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ENVIRONMENTAL CHALLENGES FACING INTENSIVE HORTICULTURE

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Abstract

Intensive horticulture faces environmental challenges from weather events as does any farmer. Notably however, the consequences can be severe from relatively minor events. Farmers accept and manage these risks, which are predicted to increase with climate change. Changing social expectations add a layer of complexity; consumers wanting year round supply but less environmental impact, loss of high value soils to urban development forcing greater intensification, and communities' desires for higher water quality and reduced extraction.

Intensive horticultural production does have a significant environmental footprint. Numerous studies find high leaching rates from vegetable production, and the Arawhata Stream has one of the highest nitrate levels in New Zealand. A look around the world quickly identifies nitrogen losses to water are a global problem, and the situation here is not significantly worse than most other places.

The Overseer™ tool is prescribed in rules governing intensive horticulture in the Manawatu-Whanganui region. Aspects of the tool make it difficult and costly to use for intensive horticulture but it is at this stage compulsory. Growers have concerns about the cost and the need for confidential information to be protected.

Under MPI SFF project, "Future Proofing Vegetable Production", LandWISE Inc. is working with vegetable growers in Arawhata and Gisborne 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.

Environmental Challenges

An intensive horticulture producer faces environmental challenges from weather events as does any farmer. Notably however, the consequences can be more severe from more minor events. A hail mark on grass makes no difference to a consuming cow but renders a fruit or fresh vegetable unmarketable or fit only for low value processing (Figure 1). Flood or drought may temporarily stop growth in pastures but write off a vegetable or fruit crop. Even prolonged rain can enable critical levels of disease development that destroys an entire crop. Farmers accept and manage these risks which are predicted to increase with climate change. Increasing weather turbulence is a major threat.

Figure 1. Environmental damage: On left, hail damage leaves lettuce unsaleable, on right, uncontrolled flash flooding destroys crops and removes valuable topsoil to waterways.

Changing social expectations add a layer of complexity. Consumers have come to expect year round supply of most fresh produce. Most fresh vegetables are locally produced because the time frames and cost for transport make importing impracticable.

Winter production is particularly difficult as cold temperatures, higher rain and wet soils make it difficult to establish, manage and harvest crops. The same conditions make nutrient leaching more likely however communities are less tolerant of nutrient losses degrading water quality.

In summer, access to water is critical with severe consequences from short stress periods, yet communities want less extraction and higher in-stream flows. More regular high rainfall events are likely to increase sediment runoff and leaching as well as crop damage.

One approach is to reduce intensification to reduce the per hectare impact on the environment. Perversely however, the ongoing loss of high value soils to urban development forces greater intensification. Even on-farm, the increase in set-aside buffers to manage sediment at phosphate loss to drains and waterways removes productive land, effectively increasing land values, and further driving intensification pressure (Figure 2).

Figure 2. Before and After: Increasing buffer strip widths and set-aside areas forces increasing intensification on remaining land to retain economic production levels

The response of central and regional government to environmental stresses has been to increase regulation and set environmental limits that are generally output related. The reasoning for limits is understood but the limits are, in some cases, seen as impossible to achieve.

To gain consent to continue growing vegetables under Horizons Regional Council's "One Plan", Manawatu growers have a 26kgN/ha/year leaching limit based on Overseer™ nutrient analysis. This is an attempt to improve water quality, and in the Arawhata case in Lake Horowhenua. Growers in Gisborne have no requirement to meet any Overseer™ budget level which creates a competitive disparity between regions.

Impacts are Real

There are challenges and available information does indicate vegetable production is "leaky".

Land and Water Aotearoa (LAWA) data show the Arawhata Stream at the bottom of the main Levin vegetable growing area is one of the most affected by high nitrates, with its 5 year mean nitrogen monitored at 10.9 g/m^3 (Figure 3).

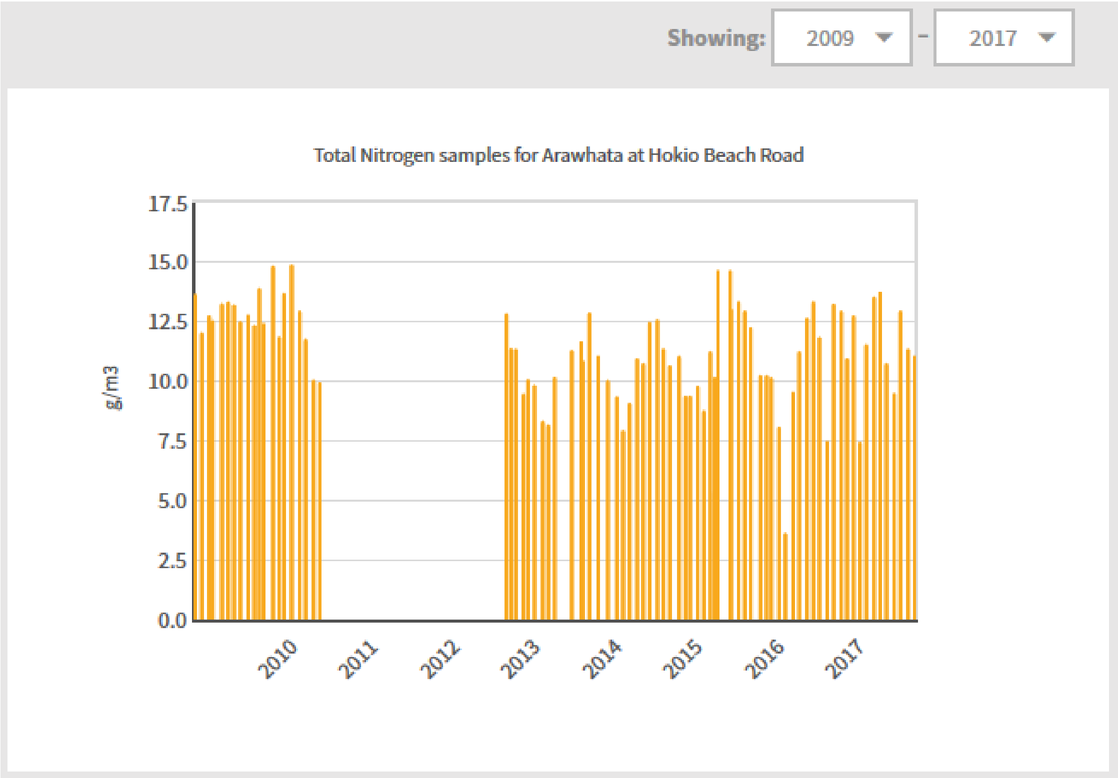

Figure 3. Total nitrogen levels recorded in Arawhata Stream at Hokio Beach Road show consistent very high levels frequently above 10 g/m³ (Horizons Regional Council monitoring; from LAWA website)

The available data from fluxmeter monitoring on one vegetable farm does show high leaching (Anon. 2018) across five years with all measurements generally high.

So, there is an issue. The question is, "What are we going to do about it?".

The challenges are not new, not unique to a farm, catchment, region or to New Zealand (Crush et al 1997, Francis et al 2003, Fenemore, Price and Green 2016). A look around the world quickly identifies nitrogen losses from intensive horticulture to water are a global problem, and the situation here is not significantly worse than most other places (Goulding 2006, Agostini et al 2010, Feaga and Selker 2004).

Solutions are Evasive

Buman (2017) speaking of corn production in the US Midwest states that, if all farmers did all the right things – the right product at the right rate in the right place at the right time – it would reduce leaching by about 15%. The reduction needed is 45%.

In Arawhata, the reduction needed to comply appears to be about 60-80%. Farmers are currently applying recognised Good Practice. If all the current Best Practices are applied, the leaching levels will still be high. What else can be done?

If local production is stopped, pollution is effectively exported and local economies severely impacted. Do we buy from Queensland and contribute to the decline of the Great Barrier Reef?

At present the methodologies by which outputs (nutrient losses) from intensive horticulture are determined are expensive and questionable. There are very limited fluxmeter or other measured data and these tools are very expensive. There is, therefore, a reliance on modelling, which tends to show high losses (Crush el al. 1997, Fenemore, Price and Green 2016).

The modelling for fresh vegetable production in the prescribed budgeting tool Overseer™ is not well understood and for horticulture there is very limited calibration. The model is based on monthly timesteps, but in fresh vegetable production crops can be planted and harvested within weeks. Growers are splitting some fertiliser applications to put on three or four applications at two to three week intervals. Overseer™ only allows one input per month. Other models such as APSIM or SPASMO (Cichota and Snow 2009) use daily timesteps that capture the nuances of horticultural systems.

The time of harvest also needs consideration. Onions may be lifted several weeks prior to "harvest" and removal from the paddock. They have no root activity during this time. Potatoes are sprayed out in some cases months before they are harvested and also have no significant activity. Conversely, fresh greens such as broccoli are selectively harvested, and the plants (minus the flower head) remain growing and roots very active until the whole paddock is cultivated for the next crop planting.

Growers are being told to expect very high fees for budget preparation. Given the nature of their complex production systems, this is a valid concern if each crop in each paddock is to be modelled.

A review of the Arawhata shows about 500ha of intensive vegetable cropping in an area of about 750ha. Within the 500ha, many "crops" are only about 1 ha, due to successive plantings to meet year round fresh market requirements. One grower grows 20 different vegetable types in over 150 paddocks with multiple sowing or plantings in each. The position of "paddocks" changes with each planting, and are sometimes larger, sometimes shifted so following the two year input structure requires a great many individual cases to be followed.

Figure 4. Aerial image of part of the Arawhata Catchment shows more than forty different plantings averaging about 1 ha each. Successive images show the locations and scale of plantings are highly variable making multiyear modelling difficult and cumbersome.

Growers and sectors also have concerns about the information required for budgeting and where that information may end up. They protect their production and agronomic information because they operate in a highly competitive industry.

As a result of regional regulations, the information being collected and potentially aggregated for nutrient budgeting and reporting is much more detailed than and covers things not included previously in information leaving the farm. This information has value and is potentially subject to inappropriate use.

The OverseerFM platform is designed for security and ensures the farmer has control of where Farm Accounts are made available. The farmer as the Account Owner has control over who has access to the Farm Account, and visibility of what information is Published (shared in a read only form) (Taylor, 2019). Farm Account Access cannot be endlessly passed on. The information is however held by various organisations outside the farm. This includes the raw or processed data collected from the farm to put into OverseerFM Analysis, and knowledge from the reports available from the analysis process. Organisations holding such information do need to ensure integrity and protection.

Nutrient budget information being submitted to a council as part of the Consenting process is public information. Such information can be requested by anyone or organisation but is not necessarily released on request. If it is deemed to be commercially sensitive, information can be withheld. Information being submitted to a council should be clearly identified as commercially sensitive.

Information has different significance and different value in different sectors and regions. What may have minimal economic value in dairy farming may be closely held intellectual property in intensive horticulture. Dairy is largely co-operative with overseas competitors. In fresh vegetable production, the competitor is the neighbour. Knowing what area of which crop is planted when, what fertiliser product and what rate and timing was used can be of considerable value in such a competitive scenario.

But what alternatives are there?

Future Proofing Vegetable Production

The LandWISE "Future Proofing Vegetable Production" SFF project is working with growers, councils and industry to reduce nitrate leaching under intensive vegetable systems in Arawhata and Gisborne.

Seeking to reduce nitrate leaching and other nutrient losses 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.

The first stage was to capture a view of baseline practices. Grower interviews of nutrient management practice were based on the Fertiliser Association Code of Practice for Nutrient Management. None of the growers interviewed have a nutrient budget, if that is defined as a documented set of calculations using a tool such as Overseer™. But they do transport and store fertiliser appropriately and they do consider a wide range of relevant variables when making decisions about fertiliser application. All the growers interviewed received advice from company representatives and many sought independent advice. All have soil fertility tests from paddocks, though some have limited numbers. Some carefully monitor trends seeking to maintain levels in the "optimum" range.

No growers have monitored the surface water surrounding their operations. There is very limited state of environment reporting data either. In particular, we note that in the Arawhata, there is no data identifying the source of nitrogen in the stream. The Arawhata Stream is a very short waterbody that arises in and passes through a dairy farm at the bottom of the catchment. It is supplemented by drainage from the vegetable growing area and from the catchment above that.

As part of the Future Proofing Vegetable Production project, the growers are working with Horizons Regional Council to monitor nitrates at 25 identified key points through the catchment. This is a combination of state of environment reporting and citizen science. The proposal includes standard SoE methodologies used by Horizons supplemented by data from Nitrate Quick Test strip sampling by growers at much more frequent intervals.

As part of precision prescription, growers have been provided with Nitrate Quick Test strips and equipment for in-field determination of available nitrate (Hartz 1994, Breschini 2002). Recent New Zealand guidelines for vegetable nutrient management are available (Reid and Morton, 2018) and will be used to inform decision making.

Towards precision application, fertiliser application equipment was assessed for application rate accuracy and uniformity. Most growers use placement equipment and except for examples with worn parts, uniformity as measured by the coefficient of variation fell well within existing guidelines although the actual and target application rates showed wide variation (see O'Brien, Bloomer and McVeagh elsewhere in these proceedings).

Keeping nitrate in the root zone involves a number of management actions; applying only enough fertiliser and using split applications, ensuring irrigators are applying the correct depth evenly, and using cover crops/catch crops where possible. Another option being explored is to use urea based fertilisers rather than nitrates, and some method to keep nitrogen in the ammonium form. That is a very significant change and likely to involve a whole system investigation rather than merely swapping products. Some vegetables are sensitive to biuret so care is needed. The growers who have tried urea applications in the past, have experienced adverse outcomes so are very wary of trying again.

Because the global picture is of leaching under intensive horticulture, the likelihood of stopping leaching, or even reducing it to the target 26 kg/ha is low. Therefore, some method of recapturing or enhance attenuation to prevent losses reaching sensitive waterways is seen as necessary. The project proposes investigation of woodchip bioreactors and wetlands for this purpose (see McVeagh, Bloomer and O'Brien elsewhere in these proceedings). The information gathered from monitoring nitrate in drainage water will be valuable in identifying any hotspots, and in determining where mitigations might best be applied.

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