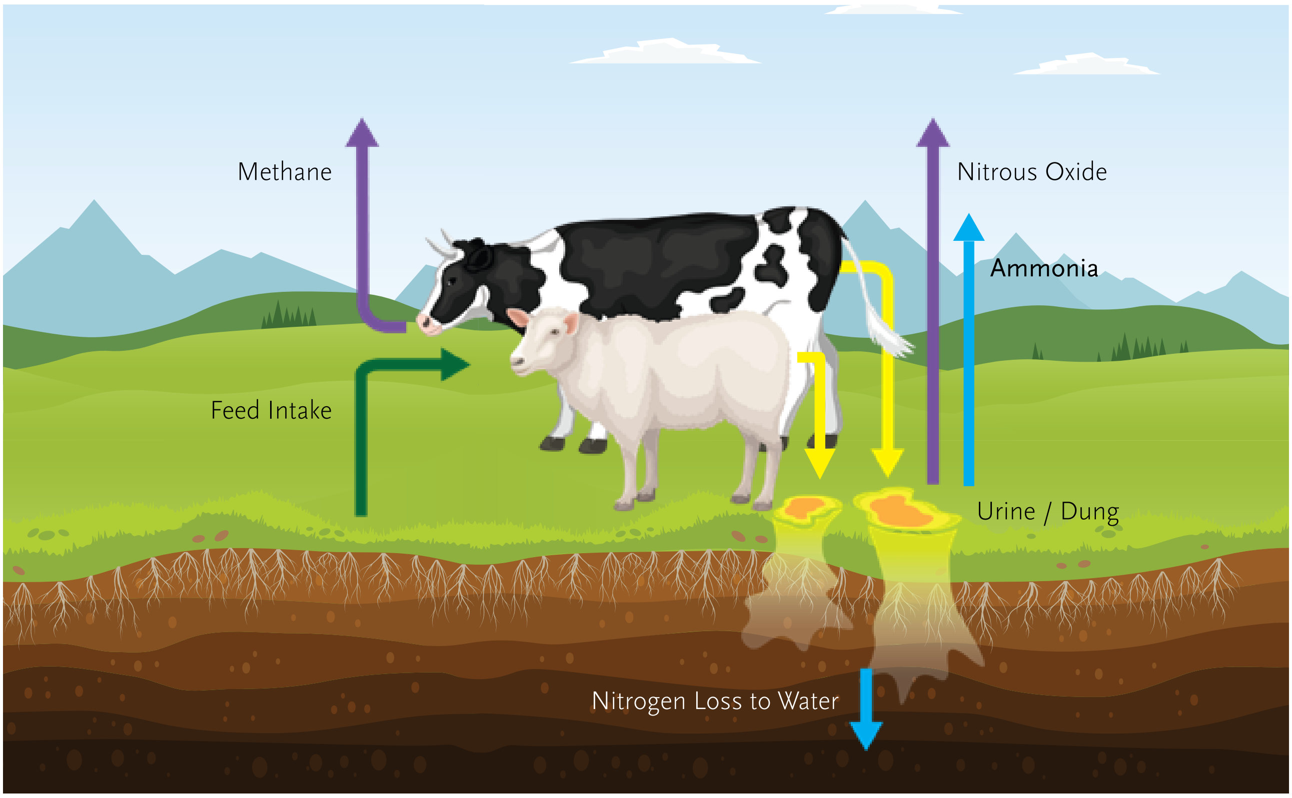
Some Environmental Attributes of Dairy Sheep Farming

There is little knowledge about the environmental impacts of sheep milking. Evidence is needed to support the reputation for environmental sustainability of New Zealand dairy sheep production and assess whether dairy sheep milking may be a suitable land-use in nitrogen-stressed catchments.



The basic principles of some environmental effects from grazed pasture farm systems in New Zealand

agresearch
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Research was undertaken to quantify some of the potential environmental effects of dairy sheep production systems in New Zealand.

As a first priority, particular focus was placed on quantifying nitrogen (N) loss to water. As a first priority, research focus was placed on the key attributes of dairy sheep effluent were measured and, in turn, used to develop good management practice guidelines that help to ensure these materials can be safely applied to land.

Secondary research goals included an estimation of greenhouse gas emissions and the refinement of farm systems models that can be used to describe nutrient flows and losses from farms that have contrasting production intensities or management approaches.

The four goals of this research were to:

1. **Quantify nitrogen losses to water**
2. Estimate intensity of N and greenhouse gas emissions
3. Characterise effluent and refine Good Management Practice guidelines
4. Refine farm system models

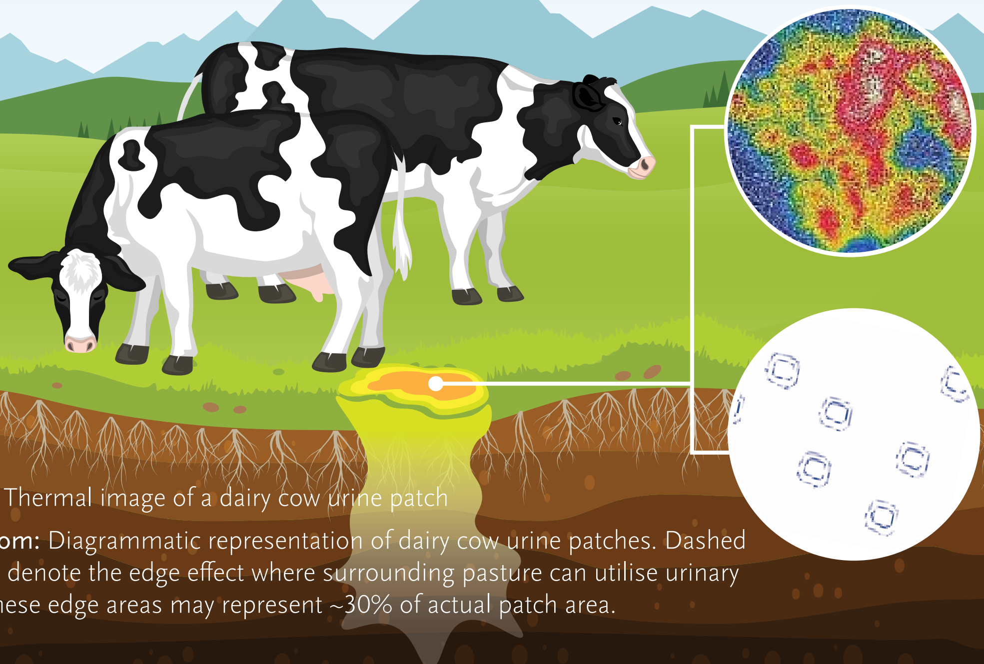
1 Quantify nitrogen losses to water

Nitrogen leaching research undertaken included:

1. To measure N leaching beneath grazing dairy sheep to provide baseline information,
2. To define the attributes of the urine patch to help explain its component parts, and
3. To compare the N intensity from differing NZ dairy sheep operations.

N loss to water can be reduced by 10-50% due to smaller urine patches, smaller N load in individual urine patches, and the edge effect

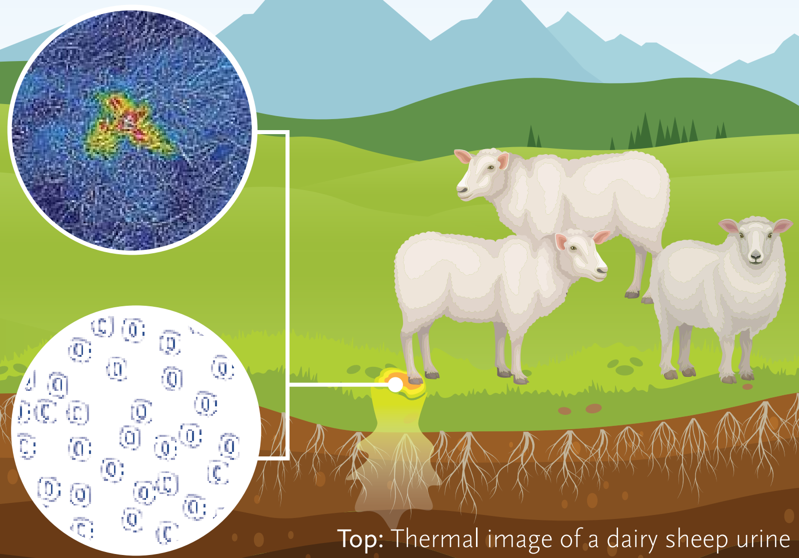
Cow urine patches are larger than those of dairy sheep. This causes urinary N to be concentrated in certain areas of the pasture. Plants are unable to utilise all the nutrients, resulting in a high proportion of losses to water and air.



Top: Thermal image of a dairy cow urine patch

Bottom: Diagrammatic representation of dairy cow urine patches. Dashed lines denote the edge effect where surrounding pasture can utilise urinary N; these edge areas may represent ~30% of actual patch area.

Dairy sheep urine patches are small relative to cow patches, resulting in urinary N being spread more evenly across pasture. This allows a greater opportunity for plants to utilise nutrients in the urine.



Top: Thermal image of a dairy sheep urine patch

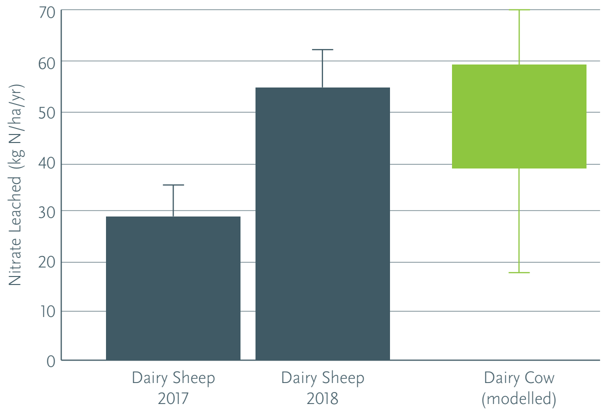
Bottom: Diagrammatic representation of smaller dairy sheep urine patches. Edge areas may represent more than ~50% of actual patch area

N Leaching Studies

We measured nitrogen (N) loss to water in two contrasting experiments: (1) beneath grazing dairy sheep on a free-draining soil in the Waikato (2017-2018) and (2) beneath grazing non-lactating sheep and dairy cows on a poorly-drained soil in South Otago (2019).

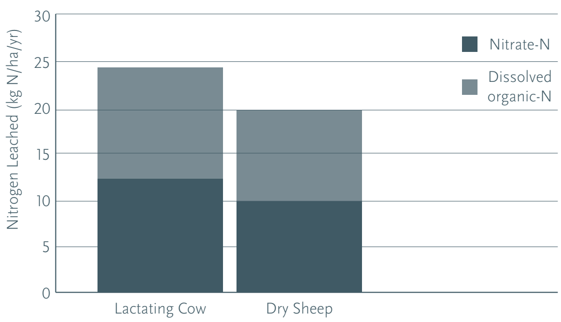
Waikato

- Nitrate leaching measured beneath grazing dairy sheep near Taupo for 2 years (2017-2018) on well-drained volcanic soils.
- Both measurement years were atypical with long summer droughts, and 2018 with late season rainfall and drainage. Neither year is considered representative so a typical year might be somewhere between the two.
- By comparison, modelled N leaching losses from dairy cow farms (n = 58) on well drained soils receiving 1300-1600 mm rainfall p.a., appeared to be higher, on average than for dairy sheep.



Otago

- Nitrate-N and dissolved organic-N measured beneath grazing dry sheep and lactating dairy cows on a poorly drained soil.
- The single measurement year (2019) had an atypically dry winter followed by a wet summer.



Findings

Waikato: On free-draining soils, N leaching losses from lactating dairy sheep were 30 kg N/ha in 2017, much lower than the 56 kg N/ha measured in the second year.

N leaching losses are typically higher in drought years due to low pasture growth and uptake of N.

On average, N leaching losses from dairy sheep appeared to be lower compared to a modelled dairy cow system.

Otago: On poorly-drained soils, N leaching from dry sheep was ~20% less than from cow grazing on a per hectare basis, although the difference was not statistically significant.

Significantly more pasture was grown (and eaten) in the sheep grazing treatment, most likely due to improved soil structure (i.e. less compaction under sheep).

When N leaching losses are expressed as a proportion of urinary N excretion, sheep grazing was approximately ~50% lower than cow grazing.

2 Estimate intensity of N and GHG Emissions

N intensity refers to the amount of N cycling through a farm system. In general, high N intensity means a greater risk of N loss via leaching or as nitrous oxide (a potent greenhouse gas). A key driver of N loss risk is the amount of feed grown and eaten by grazing animals including pasture and supplement. The amount of urinary N excreted can be used a proxy for the risk of N loss.

A ‘first look’ into greenhouse gas emissions from NZ dairy farms was conducted, in a desktop exercise. The latest NZ national greenhouse gas inventory approach was used to estimate potential nitrous oxide (N_2O) and methane (CH_4) losses from 5 dairy sheep and 2 dairy cow farm systems in NZ (scenarios described below). This approach accounted for enteric CH_4, and CH_4 from faecal dry matter (e.g., dung and effluent) and direct (e.g., excreta, fertiliser, effluent) and indirect losses of N_2O following ammonia volatilisation and nitrate leaching.

Findings

Dry matter intake (DMI) per hectare drives N leaching risk regardless of the source of feed.

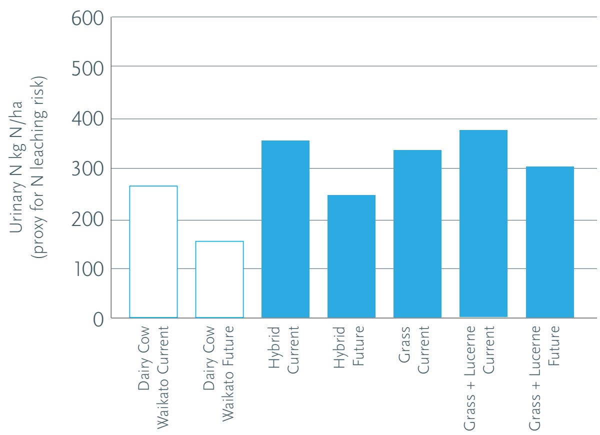
Off-paddock facilities can reduce N leaching risk by capturing N

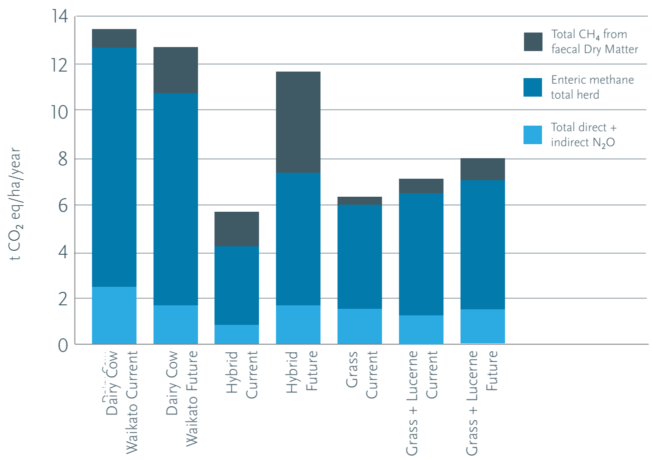
DMI per hectare was also the key driver of both N_2O and CH_4 emissions.

GHG emissions (from rumen digestion) were generally lower from sheep compared to cows

Enteric methane was the largest source of GHG emissions

Housed dairy sheep systems had higher losses of GHGs than outdoor systems





Scenarios

Dairy cow Waikato Current	Dairy cow Waikato Future	Dairy sheep Hybrid Current	Dairy sheep Hybrid Future	Dairy sheep Grass-based Current	Dairy sheep Grass + Lucerne Current	Dairy sheep Grass + Lucerne Future
Pastoral 21 Dairy farmlet Study	Pastoral 21 dairy farmlet study	Existing farm system	Existing farm system – likely future	Existing farm system	Existing farm system	Existing farm system – likely future
Represents regional average performance. Pasture-based (RG/WC), 12% dry matter intake from supplement. 3.2 cows/ha, 150 kg N/ha N fert	Represents future performance (improved genetics), stand-off pad (ave 12 hrs/d Apr-Jul). Pasture-based (RG/WC), 12% dry matter intake from supplement. 2.6 cows/ha, 50 kg N/ha N fert	Pasture based (RG/WC) plus cut & carry lucerne (homegrown). Sheep spend 8 hrs/day in shed. 12 ewes/ha. 75 kg N/ha N fert.	Pasture based (RG/red clover) plus homegrown silage and brought-in grain. Sheep spend 12 hrs/day in shed. 18 ewes/ha. 212 kg N/ha N fert.	Pasture based (chicory, RG/red clover pasture) plus maize grain and peas. Graze outdoors. 15 ewes/ha. 159 kg N/ha N fert.	Pasture based (RG/WC) plus cut & carry lucerne (homegrown). 20 ewes/ha. 0 N fert	Same as for ‘Grass + Lucerne Current’ except better genetics (e.g., system in 5 years time)

3 Charaterise effluent and refine GMP guidelines

Effluent Management

Dairy sheep effluent is a valuable resource that contains appreciable quantities of plant nutrients and water. Dairy sheep farms can produce similar volumes of farm dairy effluent (FDE) to dairy cow farms when considered on a stock unit (SU) basis.

While dairy sheep effluent nutrient concentrations appear to be lower than in effluents collected from dairy cows, dairy sheep effluent is still a valuable source of nutrients for plants when applied to land.

As with other dairy industries, the application of dairy sheep effluent to land is regulated by regional councils, either as a permitted activity with standards to adhere to, or as a controlled or discretionary activity that requires a resource consent. Following the good practice principles that have been developed for the dairy cow industry is therefore a sensible approach.

One peculiar feature of dairy sheep effluent is that it can contain wool fibres that may cause problems with the pumps, pipes and sprinklers that transport the effluent. The use of a spray-dip pump, which is better suited to handling fibres, is one approach to help cope with this potential problem.

Good management practice for dairy cows is relevant for dairy sheep, and a factsheet summarising the guidelines is available (website coming soon.)

4 Refine Farm System Models

Modelling for Nitrogen

Currently, Overseer Nutrient Budgets(R) (Overseer) does not have a specific model for capturing dairy sheep systems.

New data and research are required to develop a dairy sheep module, summarised as follows:

- Animal enterprise e.g., weight, lambing, growth profile
- Sheep milk characteristics e.g., composition and lactation curve
- Energy requirements
- Farm management e.g., where animals are located, feeding, urine patch attributes

A key challenge for Overseer will be capturing the complexity of existing and emerging 'hybrid' dairy sheep systems in NZ in terms of what animals eat and where, and how those nutrients are distributed across the farm.

Farm system models can be updated for dairy sheep when critical data gaps are filled.

Key takeaway messages

N Leaching losses appear to be lower per kg N excreted (from dairy sheep compared to cow)

Dry Matter Intake is the key driver of both N leaching risk and GHG emissions in dairy sheep (and cow) systems

Farm system models like Overseer[(R)] can be updated for dairy sheep when critical data gaps are filled.

Effluent from dairy sheep should be managed by following the GMP Guidelines for the dairy (cow) industry

On a per hectare basis, GHG emissions appear to be lower from dairy sheep systems compared to dairy cow.

Priorities for future research

Nitrogen Losses

Extend N leaching measurements

Nitrogen Cycling

Does the 'edge effect' of the urine patch explain the likely reduced N leaching from dairy sheep (compared to dairy cows)?

Other contaminants

E. coli measurements

Farm Systems

Develop module for Overseer Nutrient Budgets®

The bigger picture

Estimate in detail GHG emissions (this was only a first look!)

The bigger picture

Life Cycle Assessment (LCA)

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