining quantity and quality yield
- Continue to work with growers to build nutrient budgets in overseer and investigate options to reduce nitrate leaching in their systems.

7. Appendices

7.1 Appendix: Overseer Questionnaire

OVERSEER Inputs: Grower Interviews

Grower:

Business Name:

Address:

Ph:

Email:

Choosing a Block

- A block can be any named paddock or area on the property larger than 0.1 hectare(s) or 0.25 acre(s)
- Soil tests are strongly recommended to achieve a realistic result
- A simple rotation of just a few crops over 2 years, or long sown crops will be easiest to enter
- Fertiliser and lime inputs will need to be known (product, rate, when and how applied)
- Crop yield will need to be known (ideally in weight, but can estimate from volumes)
- Timings of planting/cultivating/harvesting will need to be known (to nearest month)

NOTES

Figure 6. Overseer Input Questions for Growers (Page 1).

Block Areas – Draw on Map

Effective Area (ha) for crop blocks includes:

- Headlands
- Tracks within the block,
- Other areas not cultivated but where plants grow e.g. pasture around fencelines.

Farm tracks are part of the non-productive area.

Soil Type 1

Any maps of property?

Known features ESP.

- Drainage (circle one)

  Poorly Drained Imperfectly Drained Well Drained

- Topsoil texture
- Stoniness %
- 10-60cm texture
- Impeded layer depth

Water Content

	Top 0 – 30cm	Middle 30 – 60cm	Bottom > 60cm
Wilting Point	mm/10cm		
Field Capacity			
Saturation			

Soil Type 2

Any maps of property?

Known features ESP.

- Drainage (circle one)

  Poorly Drained Imperfectly Drained Well Drained

- Topsoil texture
- Stoniness %
- 10-60cm texture
- Impeded layer depth

Figure 7. Overseer Input Questions for Growers (Page 2).

Water Content

	Top 0 – 30cm	Middle 30 – 60cm	Bottom > 60cm
Wilting Point	mm/10cm		
Field Capacity			
Saturation			

Soil Tests

Ideally 3 years' worth to obtain average values

Where were the soil samples taken from? Mark on map if known

Key Nutrients are:

- P
- K
- S
- Ca

Crops – Year 1 (   ) Block Name:

Require an end month of the rotation e.g. harvest date of a particular crop in the block

Need to know:

- When cultivation took place (nearest month)
- Sowing date (nearest month or average month)
- Crop type
- Product yield e.g. 12 tonnes/ha broccoli heads
- Month and year sown
- Cultivation practice at sowing (conventional, minimal, direct drill)
- Residual disposal (grazed, retained, burnt, removed)

Crops – Reporting Year (   ) Block Name:

Require an end month of the rotation e.g. harvest date of a particular crop in the block

Need to know:

- When cultivation took place (nearest month)
- Sowing date (nearest month or average month)
- Crop type

Figure 8.Overseer Input Questions for Growers (Page 3).

- Product yield e.g. 12 tonnes/ha broccoli heads
- Month and year sown
- Cultivation practice at sowing (conventional, minimal, direct drill)
- Residual disposal (grazed, retained, burnt, removed)

Fertiliser

Product

Application Rate (kg/ha)

Applied to which areas? Which months?

Application Method (incorporated, or surface applied)

Organic

- Piggery effluent
- Imported dairy (solids or slurry?)
- Other (nutrient analysis, DM% and %N in inorganic form)
- Compost/Mulch
    - Name:
    - DM %
    - Nutrient analysis
        - N P K S Ca Mg Na
        - N P K S Ca Mg Na

Irrigation

Type of Irrigator

How do you decide to irrigate?

Figure 9. Overseer Input Questions for Growers (Page 4).

Minimum application rate? mm

Minimum return period for the irrigated area? Days

Additional Notes

Figure 10. Overseer Input Questions for Growers (Page 5).

7.2 Appendix: What's your tile water analysis?

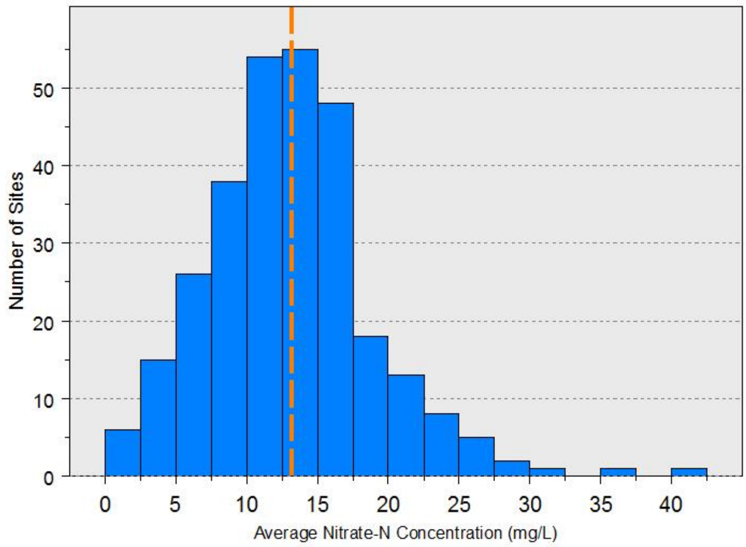
Lynn Betts 19 June 2018, Iowa Soybean Association

2017 drainage water in Iowa shows less nitrates with no-till and cover crops, more with tillage and nitrogen inhibitors. ISA staff took water samples at 342 drainage tile outlets in 2017.

Rather than rely solely on water monitoring results from outside sources, the Iowa Soybean Association staff is building a knowledge base by sampling tile waters for nitrate concentrations on a field scale, reporting back to the farmers involved. ISA gathers samples from volunteer members throughout the growing season and tests the water at a certified water lab housed at ISA headquarters.

At its annual research conference last winter, the Iowa Soybean Association released preliminary findings compiled from water monitoring on 342 drainage tile outlets in 2017. The results came from locations in about half the counties across the state; 75% of the sites had enough flow to include at least 4 samples over the growing season.

Nitrate concentrations from ISA water quality monitoring in 2017 varied considerably, but most samples fell in the 5 to 20 mg/L range.



"The primary reason we're doing this is to help our members learn more about the water quality on their farms," says ISA Water Resources Operations Manager Adam Kiel. "All individual results are given only to the participant, but we do aggregate the results, so each participating farmer can compare the results from their farm against others in the program."

Management information such as tillage, nitrogen applied, and cover crops use was gathered for the fields draining to each monitoring site. "Having that management information on numerous sites allows us an opportunity to observe how management may have affected nitrate levels," Kiel says.

One observation Kiel and ISA Environmental Research Coordinator Tony Seeman made was fields with fall and spring tillage had significantly higher nitrate concentrations than no-till fields. They didn't find any differences in nitrate concentrations based on nitrogen application timing. Surprisingly, they found fields with anhydrous ammonia applied in the spring with nitrogen inhibitors had higher nitrate concentrations than those without inhibitors. They also found bioreactors reduced nitrate concentrations by 43%.

As expected, nitrate-N concentrations yields peaked in the spring, when more water was flowing through tile.

Preliminary 2017 results showed:

- The average nitrate concentration in water leaving all fields was 13.1 mg/liter.
- Water from corn fields had slightly higher concentrations of nitrate (13.9 mg/l) than from soybean fields (11.1 mg/l).
- For the second year in a row, there was no strong correlation between the amount of nitrogen applied and the concentration of nitrate in water, on fields fertilized within normal nitrogen rate ranges. “We continue to see the system is driven by something other than rates of nitrogen applied,” says Seeman, who is heavily involved in water monitoring for ISA.
- Cover crops use showed water quality benefits. On average, fields with cover crops showed nitrate concentrations of 9.5 mg/l compared to 14.2 mg/l in fields without cover crops use. The difference amounts to a 15-pound/acre reduction in nitrate load in the water when interpolated over 6 months.
- One-sixth of the sites monitored contributed half the total nitrate loss.

Retrieved 17/6/19 from: http://www.cornandsoybeandigest.com/water/what-s-your-tile-water-analysis?NL=SO-02RESP&Issue=SO-02RESP_20180620_SO-02RESP_367&sfvc4enews=42&cl=article_1_b&utm_rid=CPG02000002565883&utm_campaign=28691&utm_medium=email&elq2=0f263778cdda429aa8d48a0bdda436f0

7.3 Appendix: Managing irrigation with a Wetting Front Detector

UK Irrigation No. 33 Summer 2005

Richard Stirzaker, CSIRO Land and Water

WFD is not the Water Framework Directive in this instance but the Wetting Front Detector. This is a relatively low-cost device developed at CSIRO in Australia for aiding and supporting good irrigation scheduling. It is also a useful tool for monitoring nutrient losses and so in this way it could prove to be a very useful tool for compliance with the more traditional meaning of WFD.

Irrigation scheduling is about knowing when to apply water and how much. The scientific tools needed to schedule irrigation are well developed. Tensiometers have been used since the 1930s (Richards and Neal 1936) and may still be the most widely used piece of equipment for monitoring soil water status. The Neutron Probe was developed in the 1950s (Gardner and Kirkham 1952) and five decades later is regarded by many scientists as the most accurate method of measuring soil water content (Evett et al. 2002). More recently a range of 'user friendly' capacitance devices have come onto the market, based on the measurement of the dielectric property of soil (Charlesworth 2005).

Given these tools, and the inexpensive logging equipment that goes with them, irrigation scheduling should be easy. It remains a conundrum therefore that the latest agricultural census in Australia, a country in the forefront of irrigation research and development and facing severe water shortages, showed that almost 80% of commercial irrigators still do not monitor soil water status (ABS 2005).

Wetting Front Detector

In response to low adoption of existing irrigation tools, a Wetting Front Detector (WFD) was developed in an attempt to attain maximum simplicity. A WFD is basically a switch, which alerts the irrigator that a front of a given strength has passed a given depth in the soil (Stirzaker 2003). The WFD comprises a specially shaped funnel, a filter and a mechanical float mechanism (figure 1).

The funnel is buried in the soil within the root zone of the plants or crop. When rain falls or the soil is irrigated, water moves downwards through the root zone. The infiltrating water converges inside the funnel and the soil at the base becomes so wet that water seeps out of it, passes through a filter and is collected in a reservoir. This water activates a float, which in turn operates an indicator flag above the soil surface. There are no wires, no electronics and no batteries.

If the soil is dry before irrigation, the wetting front will not penetrate deeply because the dry soil absorbs most of the water. A long irrigation would be needed to activate a detector. However, if the soil is relatively wet before irrigation, it cannot store much more water, so the wetting front penetrates deeply (Stirzaker 2003, Stirzaker and Hutchinson 2005).

Knowing how deep a wetting front moves into the soil is critical for irrigation management. If a crop is given frequent but light sprinklings of water, the wetting front will not go deep and the WFD will not be activated. Much of the water will evaporate from the soil surface. If too much water is applied at one time, the wetting front will go deep into the soil, perhaps below the rooting depth of the crop, wasting water, nutrients and energy.

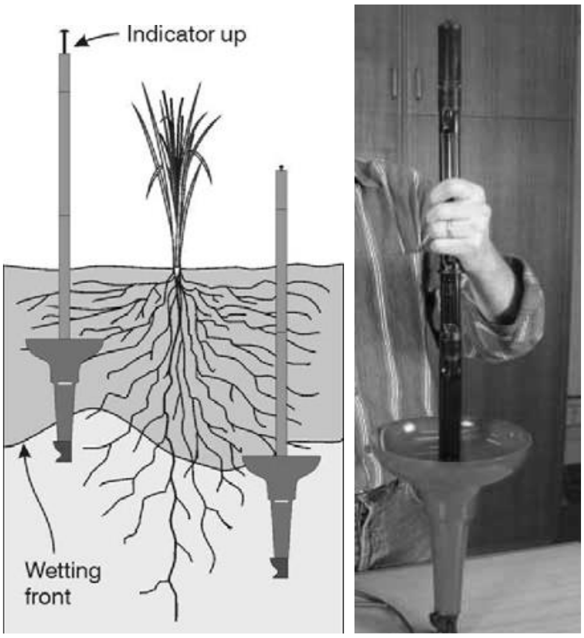


FIGURE 1. A FullStop Wetting Front Detector (WFD). The funnel part is buried in the soil with the black tube protruding above the soil surface. When a wetting front reaches the detector a red indicator pops up. Detectors are usually placed in pairs, about one third and two thirds down the active root zone.

An interactive tool

The WFD is an interactive tool. Even before placing the detectors in the ground, the irrigator has to decide how deep he wants the water to go and why. Wetting Front Detectors are usually used in pairs. The first is buried about one third of the way down the active root-zone. The second is buried about two-thirds the depth of the active root-zone (Figure 1). The active root-zone is depth of soil in which most of the roots are found, or the maximum depth of soil aimed to wetted by irrigation. The irrigator then watches the shallow and deep detectors respond through the season, to see how this matches their expectations.

One of the more common findings on-farm is that water penetrates more deeply under drip irrigation than many irrigators expect. Wetting Front Detectors have also alerted growers that they tend to apply too much water at the start of the season and tool little during the exponential growth phase (e.g. Stirzaker and Wilkie 2002).

Nutrient sampling

As well as informing the irrigator that the wetting front has reached a certain depth, the detector retains a sample of water which can be extracted via a tube using a syringe. This can be analysed for its salt or nitrate concentration. This is done using a simple field salinity meter or colour nitrate test strip (Figure 2).

Figure 2: Each time a Wetting Front reaches the detector a small sample of water is retained. This can be removed using a syringe. Routine measurement with a robust field Electrical Conductivity meter can show if fertilizer levels are too high or low, or when leaching is required to remove salt. Colour strips can be used to give a quick check of nitrate levels in the soil.

Our experience has been that monitoring electrical conductivity or nitrate levels can tell you more about irrigation management than measuring water content itself. For example nitrate levels will drop sharply if over-irrigation occurs (Stirzaker and Wilkie 2002). Depending on the quality of the irrigation water, EC levels will gradually rise during periods of underirrigation (Stirzaker et al 2004, Stirzaker and Thomson 2004).

Soil water monitoring is far more advanced than soil solution monitoring. But in the case of nitrate the two are inextricably linked. Stirzaker (1999) estimated the N-use efficiency for a selection of horticultural crops in Australia by comparing the application rates recommended by State agencies against the N-removal in crops. Even if farmers limited themselves to recommended rates, and obtained high yields, the efficiency of N-use would be 30 to 50%. Greenwood et al. (1974) present N recoveries of 7% for lettuce, rising to 65% for potatoes under conditions in the United Kingdom. This highlights the need for farmers to manage their water and nutrients together.

Some limitations

All tools have their limitations and it is necessary to work within them. The WFD does not tell an irrigator when to start irrigating - it simply informs them how well the last irrigation filled the profile and helps them to make a decision about the timing and duration of the next irrigation. The WFD also has a sensitivity limitation of 2 to 3 kPa. After irrigation has ceased and redistribution of water occurs down the profile, the wetting fronts become weaker and can fall below the detection limits of the WFD. In some situations we have observed significant amounts of water passing deep detectors without activating them. Work is continuing on more sensitive WFDs for specific applications.

Availability

The commercial version of the Wetting Front Detector has now been released for one year with several thousand in use. Feedback from irrigators is largely positive, but the depth of placement is critical to success. A common problem has been placing the deep detector too deeply - where it is rarely activated.

The key to getting the best response from the WFD is to ensure that the placement depths are right for the irrigation method, frequency and soil type. This 'finetuning' can only be done at farm/region level – the optimum placement depths need to be worked out on the ground by the leading farmers and advisors.

The Wetting Front Detector does not replace other scheduling tools, but should be used together with whatever method a farmer is comfortable with. One of the key insights the researchers have gained in working with farmers is that the detector is a learning tool. It gets farmers and extension workers talking and asking questions, and ultimately learning together.

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