

# NUTRIENT LIMITS - MAKING MONEY WHEN THE RULES CHANGE

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## Summary

- The National Policy Statement on Fresh Water Management requires Regional Councils to set objectives, water quality limits and methods (including rules) for all surface and ground waters in their region
- It is advisable, during this period of change, that farmers understand their nutrient budget and review the impact of system change on their nutrient budget before making significant change
- Nitrogen is the main nutrient of interest in most regions: however phosphorus and sediment are important in Southland and South Otago
- Farm gate nitrogen surplus is a good indicator of potential N leaching loss and is a factor over which farmers have management control
- If planning a system change, farmers should determine if their current system is optimised against annual pasture growth using such tools as the comparative stocking rate
- On-off grazing during autumn, to manage urine patch deposition onto pasture, significantly decreases the risk of N leaching. Making an investment in infrastructure to achieve this N mitigation option requires a full investment analysis to determine the financial impact on the farm business
- Removing winter crop grazing from a dairy system can significantly decrease N loss but, in practice, achieving this will be dependent on off farm grazing being available or significant capital investment in infrastructure for an off-paddock wintering systems

- Including an off-paddock facility requires a nutrient management plan to ensure the nutrients imported in feed and bedding are used as efficiently as possible and that the risk of nutrient build up is minimised
- Results from case study scenario modelling of farms in Southland and South Otago support research findings on the impact of stocking rate, nitrogen input, on-off grazing, wintering and manure management on N leaching

## **Background**

The New Zealand Government's National Policy Statement on Fresh Water Management 2011 (<https://www.mfe.govt.nz/rma/central/nps/freshwater-management.html>) requires Regional Councils throughout New Zealand to:

- set water quality limits for all surface and ground waters in their region
- avoid over-allocation of assimilative capacity within those limits
- improve freshwater bodies that have been degraded from over-allocation.

There are two key actions required from industry to ensure the desired outcome:

1. Work closely with regional councils in the prioritisation of water bodies and the setting of limits. This will help to ensure balanced expectations
2. Ensure that “the adoption of good practice options” can be extended to the catchment level and applied as a self-management framework designed to meet water quality targets.

For the Southland region this process is being implemented through the Water and Land 2020 and Beyond process (Figure 1) while in Otago it is through Plan Change 6A (Figure 2).

As a result of the National Policy statement and increasing public scrutiny of agricultural practices many dairy manufacturers are increasing their compliance monitoring to ensure farmers are adopting good practice methods for nutrient management. It is inevitable that change is coming and as such farmers need to start considering their options.

**Water and Land 2020 and Beyond**

**What is Water and Land 2020 & Beyond?**

Water is vital to our lives, it impacts on what we drink, where we play and the work we do. Already, we are seeing signs that our rivers and coastal environments are becoming compromised – affecting our experiences of these areas. Groundwater is also under pressure with drinking water standards breached in some areas. Is this something we can change? Our answer is Water and Land 2020 & Beyond, a partnership project involving you, the community, Environment Southland and Ngai Tahu Murihiku. We need to change how we look after water in a way that:

- Sustains our own ability to live;
- Preserves our environment; and
- Maintains cultural values.

All of us are connected to this project in some way – Planning as a community

The project has three main parts with action occurring now and through to 2030:

**Focus Activities**



Moving to good management practice.

**Interim Measures**



Holding the line and working towards meeting community goals.

**Catchment Limits**



Deciding on limits to ensure community goals are met.

There are a number of local and national drivers for the Water and Land 2020 and Beyond project including:

- The community goals for water captured in the Regional Water Plan for Southland 2010
- Issues arising from water monitoring and targeted investigations
- Central government water reforms (including the National Policy Statement for Freshwater Management 2011)

Figure 1: Environment Southland information on the Land and Water 2020 and Beyond process (<http://es.govt.nz/environment/water-and-land-2020-and-beyond/>)

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- > Flood Protection Management Bylaw 2012
- > Milton 2060
- > Urban Water Quality Strategy

**Plan Change 6A (Water Quality)**

Council notified Proposed Change 6A (Water Quality) on 31 March 2012 and released its decisions on 20 April 2013

Plan Change 6A was approved on 26 March 2014 and is operative from 1 May 2014

Download operative Plan Change 6A (2 MB)

Download operative Plan Change 6A Maps (6 MB)

**Media Releases**

- > Otago flood conditions update 1300hrs Tuesday, 29 April 2014
- > Otago flood conditions update 1600hrs Monday, 28 April 2014
- > Otago flood conditions update 1130hrs Monday, 28 April 2014
- > Otago flood conditions update 1730hrs Friday, 19 April 2014
- > Otago flood conditions update 1430hrs Friday, 19 April 2014
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Figure 2: Otago Regional Council Plan Change 6A (<http://www.orc.govt.nz/Publications-and-Reports/Regional-Policies-and-Plans/Regional-Plan-Water/Proposed-Plan-Change-6A-Water-Quality/>)

## Nutrients of concern

The main nutrients of concern are ionic forms of nitrogen (N) and in some instances phosphorus (P), plus other contaminants e.g. faecal coliforms and sediment. Nitrogen is more difficult to manage as it moves freely through the soil into water, whereas P usually stays bound to particles within the soil and mainly enters waterways through surface runoff and erosion. Regional nutrient plans are likely to require farmers to reduce N losses in many catchments. A method that is emerging is a 'target' nitrate leaching limit to be achieved for different categories of farms within the catchment, such as 'x' kg N per hectare per year. Depending on the catchment, soil type and farm system, the target could be lower than the level currently achieved. Ideally, the targets will be achieved with minimal impact on profitability or milksolids production so that farm businesses and regional communities can be sustained.

Nitrogen cycling via the animal is the key point of focus for controlling N losses from New Zealand grazing systems. In grazed ryegrass and white clover pastures, a cow's N intake far exceeds N output in milk, with up to 75% being excreted either in dung (25% of total N eaten) or urine (50% of total N eaten) (Pacheco and Waghorn, 2008). Urine patch N loadings vary between 500 and 1000 kg N/ha (Whitehead, 1995). These N loadings are in excess of the capacity of the pasture in and around the patch to take up the available N. Urinary N is readily transformed to nitrate in the soil. Nitrate is highly soluble and, if not taken up by the plant roots, can be carried below the root zone by drainage water. The higher the concentration of N in the diet, the higher the total amount of N excreted per day, the higher the N concentration per urination event and the greater the risk of nitrate leaching. The risk of nitrate leaching from the urine patch is higher for urine deposited in late summer and autumn than for urine deposited at other times, because plant growth is often restricted and the urinary N is deposited close to the winter drainage period (Shepherd et al. 2010). Consequently plant uptake is low and, because winter and spring rainfall usually exceeds the water holding capacity of the soil, drainage occurs taking with it the nitrate. Soil type and rainfall have a significant impact on N leaching.

Implementing farm system changes to reduce nutrient loss is complicated. Poor understanding and over-simplification can put both the achievement of reduced nutrient loss and the financial viability of the dairy farm business at risk. The options available to individual farmers need to be assessed against overall farm performance and efficiency, and tailored to meet the goals of continued business viability and improved water quality for their particular farm and region.

It is important that farmers have knowledge of the nutrient limits they are targeting. Different targets will require different strategies, and capital investment or farm system change may not be consistent with meeting a limit in an individual catchment. Capital investment or farm system change can place a business at significant risk, especially if it does not meet required long term targets. In the interim, farmers having knowledge of their nutrient budgets and completing a nutrient budget for any intended capital investments (land or infrastructure) is important to minimise business risk.

## **Strategies for reducing nitrate leaching**

### ***Farm gate nitrogen surplus***

Farm gate N surplus can be defined as the difference between external farm inputs (fertiliser, legume N fixation, supplementary feed, atmospheric N) and N outputs in product (milk, meat, hay/silage, manure leaving the farm). Fertiliser and atmospheric N are incorporated into plant proteins which are then consumed during grazing or supplementation. Beukes et al. (2013) reported that farm-gate N surplus is a useful metric for benchmarking performance of farm systems in terms of potential environmental load.

Summarising data from the nutrient budgets completed for the southern wintering systems monitor farms indicates a strong relationship between N surplus and predicted N leaching for farms in Southland and South Otago (Figure 3).

From a farm management perspective, farm gate N surplus is a parameter over which dairy farm managers have some control. There are three main options available to farmers to reduce N surplus:

- Reduce N inputs
- Improve the efficiency of converting N inputs to product
- Capture a proportion of the surplus N excreted by the cows and redistribute this in a way that reduces the risk of N leaching.

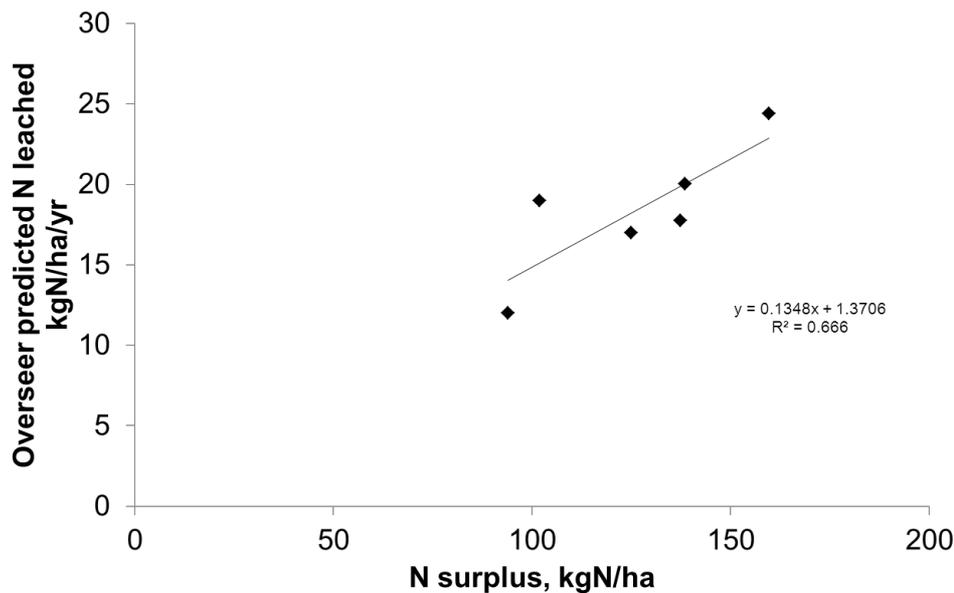


Figure 3: Relationship between N surplus and Overseer predicted N leaching for 6 monitor farms in Southland and South Otago

McCarthy et al. (2014) reported a 16% decrease in N leaching when nitrogen fertiliser input was decreased from 200 to 160 kg N/ha/year and stocking rate was decreased from 2.8 to 2.7 for a farm in the Manawatu.

There is a wide range in efficiency of N fertiliser use on dairy farms. Glassey et al. (2014) suggest one indicator of efficiency is the ratio of milksolids produced per kg N applied. In a sample of 25 farms in the Horizons region, the ratio ranged from 5 kg MS/kg N (less efficient) to 28 kg MS/kg N applied (more efficient). While other factors influence the requirement for N fertiliser, e.g. the annual pasture yield potential of the farm, the ratio does provide an indication of which farms in a region may benefit environmentally from a reduction in N fertiliser.

### **Stocking rate**

The impact of stocking rate on potential nitrate leaching occurs through the urine patch. Reducing stocking rate reduces the number of urine patches deposited on soil thus decreasing the risk of nitrate leaching. In addition to the overall farm stocking rate, any grazing strategy that increases the frequency of urine patch overlaps over a short

period of time (like high stocking densities in winter) will result in an increased risk of nitrate leaching (Pleasants et al. 2007).

As part of the Southern Wintering Systems project the Farmax farm systems model (Bryant et al. 2010) and OVERSEER v6 nutrient budget model (Wheeler et al. 2003, [www.overseer.org.nz](http://www.overseer.org.nz)) were used to predict the financial, biological and environmental performance of six dairy farms across Southland and South Otago. Following the parameterisation of the models for the current farming system, a number of scenarios were investigated for their impact on N loss and profitability.

A decrease in stocking rate from 3.3 to 3.1 cows per hectare on a farm in central Southland resulted in a 2.5% reduction in predicted N loss and an estimated 3% increase in operating profit. Conversely, in a separate scenario for a farm in coastal Southland, increasing stocking rate from 2.5 to 2.8 returned a profit of 8% but increased N loss by 3%. The impact of these changes for a farm will depend on the N loss target required to be met and this is likely to vary by catchment and region.

McCarthy et al. (2014) reported a 25% decrease in predicted N leaching from a Tararua dairy farm when stocking rate was reduced from 3.4 to 2.9. Associated with the decline in stocking rate was also a reduction in the N fertiliser input from 198 to 150 kg/ha. Because this farm was considered to be overstocked, the reduction in stocking rate resulted in an increase in milk production per cow from 380 to 440 kg MS. Predicted profitability was maintained following the changes.

Glasse et al. (2014) proposed the use of comparative stocking rate (CSR) as an indicator of the balance between feed supply and feed demand. It indicates the likelihood of N inputs being driven upwards by a feed demand higher than optimum. For example, a farm with a high stocking rate and early calving will require increasing amounts of nitrogen fertiliser and supplementary feed to support the higher feed demand and milk production. Failure to achieve high N use efficiency in such a system will result in an increased risk of N surplus and thus N leaching. The optimum CSR for profit is estimated to be 75-85 kg LWT/tDM offered (Macdonald et al. 2011).

For any farmer planning a system change to manage their nutrient loss, the starting point in the planning process should be a calculation of CSR (Glasse et al. 2014).

Another benefit from reducing stocking rate is the requirement for fewer dairy replacements. Not only is rearing replacements a significant cost to the dairy business, it also contributes to the environmental footprint either on the milking platform,

associated support block or with a grazier. Fewer dairy replacements will have a positive impact on N losses at a farm and catchment scale. The number of replacements required will also be influenced by the reproductive performance of the herd. Adopting farm management practices that improve the reproductive performance is another strategy that could be used to manage N loss targets.

### ***On - off grazing in autumn***

Management of the number of urine patches deposited on pasture in autumn through the use of on-off grazing is a strategy that has the potential to significantly reduce N loss (Beukes et al. 2013). This can be an expensive strategy due to the capital investment required.

Within the Southern Wintering systems modelling project, a scenario was investigated where an existing loose-housed barn, designed for wintering, was used to on/off graze the herd during the autumn. Through the months of April and May cows spent 8 hours per day grazing (a four hour grazing event after each milking), with the remainder of the time in the barn where they were offered 5 kg of silage. In this example estimated N loss to water was decreased by 25% with an associated 5% increase in operating profit achieved through reduced supplementary feed costs.

When investigating options to optimise the use of a loose-housed barn in the Telford P21 programme, autumn grazing restriction was included in the model simulation. When compared with only using the barn for wintering, including autumn standoff reduced predicted N leaching by 12%. However, when compared with a system wintering on crop the total N leaching reduction from using the barn was 29% (P. Beukes pers. Comm.).

The challenge for using on-off grazing in autumn as an N loss mitigation strategy is managing autumn pasture surpluses (especially in a good autumn) and the implications this has on setting the farm up for the following lactation. Clark et al. (2010) investigated the impact of either two x four hour grazing or one x eight hour grazing sessions per day on dry matter intake (DMI) in autumn. Relative to an unrestricted control, the grazing restricted groups were able to achieve the same daily DMI and this was not affected by the timing of available grazing i.e. two x four hours or one x eight hours. In contrast, Kennedy et al. (2009) and Perez-Ramirez et al. (2009) reported a reduction of daily herbage intake for cows restricted in available grazing time when compared with the daily herbage intake of unrestricted cows. Further work is

required to determine the impact of on-off grazing in autumn on herbage intake and subsequent milk production. Herbage allowance, supplementary feeding and pre-grazing pasture mass are all likely to impact on potential herbage DMI under grazing restrictions (Gregorini 2012).

For farms without adequate facilities to on-off graze, a full investment analysis is required to determine the financial impact on the farm business from making an investment in infrastructure to achieve this N mitigation option.

### ***Off paddock wintering***

Smith et al. (2012) has demonstrated that wintering cows on fodder crops has an inherently high risk of N loss as a result of high stocking densities increasing the probability of urine patch overlap, urine deposition during periods of high drainage and urine being deposited onto bare ground with no plant uptake of N until the paddock is replanted in late spring. Losses are likely to be higher on soils that are more freely draining (Smith et al. 2012).

Removing winter crop grazing from a dairy system can significantly decrease N loss but, in practice, achieving this will depend on off farm grazing being available or significant capital investment in infrastructure for an off-paddock wintering systems. Investment in infrastructure comes at significant financial cost (Dalley 2012). The P21 programme of work at Telford is investigating the farm systems' implications of off-paddock wintering. Computer modelling using the DairyNZ Whole Farm Model (Beukes et al. 2008) predicted a 19% reduction in N leaching when crop wintering was replaced with off-paddock wintering in a loose-housed barn. Associated with this decline in predicted N leaching was an estimated decline in operating profit of 20%. Intensification of the system to improve profitability eroded the N loss benefits to only 10%.

In a similar study in the Horizons catchment (P Journeax, pers. Comm.) the incorporation of a free-stall barn reduced N leaching by 34%. However, a 17% increase in cow numbers and a 71% increase in milksolids production were required to cover the cost of the wintering facility. Under the intensified scenario the N leaching returned to the level predicted prior to the capital investment in the barn and so resulted in no environmental benefit.

In the Southern Wintering Systems project, a scenario was modelled where crop wintering was replaced by a free-stall barn which was used for wintering and on-off

grazing in autumn. In this scenario, nitrogen loss to water was decreased by 23% and operating profit increased by 14%. The financial analysis did not take account of the capital cost of building the barn or any additional costs associated with its operation. Such a system is likely to be highly sensitive to milk and feed prices and the farmers involved in the project had concerns around managing the risk of relying on imported supplement for feeding in the barn.

### ***Effluent and manure management***

Opportunities exist to reduce the environmental impact of off-paddock wintering systems by improving effluent and manure management. A farm operating a free-stall barn, where liquid and solid effluent were returned to the support block that produced the silage fed in the barn, reduced average N loss to water by 7% (D Dalley unpublished). Costs to be factored into this analysis include any investment in infrastructure to pump the effluent to the support area and the operating costs associated with the movement of the solid effluent. When contemplating investment in off-paddock wintering systems it is important that consideration is given to the infrastructure required to optimise the use of the nutrients in the effluent and manure that is generated during the barn or pad use.

For off-paddock systems using bedding materials the practice of spreading these solids on land can contribute significantly to the potential N loss. Applying wintering pad material (woodchip and manure) to pasture, rather than cultivating it into a paddock being planted in crop, decreased predicted N loss by 4%. Cultivation and the added manure results in an increase in the amount of N in the soil which is at risk of leaching below the root zone before the new crop or pasture establishes and enters an active growth phase.

If investing in infrastructure for off-paddock wintering it is important that a detailed nutrient budget is completed, a nutrient management plan is established to ensure the nutrients imported in feed are used as efficiently as possible, solid fertiliser applications are reduced/tailored to meet requirements and the risk of nutrient build-up is minimised.

### **Conclusion**

The National Policy Statement for Freshwater will result in Regional Councils around New Zealand establishing objectives, water quality limits and methods

(including rules) focussed on nutrient loss. While this process is evolving, farmers should understand their current nutrient budget and complete a new nutrient budget if they are contemplating significant business changes. Implementing farm system change for reduced nutrient loss is complex. Poor understanding and over-simplification can put both the achievement of reduced nutrient loss and the financial viability of the dairy farm business at risk. The options available to individual farmers need to be assessed against overall farm performance and efficiency and tailored to meet the goals of continued business viability and improved water quality for their particular farm and region.

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