

More than just a number

Your guide to improving nitrogen-use efficiency on your farm



Protecting our present – and our future

New Zealand farmers have a reputation for producing safe, healthy food, and for doing this in a way that is environmentally sustainable. However, the benchmarks set by national and international customers continue to rise.

To maintain our position as food producers of quality and integrity, we need to continue to develop new, improved standards of practice, creating an even more sustainable future. The Sustainable Dairying: Water Accord is part of that journey.

Under the Accord, dairy farmers, dairy companies, industry advisors and related experts will work together to help reduce the impact of farming on our rivers, lakes and streams. It's about doing the right thing, as individuals, as a community and as an industry.

Working together, with a common goal, we can continue to be the best farming nation in the world . . .

Together, we will make a difference.

Sustainable Dairying: Water Accord

In recent years, New Zealanders have become more aware of the importance of our freshwater systems, including rivers, lakes and wetlands. New pressures and competing demands on these natural resources have led to a heightened call for action. In 2003, the dairy industry responded by developing the Dairying and Clean Stream Accord, which ran successfully until 2012.

The Sustainable Dairying: Water Accord builds on the Clean Stream Accord, and aims to achieve another step change in the management of risks to waterways posed by dairying. The Accord was developed under the oversight of the Dairy Environment Leadership Group, and has been signed by all of the major dairy producers and affiliated industry groups.

The purpose of the Accord is to enhance the overall performance of dairy farming as it affects freshwater by:

- Committing to good management practices expected of all dairy farmers in New Zealand
- Recording pledges by the dairy sector, with the support of others, to assist and encourage dairy farmers to adopt those good management practices and to monitor and report progress.

Key commitments have been made in the areas of riparian management, nutrient management, effluent management, water use management and conversions. Full details can be read in the Accord, which can be downloaded from www.dairynz.co.nz/publications/dairy-industry/



Read more: www.dairynz.co.nz/publications/dairy-industry/sustainable-dairying-water-accord/

Know your numbers

In terms of nutrient management, the Accord outlines an expectation that dairy farmers will manage nitrogen and phosphorus loss from dairy farming systems and pursue continuous improvement in nutrient use efficiency.

To assist with this, dairy companies have committed to collect data from dairy farmers, to model nitrogen loss and nitrogen conversion efficiencies for each farm, and to provide this information to farmers, along with benchmarking.

This data is shown in the nitrogen report sent to dairy farmers annually. The presentation of the data will vary with each dairy company, but the meaning of each term is the same. The example below shows what each number represents.

Nitrogen leaching risk

33
kg / ha / yr

This number is the estimated amount of nitrogen with the potential to be lost by leaching into groundwater or waterways.

Smaller numbers are better.

Nitrogen conversion efficiency

35[%]

This number indicates the percentage of the nitrogen brought into the farming system that is converted to product (e.g., meat, milk).

Larger numbers are better.

Nitrogen surplus

114
kg / ha / yr

This number indicates the quantity of nitrogen brought into the farming system that does not leave the farm in product.

Smaller numbers are better.

Where does your number come from?

As part of the Accord, the dairy industry has an expectation that dairy farmers will manage nitrogen loss from their farms, acknowledge the need to manage within nutrient loss limits and pursue continuous improvement in nutrient use efficiency.

An essential part of this is being able to measure your losses, so that you can then monitor your performance and your progress. Your dairy company and your fertiliser company both play a part in helping you to calculate your nitrate leaching losses.



Collecting the data

Since the Accord was established, dairy companies have asked their farmers to provide them with a range of data about their operation, including information about nitrogen fertiliser use, stock data, irrigation, effluent management, supplements grown, purchased and fed, wintering pads, feed pads, etc.

This is the data that is used to generate the nitrogen leaching loss and nitrogen-use efficiency numbers that benchmark your farm against others in your region.

The more accurate this data, the more reliable your number will be.

Getting accurate data

The way that data is collected can have an impact on its accuracy. As a general rule, accuracy is improved when:



Real measurements are used – for example, stocking rates are calculated, rather than estimated



Data is collected in a consistent manner – for example, always recording fertiliser nitrogen use as the kg N/ha applied, rather than sometimes using this and sometimes using kg product/ha



Data is collected in a timely manner – data that's recorded at the time is far more likely to be accurate than data that you try to remember a day, a week or a month later



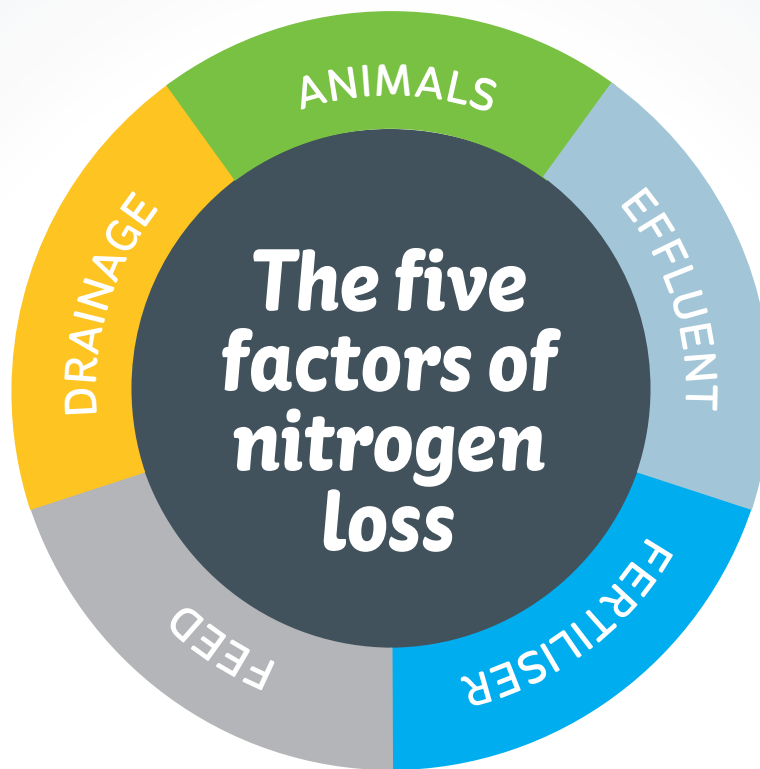
Data is recorded at a suitable frequency – for example, supplement use needs to be recorded on a monthly basis, rather than just the total amount of supplement used in a year



Generating the number

Fertiliser companies are largely responsible for analysing and interpreting the data collected by dairy companies. They do this by using OVERSEER®, nutrient budgeting software that can estimate nutrient flows into, within and out of the farm. This process is done according to industry-agreed standards to ensure a consistent approach is used.

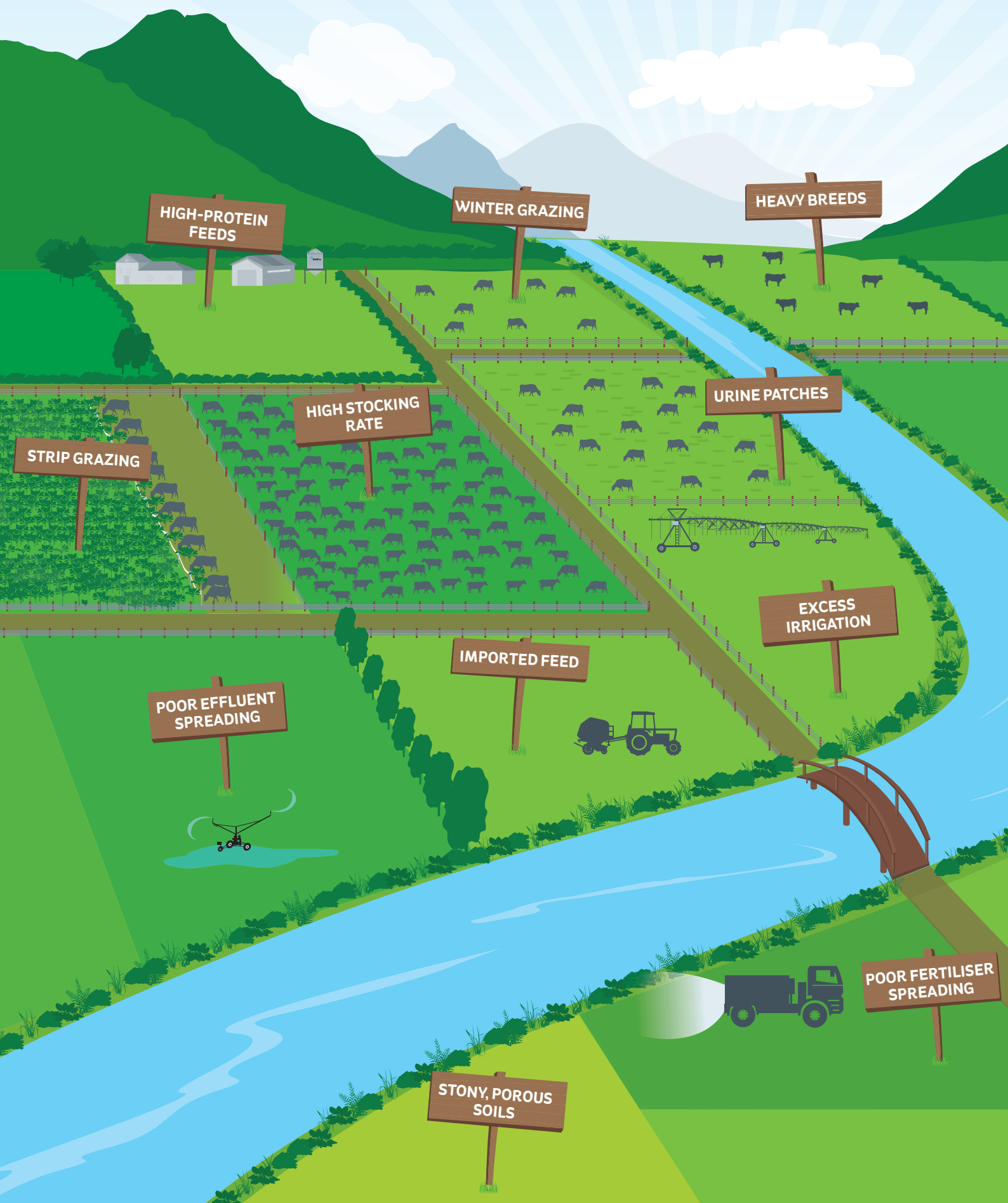
OVERSEER was developed in New Zealand for our farming systems. It has been validated for use on our major soil types and predicts long-term annual average nutrient losses with a high degree of accuracy.



All farming systems will leach nitrogen to some degree. It occurs because soil bacteria convert nitrogen to nitrate, which is a form that mainly stays in the soil water. As a result, when it rains, and soil water moves down through the soil, below the root zone, any excess nitrate moves too. This is the process known as 'nitrate leaching'.

There are five factors that govern how much nitrate will be lost by leaching on any given farm.

On-farm sources of nitrate leaching



How do animals affect nitrate leaching?

Urine from a cow applies 600-1000 kg N/ha in the urine patch

- much more than nitrogen fertiliser

A typical dairy cow urination deposits 2 litres of urine on just 0.2 m² of land

- and it's highly concentrated, which increases the chance of leaching

On a dairy farm, the cow's urine is the greatest source of nitrogen

Higher protein feeds are associated with higher levels of nitrogen in urine

- and this leads to more nitrate leaching

Higher stocking rates are associated with more nitrate leaching

- because urine patches overlap, causing even higher concentrations of nitrogen

Lighter breeds of cow deposit less urine nitrogen

- but this effect only counts if stocking rate is not increased to compensate for lower production

Activity

What is your stocking rate?

Do you adjust feed rations to manage the amount of protein in your animals' diet?

How are your stock grazed through winter?

How much control do you have over animals?

As a dairy farmer, you don't have much flexibility with the species and gender of stock you carry! However, you can influence both the stocking rate and the way you manage stock.



NOTES

Animal-related strategies to reduce nitrate leaching



Reducing stocking rate

Since animal urine is the single greatest source of nitrogen in a pastoral system, reducing the stocking rate will immediately reduce nitrogen inputs. This in turn will reduce the potential amount of nitrate that could leach from your farm. The impacts of reducing the stocking rate need to be considered carefully: e.g. think about the effect on rotations, production and profitability.



Using lower protein feeds

A high-protein diet increases the nitrogen content of urine, so reducing protein intake will reduce the nitrogen loading in the urine, and thus on the soil. Options for achieving this include using low-protein supplements instead of using nitrogen fertiliser to grow more grass, or selecting low-protein feed options in preference to higher protein feeds. The overall diet of the animal needs to be considered when this option is being investigated, and it may be helpful to seek advice from an animal nutrition specialist.



Adopting low-impact winter grazing practices

Since most nitrate leaching occurs during winter, any practice that reduces nitrogen inputs during this time will be of benefit. This could include using a feed pad, wintering off, time-limited grazing, installing an animal housing system, etc. Protecting pastures from pugging will also mean more pasture is available in spring.



Improving genetics

If herd genetics can be improved so that milk production per cow is increased, it should be possible to reduce cow numbers but maintain existing production levels. Fewer cows on farm will reduce nitrate leaching; however, higher producing cows require more feed, so the benefits are likely to be small.



Reducing the replacement rate

If replacements are grazed on farm, then reducing the numbers replaced per year will reduce the total stocking rate and therefore the amount of urine deposited on the land, which in turn reduces the potential amount of nitrate leaching. For example, a 500-strong herd with a replacement rate of 25% will mean 625 stock being carried during this time; if the replacement rate is reduced to 20%, the number of stock carried will drop to 600. A lower replacement rate will also reduce feed demand, which may mean less fertiliser is required and less imported feed is needed in autumn. However, these benefits will only accrue if the herd size is not increased.



Culling earlier

Earlier culling will reduce the number of cows carried, and thus reduce the amount of urine deposited on the land, which in turn will reduce nitrate leaching. Early culling also reduces feed demand, which may mean less fertiliser is required or less imported feed is needed in autumn.

How does effluent affect nitrate leaching?

Effluent applies nitrogen to the land, along with water

- how much nitrogen depends a lot on season and feed type

Applying effluent too heavily can increase nitrate leaching

- by increasing the depth of the effluent in the soil

The way effluent is used impacts its contribution to nitrate leaching

Applying effluent to wet pastures can increase nitrate leaching

- by increasing drainage

Applying effluent too heavily can increase nitrate leaching

- by increasing the concentration of nitrogen in the soil

Activity

What is the average nitrogen content of the effluent you apply?

What best management practices do you currently use for effluent?

Do you have systems in place to ensure that effluent application does not exceed 150 kg N/ha/year?



NOTES

How much control do you have over your effluent management?

You will nearly always have some ability to control the use of effluent on your farm. It is not possible to control the production of effluent, but there are systems that allow you to control what is spread, where and when.

Effluent management strategies to reduce nitrate leaching



Increasing the effluent area

Increasing the area of the farm used for effluent reduces the average amount of nutrients being spread on the land per hectare, so you are more able to stay within the required limits for nitrogen application. Land used for spreading effluent needs to be managed separately to the rest of the farm in terms of fertiliser application, so seek advice from your fertiliser specialist.



Using low application rates

When low rates of effluent are applied, there is much more likelihood that plants will use the nutrients and water, rather than this material being lost to waterways. Automated application systems and larger effluent areas will help you manage effluent more easily.



Refining the application timing

Applying effluent when there is a small water deficit is much more beneficial than applying it when the ground is wet. Avoiding effluent application in late autumn and winter reduces the likelihood of nitrate leaching. Adequate storage facilities are necessary to achieve this goal, however. In some regions, new effluent consents can require 60-90 days' storage capacity.



Export your effluent

If you have more effluent than you can safely manage on your farm, it may be possible to get someone else to use it, e.g. on a paddock that is going to be used for maize. Exporting the effluent off farm will result in a real risk reduction for nitrate leaching.



Calibrating effluent spreaders

Well maintained and calibrated effluent spreaders are one of the keys to ensuring that effluent is not over-applied. The models used to calculate nitrate leaching potential assume that machinery is appropriately calibrated, so any changes made will not reflect in the estimated nitrate leaching number, but they will benefit your farm and the environment.



Protecting wetlands

Fencing off existing wetlands or installing new riparian plantings to capture run-off will help remove nutrients applied in effluent (and nutrients from other sources) before they reach waterways. Correctly installed, wetland plantings will reduce nitrogen losses from your farm and will also provide a habitat for wildlife.

How does nitrogen fertiliser affect nitrate leaching?

Following good agricultural practice

for nitrogen fertiliser reduces the chance of losing this nitrogen by nitrate leaching or direct entry to waterways

Small, regular applications of nitrogen fertiliser

mean the nitrogen is much more likely to be used by plants than lost by leaching

Nitrogen fertiliser only has a small direct impact on nitrate leaching

Applying nitrogen fertiliser

when soils are overly wet or plants are not growing will increase the chance of the nitrogen being lost by leaching

Nitrogen fertiliser indirectly affects

nitrate leaching as it allows you the option of increasing stocking rate

Activity

List the ways in which you use nitrogen fertiliser on your farm (e.g. following the cows, use on maize crop, etc)

How often do you find yourself applying nitrogen fertiliser in less-than-favourable conditions?

How often do you find that you need to use higher rates of nitrogen fertiliser than are recommended?

How do you ensure your nitrogen is applied with correctly calibrated equipment?



NOTES

How much control do you have over nitrogen fertiliser?

The type of nitrogen fertiliser you use, the rate it is applied at and the timing of that application are all very much within the control of most farmers. There are some exceptions regarding timing, particularly in regards to post-emergence nitrogen fertiliser use on crops, and to a lesser extent in pastoral settings, when nitrogen is being used to fill a feed gap.

Nitrogen fertiliser management practices to reduce nitrate leaching



Use good agricultural practice

Following the fertiliser industry's guidelines for nitrogen application will help to minimise the risk of nitrate leaching and also maximise the value you get from your nitrogen fertiliser. One of the key points to observe is the timing of application: apply nitrogen when pasture is growing, so that plants can use it. If soils are too cold or too wet, plant uptake will be low. Advice on good agricultural practice for nitrogen fertiliser application can be found on the Fertiliser Association's website, fertiliser.org.nz



Optimise nitrogen fertiliser use

Applying nitrogen on a little-and-often basis, rather than using less frequent but larger applications, may allow you to apply less overall but still get the same pasture yield. Increasing pasture utilisation will also allow you to apply less nitrogen fertiliser, as will any other technique that reduces wastage (e.g. when feeding out) or that reduces the requirement for more grass (e.g. using imported, low-protein feed). Using planning tools such as feed wedges and/or nitrogen plans can help to ensure that nitrogen fertiliser use is optimised.



Consider slow-release nitrogen fertilisers in autumn or winter

Where autumn or winter nitrogen applications need to be made on pastoral soils, there is a high risk of nitrate leaching, especially on more porous soils. Using a slow-release nitrogen fertiliser will help to minimise any direct nitrogen fertiliser leaching and ensure maximal plant recovery of the nitrogen, resulting in a better production response than could be achieved with a conventional soluble nitrogen fertiliser.



Consider slow-release nitrogen fertilisers in spring-wet districts

If soils are wet in spring, it's difficult to get nitrogen fertiliser on early enough to boost pasture growth to meet early spring feed requirements. Wheel traffic on wet soils causes damage that retards pasture growth, so is best avoided. Applying a blend of slow-release nitrogen and conventional soluble nitrogen fertilisers lifts feed going into winter and then sustains pasture growth through winter and into the early spring flush. This approach provides more feed over the winter/early spring stocking rate bottleneck, and reduces the likelihood of fertiliser nitrogen being lost by leaching.



Use alternatives to nitrogen fertiliser

If you typically apply nitrogen fertiliser when the risk of nitrate leaching is high (i.e. late autumn and winter), consider using an alternative such as gibberellic acid. This could result in a small reduction in the amount of nitrate leaching.

How does feed affect nitrate leaching?

Fodder crops and imported supplement

both affect the amount of nitrate leaching that will occur on your farm

The higher the protein content of consumed feed,

the higher the nitrogen content of animal's urine, so the greater the potential amount of nitrate leaching

Feed is an easily overlooked source of nitrogen that can contribute to nitrate leaching

Strip grazing of fodder crops

means urine is concentrated in a small area, so nitrate leaching risks increase

Feeding high-protein supplementary feed also increases the risk of nitrate leaching

Winter-grazed crops increase leaching risk more than other crops

Activity

List the supplementary feeds and fodder crops that are used on your farm.

How are these crops fed to stock?



NOTES

How much control do you have over feed?

Feed is one factor that you do have an ability to influence. It is relatively easy to select feeds that have lower protein content, although it may be wise to seek advice from an animal nutrition specialist to ensure that milk production and animal health remain optimised. It is also possible to develop systems for supplementary feed that allow you to control the fate of animal waste excreted while stock are feeding.

Feed use strategies to reduce nitrate leaching



Increasing pasture utilisation

As mentioned on page 13, increasing pasture utilisation enables you to use less fertiliser nitrogen, which in turn may result in less nitrate leaching. Other factors that will help improve pasture utilisation include protecting land from pugging damage and adjusting the rotation to ensure that pasture cover and feed demand are matched as closely as possible.



Using lower protein feeds

As mentioned on page 9, a high-protein diet increases the nitrogen content of urine, and increases the risk of nitrate leaching. Using low-protein supplements or selecting low-protein feed options helps to reduce the nitrogen load in the urine, and hence in the soil. The overall diet of the animal needs to be considered when this option is being investigated, and it may be helpful to seek advice from an animal nutrition specialist.



Lifting rather than grazing crops

Grazing crops in situ results in animal urine being deposited directly on the ground, and if this occurs prior to wet months, it increases the likelihood of nitrate leaching. Lifting crops and feeding them on a feed pad or a winter pad can reduce the environmental impact associated with these crops. For this to be successful, the effluent must be collected, stored and spread when the risk of nitrate leaching is low. For optimum economic benefit, effluent application should also be timed so that it is spread when pastures are growing strongly, so there is more likelihood of nutrient uptake.



Replacing winter crops with summer crops

Grazing fodder crops in winter can increase the risk of nitrate leaching, as the animal's urine will be deposited when the risk of drainage is at its greatest. An alternative approach is to sow a summer fodder crop, graze this and build a pasture feed wedge to carry into winter. Doing this can reduce nitrate leaching and may remove the need for a winter fodder crop.



Adopting low-impact winter grazing practices

Since most nitrate leaching occurs during winter, any practice that reduces nitrogen inputs during this time will be of benefit. This could include using a feed pad, wintering off, time-limited grazing, installing an animal housing system, etc. Protecting pastures from pugging will also mean more pasture is available in spring.

How does soil drainage affect nitrate leaching?

Soil type dictates how much water can be held before drainage starts

Stony soils, sands, gravels and pumice soils drain easily
– so are more prone to nitrate leaching

Artificial drainage helps poorly drained soils
– but the water discharges nitrate directly into natural waterways

Nitrogen is leached from soil when water moves below plant roots – in other words, there's a drainage event

Areas that get more rainfall also experience more drainage
– regardless of the soil type

When drainage occurs, nitrate can enter rivers, streams and lakes

Activity

What are the soil types on your farm? Are they free-draining, or do they hold a lot of water?

How much rain do you get each year?

If you use irrigation, what processes do you have in place to ensure that you are not exceeding the moisture-holding capacity of the soil, i.e. that you are not overwatering?



NOTES

How much control do you have over drainage?

Ultimately, there is little you can do about rainfall patterns. However, you do have control over any irrigation on your farm (including effluent application). There is also little that you can do to change your soil type or the overall contour of your farm.

Reducing your number

This section of the workbook is for you.

Here you can set your goals for nitrate leaching, and record the practical steps that you might take to achieve those goals.

Nothing in this section is compulsory: the information is for you only.

Goal setting

My current nitrate leaching number is _____ kg N/ha/year

For me, taking action on nitrate leaching or improving nitrogen-use efficiency on my farm is

☐

Very important

☐

Not very important

☐

Important

☐

Not at all important

Activity

List three reasons why improving your farm's nutrient management and reducing nitrogen loss is important to you.

1.

2.

3.

Reducing your number

WHAT FACTORS CONTRIBUTE TO NITRATE LEACHING ON MY FARM?

Use the table on page 12 to assess whether or not you can influence any of these factors

FACTOR	IS THIS A FACTOR ON YOUR FARM? (yes/no)	CAN YOU INFLUENCE IT? (yes/no)
Porous soils (sands, stony soils, pumice soils)		
High rainfall (>1200 mm/year)		
Irrigation not closely monitored		
Cow breed		
High stocking rate		
Mainly high-protein feed		
Grazing-only system (no supplement)		
Cows grazed on pasture in winter		
Pastures get pugged in winter		
No feed pad available		
No stand-off pad available		
No animal housing available		
Small effluent area		
Limited effluent storage		
Effluent application not closely monitored		
Effluent application rate too high		
Effluent applied in late autumn/winter		
Nitrogen fertiliser applied at high rates		
Nitrogen fertiliser applied when plants not growing		
Nitrogen fertiliser applied when soil is waterlogged		
Pastures frequently grazed too hard		
Pastures frequently grazed too light		



Reducing nitrate leaching

List three factors that you could look at to see if you could reduce nitrate leaching or improve nitrogen-use efficiency:

1.

2.

3.

On the next three pages, you'll look at each of these factors in more detail, noting down your thoughts on what would need to be done to make these changes happen.

OPTION 1

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OPTION 2

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OPTION 3

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Now what?

Now that you have investigated a range of options for reducing nitrate leaching, you're in a much better position to actually make some changes on your farm, and to contribute to the dairy industry's goal of reducing nitrate leaching, increasing nitrogen-use efficiency and protecting New Zealand's waterways.

However, we've all got lots of things vying for our attention, and with all this busyness, it's easy to forget our long-term goals.

Use the space below to set your own personal action plan. You may want to understand more about nitrogen management practices, or you may feel ready to start making changes. Either way, putting these goals in writing is a good way to start.

Within the next three weeks I will

Within the next three months I will

Within the next year I will

[illegible]



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