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Summary of nitrate leaching data from New Zealand vegetable crops review for Sustainable Vegetable Systems programme

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Nitrate leaching occurs when soils become saturated, causing soil solution to drain down through the soil profile. Since nitrate is both soluble and mobile, it may be carried down through the soil within the draining soil solution. This is not a problem so long as the nitrate remains within the crop rooting-zone. However, it can become an issue if it moves deeper because crops will not be able to take it up and it can then enter in the ground water or other fresh water bodies, becoming an environmental pollutant.

Nitrate concentrations in fresh water have become an important indicator of pollution and are the focus of national and regional government strategies to improve water quality. Farmers and growers must understand the risk of leaching and manage their crops to minimise the potential for losses from their land. The amount of nitrate leached is governed by:

- The amount of nitrate in the soil,
- The amount of water inputs (both rainfall and irrigation),
- The subsequent amount of drainage that occurs. Different soil types also drain at different rates.

Meanwhile, the amount of nitrate in the soil is governed by factors such as:

- The amount of inherent total nitrogen present in a given soil,
- The amount of nitrogen added to that soil (fertilisers, previous crop residues and composts, and other amendments containing nitrogen),
- The amount of nitrogen that is utilised and returned by the crops grown in that soil,
- The amount of nitrogen released via mineralisation, which can be influenced by soil moisture, temperature and cultivation practices.

Most crops prefer to take up nitrogen as nitrate, so having an available supply of nitrate when the plant needs it is critical for plant growth. However, having too much nitrate in the soil can be a liability when the soil becomes saturated.

The main factors that were identified as responsible for nitrate leaching in vegetable systems are:

- The relatively high N use (e.g. fertiliser, manure, compost to ensure crops do not experience shortages),
- Frequent and often intensive cultivation (which accelerates N mineralisation processes),
- Relatively short periods of plant growth (which means the crop N uptake will occur within a short time period),
- Low nutrient use efficiency is associated with many vegetable crops,
- Low rooting densities of most vegetable crops (limiting the ability of crops to pick up N from the profile),
- Often significant crop residues remaining after harvest (returning large amounts of N to the soil).

We conducted a literature review to assess how much information was available regarding leaching from vegetable crops grown in New Zealand. The review included crops such as onions, lettuces, cabbage, pumpkin, squash, spinach, cauliflower and broccoli (potatoes are the subject of a separate report).

Our review highlighted:

- There is a scarcity of available data on nitrate leaching from vegetable crops in New Zealand.
- Some of the estimations that are available are rather outdated, especially given that a number of changes to grower practices have occurred over the last couple of decades and are likely to have influenced nitrate leaching.
- All of the available data report leaching values that are based at least partially on estimations from calculations rather than direct measurements.

  For example, the studies using ceramic solution samplers, which allow for a direct measurement of soil solution leachate, still commonly rely on a calculated soil water balance to estimate rather than directly measure drainage. Other studies use a nitrogen balance to calculate leaching losses, via soil N and plant N biomass sampling. This method provides a good indicator of the risk of N leaching as it gives a status of the soil N at a given time, but it is not a direct measurement of leaching and commonly fails to account for the ongoing process of soil nitrogen mineralisation.

- The majority of available data are focused on vegetables growing in the Pukekohe region.
- There are no or very limited data available for some of the vegetable crops commonly grown in New Zealand (e.g. carrots, vegetable brassicas, peas, beans, pumpkin).
- Information regarding the amount of nitrogen fertiliser that is currently applied by growers to each vegetable crop is also difficult to obtain.

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