LandWISE INCORPORATED

2020

Future Proofing Vegetable Production Milestone 6 Progress Report

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LandWISE Inc

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1. Executive Summary

This report describes progress made and deliverables met for Milestone 6 of Future Proofing Vegetable Production due 31st January 2020. LandWISE is pleased to report that there has been significant progress since the last milestone report in September.

As the report details, regular one-on-one visits have been made with growers to support their capability growth. Our key grower contacts are continuing to seek our advice and support with changing practices on-farm. We are also proud to have extended our contacts in the Levin and Gisborne areas, and have begun trials with growers who have never previously done formal on-farm research.

We have four trials completed with two growers, and another eight trials planned or underway with five more growers. These have proved useful opportunities to keep in touch with growers and to allow us to build close relationships which facilitate better uptake of our suggestions for practice change. A trial work summary and further description is available in Table 1 and on page 5.

In Levin, the motivation to test new practices and meet regulatory leaching limits continues to support uptake of our extension activities and recommendations. In Gisborne, because growers do not yet have to meet environmental loss limits for nitrogen or phosphorus, it is the introduction of compulsory Farm Environment Plans (FEPs) required for Commercial Vegetable Growing and Cropping enterprises by Gisborne District Council (GDC) before May next year.

As part of assisting GDC to ready growers for FEP submission, we have developed a simple nutrient budgeting tool designed specifically for vegetable production systems. This is also of interest to growers and industry in other regions. We are receiving help from a programmer to adapt the budget for digital platforms and will be presenting the content for expert feedback at FLRC 2020 in February.

The drip irrigation nutrient trial has not progressed since the last milestone, but one grower is now interested. Previously the technology was viewed as expensive and of limited benefit, but we have now identified that longer term crops with polyfilm mulch would benefit. We have also identified an opportunity to consider drip for sweetcorn in Gisborne. Unfortunately, planting of these crops has finished for the season and the next opportunity will be September this year.

2. Introduction

This report describes progress made and deliverables met for Milestone 6 of Future Proofing Vegetable Production due 31st January 2020. LandWISE is pleased to report that there has been significant progress since the last milestone report in September.

Commercially sensitive and in-confidence information has been excluded.

3. Milestone Deliverables

Growers have made extraordinary progress towards understanding and participating in nutrient management and budgeting since the last milestone. Several key interactions and programmes have contributed to this progress.

A combination of workshops, field days and demonstrations, on-farm trials and one-on-one meetings are providing knowledge and confidence for growers to review management practices and adopt new approaches. Early discussions identified knowledge gaps around soil nutrient sampling, soil/plant nutrient interactions, soil nutrient test interpretation and fertiliser prescription.

We previously reported workshops and events addressing these topics. These were valuable introductions, but it has been following one-on-one interactions where they can be put into the context of individual farms that we have observed change action occurring.

In October all growers engaged with the Future Proofing Vegetable Production project, and almost all growers in the Horowhenua district as well as surrounding districts attended a series of workshops held by Horticulture NZ. As a result, these growers are now working towards getting accredited by New Zealand GAP under the Environmental Management System (EMS) add-on. These workshops complemented the work LandWISE has been doing with individual growers, and LandWISE staff attending one of the workshops resulted in one grower requesting our support with spreader calibration.

Two extension events LandWISE held in January were attended well by growers and industry. An "Efficient Irrigation and Calibration" workshop Gisborne attracted 22 growers and others. A "Nitrate Quick Test and Liquid Fertiliser Options" field day in Levin attracted 18 attendees.

In January, a workshop in Levin was focussed on a demonstration of using Quick Nitrate Test strips to test soil, and alternative fertiliser application equipment to facilitate more frequent, and lower rates of Nitrogen. This workshop is being repeated in Gisborne in early February.

3.1 Growers self-managed nutrient budget progressing

The focus on nutrient budgeting varies slightly between regions.

In Levin, it is the need to address nutrient loss limits required to gain Resource Consent so leaching assessed by OverseerFM dominates. The LandWISE team has been assisting Levin growers determine their own fertiliser requirements using soil test results and good practice guidelines, and by comparing nutrient management options influence on OverseerFM results. We are aware that Levin growers have also provided nutrient management details for a separate Horizons' project that is assessing the impact of vegetable production in Levin. The results of this have not been made public.

In Gisborne, growers must submit a Farm Environment Plan (FEP) by May 2021, which has initiated increased interest in nutrient budgeting because it is one of the requirements.

To support growers in both regions (and wider), LandWISE has developed 1-page Nitrogen and Phosphorus nutrient budget forms (See Appendix 5.1). The budget forms refer directly to the good practice guidelines in "Nutrient Management Guidelines for Vegetable Crops" published in 2019. They pull together in one place the factors that influence fertiliser planning for a crop.

We note the outputs are intended as a guide, and there is room to justify apparent surpluses. For example:

- Phosphorus surpluses might occur where growers take over a low fertility paddock, and more P than needed for crop uptake is needed to raise Olsen P levels.
- In a rotating crop scenario, it is the crop with the highest soil P requirement that sets the target level so annual rather than specific crop budgets and adjustments are justified.
- Indicated nitrogen surpluses should be carefully considered, however may be justified in uncontrolled circumstances such as heavy rain after fertiliser application, crop failure, or yield scenarios greater than those presented in Reid & Morton (2019).

The development of the two budget forms was supported by plenty of feedback from growers, Plant and Food scientists, council representatives, Ballance representatives and their science extension

team. The nutrient budgeting forms are being presented at FLRC in February 2020 and we will seek more feedback to contribute to the final version for release at the end of the month.

LandWISE Board Chair, John Evans passed on the nutrient budget forms to Jan ten Haaf, a student interested in programming. Jan is converting the forms into a website app that will complete necessary calculations and produce printable reports. It may also make data entry easier for growers who have nutrient management information stored in databases.

In addition to this work, LandWISE has sought help from a consultant to review the GDC Tarawhiti Resource Management Plan and extract relevant rules and regulations for vegetable growers. The outputs of this will be available for growers when it is completed but due to the complexity of the unitary plan the timing of this not yet known.

In Levin, the Environmental Management System (EMS) Add-on workshops delivered by VegetablesNZ Inc. have helped immensely in solidifying grower knowledge of regulatory requirements, and the need to record their inputs. The workshops have also presented growers with the HortNZ Good and Best Management Practices for Vegetable cropping, which we are echoing in our one-on-one and group visits.

3.2 Diary of one-one-one and group grower visits

A diary of one on one and group visits since MS5 is available from LandWISE upon request.

We have been visiting growers regularly to complete trial work, equipment calibrations, and discuss nutrient budgeting. We have also been communicating regularly on the phone to keep growers up to date with our plans and hear from them about potential areas for improvement.

3.3 Nitrogen mitigation trials monitoring

There have been virtually no flows in Levin surface drains since the last report, so we have not been able to repeat the nitrate concentration measurements we began. We anticipate flows will restart in autumn, the time when leaching is predicted to be most likely. We will ensure growers are ready and support them to capture data when possible.

3.3.1 Bioreactor

In conjunction with Leaderbrand we are investigating options to design and implement a filter to remove sediment and Dissolved Reactive Phosphorus (DRP) from runoff water from nursery production areas (Trial 4c). Volumes and nutrient loads are currently being monitored and we are proposing treatments that will capture and remove nutrients before they reach surface water bodies. Initial assessments indicate these point sources may be less than diffuse losses from the much larger area of adjoining crop land.

Figure 1 Site visit to understand nutrient use and loss points from vegetable nursery production areas.

We have also linked with Phil Stevens from SlowFarm Ltd., a biochar producer who has offered product to test as a substrate for nutrient capture from drainage water. With regards to implementing a Levin bioreactor as discussed in MS5 we have not yet identified a suitable site – with high concentrations, and low flows to address nitrate losses. We are aware of other work assessing both ground water and surface water nutrient levels but any results have not been published.

3.3.2 Minimising Leaching Risk

We have a large number of on-farm trials with individual growers, testing a range of options to reduce leaching risk without compromising crop yield or quality. Current trials looking at fertiliser use include splitting fertiliser applications and optimising fertiliser rates either by dropping current rates by ≥20% if the grower is currently working at good practice levels. In the few cases where the grower is currently applying more than the new guidelines suggest, we compare current/old practice to the new "good practice" using Quick Nitrate Test strips and the Vegetables Nutrient Guidelines.

3.4 Catchment group and individual farmers supported to build capacity and capability

We are supporting growers as individuals and as catchment groups in several key ways: demonstrating and helping with fertiliser and irrigation equipment calibrations, running workshops and field demonstrations on topics jointly identified, responding to specific requests for information, and helping design and run nutrient management field trials.

Workshops introduce concepts and possible technologies and provide basic information. Individual conversations help contextualise it specifically to the farm and grower capabilities. The trials give growers confidence to use the latest tools in their decision-making process rather than just relying on their multiple years of growing experience which has delivered both success and failure.

Our trials in Levin were delayed by heavy rainfall - our potato trial (with Grower 3) had to be re-planted in another block because the crop did not emerge. We have begun working with two smaller growers who have not done field trials in the past, which we are glad to have included.

Table 1. Trials Summary Progress.

Grower	Trial Summary	Status	Trial Code
1	Cauliflower Lower Fert Rates	Harvested	1a
	Broccoli Lower Fert Rates	Harvested	1b
2	Cauliflower Lower Fert Rates	Harvested	2a
	Broccoli Lower Fert Rates	Harvested	2b
3	Liquid N/Smart Fert on Potatoes	Planted, monitoring begun	3a
	Biological with reduced fert rate	Planted, monitoring begun	3b
4	Liquid N on Sweetcorn	Harvested, samples drying, analysis waiting	4a
	Lower Fert on Lettuce in Winter/Autumn	Trial plan completed, waiting for Winter/Autumn to start	4b
	Nursery runoff mitigation	Measurements started, treatments identified	4c
5	Lower Starter Fert on Tomatoes	Planted, treatments applied	5
6	Effect of Green Manure on Sweetcorn	The crop is planted, and the block has been soil tested. Fertiliser yet to be applied.	6
7	Nil Phosphate Starter on Sweetcorn Quick N Test Side dressing rate	Planted, treatments applied, plants emerged	7

3.4.1 Grower 1

We had a reduced fertiliser rate trial in both a Broccoli and Cauliflower block – due to variable spring weather, the broccoli crop was harvested early by the grower's staff before we could get to the block. We did obtain number of heads harvested from each treatment and took post-crop soil tests for residual nitrate testing. The Cauliflower was the last planting of winter/spring Cauliflower varieties. Due to warm weather, the crop grew too quickly and had a variable and very low harvestable yield. From our initial look at the results, there appears to be no difference in yield between either treatment.

The take home from this trial was that the grower now understands how to run an on-farm trial, and he has been using the "Nutrient Management Guidelines for Vegetable Crops" book (Reid & Morton, 2019) to better understand what fertiliser rates he should be using from his soil tests.

3.4.2 Grower 2

The trial was setup to compare current practice of banding all fertiliser onto broccoli crops soon after planting (typically at 4 weeks) vs split applying the fertiliser over multiple applications. The reason for running this trial was that after heavy rainfall, the grower reapplies the same rate of fertiliser on the crop as the fertiliser applied at the start of the growing season has been washed away.

After setting up this trial, the grower liked the idea of split applying fertiliser and changed his whole farm practice. To make the most of this trial, we changed his second and third side-dressings in the trial area to CAN instead of a Complex product at the same rate of nitrogen/ha applied over the remainder of the paddock.

Due to a dry period in September, and no irrigation capability, the Cauliflower crop never properly established so the crop failed. From the broccoli area, we had a transition again where spring temperatures caused the heads to grow too fast across both treatments and very little of the crop was marketable. There appeared to be no significant difference in marketable yield between treatments.

By setting up this trial, the grower changed current farm practice to split applying all his fertiliser. This is likely to reduce the need to re-apply as much fertiliser after periods of heavy rainfall during the winter months. Furthermore, the risk of nitrate leaching through this practice change has been reduced. Therefore, despite the trial encountering difficulties and final harvest data not providing much value, the experience in testing two practices, and discussing nutrient management one-on-one was worthwhile, and resulted in positive on-farm change by the grower.

3.4.3 Grower 3

Growers have been trialling biological products to improve the nutrient use efficiency of fertiliser products. The trial was setup to compare the effect of reducing fertiliser rates when using a biological product that improves the plants ability to take up nutrients from the soil. Heavy rain two days after planting caused the initial planting to rot in the ground so the grower had to replant the crop and we marked out the trial a second time. The replacement trials are now well established and being monitored.

3.4.4 Grower 4

Current grower practice is to apply side-dressing fertiliser on sweetcorn 4-6 weeks after planting to ensure sufficient nitrogen is available through the whole growing season. This trial was setup with a grower to test whether we could achieve the same results between surface applying liquid nitrogen vs deep banding dry urea. The aim of this trial was to test the efficiency of liquid nitrogen side-

dressing as if it works well, it will allow growers to delay side-dressing sweetcorn and apply N-side-dressing closer to when the plant requires it. The Liquid-N side-dressing trial has just been harvested. Visually there appeared to be little difference in crop performance between the different treatments. The trial will be commented on in the Milestone 7.

We are now setting up a lettuce fertiliser trial with Grower 4 for the Autumn/Winter cropping period. The trial will look into the most efficient fertiliser use strategy; preliminary planning has been initiated.

3.4.5 Grower 5

A significant portion of Gisborne land is devoted to process tomato crops. Current fertiliser practice has been resulting in excellent yields, but with perceived environmental and cost pressures. We have set up a trial cutting base fertiliser rates to better match the recommendations from the "Nutrient Management Guidelines for Vegetable Crops" to test whether we can achieve the current yields with reduced fertiliser use. The tomato crop is well established – current growth measurements have shown no difference between different base fertiliser dressing rates. The crop is due to be harvested in mid-April and results will be analysed and available 2 – 4 weeks from this date.

3.4.6 Grower 6

In unirrigated sweetcorn crops, seasonal rainfall strongly determines yield potential, and therefore crop nutrient demand. Historic practice for deciding side-dressing rates is based on "*looking at the clouds to estimate crop yield and then deciding how much urea to apply*". A trial has been established to test the FAR Nitrate Quick Test decision support tool, and to give growers more confidence in using decision support tools that are available. The trial is comparing grower practice vs the recommended N rate from the Quick-N test. It is established and all the plants are emerged. We have quick N tested the paddock and continue to monitor it.

3.4.7 Grower 7

Current fertiliser practices lead to continually increasing soil fertility levels. A trial was established to test whether we can eliminate phosphate use on blocks that have an Olsen P above the crops optimum value so to start mining down the excess nutrient. The trial has been established in two paddocks. One block had variable emergence due to capping causing the population to be below the target level. There was no difference in emergence between the different starter fertiliser products.

3.5 Alternative methods for fertiliser application demonstrated and efficacy and utility assessed by growers

On the 23rd of January LandWISE, with support from Vegetables NZ and Woodhaven Gardens held a Future Proofing Vegetables field day that showcased alternative fertiliser equipment and the Quick Nitrate Soil Test. A total of 27 people from a variety of sectors attended the event including growers, sales representatives, and council staff. The notes given out on the day are available in 5.1.

One of the growers provided TeeJet fertiliser nozzles he is trialling on his farm. We are working with him to establish a replicated trial design and will help collect and analyse data.

Another grower has been using the Y-Drop type fertiliser droppers we made for the project in trials on his farm. A further on-farm trial for brassicas is being proposed.

Growers showed considerable interest and questioned how they might use these technologies with existing equipment. This conversation extended across New Zealand in response to a Twitter post about the day, with Canterbury growers asking for more details and adding their thoughts.

Figure 2. Demonstration of TeeJet Fertiliser Spray Nozzles and YR Stream Bar at FPVP Field Day in Levin (23rd Jan).

3.6 Drip irrigation nutrient trial investigated

Netafim has expressed that they are keen to contribute equipment and advice for a drip irrigation nutrient trial. To date it has been difficult to convince growers this is worth investigating.

Levin growers generally considered drip irrigation an expensive option, and that spray irrigation would still be required so it was not practical. As a substitute LandWISE has been working with Chris Pescini and Massey PhD student Fernando Avendano on trialling liquid urea to a potato crop in order to measure the effects of smaller frequent N applications on yield and quality.

However, we recently noted spray irrigation being applied to crops with polyfilm mulch and have suggested a trial for that scenario. The grower says they would be interested in testing drip in plastic mulched crops (watermelon and parsley). They identified that irrigation application to these crops was not very efficient due to the plastic barrier, and fertiliser practices on could be improved.

Unfortunately, the laying of the plastic covers for the beds has just been completed, and any dripline would need to be installed before the plastic. Therefore, the next opportunity to implement this trial would be in September of this year, allowing us to monitor it through the summer and following autumn.

In Gisborne, lack of water means lower value crops such as sweetcorn miss out on irrigation in dry seasons so increasing efficiency using drip may pay back and a grower is interested to trial it next season. As with Levin, we will use the time until then to arrange equipment for trials next summer.

3.7 Project team meeting

A number of meetings in Levin and Gisborne have been held at which project progress has been discussed. In discussion with Project Chair Jay Clarke we determined that these, rather than a special meeting at a busy time of year, would constitute a Project Team Meeting. Growers express their own going support and demonstrate it by the on-farm changes they are making and the new management approaches they are trialling.

Levin

Levin growers met at Woodhaven Gardens on 20 December to discuss options for nutrient management and assessment of progress towards reduced leaching losses. They identified the determination of losses was highly complex and difficult to assess simply. A parallel project being undertaken to quantify losses from vegetable growing required their individual information, which they were reluctant to make public because it is commercially sensitive. They determined that three farm system scenarios described vegetable growing in the area and that losses might be assessed using OverseerFM. The results of that project have not been released but indications are that recent changes have made significant differences and losses have reduced in the last two years.

The growers are happy with progress of the Future Proofing Vegetable Production project. They are working individually with the LandWISE team on customised trials and their chosen focus issues. They requested a field day focused on soil nitrate testing and liquid fertiliser options (as reported in Section 3.5). The growers want to continue on-farm trials, and to review the community group approach for catchment nutrient management over coming months.

Gisborne

Gisborne growers are also engaging in one-on-one conversations and individual field trials. We note that more growers are engaging with the LandWISE team as the project progresses. The practical help with equipment calibration, time taken to provide relevant information and fully discuss issues one-on-one, and our support for their own on-farm trials are given as reasons.

Gisborne growers are also seeking support for Farm Environment Planning and we have been working with Gisborne District Council and growers to see how these can be efficiently and usefully prepared. They asked for a workshop on irrigation testing to reduce risk of leaching from poor management, which was held on 22 January 2020 (see Section 4.1). This was very well attended.

4. Additional Activities

4.1 Efficient Irrigation Workshop

Gisborne growers requested a workshop on Efficient Irrigation. This was presented on 22 January and included a 90-minute indoor presentation and questions, followed by a field demonstration of the IRRIG8 Quick Irrigation Uniformity assessment process and software. Handout notes are included in Appendix 5.3.1.

This session was well attended by growers, industry and council staff. We thank Leaderbrand for helping arrange the day and for setting up their irrigation equipment for the field session.

4.2 Nitrate Quick Test Demonstration (Gisborne)

A workshop to demonstrate how to carry out the Nitrate Quick Test was held in Gisborne on the 4th of February. 14 growers, agronomists, council and seed company representatives attended, and feedback received was positive. Workshops such as these also provide the opportunity to meet and connect with new grower contacts and introduce them to the range of activities we are doing as part of FPVP. For example, one grower we talked to is now keen to complete some fertiliser calibrations on their equipment before the start of planting next season.

As always, the content we present is always better received when it is customised, and contextualised for the individual grower or organisation. An example of this, was the liquid fertiliser equipment we demonstrated was of interest to a maize and sweetcorn grower however, they questioned the availability to the root system in dry conditions. We have coordinated to contact

them later in the year to see if they would be interested to trial applying lower concentrations of liquid N (with higher water rates) for dryland crops.

4.3 Farm Environment Plans

Large Gisborne growers are working particularly hard to prepare for FEP submission. There is some ambiguity around what a cropping or commercial vegetable growing FEP should include, thus LandWISE is facilitating discussions with GDC to clarify expectations and review grower's draft FEPs.

In a meeting with GDC on 12th November we concluded that the key factors to include in growers' FEPs were:

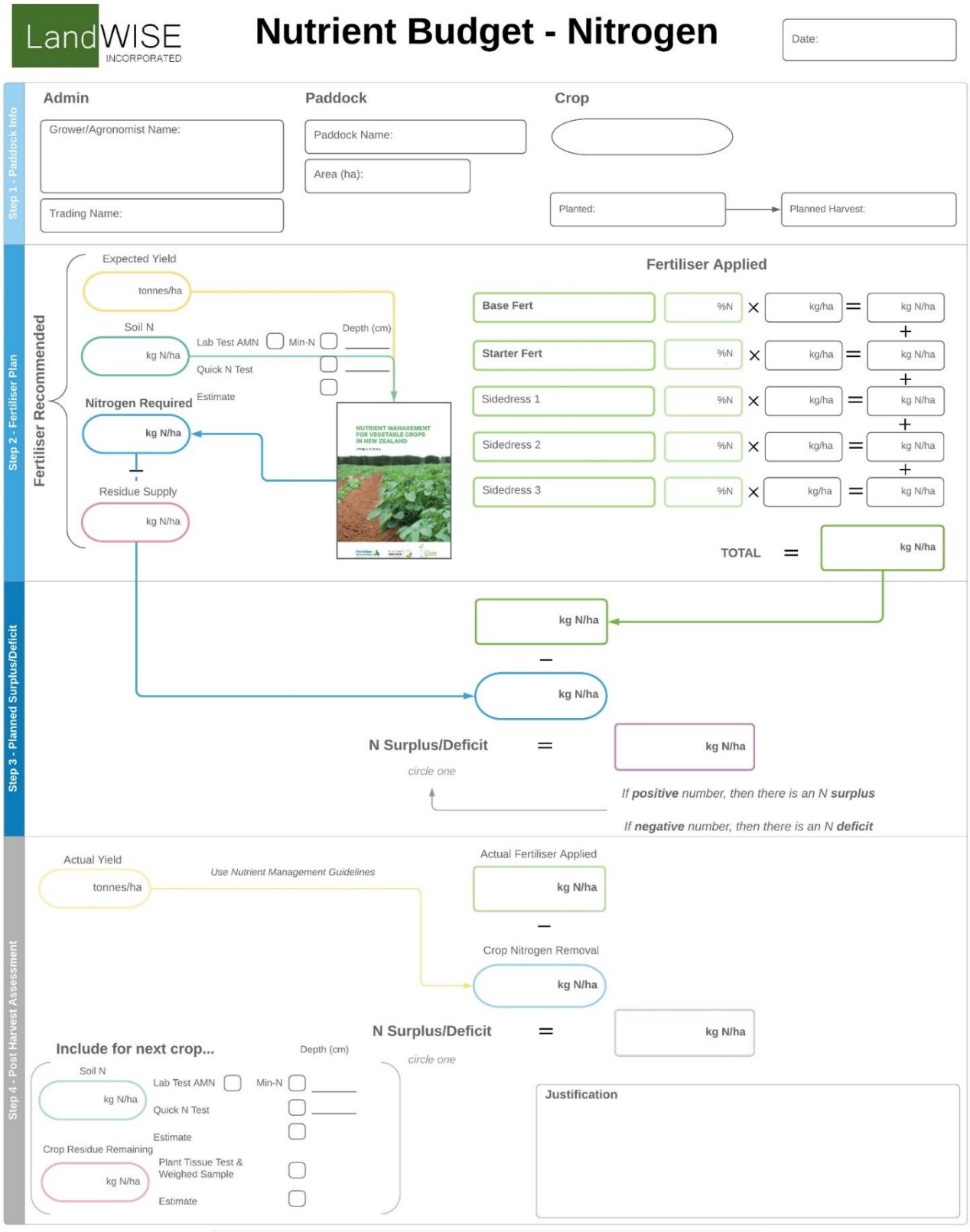
- Measures and evidence of a trajectory to:
    - Minimise nitrogen and phosphorus loss
    - Manage soil/sediment loss
    - Preserve or improve soil quality
- A Nutrient Budget

It was discussed that many growers did not have a nutrient budgeting tool for their particular crops, and that GDC would prefer to provide growers with an accessible tool, rather than necessitate hefty consultancy fees for the use of OverseerFM.

5. Appendices

5.1 Appendix 1 Nutrient Budget Forms

5.1.1 Nitrogen Budget Jan 20 Version



5.1.2 Phosphorus Budget Jan 20 Version

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Nutrient Budget - Phosphorus

Date:

Step 1 - Paddock Info

Admin

Grower/Agronomist Name:

Trading Name:

Paddock

Paddock Name:

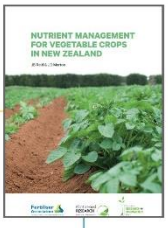
Area (ha):

Crop

Planted: → Planned Harvest:

Step 2 - Fertiliser Plan

Fertiliser Recommendation



Expected Yield: tonnes/ha

Available Soil P: Resin P ☐ Depth (cm) / Olsen P ☐ Depth (cm)

= Phosphorus Required: kg P/ha

If **0kg P/ha**, use **Crop Removal**

Crop Removal: kg P/ha

Fertiliser Applied

Base Fert	%P	× kg/ha	= kg P/ha	
Starter Fert	%P	× kg/ha	= kg P/ha	+
Sidedress 1	%P	× kg/ha	= kg P/ha	+
Sidedress 2	%P	× kg/ha	= kg P/ha	+
Sidedress 3	%P	× kg/ha	= kg P/ha	+

TOTAL = kg P/ha

Step 3 - Planned Surplus/Deficit

kg P/ha (TOTAL) − (% of Crop Removal: % × kg P/ha (Crop Removal)) = P Surplus/Deficit: kg P/ha

Circle one

If Available Soil P is **above optimum**, use only a fraction (e.g. 50 - 80%) of your crop's P removal or maintenance rate to **'mine' soil P**

If Available Soil P is **below optimum**, multiply Fertiliser Required by 120 - 150% to **raise soil P levels** through "capital application"

*If **positive** number, then there is an P **surplus,** and P will **accumulate** in soil*

*If **negative** number, then there is an P **deficit,** and P will be **mined** from soil*

Step 4 - Post Harvest Assessment

Actual Yield: tonnes/ha — *Use Nutrient Management Guidelines*

Actual Fertiliser Applied: kg P/ha

− Crop P Removal: kg P/ha

= P Surplus/Deficit: kg P/ha

Circle one

Justification:

Sustainable Farming Fund · Ballance · horizons regional council · LandWISE INCORPORATED · Gisborne District Council · Potatoes New Zealand

5.2 Appendix 2 Field Day and Workshop Handouts

5.2.1 FPVP Field Day Handout

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Future Proofing Vegetable Production Field Day

Woodhaven Gardens, Levin

With the support of

Vegetables NEW ZEALAND · Woodhaven GARDENS · Pescini Bros

Future Proofing Vegetable Production Funders

Sustainable Farming Fund · Ballance · horizons regional council · LandWISE INCORPORATED · GISBORNE DEVELOPMENT · Potatoes NEW ZEALAND

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Introduction

- Careful nitrogen management is essential to achieve good yields while minimising leaching
- Available nitrogen is highly variable within a paddock and over the season
- Keep the nitrate levels in your soil just right to keep plants growing and leaching to a minimum is about monitoring soil nitrate and applying N as needed.
- Appropriate soil sampling and testing lets you know how much N is available and needed
- Nitrate Test Strips can help measure how much N is immediately available to crops
- FAR's Nitrate Quick Mass Balance Tool predicts how much N might be required for the remainder of the season, based on expected yield

Achieving Good Yields

All plants need adequate nitrogen to grow to potential. Leafy greens with low nitrogen may not maintain the colour demanded by markets and consumers. The key is ensuring adequate supplies of N at all stages through the season. Calibrate equipment to ensure correct, even application.

Nitrogen take-up rates vary through the season, starting slow then rapidly rising as the bulk of plant growth takes place. Later the uptake slows or may stop. Depending on soil N levels at planting, some starter fertiliser may be needed. During the rapid uptake phase good supplies are essential and fertiliser is generally applied as a side or top dressing.

Minimising Leaching

To minimise the risk of N leaching, minimise Mineral N free in the soil and minimise drainage, which transports N from the rootzone to waterways. Having too much N in the soil (more than plants are able to take up) means N is available to leach when drainage occurs. More frequent, lower rates of fertiliser will provide for plants' needs and minimise leaching risk.

Avoiding fertiliser application to wheel tracks and other non-crop areas reduces the overall amount of fertiliser required and further reduces losses. Calibrate equipment to ensure correct, even application.

Growers can't control rainfall, but irrigation management can reduce the risk of drainage. Check irrigator uniformity (application evenness) and applied depth. Monitor soil moisture to avoid drought stress or drainage. Surface drainage that minimises ponding reduces leaching risk.

Alternative Application Methods

Many growers apply fertiliser direct to beds to avoid losses in wheel tracks. Because current equipment can only cover one bed at a time, they apply fertiliser in a single pass as is time consuming, creates ruts or may be very difficult in wet conditions.

Few growers use liquid N fertiliser because its availability is limited, and some have experienced leaf burn using foliar (leaf) applied liquid fertilisers. This should not occur if dilute sprays are applied. Several liquid systems that avoid or minimise leaf application are available and offer opportunity to make smaller, more frequent applications with minimal passes across the field.

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Y-Drop

A Y-Drop applicator can fit onto a spray boom setup and works best for row crops with a sturdy stem. Flow-rate control ensures even application of liquid fertiliser through two flexible hoses that drag along the soil close to the plant row. The idea with this system is to apply nutrient as close to the roots as possible whilst allowing for some movement within the crop row and soil level.

Y-Drop Applicator for Liquid Nitrogen

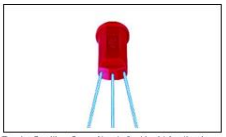
Dribble Bar

A dribble bar is a nozzle attachment to fit a standard spray boom. The nozzles apply a stream of large droplets at even spacings along the boom. The large droplets should roll off crop leaves to the soil where roots can access the nutrient. Each dribble bar is 40 cm long and can be twisted to apply fertiliser as a band.

Dribble Bar Applicator for Liquid Nitrogen

Fertiliser Nozzles

Fertiliser nozzles also apply liquid fertiliser as fine streams to minimise amounts remaining on leaves. These replace spray nozzles on any spray boom and can cover a large area quite rapidly depending on the water rate and tank capacity of the spray boom.



Tee-Jet Fertiliser Spray Nozzle for Liquid Application

Dry Fertiliser Alternative

Most growers use broadcast spreaders for crops with multiple rows on a bed because banding is impractical. A significant proportion of applied fertiliser ends up in wheel tracks wasting money and increasing losses to waterways.

Chain Driven Hopper for Solid Fert

Chain driven equipment has a chain belt in the hopper base and uniformly applies solid fertiliser granules. Machines using this system apply fertiliser uniformly over multi-row bed crops such as baby leaf greens. For crops with small root systems, application uniformity is even more important to ensure nutrient uptake.

Solid Fert Applicator for Bed Grown Vegetables

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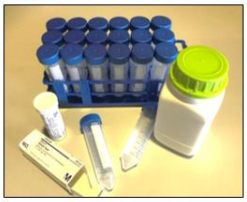
Quick N Test – How much N is available right now?

In order to manage soil nitrogen efficiently it helps to know how much N is available to your crop at the key growth stages, when plant demand for N is high. Nitrate Quick Test Strips allow you to test a sample from soil for nitrate levels and have results in 5 minutes.

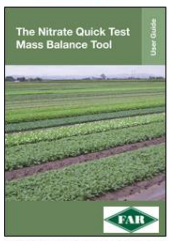


Test strips are also a cost effective solution for in-season soil testing as they work out to be about $1 per strip.

Nitrate Test Kits containing all the equipment needed are available from Lab Supply ($165 + GST)
https://www.labsupply.co.nz/nitrate-test-kit

How to use Quick N Test Strips

1. Collect a representative sample from soil (minimum 20 cores to crop rooting depth)
2. Mix soil sample well then pass through a sieve
3. Fill a 50mL test tube with 30mL of $CaCl_2$ solution
4. Top up with sieved soil to 40mL
5. Shake well for 2 minutes
6. Allow to stand until top 3cm of solution is clear and soil has settled (15 minutes – 1 hour)
7. Dip test strip into clear solution for 2 seconds
8. Wait 1 minute
9. Compare Test Strip with colour chart on the container (results in ppm Nitrate)
10. Convert ppm to kg Nitrate/ha using FAR's mass balance tool



Quick Test Mass Balance Tool
https://www.far.org.nz/articles/1231/quick-test-mass-balance-tool-user-guide

5.3 Appendix 2

5.3.1 FPVP Efficient Irrigation Workshop - Gisborne

LandWISE INCORPORATED

Future Proofing Vegetable Production
Efficient Irrigation Workshop
Gisborne

With the support of

LEADERBRAND Locally Grown

Future Proofing Vegetable Production Project Funders

Sustainable Farming Fund · Ballance · horizons regional council · LandWISE · Gisborne District Council · Potatoes New Zealand

LandWISE

What are we trying to achieve?

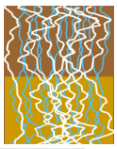
Improved irrigation efficiency
- Crop per litre
- Crop per dollar

Better system performance
- Water use efficiency
- Energy efficiency

Better irrigation management
- Correct scheduling
- Minimum environmental impact

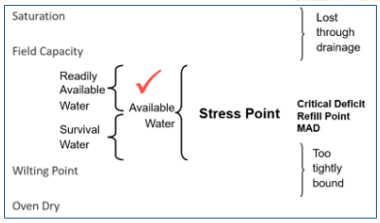
Understanding Soil Water

Soil is about half solids and half holes.



- Macropores (large holes) let water move the soil
- Micropores (small holes) hold water against gravity keeping it available for plants

Soil Water Terms



Available Soil Water

The amount of rain (or irrigation) the soil can hold for plants (mm /100mm soil)
- Difference between Field Capacity and Wilting Point (%)
- Encourage deep rooting: 300mm root depth has half water of 600mm roots

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LandWISE

Application Efficiency

What most people mean by "irrigation efficiency":

$$\frac{\text{Water Stored in Root Zone (mm)}}{\text{Total Water Applied (mm)}}$$

How much of the water you applied to the field was stored in the soil and available to plants?

Distribution Uniformity (DU)

How evenly is the water applied to the plants?
- Sets capacity for Efficient and Effective Irrigation

Low quarter uniformity, DU_{LQ}

- 7/8ths will get enough or more
- Raise DU_{LQ} from 0.70 to 0.90
- Water half as much again for same volume of water
- Or save one third of water and power

The Main Inefficiencies

Loss Component	Range	Typical
Leaking pipes	0-10%	0-1%
Evaporation in the air	0-10%	< 3%
Wind blowing water off target (drift)	0-20%	< 5%
Interception (canopy losses)	0-10%	< 5%
Surface runoff (spray irrigation)	0-10%	< 2%
Uneven Application and/or Excessive Application Depths and Rates	**5 - 80%**	**5 - 30%**

The biggest loss factors apply equally to drip/micro irrigation systems

Excess soil moisture drives nutrient leaching. Growers can't control rainfall, but irrigation management can reduce the risk of drainage.

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LandWISE

Irrigation Scheduling

Maximum Allowable Depletion
Readily available water is used up so irrigate

Readily Available Water
Held in soil, usable without plant stress

Irrigation Return Interval
Time between one irrigation and the next

Irrigation Calibration (Bucket testing)

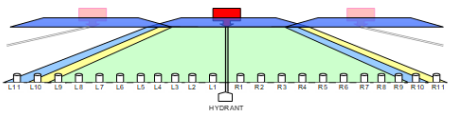
Quick assessment for farmers
- How much am I applying?
- Is it going on evenly?
- Is it going on too fast?

IRRIG8 Quick and IRRIG8 Lite

- How to make measurements
- Where to make measurements
- How to calculate key values

IRRIG8

- Guidelines
- Worksheets
- Calculator



Downloads from www.pagebloomer.co.nz/resources/irrigation-calibration/

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