FORAGES FOR REDUCED NITRATE LEACHING

Grant Edwards1, Ina Pinxterhuis2, Paul Edwards2 and Mike Beare3
1Lincoln University, 2DairyNZ, 3Plant & Food Research

Summary

Forages for Reduced Nitrate Leaching is a DairyNZ-led programme researching the possibilities of diverse pasture species and forage crops to reduce nitrate leaching while maintaining or enhancing profitability of farming enterprises. The programme is directed to dairy, arable, sheep and beef farms and mixed-farming systems. The collaborating research organisations are DairyNZ, AgResearch, Plant and Food Research, Lincoln University, Foundation for Arable Research and Landcare Research. The principle funder is the Ministry of Business, Innovation and Employment; all partners co-fund the programme.

Using a *cross-sector approach*, the aim of the programme is to provide by 2020 new scientific knowledge, tools and technologies for forage and livestock production and farm systems that:

- sustain high levels of forage and livestock production;
- reduce livestock urinary nitrogen (N) excretion;
- improve N uptake efficiency of plants, reducing the amount of potentially leachable N;
- maximise yield and N use efficiency in forage crop phases of arable crop rotations; and
- can be readily integrated into, dairy, arable, beef/sheep or mixed-farming systems.

Introduction

The New Zealand agriculture sector is facing a significant challenge: achieving increased production while reducing its environmental footprint and maintaining its cost-competitiveness. There is substantial potential for growth in the dairy and red meat industries. Milk production could increase 31% between 2010 and 2030 (DairyNZ 2010), equating to an additional $12.8 billion p.a. gross value nationally (using economic multipliers from Sanderson & Webster

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2009). The value of output in the red meat sector could also increase from $8.5 billion p.a. in 2010-11 to $11.4 billion p.a. in 2024-25 (Deloitte 2011).

Achieving these growth opportunities will undoubtedly require substantial increases in livestock feed production, including a large contribution from supplementary forage and feed crops. Consequently, this represents a significant opportunity to grow value from both the pastoral and cropping sectors. However, these growth opportunities will need to be met within the nutrient discharge limits set by regional councils under the guidelines imposed by the National Policy Statement for Freshwater Management (Ministry for the Environment, 2011). Of particular concern are issues associated with water quality, due to nitrate leaching from agricultural systems.

In recent years, there has been considerable research focus on approaches to meet the challenge of farming with reduced nitrate leaching. This includes the national *Pastoral 21 Phase 2* programme, which focusses on a range of approaches to reduce nitrate leaching including: reducing stocking rates and increasing per cow performance, while relying on fewer inputs; off paddock feeding systems and controlled duration grazing strategies (Chapman et al. 2012). The *Forages for Reduced Nitrate Leaching* Programme complements this work by addressing pasture and forage based approaches to reduce nitrate leaching. The programme focusses on three specific research aims:

1. Benefits of alternative plant species in pastures;
2. Productive and N efficient forage and conserved feed crops and crop management systems; and
3. Farm systems for improved N use efficiency and reduced nitrate leaching losses.

Benefits of alternative plant species in pastures

The first research aim examines how a variety of pasture species and pasture management (irrigation, grazing and fertilizer) may be used to reduce both N excretion from livestock and improve the uptake of N from the soil. It is based on the hypothesis that the urine patch is the primary cause of nitrate leaching in grazed systems due to the high loading of N relative to N demand for plant growth. Past research indicates that dairy cows grazing alternative plant species in mixtures such as chicory and plantain in addition to perennial ryegrass and white clover have lower urinary N concentrations and total urinary N excretion than cows grazing a standard perennial ryegrass white clover mixture (Woodward et al. 2012; Totty et al. 2013). Other work highlights the importance of greater winter growth, such as that provided by Italian ryegrass species, for increasing the efficiency of plant uptake of soil N and reducing nitrate leaching (Malcolm et al. 2014). The programme continues this thread of research, further testing a range of pasture species for effects on N excretion and N uptake, modelling the productive

capacity of alternative pasture mixtures, and developing new systems and optimal management using existing varieties of these pasture species.

Productive and N efficient forage and conserved feed crops and crop management systems

The second research aim focuses on identifying and producing high nutritive value, low N forage and feed crops that maintain or increase livestock performance while reducing urinary N excretion. High yielding crop rotations will be developed that maximise N use efficiency and minimise N losses. Past research indicates that very high yielding crop sequences can be achieved but that these typically come with a significantly great risk of N losses to the environment (Beare et al. 2010, de Ruiter et al. 2009). This research aim also focusses on developing integrated soil, crop and effluent management systems for forage and conserved feed crops that reduce N losses from continuous cropping and livestock enterprises by improving the retention and recycling of N for productive uses, while reducing the reliance on inputs of fertiliser N. The use of manure (effluent and solids) in crops to reduce N loading on pastoral sector farms and reduce fertiliser N inputs on mixed-cropping farms (Johnstone et al. 2014) will be evaluated, thereby improving the combined N use efficiency of both enterprises.

Farm systems for improved N use efficiency and reduced nitrate leaching losses

The third research aim will develop readily adoptable farm systems that incorporate successful options to improve N use efficiency and reduce nitrate leaching, as determined in the first two research aims. Farm system modelling studies will be used to determine potential risks or unintended adverse consequences. Modelling will also be used to extend the research results beyond the experimental situation (e.g. for differing weather patterns and soil types), making the results more applicable across the country. Of note in this research aim is that nine leading farmers in Canterbury (dairy, beef and sheep, arable and mixed farm systems) are participating in the programme to co-develop, test and demonstrate successful options. Their current management and farm performance are being monitored, and the farm system models will be used to evaluate a range of scenarios for these farms to reduce nitrate leaching. Any options

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adopted will be monitored and results communicated. These farmers, together with other industry representatives, provide input for trials and feedback on results. They will also assist in the development of communication material, decision support tools and extension of the results.

The unique collaboration in this programme brings together farmers, researchers, developers of management support tools and farm consultants. This provides an environment where innovative options to reduce nitrate leaching will be developed which can readily be integrated into New Zealand farm systems.

Key messages

- The Forages for Reduced Nitrate Leaching programme aims to identify alternative pasture species and forage crops, and their appropriate management, to reduce nitrate leaching while maintaining or enhancing profitability of farming enterprises.
- Reducing urinary nitrogen excretion of animals and improving the efficiency of soil nitrogen uptake by plants will reduce the nitrate leached from the soil.
- Focusing on forage and crop solutions will help develop systems that increase nitrogen efficiency and maintain international competitiveness.
- Researchers and developers work with leading farmers and industry representatives to develop options that can be readily integrated into arable, beef/sheep, dairy or mixed-farming systems.
- Farmers can be confident the new options will work for them because there will be demonstrated benefits for the environment while maintaining or improving productivity and profitability.

Acknowledgements

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