LandWISE INCORPORATED

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Future Proofing Vegetable Production Milestone 10 Progress Report

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1. Executive Summary

This report describes progress made and deliverables met for **Milestone 10, Confirmation of new good practice guidelines** of Future Proofing Vegetable Production completed on 31th December 2020. Due to not finding nitrogen earlier in the drainage network through Levin, the nitrogen mitigation portion of the project was redirected to updating the FertSpread calibration page for side-dressing equipment to ensure the correct rate of fertiliser is applied in the right place.

A significant portion of the work completed over the last three months has involved setting up replicated nitrogen application trials on twelve different grower's paddocks. The trials are to further validate using soil tests, nitrate quick tests and the associated FAR Nitrate Mass Balance tool to make informed fertiliser application decisions. The focus of the trials over the summer have been to get growers trying out new decision support tools in their operations and to see how the tools can work across their own blocks.

Over the next month, field walks across the trial blocks are planned with the wider growing community to reach as many growers as possible. Whether using the Vegetables NZ Nutrient Guidelines for tomatoes or the FAR Nitrate Mass Balance tool for sweetcorn, using a soil test and a decision support tool to make fertiliser decisions has resulted in a significant reduction in the nitrogen being applied on all but one trial block.

Figure 1. Sweetcorn at V3 prior to side-dressing

2. Introduction

Over the past few months, nitrogen application rate split paddock trials in tomato and sweetcorn crops have been established through Gisborne and Hawke's Bay. The trials are focused on answering the questions "Are the Vegetables NZ Nutrient Guidelines valid for NZ tomato process crops?", and "Does the Nitrate Quick Test allow growers to determine the optimum nitrogen requirement to be applied at side-dressing for sweetcorn?".

Work completed to date has shown that using the "Nutrient Management for Vegetables in New Zealand" guidelines and Nitrate Quick Tests with the FAR Nitrate Mass Balance tool could lead to a substantial reduction in the average rate of nitrogen applied across these crops. Where soil tests indicate large concentrations of nitrate-N in the soil prior to applying nitrogen fertiliser, reduced nitrogen applications will help to reduce excess nitrogen left in the paddock after a crop. Having less residual nitrogen in the soil will lower the potential for nitrate leaching when high rainfall and drainage events occur.

Concerns has been noted that growing peas could increase the leaching risk for subsequent crops due to peas being a Legume and fixing nitrogen. Crop residue samples collected in November 2020 indicate that a pea crop can take up close to 500kg N/ha. Where the pea straw is baled, the majority of the crops' nitrogen is removed from the paddock.

Across the four paddocks sampled after a pea crop harvest residual nitrogen levels were low. It is likely the pea crop used all the nitrogen in the soil to grow the crop. When the straw is incorporated back into the soil, some of the nitrogen in the crop residue will mineralise and become available for the subsequent crop and this should be factored into any side-dressing decisions.

The main portion of work over the following few months will be completing the nitrogen trials with the growers and to discuss with growers how they can take these results forward on their properties next season. A key focus of the trials is to get growers using soil tests to make more informed side-dressing decisions across their crops. A priority will be to ensure growers gain enough confidence from the results of this year's work on their properties that they start to trust soil tests and know how to use them for future management decisions and actions.

Figure 2. Tomato Fertiliser Side-Dresser/Herbicide Cultivator

3. Grower Engagement

Over summer, we are conducting trials on six tomato blocks and twelve sweetcorn blocks across Gisborne and Hawke's Bay looking at nitrogen application rates. The trials have been setup with twelve different growers. The purpose of the trials is to validate and coach growers on their own properties in using new tools that are available to help them make more informed nitrogen application decisions.

With the growers, soil tests are being collected and being used to make side-dressing decisions. With the operators, we are calibrating fertiliser application equipment before side-dressing to ensure the correct fertiliser rate is being applied the desired area. Regular conversations with the growers prior to each application has achieved a high level of engagement, with growers often keen to see if their higher fertiliser areas are going to out-yield the areas where application rates have been reduced in-line with their soil test and recommendations from decision support tools.

In Levin, further work has been done to support growers, helping collect and make side-dressing decisions from nitrate quick test results, and to complete nutrient budgets. One significant barrier we had identified to getting growers to collect soil samples was the lack of soil sampling equipment that can sample below 15cm. Most growers have purchased nitrate quick test kits and completed a few tests but struggle to collect the soil samples. Through a grower and Engineer in Palmerston North, we are having ten soil sampling probes made for growers that have indicated that they are keen on purchasing one.

Through a connection with the Sustainable Vegetable Systems (SVS) project being run by Plant and Food Research, data that we collected to complete nutrient budgets on Shanghai Bok Choi has been used to build the vegetable plant sub-model for Overseer. We are pleased that by working with growers to better understand some less traditional vegetable crops, collected data can be shared to help build baseline information and to inform researchers.

Figure 3. Asian Brassica crops in Levin

Figure 4. Calibrating Fertiliser Spreader

3.1 Tomato Trials

In our work with growers, we noted hesitation to use the "Nutrient Management for Vegetables in New Zealand" guidelines for tomatoes. Growers' past experiences have shown that reducing nitrogen application rates causes plants to be 'more yellow' and to have reduced yields.

With additional support from Process Vegetables NZ, we are working with four large tomato-growers to test reducing nitrogen rates in plots across six different blocks (refer to Table 2). The aim is to help inform growers whether they can rely on a soil test and the current tomato recommendation models published by HortNZ.

Six split paddock trials (four in Gisborne and two in the Hawkes Bay) have been set up with a standard soil test and replicated nitrate quick soil tests being taken from each block.

Figure 5. Transplanting Tomato Trial

Overwinter, the blocks have either been winter fallowed (Blocks 1, 4, and 5), planted in ryegrass (Blocks 2 & 3), or in autumn sown vegetables (Block 6). As shown in Table 1, the winter fallow paddocks had substantially higher residual nitrogen in the soil at the time of crop establishment than those where a crop had been growing.

Standard soil samples were collected prior to planting for all the blocks.

Table 1. Nitrate Quick Test Results prior to planting Tomato trial blocks

Sample Depth *cm*	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
	kg N/ha					
0-30	74	10	0	74	28	20
30-60	56	0	0	56	13	21
60-90	51	0	0	57	31	5
Total (0-90cm)	***181***	***10***	***0***	***187***	***72***	***46***

Based on soil tests and the "Nutrient Management for Vegetable Crops in NZ" guide, nitrogen application rates of between 0-50kg N/ha were required to complete crop growth. This is substantially lower than rates currently being applied by growers (90-192 kg N/ha) which growers are applying to replace expected crop uptake of between 200-300 kg N/ha.

Table 2. Comparative Nitrogen Application Rates at the Six Tomato-Trial blocks

	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
	kg N/ha					
Grower Practice	137	192	192	192	90	126
Trial Rates	56	56	56	56	27	24
Recommended N	***20***	***0***	***0***	***50***	***20***	***0***

For the trial, nitrogen application rates in monitor plots were reduced as feasible. Where prilled fertilisers (e.g. Yaramila Complex) were being used, custom blends were made to include all the nutrients except for the nitrogen.

At harvest, yield and fruit quality will be measured and compared between the grower standard treatment and the reduced nitrogen treatments.

3.2 Sweetcorn Trials

In Gisborne and Hawke's Bay, twelve split paddock trials have been setup to validate using Nitrate Quick Test strips and the FAR Nitrate Mass Balance tool to manage side-dressing rates in sweetcorn. Across the paddocks, we have taken a standard soil test in the top 15cm and a nitrate quick test down to 90cm (0-30cm, 30-60cm, and 60-90cm). The trial this year is comparing the current grower practice with side-dressing based on using the nitrate quick test results.

Across the six fields side-dressed so far, just one block required side-dressing when using the nitrate quick test results. Over the next two weeks, the remainder of the paddocks will be soil sampled and side-dressing rates determined for each paddock based on the nitrate quick test results.

Table 3. Calculated post-harvest Nitrogen Surplus/Deficit pre side-dressing

	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
	kg N/ha					
Nitrogen Surplus/Deficit	178	11	(- 117)	347	186	65

The typical side-dressing rates for sweetcorn crops is between 250-350 kg/ha of Urea (115-161 kg N/ha). Block 3 was in annual ryegrass over winter and had very little nitrogen left in the soil after ploughing the grass back in. Assuming that the FAR Nitrate Mass Balance tool is correct, side-dressings for Sweetcorn could be significantly reduced if growers were to targeted paddocks based on a soil test.

Figure 6. Population Counts on Sweetcorn

Figure 7. Deep Nitrate Quick Test sampling pre side-dressing

3.3 Peas

It is a reasonably common practice to double crop early process pea followed by a late sweetcorn crop. As peas are a legume, they fix their own nitrogen and do not typically require any fertiliser. In the nitrate quick test trial, four late-planted sweetcorn crops follow process pea crops. We are monitoring these four paddocks to assess whether side-dressing rates should be considered differently when compared to winter fallow ground or recently ploughed pasture.

The paddocks sampled soon after harvesting the peas, there was little nitrogen left in the soil in any of them (Table 4). The growers suggested that as peas are a legume, they fix nitrogen in the soil which could be around for the subsequent crop. Peas are able to fix their own nitrogen, but it is likely they use the majority of that nitrogen through the development of the pea crop with little remaining in the soil after the crop is harvested.

Table 4. Nitrate Quick Test Results following Process Peas.

Sample Depth *cm*	Block 9	Block 10	Block 11	Block 12
	kg N/ha			
0-30	0	0	12	0
30-60	0	0	12	11
60-90	33	11	11	31
Total (0-90cm)	33	11	35	42

Crop residue samples were collected from 1m^2 plots in trial blocks 11 and 12 at pea-harvest. These two paddocks had similar yields (7.5-8.4 t/ha) and the nutrients removed in the yield would be similar. As shown in Table 5 and Table 6 however, a significant difference in dry matter (DM) yield of straw resulted in a large variation in the total nutrient removal from the paddock when the straw was baled and sold. Where the pea straw is not baled and removed from the paddock, a significant amount of nitrogen could become available and should be factored into the side-dressing decision through a pre side-dressing soil test.

Table 5. Block 11 Nutrient Removal

	N	P	K
	kg/ha		
Yield (7.5 t/ha)	75	8	23
Crop Residue (15 t DM/ha)	420	38	360
Total Nutrient Removal	*495*	*45*	*383*

Table 6. Block 12 Nutrient Removal

	N	P	K
	kg/ha		
Yield (8.4 t/ha)	84	8	25
Crop Residue (6.1 t DM/ha)	171	62	140
Total Nutrient Removal	*255*	*71*	*166*

Figure 9. Pea Residue Sampling

Figure 8. Pea Harvesting at LandWISE MicroFarm (6.1 t DM/ha crop residue)

4. Planned Activities

Over the next month, field walks in Levin and Gisborne are planned to further extend the work across the growing community. Through our work with growers in Gisborne with the Future Proofing Vegetables project, we have helped spearhead a GAP EMS workshop series to support vegetable growers completing Farm Environment Plans, due by May this year for the Gisborne District Council. Through the on-farm trials being run with growers in Gisborne, growers have been engaged in looking at ways to further improve their own nutrient use efficiencies across their operations.

Monitoring crop development and harvest measurements should be complete by late April. As trials are harvested growers will be given the specific details for their own blocks, and the data from all the crops will be anonymised and distributed around the wider growing community.

Our goal is for growers to have confidence in using soil tests and decision support tools to help them make informed side-dressing decisions for the following seasons. Taking the results of the on-farm trial work we have completed to date across further regions could add significant value for little extra cost and we are currently looking into ways to extend the current project to additional regions.

Figure 10. Woodhaven Gardens Ballance Farm Environment Awards Field Day

5. 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.

Mathers, D., Norris, M., & Hunt, A. (2019). *The Nitrate Quick Test Mass Balance Tool*. https://www.far.org.nz/assets/files/blog/files//e7b9c43f-c4f6-52cb-b0f9-1e9e6539bb91.pdf Accessed 28 March 2020