

FACTSHEET

Nitrogen loss to water from sheep and beef farms

June 2024

Sheep and beef farming can impact freshwater quality and stream health. Predominantly the risk comes from the loss of four key contaminants to water. These are sediment, *E. coli*, phosphorus (P) and nitrogen (N). It is important to understand the risks to freshwater from your farming operation and to put into place actions to mitigate, minimise or eliminate those impacts.

This factsheet relates to nitrogen loss from drystock farms. At the end of this document there is a link to the other three factsheets in this series.

Nitrogen is an essential nutrient for plant growth. It occurs naturally in the environment but can be added by clover fixation or as fertiliser to boost production. In addition, urine deposited on the ground contains very large loads of nitrogen (a beef cow urine patch can be 700 kg N/ha and a sheep 500 kg N/ha).

There are 3 factors that can influence the impact of nitrogen loss on waterways;

1. A source of nitrogen (either natural or anthropogenic).
2. A transport pathway for the nitrogen to waterways (free-draining soils are at risk of losing more nitrogen).
3. The susceptibility of the receiving waterbody and freshwater ecosystem to nitrogen.

Waterbodies naturally contain certain levels of nutrients and sediment. Waterbodies that have naturally low levels of nitrogen are more susceptible to adverse effects of additional anthropogenic nitrogen than those that are naturally higher in N.

Regional Council plans can have specific rules and in-stream targets to meet. The NPS-FM currently has attribute state values for nitrogen concentration in streams and lakes. It is the role of Regional Councils to set rules and plans so that they can meet, at a minimum, national bottom lines for these attribute states.

Summary

Nitrogen (N) leaching loss to water is often associated with other, more intensive, farming systems. However, there is nitrogen leached or lost from sheep and beef farms and it is important to assess the risk of N loss for your farm and to investigate means to mitigate, manage or minimise losses.

On a sheep and beef farm animal urine is typically the greatest source of nitrogen. Other sources include fertiliser, imported feeds, effluent (although effluent systems are uncommon on sheep + beef farms), and nitrogen fixing bacteria associated with legumes such as clover.

Nitrogen loss risk is closely linked to farming intensity and, in the case of livestock systems, stocking rate. Thus, the risk of N loss on extensive sheep and beef farms is often relatively low.

The risks of nitrogen loss are individual to each farm, as are the best ways to manage and mitigate those risks. To protect your productivity and support healthy ecosystems, it is important to understand nitrogen risk on your farm and to have a comprehensive long-term risk management plan.

Nitrogen loss to water is bad for waterways because:

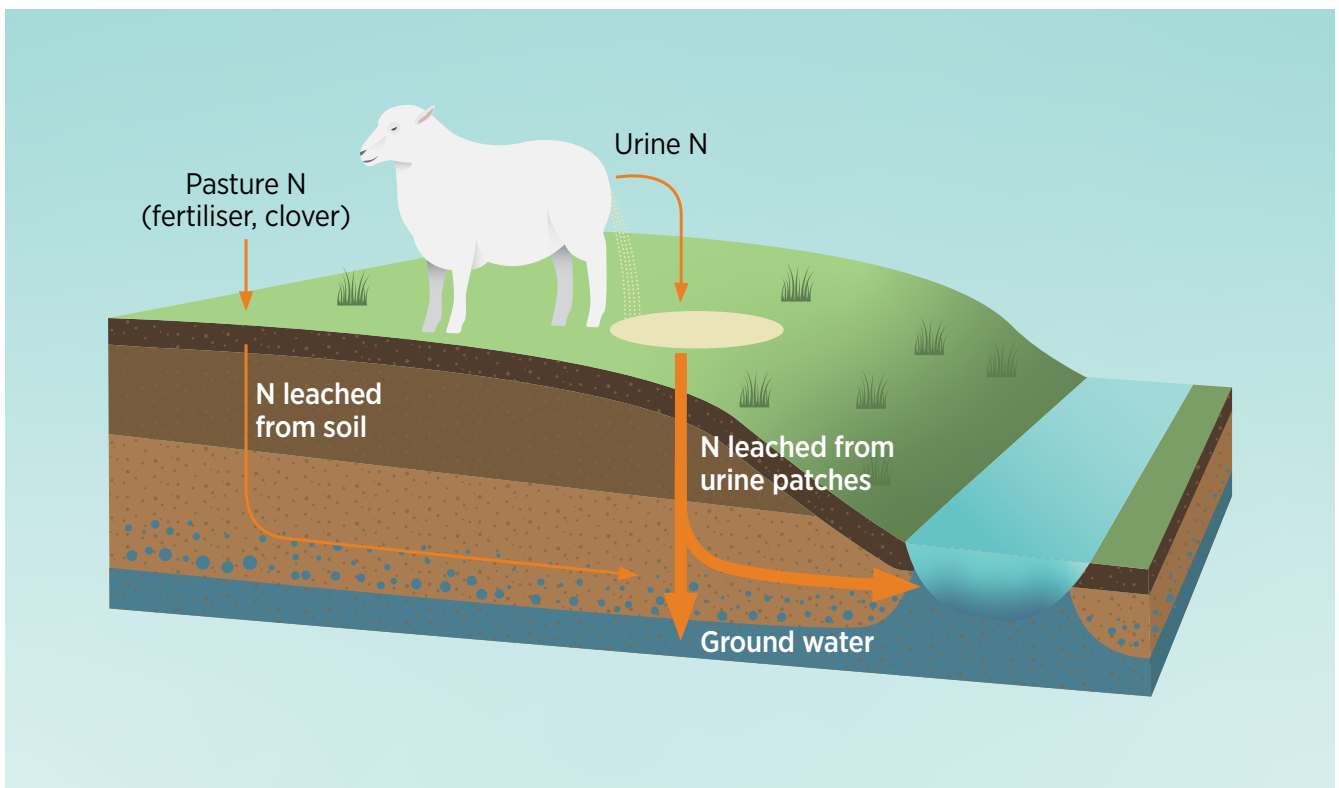
- It causes aquatic weeds and algae to grow too fast which 'chokes' waterways and blocks water intake
- At high concentrations it causes harm to fish and macroinvertebrates
- High levels in human drinking water can affect people's health

Nitrogen loss is bad for the farm because:

It is a loss of nutrient that could be used for additional pasture production and it can be expensive to apply extra fertiliser.

How is Nitrogen lost?

Soil bacteria convert nitrogen to nitrate which is soluble and stays in the soil water and, if not taken up by plants, can be lost via leaching to ground water. This leaching of nitrate is the predominant loss pathway for nitrogen from sheep and beef farms. Nitrogen can also be lost via runoff (also known as overland flow), via direct deposition into water (of urine or fertiliser), or through drainage systems.



What causes N loss?

Excessive N in the soil (beyond what is needed for plant growth) can move down through the soil profile and eventually lost via leaching during drainage events (most commonly). Nitrogen can also be lost via overland flow or runoff events.

Soil is like a sponge, able to store water in the pores of the 'sponge' until it is saturated and then water leaks out. The amount of water a soil can hold on to before it drains out is known as 'soil water holding capacity' and this varies by soil type. Stony soils have a very low soil water holding capacity and thus are more 'leaky' than other soils. Combine this with high soil N levels and irrigation or rainfall and the amounts of nitrate leached can be high.

Risk factors for nitrogen loss to water

- 1 Soil type and soil water holding capacity
- 2 Stock type, stocking rate and density
- 3 Irrigation
- 4 Nitrogen fertiliser application
- 5 Animal urine
- 6 Intensive winter grazing



Inherent risks: the risks associated with the land and location.

(See graphic on risk factors for nitrogen loss to water)

There are three main drivers of inherent risk for N loss:

- Soil type: Soils have differing soil water holding capacity and some are more 'leaky' or have more drainage than others, for example stony soils. **1**
- Attenuation: This is the ability of the soil and subsoil to remove nitrate through biological denitrification (forming either benign N₂ gas, or N₂O, a more harmful greenhouse gas).
- Climate:
 - Rainfall (both annual volumes and number and extent of large rainfall events) impact drainage.
 - Soil temperature impacts plant growth and N uptake which reduces the amount of N available in the soil for loss during drainage events.

What are the risk factors associated with farm systems and management practices?

(See graphic on risk factors for nitrogen loss to water)

The main sources of N leaching loss to water, and the farm practices that influence these, are:

- Nitrogen cycling via animal urine: **5**
 - Stock type: Larger animals excrete more N, and in more concentrated urine patches. Cattle excrete more than sheep and deer in each urine patch. **2**
 - Feed type influences the concentration of N in the urine. High protein feeds have higher N contents.
 - Grazing management influences losses of N in different ways:
 - Grazing on wet soils can increase the risk of urinary N being lost in drainage because the soil 'bucket' is full and drainage is occurring. It also increases the risk of losses via overland flow pathways. **1**
 - Stocking density impacts N loss as a higher stocking rate means more urinary N is deposited per area of ground. **2**
 - Stock management also influences the amount of time that animals remain on one area and therefore the amount of urinary N deposited. **2**

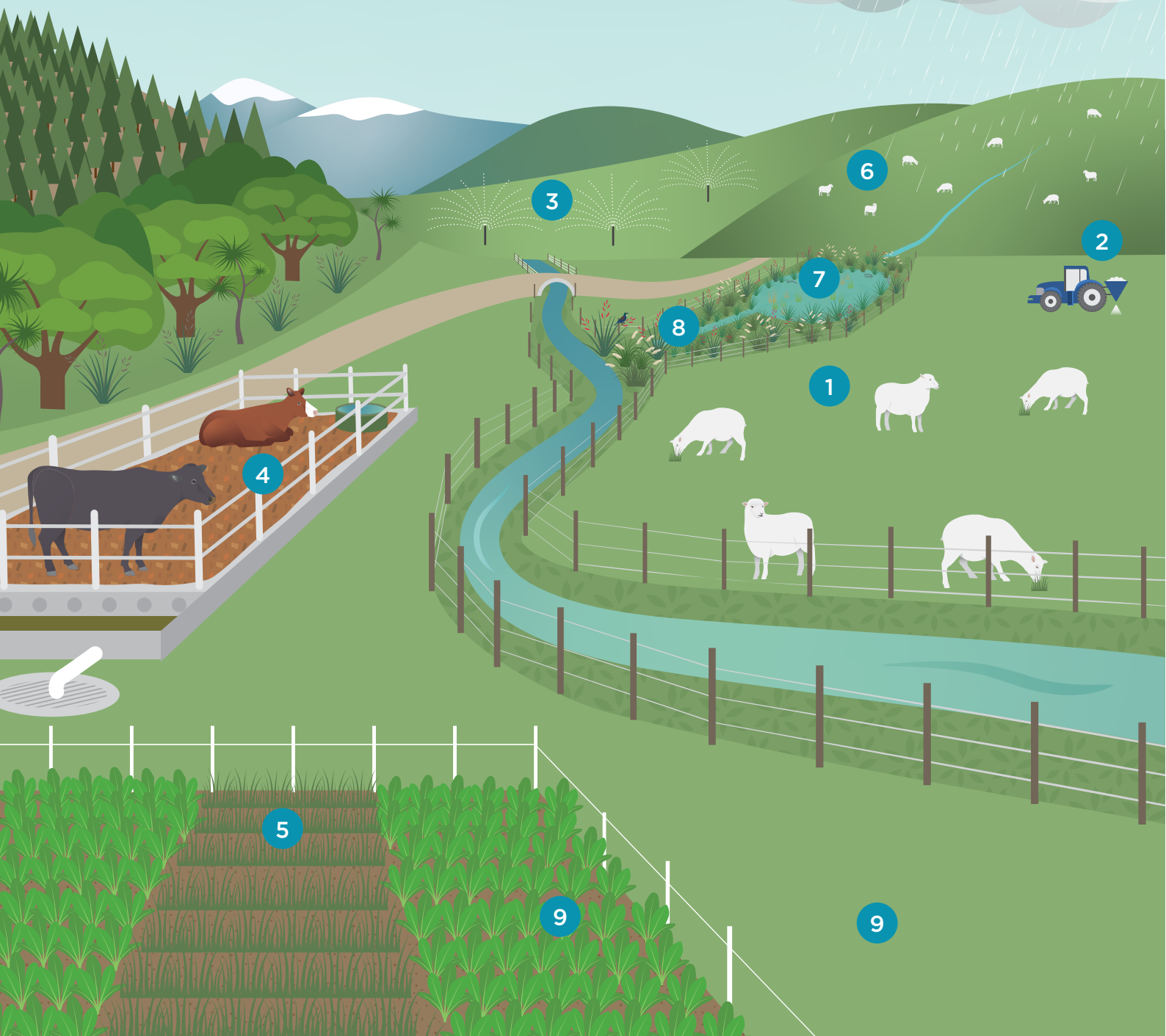
- Cultivation results in mineralisation of the N in the soil which is then available for either plant uptake or, in some cases, leaching to groundwater.
- Intensive grazing on wet soils. This results in areas where much urinary N has been deposited and, in many cases, that do not contain a growing plant to take up this N. There is also an increased risk of losses via overland flow when soils are wet. **1 2 5 6**
- Intensive grazing on soils with a low soil water holding capacity (e.g. stony soils and excessively free-draining soils). In these situations, the main risk is N leaching loss. These stony and excessively free-draining soils have a low soil water holding capacity, thus the N in the urine patches is more prone to leaching during rainfall events. **1 2 5 6**
- Fertiliser applications. Fertiliser applications can exceed immediate plant requirements resulting in a (usually temporary) greater risk of N loss to water. The two pathways of nutrient loss from fertiliser applications are: **4**
 - Direct applications into waterways; and
 - When nutrients exceed requirements and are available in the soil to be lost via leaching when drainage events occur.
- Imported supplements are another source of N brought onto the farm or transferred to another part of the farm resulting in increased stocking rates and density and urine concentrations. **2 5**
- Irrigation. Irrigation is a risk in two ways – firstly it can increase the carrying capacity of the farm, thus increasing the amount of urinary N in the system. Secondly, it can result in increased drainage, particularly inefficient or poorly managed irrigation, resulting in more N leached. **3**
- The management of effluent storage systems and land application of stored effluent can result in losses to water via a number of pathways. Effluent or manure systems are not common on sheep and beef farms but may be associated with feed pads or wintering pads.

➤ In summary, the main drivers of N loss are:

- Factors associated with farming intensity: stocking rate, purchased supplementary feed, N fertiliser, irrigation.
- Inherent characteristics of the soil and climate including soil water holding capacity and rainfall.

Management actions to reduce the risk of N loss

- 1 Alter the sheep to cattle ratio. Cattle have higher N loading than sheep
- 2 Reduce N inputs, including fertiliser
- 3 Irrigation scheduling of rate and timing. Monitoring of soil moisture and fault detection.
- 4 Install stand-off pads with capture and storage of effluent
- 5 Reduce intensive winter crop grazing areas
- 6 Alter farming system to carry less stock during winter
- 7 Management of critical source areas to reduce losses via overland flow
- 8 Look after, reinstate or build wetlands - these are great places to attenuate N
- 9 Maintain as much vegetation cover on paddocks as possible



Management actions to reduce nitrogen loss via leaching

- The most effective ways of reducing the amount of urinary N in the soil are to:
 - Reduce stocking rates by reducing those inputs that allow for greater feed production:
 - Reduce N fertiliser. **2**
 - Reduce imported supplementary feed.
 - Reduce areas of intensive winter grazing. **5**
 - Reduce the amount of urinary N deposited on soil during the at-risk autumn and winter months by:
 - Installing stand-off pads with capture and storage of effluent. **4**
 - Altering the farming system to carry less stock during winter. **5 6**
 - Alter the cattle to sheep ratio. Cattle urine has a higher N loading than sheep. Thus, the same stocking rate of sheep is likely to have a lower leaching rate than the same stocking rate of female adult cattle. However, cattle perform an important role in the sheep and beef system so it is not always practical to simply replace cattle with sheep in all situations. The individual farm and farm system must be considered. **1**
- Reducing N losses from fertiliser can be achieved by considering the timing and rate of application and using a certified contractor to apply the fertiliser. Contact your fertiliser rep to discuss your fertiliser management plan and do a nutrient budget. **2**
- Losses of nitrogen via overland flow pathways can be reduced by:
 - Management of critical source areas. **7**
 - Management of intensive winter grazing. **5**
 - Reducing periods of bare soil and considering the timing of fallow periods.

- Manage irrigation applications to avoid soil saturation and increased N leaching. Monitor soil moisture levels and for any faults. Consider the rate, timing and scheduling of irrigation applications. **3**
- Maintaining as much vegetative cover as possible. This is important not only for winter scenarios but also for uptake of N out of soils that could be left bare by summer or autumn crop harvests or grazings. **9**
- Looking after existing, or creating new wetlands. These are great places to attenuate N. **8**

Links to further information

For factsheets on Sediment, Phosphorus, *E. coli*, and Nitrogen loss to water from sheep and beef farms, visit the [B+LNZ webpage on managing stock near water](#)

Landcare trust – factsheet on nutrients and CSAs <https://landcare.org.nz/wp-content/uploads/2023/01/Nutrients-Critical-Source-Areas.pdf>

Ballance Managing Nitrogen Loss <https://ballance.co.nz/advice/nitrogen/managing-n-loss#:~:text=Losses%20to%20water%20occur%20because,process%20known%20as%20nitrate%20leaching>

Waikato Regional Council - Managing Farm Nitrogen <https://www.waikatoregion.govt.nz/environment/land-and-soil/managing-land-and-soil/managing-farm-nutrients/managing-farm-nitrogen/>

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