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OPPORTUNITIES TO REMOVE NITRATES FROM DRAINAGE WATER UNDER INTENSIVE VEGETABLE PRODUCTION

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Abstract

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

While nitrate leaching can be reduced, some level of leaching will be inevitable under current intensive vegetable production systems. Options to capture nutrients lost to drainage water include wetlands and bioreactors. The project aims to work at a catchment scale, with grower input from the outset. Wetlands are already under construction on some blocks in the Arawhata catchment and more are planned. A bioreactor will also be constructed as part of this project, with sites and designs currently being researched. Monitoring of nitrate levels throughout the catchment and work previously completed developing a catchment wide drainage plan will help identify suitable sites.

Wetlands and bioreactors are being trialled to mitigate nitrate loses in sensitive catchments in New Zealand, Australia and the United States, and initial results are promising. A forum was recently held in Townsville, Queensland where researchers shared information and lessons learnt from their installations.

Future Proofing Vegetable Production

The Sustainable Farming Fund project 'Future Proofing Vegetable Production' aims to work with growers, councils and industry folk to reduce nitrate leaching under intensive vegetable systems in Levin and Gisborne. Levin growers are currently facing a 26kgN/ha/yr leaching limit based on Overseer nutrient budget outputs to gain consent to continue growing vegetables under Horizons Regional Councils One Plan. This has been bought about in an attempt to improve the water quality in Lake Horowhenua. The Arawhata stream, as a tributary flowing into the lake, has some of the highest nitrate levels in New Zealand. The project addresses four key areas.

Firstly, the precise prescription of nutrients to meet the needs of the crop. Secondly precise application, which focuses on applying fertiliser accurately in terms of rate and placement. The third focus is around maximum retention and strategies to keep nutrient in the root zone. It is inevitable that under intensive vegetable systems some nutrient will be lost to drainage water and the final part of the project explores options to capture this nutrient before it enters waterbodies. The Gisborne growers are watching what is happening in other regions, as they anticipate what approach the Gisborne District Council will adopt for their region in the future and the implications this would have on their systems.

Nitrates and water quality – a global issue

Poor water quality is a major issue in many catchments. The monitoring site in the Arawhata stream at Hokio Beach Road states that the stream is in the worst 25% of like sites in New Zealand for Total Oxidised Nitrogen with a 5-year median of 10.6 g/m^3 (Land Air Water Aotearoa, 2019). Nitrate levels in waterbodies is a global issue. For example, reducing the effect of nutrient and sediment from Queensland's grazing and cropping areas on the Great Barrier Reef in Australia and from the corn belt in the Midwestern United States contributing to the nutrient load in the Mississippi River and Gulf of Mexico receive a lot of attention from research groups. These areas receive significant funding and research projects, which can provide valuable information that can be transferred to other catchments such as Arawhata.

The 'treatment train'

The concept of a treatment train is to address the issue of water quality throughout the whole system and catchment. A treatment train works by firstly preventing or minimising pollutants entering the surface or ground water through best management practices, which are included in the first three steps of the project. At the catchment scale, areas of 'cleaner' water, can be diverted away so that water captured from intensive production areas can be intercepted and treated through one or more treatment systems (Department of Environment and Science, Queensland Government, 2019). A number of treatment systems may be used throughout the catchment, or sequentially at one site to treat different pollutants, such as sediments and nitrates. There are many different types of treatment systems including: wetlands, sediment basins, recycle pits, bioreactors, algal ponds, micronutrient dosing and floating wetlands (Department of Environment and Science, Queensland Government, 2019). It is important that each treatment system considers the site, catchment and the treatment train to ensure an efficient and cost-effective system is developed.

Vegetable growing in the Arawhata catchment

Intensive vegetable production is a major part of the Levin area. There is approximately 500 hectares of land used for vegetable production, which supplies the majority of the lower North Island with fresh vegetables, with a small proportion exported. The largest grower in the area grows 18 different crops and employs 220 staff (Woodhaven Gardens, 2019). Intensive vegetable production is important for the local community.

A collaborative approach

There is a lot of work happening around treatment systems to improve the quality of water entering the great barrier reef in Queensland, Australia. A recent forum held in Townsville on water treatment systems highlighted the importance of working at a catchment scale and involving people from all disciplines. Within the Arawhata area we want to treat this issue at a catchment scale rather than treating properties individually. The project has been successful in bringing together the regional council, growers and researchers to address the issue.

Potential mitigation strategies for Arawhata

Addressing the issue of nitrates in drainage water from intensive vegetable production systems first requires understanding of the spatial and temporal movement of nitrates throughout the catchment. Flow rates and nitrate loads in drains and streams are crucial for locating and designing effective treatment systems. Currently, there is only one monitoring point in the Arawhata catchment, which is in the Arawhata stream at Hokio Beach Road. A monitoring programme is currently being designed to combine laboratory analysis of water samples collected by the water quality scientists at Horizons and a ‘citizen science’ approach to be carried out by the growers in the catchment using simple nitrate test strips. Approximately 15 sites across the vegetable growing area will be formally monitored. It is important to begin to understand the extent of the contribution of these systems to nitrates in the waterways and that of other land uses. To achieve this monitoring sites will be located not only throughout the intensive vegetable growing area, but where waterways enter and exit the area. Nitrates ideally should be monitored every 15 minutes as grab samples can over or under estimate nitrate loads in drains and streams.

Opportunities for bioreactors in Arawhata

Bioreactors convert nitrate in groundwater or surface water to nitrogen gas using microbes and a carbon source, typically woodchip, under anoxic conditions. Installations of these treatment systems have grown significantly over the past decade (Christianson & Schipper, 2016). Bioreactor walls are constructed to intercept groundwater while bioreactor beds receive surface water runoff or are connected to subsurface drains. Inline bioreactors are located directly in the drain, or water diverted through the bioreactor before re-entering the waterway, are referred to as offline (Wegscheidl, Layden, & Bryce, 2018). There are many different designs of bioreactors and the specifications need to be specifically tailored for each site. Selecting a location and determining the size and retention time of the bioreactor are critical for constructing a system that is effective. Research has shown that bioreactors can be very effective in some cases 96-99% nitrate removal efficiency of intercepted flow (Rosen & Christianson, 2017) and 81-98% of the load (Verma, Bhattarai, Cooke, Chun, & Goodwin, 2010). Sites for bioreactors in Arawhata are being investigated. The hydrology of the system is critical, and the proposed water monitoring will aid identifying a suitable location and design.

Opportunities for wetlands in Arawhata

Wetlands can be effective water treatment systems that slow the flow of water and remove fine sediment and nutrients. One example is in Queensland, where a constructed wetland was built in an old borrow pit in the Barratta Creek catchment. This constructed wetland improves the quality of furrow irrigation water from sugar cane. The BBIFMAC (Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc.) project which was funded by Queensland Government Reef Water Quality Programme have constructed a wetland that is showing good initial results for nutrient capture, with a reduction in dissolved inorganic nitrogen entering Barratta creek (Opajdowska, 2019). There is potential to include wetlands within the Arawhata catchment as part of the treatment train. Currently, one design and planting plan is being developed, another grower has plans for two, and there are opportunities to develop more through the catchment. The drainage maps developed as part of a community drainage scheme and the flow rates at the monitoring sites will help identify and plan constructed wetlands.

Conclusions

Nitrate leaching in Arawhata is a well-known issue and the effects on Lake Horowhenua are evident. The Future Proofing Vegetable Production project aims to bring together growers, councils and researchers to address all areas of the intensive vegetable growing system and whole catchment to build the foundations for an effective treatment train.

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