

Future Proofing Vegetable Production Milestone 9 Progress Report



D Bloomer & L Posthuma

LandWISE Inc

30 September 2020

Table of Contents

1. Executive Summary.....	2
2. Introduction	3
3. Water Testing data available – farmers experiences documented	3
4. Supporting Groups and Growers	4
5. Summer Trials Planned	8
6. References	10

1. Executive Summary

This report describes progress made and deliverables met for **Milestone 9 Consolidating lessons from early work** of Future Proofing Vegetable Production completed on 30th September 2020.

As noted in the previous milestone report, we have been unable to find a regular flow of nutrient rich water that we can treat to manage nitrogen leaving the field. Further drain flow monitor through Levin has continued to show little nitrogen in the drains flowing past the cropping blocks so any nitrate losses are assumed to be via groundwater, possibly reappearing in the Arawahata Stream between the cropped areas and Lake Horowhenua.

As part of the suite of tools to help growers apply the right amount of fertiliser, we updated FertSpread to include Fertplace for placement equipment and we have created LandWISE Nutrient Budget templates. We are working with growers to ensure that they can use these tools, to ensure they apply the correct rate of fertiliser in the right place and minimise loss of excess nutrients from the field. The three main tools we are working with growers to adopt are:

- The LandWISE Nutrient Budget: used in the crop planning stage to ensure planned fertiliser practice follows industry good practice.
- The Nitrate Quick Test soil test: used as an active management tool during the crop to check the fertiliser plan and to validate additional fertiliser applications where the grower expects that extra fertiliser is required on top of what was originally planned.
- The calibration tools, FertSpread and FertPlace: used to ensure that the fertiliser application equipment is evenly applying the fertiliser at the target rate where it is required.

For the coming season we have started two large, replicated trials in Gisborne focusing on nitrogen application rates to tomato and sweetcorn crops. Late winter soil testing to 90cm has shown a large range of soil nitrate levels (60-257 kg N/ha) in paddocks across Gisborne. Planned nitrogen fertiliser applications across these blocks were the grower standard rate.

Further work that we are completing is making the LandWISE Nitrogen Budget template into an online app for growers to use. The aim is to create a mobile-friendly tool that growers can use in the field. By making the information available on the technology growers always have with them, they will be able to simply validate their planned fertiliser plan against industry good practice and make more informed fertiliser decisions.

Discussion groups and field walks associated with the various trials are to be scheduled over coming months.

2. Introduction

Our last round of water monitoring has shown the same trends as identified during earlier water monitoring in the project; low levels of nitrate nitrogen in the drains around the vegetable growing blocks, while monitoring at the lake end of the Arawhata stream have continued to show consistently moderate to high nitrate levels. This continues to reinforce the need to push the message that growers should apply appropriate rates of fertiliser on their crops to grow quality yield, while minimising leaching to the ground water.

A potato trial was harvested in July. The trial tested a claim of a biological product company that nitrogen applications could be reduced by 25% where their biological products were applied to the crop. Where the biological product was used as suggested, there was no clear impact on yield. Where fertiliser rates were reduced, the crop yield declined.

Under the current climate of pressure to reduce nutrient usage, growers are keen to try using less fertiliser to grow their crops. We have found many alternative products that come with claims of the potential to reduce fertiliser usage while maintaining yield. From the on-farm trials we have been completing with growers, the key message is the importance of applying the correct rate of fertiliser in the right place to grow the planned crop – using a precision prescription and applying the fertiliser evenly where it is desired.

Over the last three months, we have spent time working with growers to complete further nutrient budgets. We have also started working with growers to understand how to better understand crops not currently covered in the “Nutrient Management for Vegetables in New Zealand” guidelines. Along with that, we have spent considerable time working with growers to support them to use the Nitrate Quick Test strips to inform nutrient management and side-dressing decisions over winter.

A further project has been to collect deep soil tests in late winter in paddocks left fallow over winter follow either a process sweetcorn or tomato crop in the 2019-2020 season. This has shown a wide range (60-257 kg N/ha) of soil nitrate levels in the top 90cm.

Over the coming summer, we are setting up a two large, replicated trials to test compare grower practice with industry good practice in both process sweetcorn and tomato crops. The sweetcorn trial involves testing the use of a Nitrate Quick Test prior to side-dressing to target the nitrogen application rates. This trial involves 12 paddocks from many growers across Gisborne. The trial will include early, mid and late season crops following a range of previous land-uses. The tomato trial will include four paddocks and seeks to validate the current industry good practice recommendations.

3. Water Drain Testing

We have continued monitoring drain water nitrate levels throughout the catchment using the Nitrate Quick Test strips. A full survey of the Arawhata catchment completed on the 22nd September 2020 following a large rain event again showed low nitrate levels throughout the catchment except for at the Hokio Beach Road bridge over the Arawhata stream. This has been further backed up by work completed by a local grower giving similar trends during and after recent rain events.

4. Supporting Groups and Growers

Over the course of the last three months, we have spent time with growers in Palmerston North and Hawke's Bay as well as Levin and Gisborne, helping them complete nutrient budgets and work through making fertiliser decisions using the nitrate quick test.

A typical grower visit will include sitting down in the packing shed with a grower and working through their soil test reports and completing a couple of nutrient budgets. This has been useful to show the challenges growers face completing the nutrient budgets for their less-common crops.

A follow up visit will then include going into the paddock where we have completed a nutrient budget, collecting a nitrate quick test with the grower, and helping the grower work through the test result to make a nitrogen application decision. We will then go and calibrate the grower's fertiliser equipment in yards, so that the grower can confidently apply the planned amount of fertiliser evenly in the paddock.

On a subsequent visit or through phone calls, we support the growers continue to gain confidence using these tools on their own properties. This can include sitting down and working through odd crops situations where the grower is confused. Without this support, we notice a fall of in use of these tools.

4.1 Grower Trials

We harvested our last trial from last summer; a potato crop trial using biological products to reduce the nitrogen requirements. The trial tested a claim of a biological product company that nitrogen applications could be reduced by 25% where their biological products were applied to the crop. The trial included four replicates and tested both using a lower rate of fertiliser and using the biological products on both fertiliser treatments. Where the biological product was used as suggested, there was no clear impact on yield. Where fertiliser rates were reduced, the crop yield declined. We are waiting on a peer review of the results by Plant and Food before publishing the actual results.

Over the same period, we setup two on-farm trials comparing Smart-Fert Slow release urea fertiliser applied to winter cauliflower and broccoli crops at transplanting compared to a split side-dressing application of Nitrophoska Perfect. Both of these trials have been stopped due to tractor error making the results invalid. However, the trial has been a great way to engage with the grower around using replications in on-farm trials, and on the use of nitrate quick test to measure soil nitrogen levels.

A planned trial with a micro-green grower was cancelled due to continual difficulty accessing the grower due to risk aversion with Covid. The trial was planning on comparing the standard grower practice to using the nitrate quick test to target nitrogen applications to match plant demand. After repeated delays, we worked through over the phone how to use the nitrate quick test and will hope to have achieved a similar outcome – with the grower having a tool to target nitrogen applications where required rather than continually applying nitrogen when it is potentially not required.

4.2 Nutrient Budgets

From further use of the nutrient budgets with growers, we have simplified some terms to create less confusion. After meeting with Bruce Searle from Plant & Food Research, we are in the process of further reviewing some of the terms.

The nutrient budgets serve three key purposes: to get growers reading their soil tests, to get growers to look up the "Nutrient Management for Vegetables in New Zealand" guidelines, and to use that data to compare their current fertiliser practice to what is considered good practice.

Using the phosphate nutrient budget, the smaller market garden growers are realising that they have very high Olsen P soil test levels, and that they are often applying 2-4 times more phosphate than the crop is removing from the paddock – leading to a continual increase in their soil test values. They see that the good practice guidelines in “Nutrient Management for Vegetable Crops” recommend that they do not apply any additional phosphate.

Having a post-harvest review section prompts growers to record and calculate what they actually applied to a particular crop. This step also encourages growers to soil test after their crop to validate their fertiliser application rates. This shows if their current fertiliser practices are leaving a high level of residual nitrogen in the soil after harvest.

All the growers that we are dealing with have fertiliser records, but they can be difficult to interpret. By having the growers complete their own nutrient budgets, they use their records more which is a further incentive to keep them more organised, allowing easier auditing later if required.

4.3 Nutrient Budgeting – Crop Selection

To complete a nutrient budget using the LandWISE template, growers need to know their typical yields (t/ha), have a soil test that includes the “potentially available Nitrogen” soil test, and have the *Nutrient Management for Vegetable Crops in New Zealand* guide. To review their fertiliser practices for a particular block, growers need to have fertiliser records for each crop in each block, an estimate of the crop left in the paddock, and a soil test following harvest.

Below is a list of common crops in New Zealand. For the most common crops, the *Nutrient Management for Vegetable Crops in New Zealand* guide outlines good nutrient management practice. There are however an equally large number of crops that are commonly grown in New Zealand on a smaller scale and there are no clear industry guidelines on good practice for fertiliser use in these crops.

Table 1. List of common vegetable crops grown in New Zealand

Nutrient Budgets for common crops in New Zealand	
<i>Good Practice from "Nutrient Management for Vegetable Crops"</i>	<i>Good practice not currently defined</i>
Broccoli	Baby Greens
Cabbage (white)	Bok Choy
Cauliflower	Choy Sum
Squash	Wongbok
Carrots	Coriander
Beans	Fancy Lettuce
Lettuce	Fennel
Onions	Garlic
Peas	Leek
Potatoes	Spring Onion
Spinach	Parsley
Silverbeet	Radish
Beetroot	Crown Pumpkin
Sweetcorn	Watermelon
Tomatoes	Zucchini

We believe there is a major gap in information to guide growers in best practice for these other crops. The notes on how to estimate good practice fertiliser rates for crops not currently within the Fertiliser guidelines are:

- ✓ Estimate crop N uptake = (Harvested Yield x N%) + (Residue Yield x N%)
- ✓ Measure soil nitrogen within the active root zone
- ✓ Subtract “Crop N Uptake” from “soil nitrogen” to estimate how much fertiliser is required.

This simple equation ignores the fact that fresh green vegetables often have shallow root zones and are harvested while they are rapidly growing. If growers were to “use” all the nitrogen in the soil for their crop, they are likely to have a crop failure due to the crop having poor colour or visual imperfections.

Research published in Europe has shown a range of target minimum soil nitrogen levels at harvest for various crops ranging from 0 kg/ha to 50 kg/ha over the crop rooting depth.

4.4 Nutrient Budgeting – Online Nutrient Budget

We are working on an online app version of the LandWISE Nutrient Budget calculator. The tool will include all the crops from the *Nutrient Management for Vegetable Crops in New Zealand* (refer to Table 1). If a crop is not included in the drop-down list, the grower will be able to add their own custom crops.

The aim is to create a mobile-friendly tool that growers can use in the field. With the information available on the phones they always have in the field, growers will be able to simply validate their planned fertiliser plan against industry good practice. The tool will also create a digital record that growers can then easily export and share for compliance purposes as required.

4.5 Nutrient Accumulation in Cover Crop

We have measured yield across a couple of cover crops being grown in Hawke’s Bay and had plant samples tested through the lab. The crops were planted in Autumn and were about to be incorporated in late August.

The lab test reports the sample dry matter content and the nutrient content as a % of dry matter. Use the following formula to convert from “% dry weight” to “kg/tonne fresh weight”.

$$\text{Kg Nutrient / tonne Fresh Weight} = \text{DM \%} \times \text{Nutrient \%} / 10$$

Table 2. Cover Crop Nutrient Accumulation

Crop Type	Plant Height (m)	Yield (t/ha)	DM %	N kg/t Fresh Weight	P kg/ha	N kg/ha	P kg/ha
Oats	0.8	55	7.9	2.1	0.24	117	17
Caliente Mustard	1.3	49	16.1	4.0	0.48	198	15

*In this sample, the mustard was in full bloom. The oats were still vigorously growing.

The above suggests that where a catch crop is required, Caliente mustard is an effective crop at scavenging nitrogen from the soil. However, mustard is part of the brassica family and susceptible to club-root. Where brassicas are included in the vegetable rotation, disease risk should be factored into the cover crop that is chosen.

4.6 Using the Nitrate Quick Test

Work using the Nitrate Quick Test to inform nitrogen management decisions has been ongoing.

The FAR Nitrate Mass Balance tool works well to estimate how many kg / ha of nitrogen is in the soil for a given day – however, it gives crop growth over a fixed period and the definition of yield is often poorly understood by growers.

Using the tool with vegetable growers in Levin, we have found that it typically recommends growers apply higher rates of fertiliser than they are currently using. A second issue we have found is that growers cannot change the growing length of a crop. For example, the lettuce crop in the FAR tool is a summer crop growing relatively quickly and the nitrogen uptake graph is not appropriate for winter production.

The calculator is likely to work well for sweetcorn if growers' sample to the rooting depth – we would suggest this is approximately 90+cm prior to side-dressing. The calculator estimates how much nitrogen the crop will actually use, and how many kg of nitrogen is in the soil. There are particular instances when it must be treated with caution – sweetcorn yields for IVF and powder are different. Powder crops are harvested slightly earlier while the yield is still increasing. We plan to make measurements over this summer to measure likely yield differences when sweetcorn is harvested for different purposes.

The Nitrate Quick Test has three uses for in-season nitrogen management:

1. Testing the soil nitrogen level before a planned side-dressing to validate the fertiliser recommendation
2. Testing soil nitrogen levels after heavy rain events to assess whether there is still sufficient nitrogen in the active root zone.
3. Testing to the final rooting depth of a crop to validate a fertiliser plan by measuring how much residual nitrogen remains in the soil at harvest.

Using the Nitrate Quick Test, a general “rule of thumb” would be that where the Nitrate Quick Test result is at or below 10ppm in the rooting zone, additional fertiliser is required. Where the Nitrate Quick Test is 20ppm, there is less urgent need for additional fertiliser (there is still some nitrogen in the tank). The grower should estimate how much nitrogen the crop still needs to use. If the Nitrate Quick Test comes back at 50ppm or higher, there is a large surplus of nitrogen in the soil and the crop is unlikely to need additional fertiliser inputs.

4.7 Soil Nitrate Levels at the end of Winter

Winter rainfall was relatively low in Gisborne this year so leaching was less than usual.

Deep soil tests taken from a range of blocks in early spring showed that there are wide range of residual nitrogen levels in the soil. This further demonstrates the need to complete deep soil testing to measure soil nitrogen and manage nitrogen applications. In some cases there is already sufficient nitrogen in the soil profile and no more is required.

Gisborne Post Winter Nitrate Quick Test Results

Sample Depth <i>cm</i>	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7
	<i>kg N/ha</i>						
0-30	41	58	12	58	41	22	71
30-60	23	88	23	23	94	16	39
60-90	98	92	43	24	122	22	23
Total (0-90cm)	162	238	78	105	257	60	133

5. Summer Trials Planned

5.1 Gisborne Sweetcorn Trial

Sweetcorn Summer Trial Question:

“Does the Nitrate Quick Test allow growers to determine the optimum nitrogen requirement to be applied at side-dressing?”

The purpose of the trials will be to validate the FAR Nitrate Mass Balance calculator. There has been pushback from growers due to pre-side-dress testing due to the time it takes for the soil test results to return from the lab, and not knowing what to do with the soil test results they receive. This replicated trial will assess the suitability of the Nitrate Quick Test and the associated calculations to give growers a timely fertiliser recommendation.

The trial will include twelve replications in Gisborne.

- ✓ 4 x October Planted
- ✓ 4 x November Planted
- ✓ 4 x December (want four crops double cropped with peas) Planted

Time Frame	Work Schedule
2 weeks prior to planting	Soil test to 15cm and nitrate quick test to 90cm Complete Nutrient Budget – both N and P
Planting	Record: Date Hybrid Population Starter Fertiliser type and rate
Emergence	Date
V1	Population Count
V4	Mark four plots – GPS position Pre-side dressing Nitrate test to 90cm divided in 30cm intervals in two replications per trial.
Side-Dressing	At side-dressing, apply the grower practice to the majority of the paddock, apply an adjusted fertiliser rate based on the nitrate quick test recommendation to a double pass of the side-dressing equipment in one area of the paddock.
VT	Tasselling date for both treatments in each plot. Note presence of weed pressure.
Harvest	Record Yield from both treatments (2 rows x 3m strip pick x 4 replications) Note any incidence of lodging Record cob quality parameters Soil Test to 90cm in two replicates in both treatments. Measure wet weight, dry matter, Nitrogen and phosphate sample of both marketable yield and crop residue from each block for each treatment.

5.2 Tomato Fertiliser Trial

Tomato Trial Question

“Are the Vegetables NZ Nutrient Guidelines valid for Gisborne tomato process crops?”

Based on trial work completed by Plant and Food Research in the early 2000’s, growers are currently applying significantly more nutrients than is considered good practice. The guidelines are published in the HorticultureNZ book, *Nutrient Management for Vegetable Crops in New Zealand*. This collaboration with growers will compare on their own farms, grower practice with the published nutrient guidelines. A further output will be measured nitrogen levels remaining in the soil following these “typical” tomato crops.

The trial will include four replications being each of four crops grown in Gisborne.

Time Frame	Work Schedule
Prior to planting	Soil test to 15cm and nitrate quick test to 90cm Complete Nutrient Budgets – both N and P
Planting	Record: Date Hybrid Population Starter Fertiliser type and rate
1 week prior to side-dressing	Pre-side dressing Nitrate test to 90cm divided in 30cm intervals in two replications per trial. Attempt to miss any fertiliser application bands directly under the tomato plants
Side-dressing	Apply a current grower practice on the majority of the paddock. Apply “good practice” to two side-dresser passes in one area of the paddock
Row Closure	Count percentage of plants with set fruit. Use Canapeo to monitor green leaf area on each plot under both treatments. Monitor for weed, pest and disease pressure.
Harvest	Measure yield as both red fruit and green fruit (2 plants x 4 replicates x 2 treatments). Divide the fruit as green and red fruit Measure fruit quality with one representative fruit sample from each treatment at each block through Cedenco Quality Lab. Soil Test to 90cm in two replicates in both treatments. Measure wet weight, dry matter, Nitrogen and phosphate sample of both marketable yield and crop residue from each block for each treatment.

6. References

- Reid, J. B & Morton, J. D. (2019). *“Nutrient Management for Vegetable Crops in New Zealand”*. Horticulture New Zealand on behalf of Vegetables Research and Innovation Board and Fertiliser Association of New Zealand, Wellington.
- Sullivan, D. M., Ameloot, N., Sullivan, C., & Brewer, L. J. (2019). *OSU Organic Fertilizer & Cover Crop Calculator: Predicting Plant-available Nitrogen Why use the OSU calculator? Oregon State University Extension Service*. May, 1–19. www.oregon.gov/oda/programs/pesticides/