Horizons Regional Council: Nutrient Management

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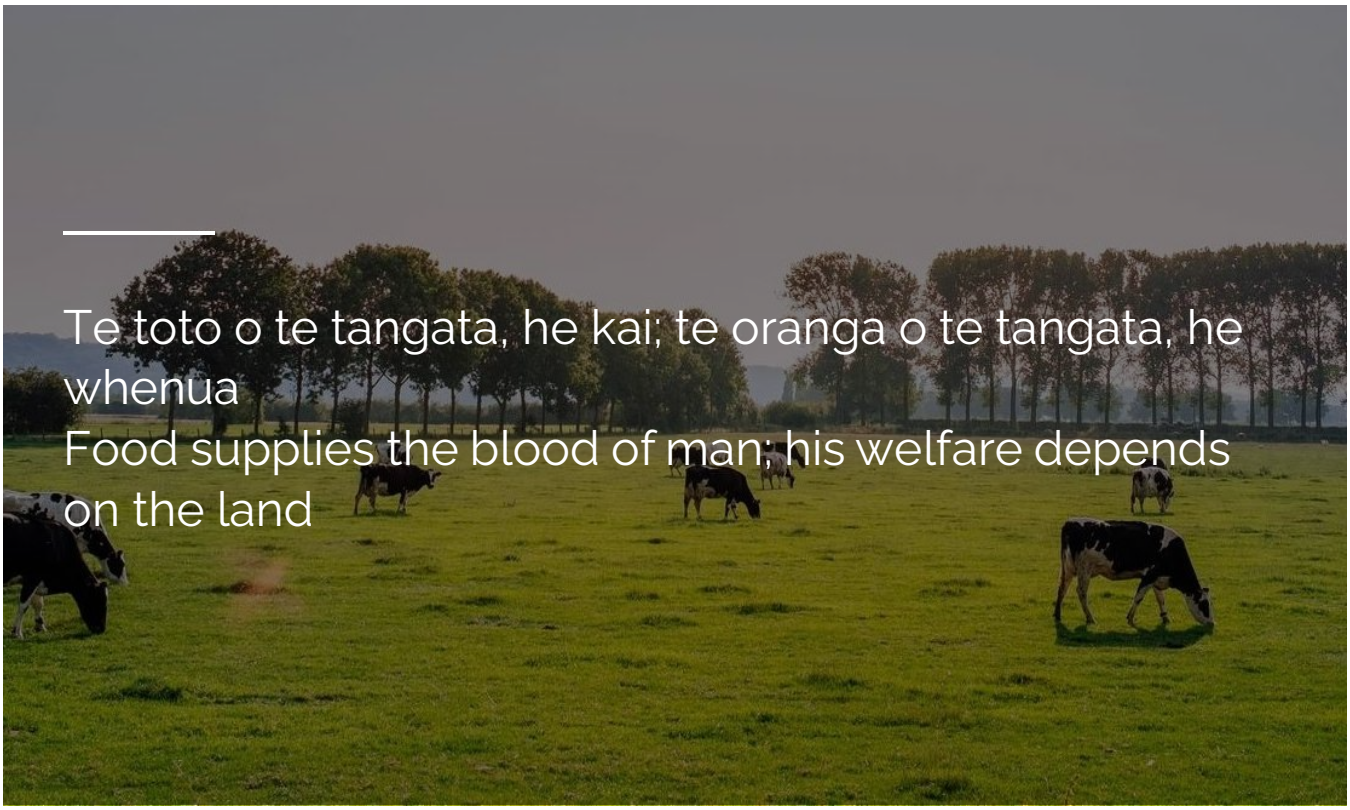
Lesson 1 – Nutrient Management Introduction



In this document we will look at the importance of understanding nutrient management and the main pathways of nutrient loss in the Horizons region.

This relates to Freshwater Farm Plans (FWFPs) and it will give insight into potential on-farm mitigations to reduce nutrient loss and an understanding of the following:

- The key processes (risks and flow paths) of the nitrogen (N) and phosphorus (P) cycle, relevant to nutrient loss.
- The sub-areas in the Horizons region with poor nutrient level scores (N and P) and possible reasons why.
- The key sources of nutrient loss in the Horizons region across dairy, sheep and beef, cropping and vegetable farms.
- The soil type affects N and P losses through leaching and overland flow. And the key risk areas (in regard to soil type) in the Horizons region.
- The mitigation practices that can be used to reduce nutrient loss on farm.

Excess N can create significant problems in waterways by promoting the overgrowth of large plants known as macrophytes and smaller algae called periphyton. This excessive plant growth can lead to a dramatic drop in oxygen levels leaving fish and other aquatic animals unable to breathe.

N can also contaminate drinking water causing serious illness to humans and can pose a risk to pets and stock.

Excess P concentrations in waterbodies can also cause rapid weed growth and algal blooms that choke aquatic life and cause long-term damage to the health of a waterbody.

Understanding how nutrients move through the soil and environment allows us to better understand how we can prevent excess accumulation of nutrients and reduce the risk of loss to the environment.

Nitrogen

The biggest source of N in waterways is N in urine from farm animals. Urine is rich in N and is often too concentrated for the grass to take up all the N provided – especially in winter when soil water capacity is often exceeded and pasture growth is reduced.

Excess N seeps down into ground water (then enters streams and rivers), or washes off the paddocks and enters streams and waterways through drains. Lost N fertiliser is a much smaller source of N in freshwater than urine. However, adding N fertiliser increases the amount of N around the farm and can increase the N loss via urine.

The below image depicts the nitrogen cycle and below are some supporting explanations:

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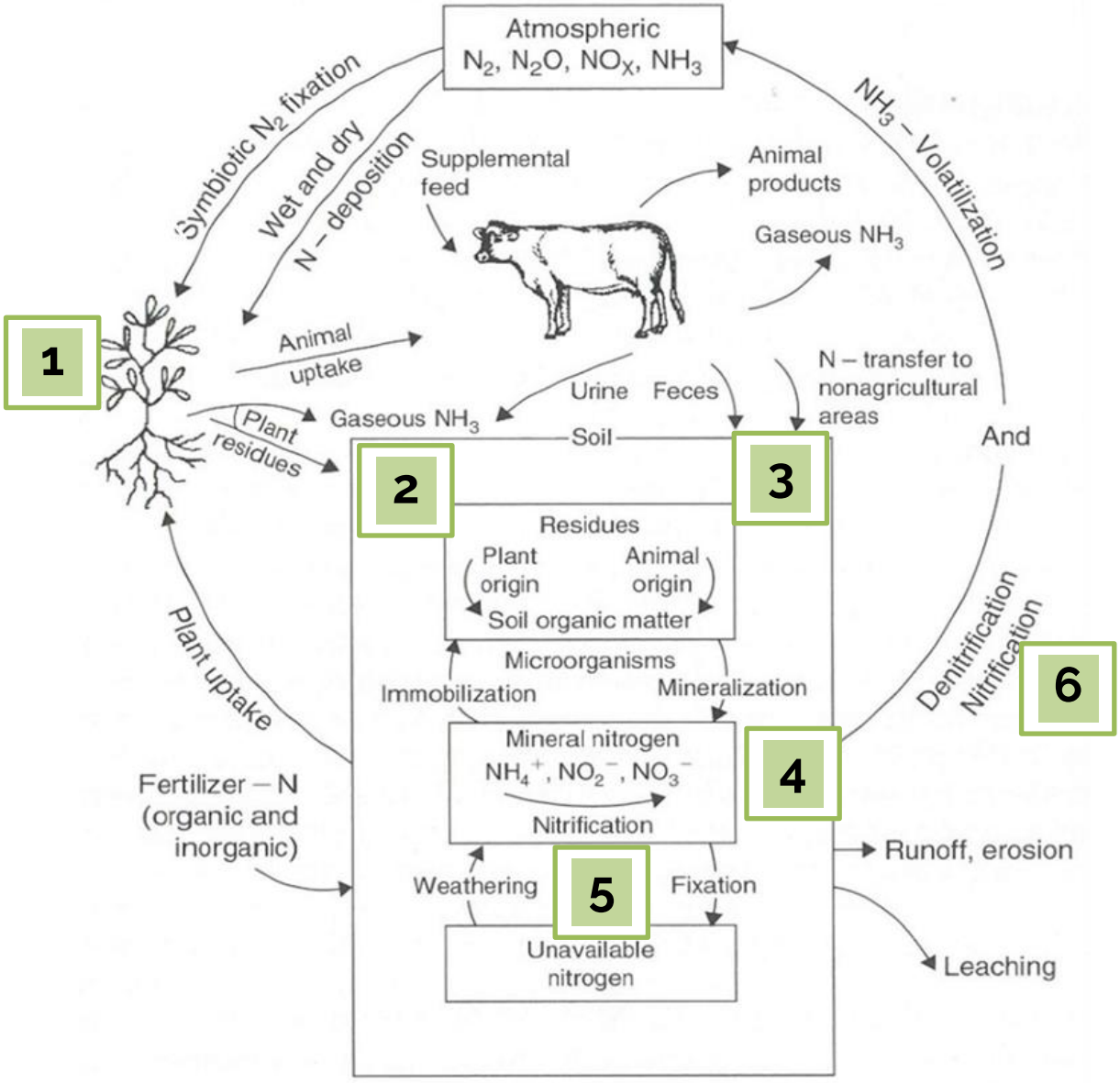
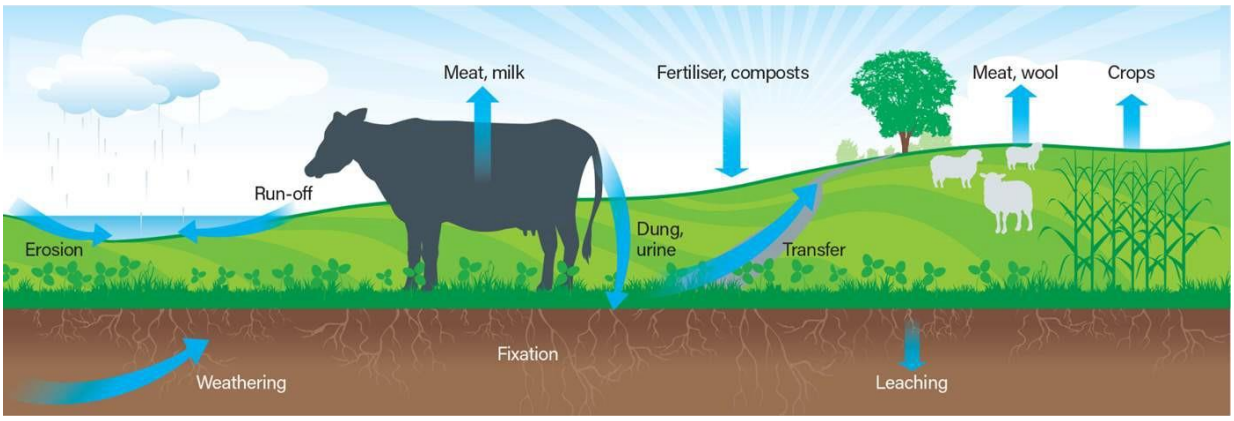


1	**Nitrogen fixation** Nitrogen fixation of legumes
2	**Decomposition** Decomposition of organic matter to ammonium
3	**Soil pool** Plant residues and dung add to soil organic pool
4	**Nitrification** The conversion of ammonium to nitrate
5	**Enzyme conversion** Enzyme conversion of urea to ammonium
6	**Denitrification** The conversion of nitrate to nitrous oxide gas and then to nitrogen gas

Phosphorus

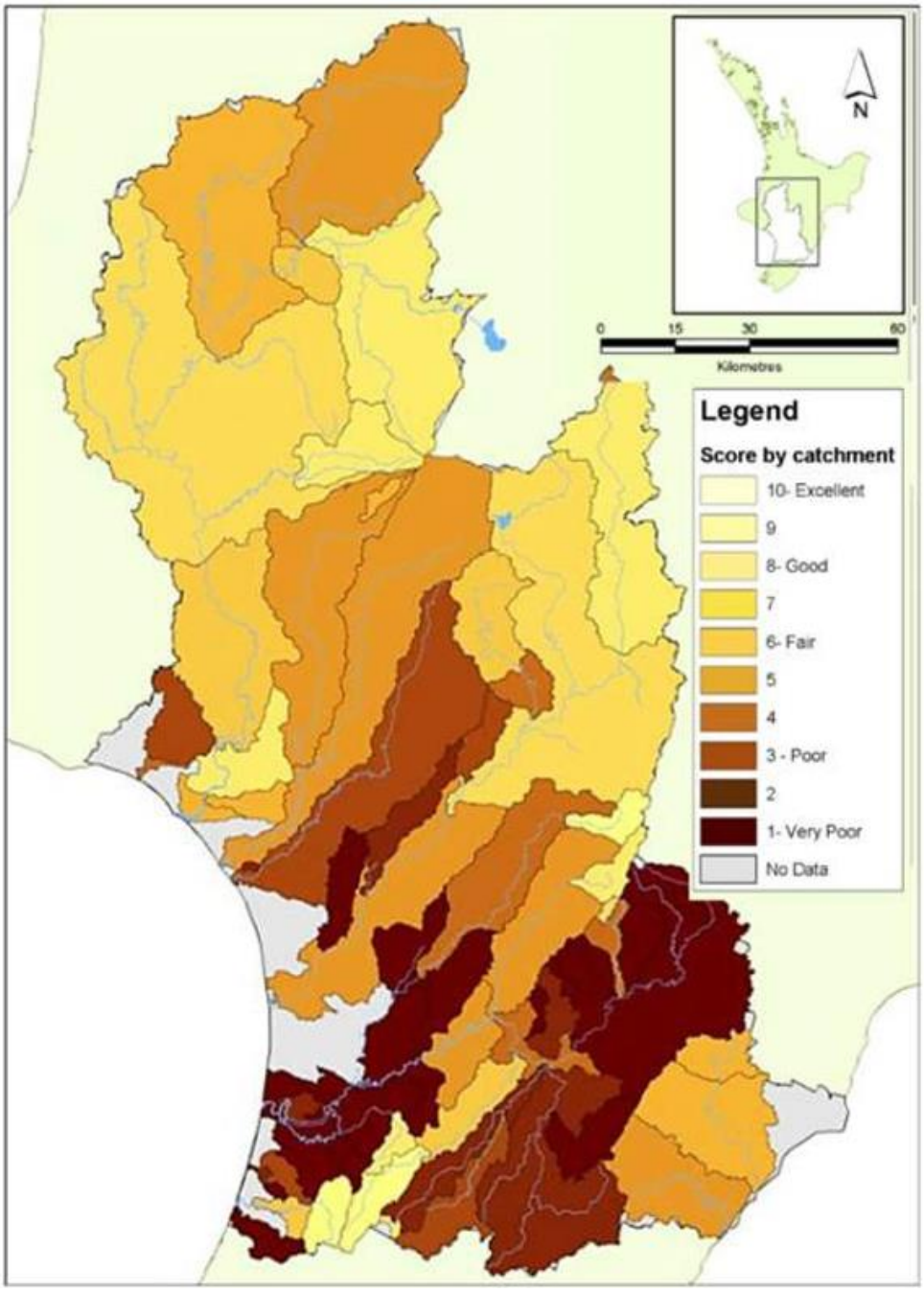
Phosphorus enters the cycle as fertiliser, imported feed and dung. Soil weathering also releases P for plant uptake. Plants take up inorganic P, animals ingest this P and convert it to product (milk, meat, wool), or it is harvested as a crop. P can be returned to the soil as organic P through animal excreta or plant decomposition. Organic P can be mineralised by soil microbes and converted to inorganic plant available P. Erosion and overland flow causes loss of P to waterways.

Most of the P in our rivers is the result of erosion and fertiliser overland flow.



The phosphorus cycle

Sub-areas in the Horizons region with poor nutrient level scores (nitrogen and phosphorus) and possible reasons why



Sub-areas nutrient levels in the Horizons region

Possible reasons for poor nitrogen level scores

- The majority of N leaching occurs during winter when soil drainage is greatest as a result of rainfall.
- Farming systems with typically the highest risk of N leaching are vegetable/cropping systems, this is followed in decreasing order of; dairy farming, arable/mixed farming, sheep/beef/deer and forestry.
- In grazing systems, the main source of leached N is from urine patches.
- In cropping systems, the main sources of leached N is from nitrogen fertiliser, the mineralisation of N following cultivation and crop residues that remain in the soil following harvest.

Possible reasons for poor phosphorus level scores

- In general, forestry contributes the least amount of P to the waterways.
- Sheep and beef grazing systems on hill country farms show considerable losses of phosphorus, mainly in the form of particulate phosphorus linked with sediments.
- Dairy systems have in general a lower contribution to P losses as they are usually developed in lowland landscapes where erosion and overland flow is minimal. However, when soil drainage is poor, or in extremely high rainfall areas, P losses can be larger and this is exacerbated in soils where Olsen P is above optimum for pasture growth.
- P losses from intensive land uses (dairy and cropping systems) are likely to vary dramatically with animal stocking rate, soil type, topography, cultivation, cover crops and P fertiliser management.
- Where soil erosion occurs, the majority of P (up to 80%) in overland flow is particle-bound, while less than 20% is present as dissolved P.
- Where there is good ground cover and Olsen P is above optimum, the majority of P (up to 80%) in overland flow is in the dissolved form, while less than 20% is present as particulate P.
- Volcanic geology can also be a major diffuse source of P, and streams draining recent volcanic areas may have naturally high in-stream P concentrations. Limestone and Mudstone geologies are also natural sources of P.
- Phosphorous leaching is minor relative to overland losses on most New Zealand soils, except where anion storage capacity (P- retention) is very low.

Effect of soil type on N and P losses through leaching and overland flow

Soil type has an impact on nutrient loss via overland flow and leaching. Contaminant loss risk via overland flow is categorised by soil drainage properties.

Horizons has categorised soils risk associated with overland flow contaminant loss based on drainage soils of the properties.

Category	A	B	C	D	E
Drainage Class	1	2	3	4	5
Description	impeded drainage or low infiltration rate – loess terrace soils – high risk	poorly drained alluvial soils – high risk	imperfectly drained – medium to high risk	well drained – low risk	well drained – low risk
Drainage Class	very poorly drained	poorly drained	imperfectly drained	moderately well drained	well drained

Moderately steep slope	**21 – 25 degrees slope** There is a very severe risk of overland flow under cultivation or intensive winter grazing (IWG).
Strongly rolling	**16 – 20 degrees slope** There is a severe risk of overland flow under cultivation or IWG.

Gently rolling	**8 – 15 degrees slope** There is a moderate risk of overland flow under cultivation or IWG.
Flat, poorly drained and clay	**Relatively flat land with a slope of 7 degrees or less.** Light volcanic soils (such as Ohakune soil) or with clay loam subsoil with slow permeability (such as Marton, Tokomaru or Kairanga soils) the risk of overland flow is slight.

Flat, poorly drained and sandy	**Relatively flat land with a slope of 7 degrees or less.** With poorly drained soils; the risk is very slight and with other soils the risk is negligible.

You can find further information on the risks of different soil types in the Horizons region:

https://www.horizons.govt.nz/HRC/media/Media/Soil-Risk-list.pdf

The impact of soil type on leaching losses

Sandy or shallow (coarse) soils have higher leaching potential than clay, loam or deep soils as they have a lower water holding capacity. Whenever water input exceeds the soil's ability to hold water run-off or leaching will occur. An example of where well-draining soils pose a greater risk of leaching can be seen in dairy farming urine patches.

- Gravel or coarse soil, which has a loamy sand or sand texture has rapid deep drainage and therefore has the highest N leaching risk, particularly if close to a stream or river.
- Loam soils have medium speed deep drainage. So there may still be a lower risk of N leaching.
- Clay subsoil has negligible leaching risk but high overland flow and bypass flow risk (bypass flow is rapid flow down mole cracks into the drainage network).

Leaching risk is the reverse of overland flow risk, with well drained soils being the highest risk for leaching and very poorly drained soils having the lowest risk for leaching.

Rainfall, climate and irrigation will have an impact on the frequency of which leaching and overland flow occur. Most leaching occurs in the drainage period (Jun-Aug) where rainfall is highest and plant uptake of nitrogen is lowest.

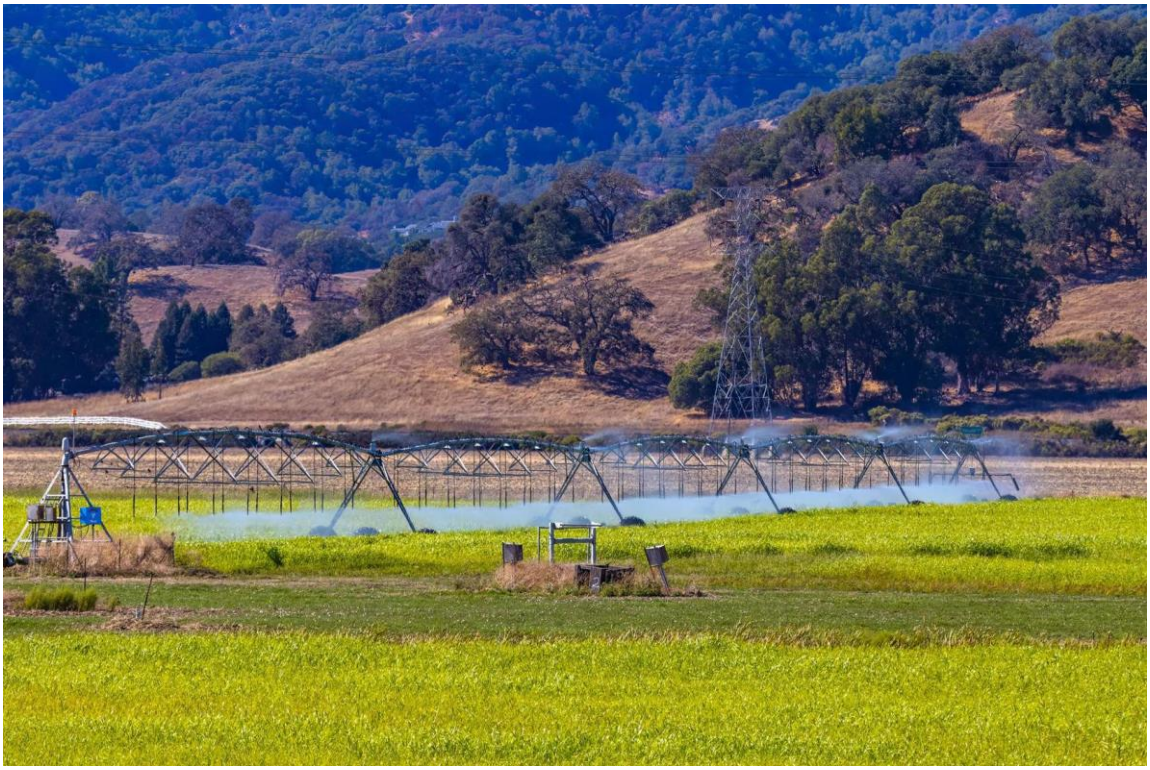
Mitigation practices to reduce nutrient loss on farm

Mitigations are actions that can be carried out on-farm to reduce the severity and occurrences of nutrient loss on farm. Landforms are a key part of the process of determining appropriate mitigations/action to address catchment issues because landforms control how the contaminants get to the river and where they can be caught or stopped. For more information on landforms, please refer to the Regional Information document.

Below are specific mitigations to avoid nutrient loss:

Irrigation management

Avoid exceeding water holding capacity of soil type on farm by using soil moisture monitoring and targeted irrigation practices.

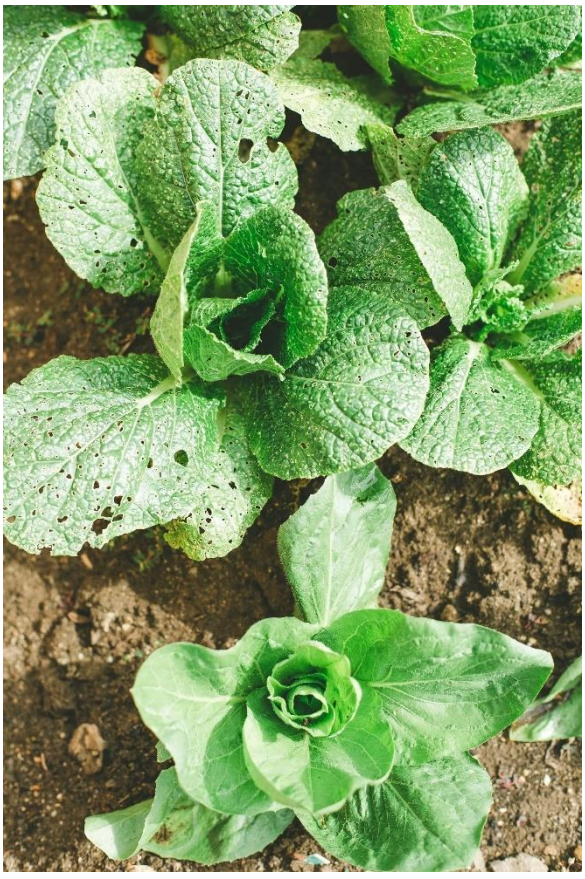


Effluent

- Capture effluent and spread farm dairy effluent (FDE) in a way that allows uptake by plants and avoids any surface ponding or overland flow.
- Ensure effluent system is applying expected rate and intensity.
- Select effluent areas with suitable soil type (low risk).
- Have a sufficient sized effluent pond to avoid applying effluent in wet conditions when the soils are saturated. This is called deferred irrigation.

Nutrient budgets

Identify all the outputs and inputs into the farming system (both pastoral and cropping) and use this information to determine fertiliser requirements. Nutrient budgets are also a useful decision tool to describe the effects crop rotations, fallow period etc. will have on nutrient availability and therefore fertiliser requirements.



Risk factors

Identify risk factors that could result in soil loss, nutrient loss and damage to soil structure and implement good management practices. Examples of risk factors include cropping, cultivation, stocking rate etc.

Cultivation

- Avoid winter fallow periods, particularly after pasture.
- Minimise depth and intensity of cultivation to reduce organic matter breakdown in the soil.
- Consider the effect cultivation will have on N mineralisation and include this release of N when determining Nitrogen fertiliser requirements.
- Consider minimum tillage options.

Fertiliser use

- For crops, use fertiliser rates and timing that match plant growth and minimise residual nitrogen and ammonium left in the soil at harvest.
- For pasture, split fertiliser applications to increase plant utilisation.
- Use well calibrated application equipment.
- Account for and manage nutrient application from fertiliser, including using fertiliser records.

Supplementary feed

- Moisture content, feed out location, storage etc., will have an impact on nutrient flow and losses. Supplement type also has an impact on the N introduced to the nitrogen cycle i.e., some supplements are higher in N content than others.
- Account for and manage nutrients from brought in feed sources.

Soil testing

Regular soil testing to identify nutrient needed and apply N and P fertiliser strategically to meet plant growth requirements, e.g., apply when plant uptake is the highest in the growing phase.

Nutrient loss pathways

Knowledge of nutrient loss pathways and soil type will help to understand how nutrients move through soil and how to reduce losses.

Erosion and sediment loss

Take all possible precautions to reduce erosion and sediment loss on farm. Examples could include hill side pole planting and careful selection and management of intensive winter grazing paddocks.

Economic and environmental implication

Investigate the economic and environmental implications of using different management factors including; reducing N and P fertiliser or wintering cows off farm.

Stock management

Appropriate stocking rate, rotation and matching the stock class to soil type can minimise pugging and damage to soil structure, thus reduce the risk of nutrient loss.

If you would like to provide feedback on this document, please email: freshwaterfarmplans@horizons.govt.nz