Land Use Research Inventory

Watercress trials Wharenui Station, Rotorua

Sustainable Management Fund, Project Number: 2238

Addressing Land/Water Issues Through partnerships in Rotorua

Melinda Dresser, New Zealand Landcare Trust

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Ministry for the Environment
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landcare action on the ground

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Executive Summary

Milestone 2 of the Sustainable Management Funded project 2238 required a report on key research initiatives to support sustainable land management in the Rotorua Lakes Catchments.

An inventory has been produced documenting a number of what are considered to be the main research initiatives being carried out in the Rotorua Lakes Catchments. Other national research projects are also looked at which may be applicable in the Rotorua Catchments.

Summary of Research Covered in Inventory

- On-Farm Biological Mitigation Options for Nutrient Management – NIWA (Rotorua Lakes and Lands Trust)
  - *Grass filter strips, watercress harvesting*

- On-farm mitigation options to control nutrient losses from lake catchments - AgResearch (Ngati Whakaue Tribal Lands) both projects
  - *Nitrification inhibitors, Mitigation Option Adoption, P Sorbing mitigation options, changes in fertiliser management, Use of OVERSEER, Farm supplements.*

- Project Rerewhakaaitu: Phosphate Mitigation (both Projects) - AgResearch
  - *Phosphorous mitigations, critical source areas, Regrassing to prevent particulate P loss, Vegetated filter strips, Waste products as P binders, Soil conservation techniques, Bunding causeways and tracks, P sorbers*

- Rotorua Lakes Catchment Project: Nitrogen (N) Leaching Calculations – Fonterra, Dairy NZ, AgResearch
  - *Farm Models using UDDER and OVERSEER*

- Lake Rotorua Catchment Project Report to Meat and Wool NZ, Fonterra, AgResearch
  - *Farm Models using FARMAX and OVERSEER*

- Cost-effective Analysis of Grazing Management Options for Rotorua Dairy Farms
  - *Winter off farm grazing, Concrete winter feed pads, Stand-off pads, Herdhome Shelter*

- OCTAPUS Model – ENSIS - SCION

Relevant NZ Wide Research

- Best Practice Dairying Catchments for Sustainable Growth – Fonterra, AgResearch, NIWA
  - *Identifying best management practices*

- Sustainable Dairy Farming in the Lake Brunner Catchment Project – NZ Landcare Trust
  - *Sustainable Farm Plans*

- New Profitable Farming Options for the Lake Taupo Catchment – Puketapu Group
  - *Forage Crops, Grazing management, Farm system Modelling and Economic Analysis*

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Introduction

Water Quality of the Rotorua lakes has been in decline over the last few decades with 3 lakes currently eutrophic and lake Okaro supertrophic (EBoP Website). Numerous research projects have been undertaken to determine the causes of the high nutrient levels entering the lakes and how to reduce them. It has been estimated that 75% of nitrogen and 46% of phosphorous entering the lake is due to agricultural land use in the catchments (PCE, 2006)

The purpose of this report is to identify the current land-based nutrient mitigation research being carried out in the Rotorua Lakes Catchments and in other lakes catchments dominated by pastoral farming. The inventory is part of an SMF funded project titled: 'Addressing Land/Water Issues through Partnerships in Rotorua' (Project # 2238) and came about from a need identified in the 'Rotorua Lakes Catchments Research Action Plan' (Edgar, 2005). It is also part of the action plan in the Research Committee Terms of Reference for the Land Use Futures Board.

A comprehensive summary of current and recent research has been produced by Simon Park (Feb 2008) which has been the basis for this report (see Appendix 1 for full report).

Inventory for Rotorua Lakes Catchments Area

On-Farm Biological Mitigation Options for Nutrient Management

Project Manager

Monica Peters, NZ Landcare Trust

Project Partners

NZ Landcare Trust, Ngati Whakaue Tribal Lands, Rotorua Lake and Lands Trust

Funding providers

Sustainable Farming Fund (Project # SFF06/117), NZ Landcare Trust, Ngati Whakaue Tribal Lands, Environment Bay of Plenty

Research Provider

NIWA

Key Concepts

Grass filter strips, aquatic plant harvesting

Aims & Objectives of Project

To provide actual measurements of P and N losses from farms in conjunction with measurements of the extent to which they can be reduced through biological mitigation practices such as grass filter strips, riparian management, constructed wetlands and aquatic plant harvesting.

The project will:

- Review four potential biological mitigation options for their ability to retain or transform mobilised P and N in grazed systems.
- Develop a practical experimental regime for testing two biological mitigation options, grass filter strips and aquatic plant harvesting, for their ability to trap and absorb P and N under varying land management conditions (a dairy and a sheep/beef farm). Measurement of P and N inputs into field trials will provide additional valuable information on nutrient losses under current pasture management practices.
- Examine the feasibility (costs, farm management requirements, practicality) of establishing biological mitigation options at the farm scale (Wharenui)

- Estimate the costs and potential of the four biological mitigation options to reduce P and N losses if adopted by landowners and implemented at the catchment scale (Lake Rotorua catchment)

Timeframe

July 2006 – June 2009

Project Design

Although sites have been selected for the grass filter strips and the watercress trials no actual data have been reported yet. Below is a description of what has happened to date with the trials.

The proposed grass filter strip trial will investigate the performance of grass hedges on Wharenui. Retired pasture will be protected from grazing by enclosures to create the grass hedges. The surface runoff volumes and sediment, total nitrogen, and total phosphorus concentrations will be measured entering and exiting from the grass hedges. Composite samples will be collected for each storm event by diverting a proportion of the sample passing through each tipping bucket to a storage container. Two sites have been selected on the sheep/beef unit. Monitoring equipment for the grass hedge trial has been designed and is in place.

A further trial was established at Wharenui in December 07 to investigate watercress growth rates and nutrient uptake with regular harvesting. To date, watercress plants have been propagated and seedlings were to be planted in early November 07 into a series of small troughs. The troughs will receive streamflow, fed by gravity. Two different flow rates will be trialled to assess the impact of contact time on plant uptake. The water quality will be sampled fortnightly, with inflow and outflow samples analysed for total phosphorus (TP), total dissolved phosphorus (TDP), total nitrogen (TN), nitrate (NO3) and ammonium (NH4) and the flow between tanks sampled for NO3. An additional study has been completed which looks at ways of removing E-Coli from the watercress once harvested, (SFF Report Oct 07).

Results to Date

Grass hedge trial

The grass hedge enclosures were installed in two adjacent catchments at Wharenui Station in late January 2007. A rain gauge has been installed at the site and the remaining monitoring equipment will be installed shortly. There was heavy rain on site on Tuesday 5 February 2008 and there was evidence of surface runoff at the grass hedge in the larger catchment. This research is on going therefore a full set of results is not yet available.

Watercress harvesting trial

The watercress harvesting trial was installed at Wharenui Station in December 2007. Watercress seedlings were planted in a compound erected by a Ngati Whakaue fencing contractor in late November 2007. Two sets of four troughs at two differing flow rates were installed in the compound. Seedlings several months old were transplanted and by mid January 2008 these were reaching the surface of the water.

To prevent disturbance to the plants, a netting roof has been placed over the compound and a sign will be erected highlighting the scientific nature of the work. This research is on going therefore a full set of results is not yet available.

Dissemination of findings

Lucy McKergow delivered a presentation on filter strip trials including the proposed trials at Wharenui station at the NZ Hydrological Society Conference 20th-23rd November 2007. A Rotorua focus day was included in the conference (Nov 22) to highlight issues and research opportunities in the catchment.

James Sukias was interviewed by National Radio (Rural News, August 8) on the use of watercress for nutrient removal from farm run-off.

There will be a workshop to provide farmers and members of the community with information on the project so far on May 15th 2008.

Publications arising directly from Research

Edgar, N., (May 2007), 'On-farm mitigation options to control nutrient losses from lake catchments' SFF (07/085) Funding Application

Peters, M., (October 2007) 'On-farm biological mitigation options for nutrient management'. SFF (06/117) Progress Report.

Peters, M., (February 2008) 'On-farm biological mitigation options for nutrient management'. SFF (06/117) Progress Report.

McKergow, L., Sukias, J., (June 2007) 'Biological nutrient mitigation options for runoff and streamflow in the Rotorua Lakes area. (SFF 06/117) – NIWA Client Report

Lisant, L., (2007). Faecal indicator bacteria on watercress (Nasturtium officinale): a study on the removal of surface-attached Escherichia coli. NIWA Internal Report (RLL07201).

Lucy McKergow and James Sukias have developed a visual representation of farm field trials for distribution to Project Management Group.

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Practical Mitigation Options to reduce Nitrogen and Phosphorus Losses from Farms into Rotorua lakes

Project Manager

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Project Partners

NZ Landcare Trust, Ngati Whakaue Tribal Lands, Rotorua Lakes and Land Trust

Funding providers

Sustainable Farming Fund (project # SFF04/091), NZ Landcare Trust, Ngati Whakaue Tribal Lands, Environment Bay of Plenty

Research Provider

AgResearch

Key Concepts

Nitrification inhibitors, Wintering off, Ephemeral Stream Mitigation by Straw Bales, Flow Spreading and Vegetative Filtering, Phosphorous Source Trial, Desk top analysis using OVERSEER, UDDER & FARMAX.

Research

This research had three parts; the first part focused on the effectiveness of the mitigation options applied to minimise N leaching from the dairy farm, the second part dealt with the effectiveness of mitigation options applied to minimise P export from the critical source areas and the third part presented desktop studies on scenario analysis of various management options to optimise production and to reduce environmental concerns.

Part 1 – Nitrogen Research

Aims & Objectives of Project

The provision of actual measurements of N loss from farms, in conjunction with measurements of the extent to which they can be reduced through use of mitigation practices. This illustrated the benefits of action to reduce impacts on lake water quality.

Project Design

Six blocks were marked over three paddocks and were split into three plots. Treatments were randomly allocated to each plot:

1. Control, normal grazing and fertiliser regime.
2. Normal grazing and fertiliser regime with nitrification inhibitor applied twice, following the May grazing and the subsequent winter grazing.
3. No Grazing from May through till the end of September (equivalent of two grazings). Pasture mown and baled.
4. A further treatment was established in two paddocks on a Rotomahana mud soil and was run under normal farm grazing, effluent and fertiliser regime (as per treatment one). This treatment was added to explore if soil type differences affected nitrate leaching on the farm.

A total of 312 ceramic cup soil solution collectors were installed at a depth of 60cm in each treatment.

Grazing
Plots/paddocks were grazed as for normal farm management practices. From May through early-October the no-grazing plots were fenced off to exclude animals and the herbage on them was mown and baled instead.

Fertiliser
In both years, N fertiliser was applied to all plots at a rate of 36 kg N/ha following the May grazings/mowings. At the same time nitrification inhibitor (DCD) was applied @ 18kg DCD/ha to all plots of treatment two. A further N fertiliser / DCD application took place at the same rates after the winter grazing in the month of July/August.

Herbage measurement and sampling
Rising plate meter measurements were taken before and after each grazing/mowing to estimate pasture dry matter. Pasture samples were taken from each plot prior to grazing/mowing and analysed for botanical and chemical composition.

Nitrogen leaching loss measurements
Leachate samples were analysed for ammonium-N and nitrate-N concentrations. Drainage volume was calculated using a water balance equation and climate data from the Rotorua airport meteorological station.

Results

In 2005 when treatments were newly commenced, there was a trend for lower N leaching from DCD (-15%) and nil winter grazing (-34%). In 2006 N leaching was reduced by 25% and 42% for the DCD and nil winter grazing treatments, respectively. The DCD treatment also resulted in increased early spring pasture growth (equivalent to 7% annual DM), presumable due to an N response from saved-N (due to reduced leaching) and N applied in the DCD. The nil winter

grazing treatment could be achieved by grazing off over winter or using a feed pad system.

Part 2 – Phosphorous Research

Aims & Objectives of Project

To assess the run-off transport of P from sheep/beef farms and to evaluate some possible mitigation practices to reduce P losses from farms in the Rotorua lake catchments.

Project Design

Ephemeral Stream Mitigation by Straw Bales
A trial was established to test the effectiveness of straw bale dams across the ephemeral stream in retaining P. Five “dams” were constructed from straw bales placed on the valley floor at 50m intervals, and firmly wired into place with cables, steel pegs, and covered in chicken wire mesh.

Ephemeral Stream Mitigation by Flow Spreading and Vegetative Filtering Trial.
The mitigation strategy aimed to force as much interaction as possible between overland flow and a vegetative filter in the valley floor. In its initial state, flow tended to follow a bare stock track located along the floor of the valley, resulting in little vegetated filter strip effect. An area of the valley floor was selected as the treatment area and levelled perpendicular to the direction of stream flow. Four shallow levelled wooden weirs were installed to encourage an even flow of runoff over a wide area of vegetated filter, rather than down a narrow sheep track. Spreading the flow of runoff increased the interaction between vegetation and runoff, increasing trapping of phosphorous bearing particulates in proportion to the increase in flow width.

Phosphorous Source Trial
Twelve small overland flow plots were established on a Rotomahana mud soil. These consisted of wooden boards embedded within the soil leaving 20mm protruding above the soil surface, and forming plot boundaries. At the bottom end a covered collection gutter with an attached outlet hose was embedded into the soil, collecting natural run-off and directing it to a 25L collection vessel.
Three treatments were imposed each with four replicates:

1. Ungrazed control with the same fertiliser regime applied to the farm production area. Pasture mown and removed, plots fenced off.
2. Normal sheep grazing with the same fertiliser regime as applied to the remainder of the production area.
3. Normal bull-beef grazing with the same fertiliser regime as applied to the rest of the production area.

Results

Mitigation using Straw Bales
The straw bale filter dams rotted down to a thickness of about 75mm within three months releasing considerable phosphorous. This trial was halted until better mitigation strategies could be developed.

Flow Spreading and Vegetative Filtering
Data collected shows that runoff was rare, and volumes flowing and collected were very low. This presents a very limited data set for analysis, and only tentative statements can be made that require further data to back them up. The planar vegetated filter area and shallow weirs appeared to reduce the suspended solid load of the runoff, and greatly reduce the particulate P load. Total runoff volumes from the treatment plots were lower than the volumes entering them, demonstrating the greater infiltration occurring on the plots.

Results from the 8/11/2006 runoff event suggest that the filter strip is ineffective at removing dissolved P from solution, as dissolved P concentrations have actually increased across the treatment. Loads of all forms of P were reduced through the increase in infiltration. Given the high proportion of total P load that occurs at this site in dissolved forms there is a good reason to establish mitigation methods capable of capturing these dissolved P forms.

Phosphorus Source trial
Data clearly indicates that losses from the beef system were significantly and substantially higher for all forms of P than they were for the control or the sheep treatment. Losses from grazed sheep did not appear to be substantially different from those associated with the control.

The small scale of this experiment suggests that data should be interpreted with care. However, the data suggests that sheep production from critical P source areas may be a significantly lower risk production option than frequently grazing beef cattle in these high risk areas. An alternative way to consider the result is the concept that where critical source areas are found to be important for total beef productivity, use of additional mitigation measures to intercept mobilised P may be important.

Part 3 - Desktop Analysis

Aims & Objectives of Project

To model dairy and sheep and beef farms in order to examine the nutrient losses from the farms and compare effects of different management practices on production.

Project Design

Dairy
The current Wharenui dairy farm system was simulated using the UDDER model and the sheep and beef farm using the FARMAX model. Data from the UDDER and FARMAX model was then used in the OVERSEER nutrient budget model to estimate N flows and N leaching losses. From the current (or base) farm set up in the models, comparisons were made on the effects of different management practices on production, economics and N leaching.
Discussions with farmers in the applicant group and at the field days were used to identify a range of scenario options with potential to reduce N leaching or increase overall efficiency.

Results

For the Dairy farm the analysis indicated:

- The largest N leaching reduction (by almost 50%) was estimated from nil N fertiliser use but profitability decreased.
- Options with maize silage, winter stand-off and winter feed-pad reduced N leaching, but also reduced profitability.
- Use of DCD (based on data from the Part 1 study) was calculated to be cost-neutral, assuming the increased growth was utilised
- An optimised scenario (no winter N, greater wintering off, less maize, earlier calving) was calculated to reduce N leaching by 15% and increase profitability by 19%.

For the sheep and beef farm, the analysis indicated:

- Use of DCD (based on data from the part 1 study) was calculated to reduce N leaching but reduce profitability. Increased growth and stocking rate with DCD was insufficient to cover DCD application costs.
- Planting steep land in forestry reduced whole farm N leaching. However, to be cost-neutral it required a change on remaining pasture land to a higher profitability cattle-only system.
- Increasing lambing percentage of sheep enabled an increase in profitability with no change in N leaching.

Timeframe

2005 - 2007

Dissemination of findings

There were three farmer field days. These involved presentations on the principals which affect N and P loss from farms and results from research done in the project. They included farmers' feedback on alternative options for reducing nutrient losses. Information from this and from farmers in the applicant group were used to define additional options to test using the desk top modelling.

Publications

Ledgard, S., Sprosen, M., Redding, M., Ghani G., Smeaton, D., Webby, R., (2007), 'Practical Mitigation Options to Reduce Nitrogen and Phosphorus Losses from Farms into Rotorua Lakes', SFF final report.

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On-farm Mitigation Options to Control Nutrient Losses from Lake Catchments

Project Manager

Monica Peters, NZ Landcare Trust

Project Partners

NZ Landcare Trust, Ngati Whakaue Tribal Lands, Rotorua Lakes and Land Trust

Funding providers

Sustainable Farming Fund (SFF07/085), NZ Landcare Trust, Ngati Whakaue Tribal Lands, Environment Bay of Plenty.

Research Provider

AgResearch

Key Concepts

Nitrification inhibitors, Mitigation Option Adoption, P Sorbing Mitigation Options.

Aims & Objectives of Project

The project aims to identify practical, low-cost N and P loss mitigation options that farmers can directly adopt on their farms. The project will demonstrate these mitigation options to farmers using Ngati Whakaue Tribal Lands' Wharenui farm as a working model of what can be achieved. The project has a strong emphasis on (1) raising farmer awareness of these mitigation options, (2) highlighting both the costs and benefits of adopting the technologies and (3) determining the level of farmer adoption as a way of quantifying the outcomes of this project's investment in modifying farm management systems for nutrient management. This is a continuation of the SFF 04/091 project focusing on the N and P loss from farms.

Timeframe

1 July 2007 - 30 June 2010

Project Design

N and P Trials

The key nitrogen techniques used were control (normal grazing practice), grazing + DCD and no-winter grazing. Modifications made to the grazing + DCD treatment consisted of applying DCD three times instead of twice but using a

lower application rate 12.5 kg/ha instead of 18 (Table 1). Following the late April grazing 36 kg N/ha of urea was applied to all treatments.

Table 1. Mitigation trial management; autumn to spring 2007

	Control	Grazing+DCD	No-grazing
Late April	Grazed + urea	Grazed + urea + DCD	Mown + urea
Late May	Grazed	Grazed + DCD	
Mid-July	Grazed	Grazed + DCD	
Mid-August	Grazed	Grazed	Mown
Early-October	Grazed	Grazed	Grazed

Pasture dry matter was measured before and after each grazing/mowing. Pasture samples were taken from each plot for species composition and chemical analysis. Leachate samples were collected from the ceramic cup samplers following periods of drainage. These leachates are yet to be analysed.

Mitigation Option Adoption

There will be an evaluation of farmer knowledge uptake to determine the extent of farmer adoption of the nutrient loss mitigation options developed by the project. It is proposed that three separate initiatives (in Years 1, 2 and 3 of the project) be implemented with farmers. In Year 1 dairy and sheep/beef farmers in the Rotorua Lakes catchments – who attended workshops on project 04/091 - will be surveyed to determine their awareness of on-farm P and N loss mitigation practices (specifically, those mitigation practices developed by project 04/091). These farmers will be asked to identify the most useful strategies to encourage on-farm adoption of mitigation practices. This survey will identify farmers for in-depth workshop training on mitigation practice adoption in Year 2 of the project. In Year 2 a group of selected dairy and sheep/beef farmers in the Rotorua Lakes catchments will be invited to attend specific on-farm training workshops ('how to workshops') - to implement the mitigation options for N and P being developed by the new project (07/085). These training workshops will focus on the economics of implementing the mitigation options and what incentives are available from industry and local government to assist adoption. In year 3 a survey will target farmers who have participated in the project to determine the actual level of on-farm mitigation option adoption. This will involve on-farm visits for evaluation purposes.

The three initiatives will provide a comprehensive basis to determine farmer knowledge of nutrient loss mitigation options developed by the project, the factors that promote (or impede) implementing the mitigation options on-farm,

and the actual level of on-farm mitigation option adoption by farmers participating in the project.

Results to Date

Results for pasture N Trials
Although the grazing+DCD treatment produced 16% more dry matter than the control treatment in August, this was not statistically significant. However, the 21% greater dry matter production on the grazing+DCD treatment during September was significant ($P<0.05$).

The final pasture measurements for 2007 were carried out in November and December. Rising plate meter readings were taken before and after grazings in both those months and herbage was collected for pasture composition and nitrogen content. There were no significant differences between the control and grazing+DCD treatments at these samplings but the no winter grazing treatment tended to have lower pasture yields, possibly due to the loss of nutrients in the May and August harvests.

The 10th and final leachate collection of 2007 was carried out on October 16. Following that date there was insufficient rainfall to trigger drainage and hence any further sampling. On January 23 and 24 2008 all 312 leachate collectors were removed. All 2007 leachate samples have now been analysed and statistical analysis of the results is in progress.

Progress on P work
Several P absorbing mitigation options were presented to the Project Management Committee at a meeting in October 2007. These included using ferric chloride, simple synthetic sorbers like ferrihydrite and low Al ferrihydrite, electric arc furnace slag (least sorption capacity), potable water treatment residue, scoria (fine uncrushed) and red mud from aluminum manufacture. As these options vary greatly in their costs and ease/practicality of application, the less expensive and practical materials that can absorb reasonable amounts of dissolved reactive P will be used. Suitable trial sites will be selected in the next quarter. The actual P mitigation trial will start in 2008.

Dissemination of findings

A range of communication and evaluation methods will be employed to share project outputs. These include: project and wider community newsletters; the media - newspapers, radio and television; internet links; and workshops/information sharing events. The target audience will include: farmers, maori landholders and incorporations, local and central government agency staff, research providers and the wider Rotorua Lakes community.
A workshop has been organised for the 15th May 2008 to present the research findings so far to the landowners and the community.

Publications

Edgar, N., (2007), ‘On-farm mitigation options to control nutrient losses from lake catchments,’ SFF Funding Application– Phase 2.

Peters, M., (Oct 2007), On-farm mitigation options to control nutrient losses from lake catchments,’ SFF Progress Report (07/085)

Peters, M., (Feb 2008), On-farm mitigation options to control nutrient losses from lake catchments,’ SFF Progress Report (07/085)

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Project Rerewhakaaitu I

Project Manager

Bob Parker – Fruition Horticulture

Project Partners

Environment Bay of Plenty, Rerewhakaaitu Farmers

Funding providers

Sustainable Farming Fund (Project # SFF02/032), FertResearch, Dairy Insight, Environment Bay of Plenty.

Research Provider

AgResearch

Key Concepts

Changes in Fertiliser Management, Use of OVERSEER, Farm Supplements

Aims & Objectives of Project

Aim:

The aim of this project was to identify ways that pastoral management in the catchment of Lake Rerewhakaaitu can be changed to minimise the environmental impact on Lake Rerewhakaaitu of the surrounding farms, while at the same time allowing for sustainable farm business to continue.

Objectives:

1. To determine current farm management practices of farms in the catchment by updating previous data collected by Environment Bay of Plenty.
2. To use AgResearch to analyse this data and identify practices that are contributing to nutrient leaching.
3. AgResearch, in conjunction with the farmers, to discuss the analyses and determine what practices would best result in a reduction of nutrients to groundwater and to the Lake.
4. To document and highlight the best management practices that have been derived from objectives 1, 2, and 3.

In 2005 the following objectives were added after it was identified that catchment groundwater did not necessarily go to the lake:

5. To use the OVERSEER nutrient budget model on a farm basis to show how different management decisions could reduce nutrient flow to groundwater, irrespective of where this groundwater went.

6. To have a majority of farmers in the catchment adopt the use of OVERSEER as an environmental management tool on their decision making on nutrient management.

Timeframe

2002 - 2006

Project Design

The approach to this project was to facilitate farmer discussion on issues affecting the quality of the lake water of Lake Rerewhakaaitu. A participatory action research model was used to enable this. Farmers were encouraged to participate and the science providers collected and analysed data as evidence for this focused discussion.

The nutrient budgeting model OVERSEER was used as a tool to assess what was happening on farm and what were the effects of changing decisions on nutrient use.

Eight meetings of farmers and the science providers were held during the project period to present the key data. There were also eight newsletters circulated to all the farmers and interested parties in the catchment.

Alongside the project Environment Bay of Plenty commissioned a number of studies in the catchment and their results were made available to this project.

Results

As a result of the project, farmers in the catchment have altered their nutrient management by making relatively simple changes in their decision making. The changes are based on the comparison of the Farm OVERSEER analyses taken earlier in the project with those taken on the nine farms later in the project.

Main changes in farm management:

- *Changes in fertiliser management*: Farmers have reduced both their nitrogen and phosphate inputs into the farming system.
- *Soil sampling*: Farmers have become more strategic in taking soil samples to get more useful information.
- *Use of OVERSEER*: Farmers have a better understanding of how this model works. They see OVERSEER as a farm management tool rather than a regulatory tool and have gained a greater understanding of the issues involved in their nutrient management.
- *Farm supplements*: Farmers have increased the use of supplements and now bring in more low nitrogen supplements (maize) rather than simply applying nitrogen fertiliser as urea to boost pasture growth.

Dissemination of findings

Then results have been discussed at numerous farmer meetings held at a local hall or on farms in the lake catchment. Presentations were also made to the project funders. To more widely extend the project results, copies of newletters written after each farmer meeting were circulated to participants in the project and those interested in the project outputs. Furthermore a paper was presented at Fertiliser and Lime Research Conference, 2006 and Central North Island Lakes and Land Use Summit, 2006, by Ian Power and Bob Parker, discussing the findings of the project.

Publications

Parker, B., Power, I., (2006) 'Implementing Sustainable Nutrient Management Strategies in Agriculture', Fertiliser and Lime Research Conference, Massey University.

Parker, B., (2006), Project Rerewhakaaitu SFF 02/032, Final Report.

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Project Rerewhakaaitu II: Phosphate Mitigation

Project Manager
Bob Parker – Fruition Horticulture

Project Partners
EBoP, Farmers in the Lake Rerewhakaaitu Catchment.

Funding providers
Sustainable Farming Fund (Project # SFF06/032), Dairy NZ

Research Provider
AgResearch

Key Concepts
Phosphorous Mitigations, Critical Source Areas, Regrassing to Prevent Particulate P loss, Vegetated filter strips, Waste products as P binders, Soil Conservation Techniques, Bunding Causeways and Tracks, P Sorbers

Aims & Objectives of Project
To improve pastoral management to protect the lake from P inputs while maintaining farm businesses.

Timeframe
2006 – 2009

Project Design
The process:

- Get latest OVERSEER runs for the nine farms
- Phosphorous mitigations
- Valid information on phosphorous so farmers can make decisions and apply appropriate mitigations
- Provide phosphorous mitigations to develop BMP's
- Identify some example source areas
- Identify critical source areas
- Trial mitigations

Methods to be assessed include:

- Optimum Olsen P levels

- Regrassing to prevent particulate P loss
- Vegetated filter strips
- Waste products as P binders
- Soil conservation techniques
- Bunding causeways and tracks

This is a continuation of Project Rerewhakaaitu which ran from 2002 – 2006 focusing on N loss and mitigation processes.

Results to Date

Nutrient Data has been collected from 12 farms and OVERSEER model used to predict P runoff losses:

- Phosphorus is strongly adsorbed to soil constituents
- Very little P leached through soil profile
- Pumice soils amongst highest risk soils for P runoff
- P loss does not occur from whole catchment, however some small areas can dominate (approx 80% loss comes from 20% area) – "critical source areas" (CSA).

Critical source areas are a major contributor to P runoff. The trials sites are looking at two sources:

1. Runoff from races – carry sediment and P to streams either via overland flow or drainage pipes.
2. Ephemeral streams – shallow gully in pasture drains through culvert. Downstream from culvert, drainage passes over bare ground through trees.

Possible Mitigation Options – At Farm Level

- Consider reducing soil Olsen P levels
- No Soluble P fertiliser applications in high –risk months (May-October)
- Consider applying slower release forms of fertiliser P
- Extend the area of effluent block
- On races near waterways, consider sediment traps
- Install cut-offs at regular intervals on slopes and divert runoff to grassy areas
- Fence off stock access to waterways
- Riparian planting at vulnerable areas

Possible Mitigation Options – At Critical Source Area

Mobilised P contains both dissolved and particulate forms. Mitigations for two forms are different:

- Sediment traps – not effective against most mobile factions, however may capture coarser sediment
- Vegetative filter strips – dissipates energy flow, allows sediment to settle out

- P sorbers – residues from steel industry (electric arc slag), water treatment plants (alum), other chemical products (need to ascertain if any risks). Effective at capturing dissolved P.

Dissemination of findings

Farmer demonstrations of effective mitigation techniques are a major focus of the project. There will also be meetings at the local hall to relay findings and three newsletters have already been sent out to local farmers to keep them up to date with the project.

Publications

Sutton, C., (November 2007), Project Rerewhakaaitu: Phosphate Mitigation, SFF Project Summary (06/032)

Parker, B., (February 2007), Lake Rerewhakaaitu II – Newsletter no. 1

Parker, B., (July 2007), Lake Rerewhakaaitu II – Newsletter no. 2

Parker, B., (February 2008), Lake Rerewhakaaitu II – Newsletter no. 3

Park, S., (February 2008), 'Nutrient Mitigation Research Summary', Report to the Land Use Futures Board

Contacts for key personnel

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Rotorua Lakes Catchment Project: Nitrogen (N) Leaching Calculations

Project Manager

Johanna Blackman

Project Partners

Fonterra, Dairy NZ

Funding providers

Dairy Insight, Fonterra, Federated Farmers and Dexcel

Research Provider

AgResearch

Key Concepts

Farm Models using UDDER and OVERSEER

Aims & Objectives of Project

Determine the current levels of N leaching from Dairy farms in the Rotorua catchment
Test options for reducing N leaching and the effects of these on farm profit
Compare the amalgamated results with the target reductions in N leaching proposed by Environment Bay of Plenty.

Timeframe

Sept 2006 – 2007

Project Description

Data was collected about each farm, where available, so that N leaching for the benchmark years (2001/02 to 2003/04) and a base year (usually 2005/06) could be determined. The farms were modelled on UDDER to calculate profitability. The UDDER information was also then used in OVERSER to estimate N leaching values.

Scenario tests were carried out to model the impacts of alternative farming options on profit and N leaching to identify whether a reduction in N leaching was possible without compromising profit. The options in Table 2 below were divided into two categories depending on their likely impact on farm profitability:

- Category: 1 Options for reducing N leaching that could be adopted at little or no cost or impact on profit. In some cases these could reduce N leaching and increase profit.
- Category 2: Options which reduce N leaching but are also likely to result in reduced profit.

Table 2: Options for reducing N Leaching

Option	Likely % reduction in N Leaching	Likely Profitability of Option	But….
1. Increase winter grazing off	20 (5-30)	++	Dependent on availability and cost, transfers N loss to other catchments, requires system changes
2. Nitrification Inhibitor (DCD)	10 - 25	O	Unproven technology under high rainfall; more profitable in South Island
3. Reduce N fertiliser use and reduce production	15 (0-35)	-	If current N use is high (>200kg N/ha) reduced N use may increase profit
4. Use winter feedpad/stand-off pad	10 (5-20)	O?	Increased work, capital cost including infrastructure, availability, or price, of bark or sawdust could be a problem
5. FDE on larger area & less N fertiliser	5 (0-10)	+	Depends on current FDE area
6. Replace winter crop with grass–to-grass	5 (0-15)	O	Typically only a small area is cropped, profit depends on need for pasture renewal
7. Don't apply winter N fertiliser	5(0-10)	-	May need other management changes
8. Sell off silage in autumn & have a shorter lactation	5 (0-15)	--	Unprofitable due to foregone milk production
9. Put in artificial wetland	Unknown	--	Highly farm specific (contour, soil)
10. Reduce use of bought in feed	4 (0-7)	-	Depends on quality, use and price of bought in feed
11. Change brought in feed to low protein source (e.g. maize silage)	2 (0-5)	-	Depends on current level of bought-in feed and feed costs
12. Reduce stocking rate & increase per-	1 (-5 to 5)	- / +	Profitable on very high stocked farms, change will

cow production			require increased management skill

++	Profitable
+	Slightly profitable
O	Neutral
-	Slightly unprofitable
-	Unprofitable

Results to Date

It was estimated that for the base year (05/06) the average leaching from each farm was 58kg/N/ha/yr. Using best practice options presently available, and assuming all the farmers would be willing and able to adopt the optimum scenarios derived, it was determined that it would be possible to reduce N leaching on a catchment wide basis by 34tN/year below the benchmark figure without negatively affecting profit.

Further significant reductions in N leaching/ha/year were possible but these reduced farm profit and it is therefore less likely that these options would be adopted. Innovative solutions are required if the N leaching catchment-wide target of 170t N/year (by 2017) set by Environment Bay of Plenty is to be met without significant loss of profitability.

Dissemination of findings

The results of the research were reported to the farmer group and the wider community for discussion.

Publications

Ledgard, S., Smeaton, D., (August 2007), Rotorua Lakes Catchment Project: Nitrogen (N) leaching calculations – AgResearch.

Contacts for key personnel

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Lake Rotorua Catchment Project Report to Meat and Wool NZ

Project Manager

Johanna Blackman

Project Partners

Fonterra, EBoP

Funding providers

Sustainable Farming Fund, Meat and Wool NZ

Research Provider

Fonterra, AgResearch

Key Concepts

Farm Models using FARMAX and OVERSEER

Aims & Objectives of Project

Determine the current levels of N leaching from beef and sheep farms in the Rotorua catchment. Test options for reducing N leaching and the effects of these on farm profit. Compare the amalgamated results with the target reductions in N leaching proposed by Environment Bay of Plenty.

Timeframe

2006 - 2007

Project Design

The project used OVERSEER and STOCKPOL (now revised as FARMAX) modelling to calculate benchmark levels of nutrient loss (2001- 2004), estimate current farm losses, and examine the potential for reducing losses while still maintaining farm profitability.

Once the benchmark nutrient losses were defined for each farm, the team investigated different scenarios to determine options for reducing nutrient losses while maintaining or enhancing farm profitability.

Results to Date

The tables below illustrate the leaching levels for N and P for the three individual farms tested. They show that losses in the most recent years (where information is available) have not exceeded the benchmark levels (2001 – 2004).

N leaching estimates for the 3 farms (kg N/ha/year)

Year	Farm 1	Farm 2	Farm 3
01/02	22	28	12
02/03	21	20	12
03/04	22	19	12
Benchmark average	21.7	22.3	12
04/05	20	20	
05/06		19	

P leaching estimates for the 3 farms (kg P/ha/year)

Year	Farm 1	Farm 2	Farm 3
01/02	1.3	1.6	0.5
02/03	1.0	1.4	0.5
03/04	0.8	1.4	0.5
Benchmark average	1.03	1.47	0.5
04/05	0.9	1.3	
05/06		1.3	

Work in Progress

With the benchmarking complete, scenarios are currently being tested to identify management systems which may increase farm profitability while reducing and/or maintaining current leaching losses.

Dissemination of findings

The results of this project have been presented to Environment Bay of Plenty staff and councillors but are still to be disseminated to the farmers.

Publications

Blackman, J., Smeaton, D., (June 2007), Lake Rotorua Catchment Project Report to Meat and Wool.

Contacts for key personnel

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Duncan Smeaton, Consultant to AgResearch: dsmeaton@xtra.co.nz

Cost-effective Analysis of Grazing Management Options for Rotorua Dairy Farms

Project Manager

A Taylor, Environment Bay of Plenty

Project Partners

Environment Bay of Plenty, Agfirst, Herdhome Ltd, Nimmo-Bell,

Funding providers

Environment Bay of Plenty

Research Provider

AgResearch

Key Concepts

Winter Off Farm Grazing, Concrete Winter Feed Pads, Stand-Off Pads, Herdhome Shelter

Aims & Objectives of Project

To assess winter grazing management options that will reduce nitrate leaching from a dairy farming property. This was achieved by:

- Determining the amount of N leaching per year for each grazing management option
- Determining the costs associated with each grazing management option
- Comparing the cost-effectiveness of each grazing option

Timeframe

2007

Project Design

The specific practices that fall within the category of "winter grazing management" include:

- Winter off farm grazing
- Concrete winter feed pads
- Stand-off pads, generally with soft bark or wood waste surfaces
- Combinations of feed pads and stand off pads
- Herdhome Shelter – proprietary covered feed pad system utilising a plastic roof over a slotted concrete floor which allows dung and urine to fall through into a collection bunker.

The methods used to assess winter grazing options were divided into the following sub-sections:

- Hypothetical farm development for analysis.
  To enable the cost-effectiveness analysis to be completed, a hypothetical dairy farm was developed. The data from the hypothetical dairy farm would form the basis for each grazing management option

- Cost-effectiveness analysis
  This is a decision making tool. Quantifying all costs (monetary) and effectiveness (physical) makes it possible to compare the grazing options: between a given option and the status quo; or between various options.
  Assessment of costs of each grazing management option has been determined using a series of calculations. Gross margin, adjusted gross margin and relative return are the main methods used for each grazing option.
  Assessment of effectiveness uses the OVERSEER nutrient budgets to determine the effectiveness of each grazing management option. The key outcome used as a measure of effectiveness from the nutrient budget is the amount of N leached (kg/ha/yr).

- Sensitivity analysis
  Sensitivity analysis is a form of quantitative analysis that examines how present values, total cost, or other outcomes vary as individual assumptions or variables are changed.
  This analysis can address two key questions:
  1. Would the grazing management option still be worthwhile pursuing if some of the key assumptions do not eventuate?
  2. Are there actions that can be taken to reduce the risks before deciding on a particular option?

  The most sensitive assumptions and prices were considered to be:
  - Capital cost of a Herdhome Shelter
  - Production gain from using a Herdhome Shelter
  - Cost of feed for the grazing options

- Payback period
  This tool of analysis is often used because it is easy to apply and easy to understand for most individuals. It will tell you the time required for the cash flows to equal the original capital investment. Payback Period is a simple method where you can compare projects.
  The formula used is:

$$\text{Payback Period} = \frac{\text{Capital (winter off)} - \text{Capital (option)}}{\text{Profit of (winter off)} - \text{Profit of (option)}}$$

In this analysis the payback period was calculated for the grazing options relative to wintering off.

Under the Payback method of analysis, projects with shorter paybacks rank higher than those with longer paybacks. The theory is that projects with shorter paybacks are less risky.

However the simplicity of payback period carries with it weaknesses, including:

1. Payback period ignores any benefits that occur after the payback period
2. Payback period ignores the time value of money, inflation and risk.

Due to the limitations of the payback period method and advice during peer review it was decided that Net Present Value analysis was needed for the grazing management options.

- Net Present Values, Marginal Net Present Values and Sensitivity Analysis.

  NPV analysis (ranking alternative grazing options by considering the time value of money) was carried out by Nimmo-Bell, using assumptions and parameters provided by Environment Bay of Plenty. Marginal NPV was calculated for each option, relative to the status quo option of Winter Off grazing, and using 3%, 6% and 9% discount rates. Associated sensitivity analyses on marginal NPV were carried out for the discount rate and the capital cost of a Herdhome Shelter while simultaneously considering a range of potential milk solids (MS) production gains per cow. The impact of MS payouts was also considered.

While the cost-effectiveness analysis was carried out using a range of reasonable estimates and assumptions, it is clear that variations in costs and prices over time will impact on the modelled outcomes and caution is needed in interpreting results.

Results

Cost-effective Analysis

The main results from the adjusted gross margin and N leaching analyses were:

- The status quo of *Winter Off* grazing option was the most profitable at $1,473/ha, with other options in the range of $908 - $1,195/ha.

- The lowest nitrate (N) leaching of 26kg N/ha/yr occurs using the *Herdhome full-time* option, a 41% reduction relative to the *Winter Off* level of 44 kg N/ha/yr. The reduction in N leaching across all options primarily reflected the time the herd spent off pasture.

- The cost-effectiveness rankings followed the N leaching rankings, despite the poorer economic performance of all grazing options relative to the *Winter Off* option. The *Herdhome full-time* was the most cost-effective option for reducing N leaching at an annual cost of $25.60/kg reduction in N leached, relative to Winter off, ($4.20/kg MS payout and a 9% production gain (assumed)

- Adjusted gross margins, N leached and cost effective ratios

Option	**Winter On**	**Winter Off**	**Winter feed-pad**	**Stand-off pad**	**Combination Pad**	**HH winter** 5% Production increase	**HH part-time** 7% production increase	**HH full-time** 9% production increase
Adj. Gross margin/ha	$1195	$1473	$1055	$1067	$980	$908	$978	$1013
Relative return/ha	-$279	$0	-$418	-$406	-$493	-$566	-$495	-$460
N leached kg/ha	**48**	**44**	**43**	**39**	**36**	**34**	**31**	**26**
Relative reduction kg/ha	4	0	-1	-5	-8	-10	-13	-18
Reduction %	**0%**	**0%**	**-2%**	**-11%**	**-18%**	**-23%**	**-30%**	**-41%**
CE Ratio $/kg N			$418.10	$81.30	$61.70	$56.60	$38.10	$25.60

- The sensitivity analysis on relative return showed that the relative return and Payback Period for a *Herdhome full-time* option is highly sensitive to Herdhome Shelter capital cost and milk solids production increases (if any). In order to improve profitability and hence enable a positive payback period relative to the *Winter off* option, it is necessary to have a combination of significant Herdhome capital cost reduction and productivity gain. For example, a reduction in the capital cost of a Herdhome from $350,000 to $250,000 also requires a production gain somewhat greater than 10% before a positive relative return and hence positive payback period can be achieved.

NPV Analysis

The main results from the NPV were:

- All options had economic costs (negative marginal NPV) relative to *Winter off* grazing, summarised in the table below

Marginal Net Present Values (Discount 6% $4.20/kgMS)

Option	**Winter On**	**Winter Off**	**Winter feed-pad**	**Stand-off pad**	**Combination Pad**	**HH winter** 5% Production increase	**HH part-time** 7% production increase	**HH full-time** 9% production increase
NPV ($/ha)	$8183	$9865	$7374	$7345	$6874	$6536	$6973	$7175
Marginal NPV ($/ha) discount	**-$1682**	**Status quo**	**-$2491**	**-$2520**	**-$2991**	**-$3329**	**-$2892**	**-$2690**
Reduction N leached (kg/ha)	-4.0	Status quo	1.0	5.0	8.0	10,0	13.0	18.0
NPV Ratio ($/kg/N)	n/a	Status quo	-$2491	-$504	-$374	-$333	-$222	-$149

- The *Herdhome full-time* was the most cost-effective option for reducing N leaching at an economic cost of $149/kg reduction in N leached, relative to *Winter off*, ($4.20/kg MS payout, 9% production gain and 6% discount rate). Conversion from *Winter off* to *Herdhome full-time* would incur an economic cost of $2690/ha, this is reduced $1982 per hectare with a MS payout of $5.53 (all other assumptions held constant).

- If no production gain was achieved, the *Herdhome full-time* option marginal NPV was $4539/ha less than *Winter off* grazing, lower than all non Herdhome options.

- The sensitivity analysis on marginal NPV showed that the economic benefits of the *Herdhome full-time* option (relative to *Winter off*) is sensitive to discount rate with the relative economic cost of $2690/ha at a 6% discount rate rising to $3038/ha at a 9% discount rate, both assuming $4.20/kg MS payout.

- The *Herdhome full-time* production gains required to gain parity (in NPV terms using a 6% discount rate) with *Winter off* option were a 20% production gain in MS at $4.20 payout and 15% production gain in MS at $5.53 payout.

- Reducing the Herdhome Shelter capital cost significantly improved the marginal NPV (relative to *Winter off* grazing), with a net benefit resulting with various favourable combinations of reduced capital cost, higher payout and higher production gain.

Dissemination of findings

The report is to be put on the Environment Bay of Plenty website.

Publications

Taylor, A., Park, S., (July 2007), Cost-effectiveness Analysis of Grazing Management Options for Rotorua Dairy Farms, Environment Bay pf Plenty Environmental Publication.

Contacts for key personnel

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OCTAPUS Model

Research Provider

ENSIS-SCION initiative with Ngati Whakaue

Aims & Objectives of Project

To assess long term land use change scenarios at the farm level with multiple visual GIS output layers.

This project is commercially sensitive and therefore there are no further details available at this time.

References

Park, S., (February 2008), 'Nutrient Mitigation Research Summary', Report to the Land Use Futures Board

Relevant NZ wide Research

Best Practice Dairying Catchments for Sustainable Growth

Project Manager

John Russell

Project Partners

Dairy Insight, Fonterra

Funding providers

Sustainable Farming Fund (Project # SFF00/145),

Research Providers

Fonterra, AgResearch, NIWA, Dexcel (now Dairy NZ)

Key Concepts

Identifying best management practices

Aims & Objectives of Project

Main Aim
"To integrate practices that protect the environment into dairy farming, against a background of intensification, dairy industry environmental and animal welfare guidelines and the industry policy to increase productivity by 4% per annum"

Objectives
Encourage adoption of practices that meet industry and regulatory authority requirements and address local issues.
Monitor changes in farm practice, adoption of new practices and waterway condition to establish the success of the project and identify areas where the system is not responding as expected.
Publicise the results of the study as it progresses to demonstrate industry commitment to change and sustainable management, and to encourage other farmers to consider these issues and adopt improved management practices.
To increase farmers understanding of what represents healthy streams and then apply scientific principles to develop new management practices that have the potential to improve water quality.

Timeframe

October 2003 – October 2006

Project Design

The project was undertaken in the Toenepi (Waikato), Waiokura (Taranaki), Waikakahi (South Canterbury) and Bog Burn (Southland) catchments. These catchments were predominantly dairying catchments but differed in geography and farming aspects.
Regular monitoring of water and soil quality, and of farm management practices, was undertaken throughout the project to determine the key linkages between on-farm activities and the potential of these activities to degrade water quality. These linkages have then been used to derive a toolbox of best management practices (BMPs) that are appropriate for each catchment and have wider application in other regions as well. Ongoing monitoring has been used to follow the uptake of BMPs and the resultant changes in water quality.
Biological assessments of the catchment streams have been done throughout this study. The Toenepi Catchment has also been extensively studied through previous Dairy Industry studies and SFF Project 00/145. These studies allow comparisons between the catchments and to determine what changes had occurred in the Toenepi Stream since it was examined in 1995-97. In that period two environmental strategies recommending BMPs have been implemented by the dairy industry, viz. Market Focused and the Clean Streams Accord. Monitoring data has been used to review trends within the catchments and to set benchmarks for the current industry targets of reducing N and P outputs to waterways.

Results

The biological assessment of Toenepi Stream has shown quite dramatic improvements have occurred over the past 10 years. The results are in line with water quality monitoring (improved water clarity and lower N and P concentrations) and show that habitat has improved greatly. The native freshwater crayfish (Koura) has been observed in Toenepi Stream, whereas previously only species that are tolerant of harsh conditions were seen (e.g. snails and worms). A reduction in the number of dairy pond discharges and improved fencing of streams are two likely reasons for the improved stream condition.
Results from the spring surveys shows that quite significant reductions in emergent groundwater nitrate concentrations are occurring, with plant uptake the main mechanism. Subsequent decomposition of plant material will return some of this to the waterways but in a less reactive form.
A list of BMPs that have been evaluated and included in the dairy BMP toolbox under development is shown in the table below. Additional BMPs will be added to

the toolbox as data on the cost-effectiveness of new technologies becomes available.

Best management practices identified for the dairy farms in the four catchments

Best Management Practice (BMP)	Target
Deferred irrigation of dairy shed effluent to land.	P & faecal pollution
Low depth application of shed effluent to land	P & faecal pollution
Low rate (K-line) application of shed effluent to land	P & faecal pollution
Advanced Pond Systems for effluent treatment	P & faecal pollution
Feedpad systems for wintering animals	N
Nitrification inhibitors	N
Low input dairy farming	N
Producing milk at economically optimum soil Olsen P levels.	P
P fertilisation strategies for dairy farms using border dyke irrigation	P
Optimal use of N fertilisers	N
Grazing strategies for minimising soil compaction and pugging	P & faecal pollution

Dissemination of findings

Information from this project has been disseminated in a number of forms. As information was gathered it was reported back to the farmers in each catchment at Catchment meetings. A number of scientific papers have been prepared and either published or presented at scientific/farmer conferences.
A newsletter on the project was prepared and distributed to all dairy farmers in New Zealand in June 2006. This newsletter contained articles on the water quality monitoring in the Toenepi Stream, best management practices, adoption of best on-farm practices and a copy of the catchment poster.

Publications

Russell, J., Monaghan, R., Wilcock, R., Bramley, M., (2006), Final Report on the Best Practice Diary Catchments Project, SFF Project 03/069.

Contacts for key personnel

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Sustainable Dairy Farming in the Lake Brunner Catchment Project & Evaluation of the Implementation of Sustainable Farm Plans

Project Manager

Jan Derks / Shelly Washington

Project Partners

New Zealand Landcare Trust, Lake Brunner Farmers, West Coast Regional Council.

Funding providers

Sustainable Management Fund (Project # 3059), Dairy Insight

Project Partners

NZ Landcare Trust, West Coast Regional Council.

Key Concepts

Sustainable Farm Plans

Aims and Objectives

Contribute to the maintenance or enhancement of water quality of Lake Brunner and its catchment waterways, while allowing achievement of farming objectives. This was done by working with farmers/landowners to produce a sustainable farm plan for their farm that they will implement over an agreed timeframe.

Timeframe

1st July 2004 – 30th June 2005. Evaluation carried out in July 2006.

Project Design

The first five months of the project were a foundation-building phase, not only establishing resources and project systems, but contact and trust with farmers, as the key project stakeholders.

Three Sustainable Farm Plans were completed and approved through all stages of the development process. These represented evaluation models and a trial phase of the project, critical to ensure farm plans were of practical use to farmers. This means appropriate content, structure and level of detail to achieve on going use and objectives of the plans – to maintain or enhance the quality of water in Lake Brunner and its catchment waterways, while farming continues.

The project methodology is described under a number of steps:

1. Identification of farms and contact details.

The results show that a great improvement has been made in terms of positive attitudes and levels of behaviour towards the project and its sustainability message. The project has motivated farmers to initiate work that will enhance water quality, it has raised awareness of the sustainability implications of farming, it has caused farmers to demonstrate enthusiasm for the issues at hand and it has been a learning exercise that will aid in future projects. Basically, the project reached its goals in terms of participation, enthusiasm and quality.

Dissemination of findings

An introductory field day and a farm plan workshop were held, Farmers felt these were valuable and were and opportunity to meet people, gave useful information and provided an opportunity for farmers to discuss the project and to have there ideas incorporated in farm planning and in the operation of the project.

Publications

Derks, J., (2005), Sustainable Farming in the Lake Brunner Catchment, Project Outcomes. Sustainable Farming Fund Final Report

Russo, M., Washington, S., Brown, I. C., (2006), Evaluation of the Implementation of Sustainable Farm Plans – Report

Contacts for key personnel

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New Profitable Farming Options for the Lake Taupo Catchment – Puketapu Group

Project Manager

Bruce Thorrold – Dairy NZ, Hamilton

Project Partners

Puketapu 3A Incorporation
Oraukura No. 3 Incorporation
Hauhungaroa 1C Incorporation
Waihi Pukawa Trust
Waituhi Kuratau Trust

Funding providers

Sustainable Farming Fund (project # SFF02/110), Puketapu Group, FertResearch, Dairy Insight, Environment Waikato, Meat and Wool, Wrightons Seeds and Genetic Technologies.

Project Partners

Dairy NZ and AgResearch

Key Concepts

Forage Crops, Grazing management, Farm system Modelling and Economic Analysis

Aims and Objectives

To investigate farming options that:

- Had a proven ability to affect N cycling
- Were adoptable at a large scale, not a niche applicable to only a few farms

On this basis the project set out to investigate the following options:

1. Growing of forage crops for sale off the farm
2. Removing winter grazing of cattle on pasture
3. Forestry

Timeframe

2002 – 2006

Project Design and Results

Forage crops

This experiment examined the use of forage crops grown for harvest and sale rather than grazing. Field experiments with annual crops (triticale and maize) clearly demonstrated the risks to N leaching posed by a combination of high N fertiliser inputs and lack of perennial plant cover. Measured leaching losses were highest in these treatments (triticale 107 kg N/ha/yr, maize 226 kg N/ha/yr). Triticale yields (8000 kg DM/ha) were below expectation, which contributed to N leaching as N fertiliser was applied for a 14 t DM/ha maize crop grown with plastic cover technology.

Perennial crops (pasture and lucerne) grown under continuous cutting and high fertiliser inputs had measured N leaching levels similar to grazed pasture (pasture 18 kg N/ha/yr, Lucerne 24 kg N/ha/yr). Pasture yield was below expectation, and high N fertiliser rates applied to address this contributed to N leaching. Better management of rates and timing would probably have improved the efficiency of this treatment. Lucerne yields were very low in the establishment year due to dry conditions, however once established lucerne was the highest yielding treatment (10500 kg DM/ha) other than maize. Measured leaching losses for lucerne were higher than expected, possibly due to a combination of a high rainfall site compared with other studies and high sensitivity of the N leached calculation to Lucerne rooting depth. Given the yield potential of high quality forage and the possibility that leaching was overestimated, lucerne warrants further exploration as a cut forage crop.

Grazing Management

A grazing experiment, using steers or heifers demonstrated the impact on N leaching of zero grazing with low fertiliser inputs (3 kg N leached/ha/yr) compared to year round grazing of cattle (14 kg N/ha/yr). With pasture harvested only 13% below the grazing treatment, the zero grazing treatment was easily the most efficient system in terms of feed harvested per kg N leached. In an intermediate treatment, no grazing occurred in the April to September period. This treatment reduced N leaching to 6 kg N/ha/yr at the cost of 12% pasture yield compared to year round grazing. This experiment clearly demonstrated the controlling influence of grazing (urine patches) and winter drainage on N leaching in grazed systems. Leaching following high summer rainfall in one year reinforced these principles.

Farm system Modelling and Economic Analysis

Farm systems modelling based on case study farms in the catchment studied the financial impact and feasibility of a number of alternatives.

1. Improving stock performance through lambing percentage and growth rates emerged as a highly efficient option for farmers to improve profit without increasing N leaching.
2. Options designed to alter winter cattle management were not able to maintain profitability, although small reductions in N leaching were predicted. These reductions (10%) were well below the 55% reductions measured in the field studies. This was due to the fact that the cattle comprised only 30% of stock units on the case study farm, and a shorter period of grazing off was used in the farm system case study compared to the experiment.
3. Use of DCD (nitrification inhibitor) products showed potential in the higher input dairy systems but was little value as a broadcast application in sheep and beef systems. The assumptions made about responses to DCD are critical in the analyses and these assumptions require further proof in order to optimise the role of DCD products in this environment.
4. Combinations of forestry with high performance Sheep and Beef farming provided increased long term income, combined with reduced leaching losses. When the forestry income was expressed as an annuity, this was an attractive option, but in the absence of the annuity, farm cash flow was significantly reduced.
5. Wintering off and DCD's were the most promising options for dairy farmers.
6. Comparison of the best Dairy and Sheep and Beef systems, when adjusted for the capital costs of dairy conversion indicated that the two systems were similar in their efficiency (profit /kg N leached). However the best Dairy system still leached twice as much per hectare as the Sheep and Beef system.

Main Results

- The efficiency of forestry and cut forage systems in terms of yield and profit per kg N leached suggests that they require further analysis to overcome issues of yield and feasibility.
- The potential impact of DCD products similarly suggests that research into better predictions of responses and optimising their use especially on Sheep and Beef farms is warranted.
- Improving stock performance emerges as the most profitable rout for farmers in the short term as they seek to improve profitability without increasing N leaching.

Dissemination of findings

The report is available on the Environment Waikato Website

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Publications

Thorrold, B., Betteridge, K., (2006), New Profitable Farming Systems for the Lake Taupo Catchment. SFF Final Report

Conclusions

The summaries of research projects above show a snap shot of what is being done already in the Rotorua Lakes catchments and New Zealand wide in an attempt to stop the degradation of water quality due to nutrient runoff and leaching from land based activities. These are by no means all of the projects going on in the area (see Appendix 1 for a summary of other research) but are seen to be some of the most important / effective being investigated at the moment or recently.

It is now important to take on board what the research is showing and develop it into Best Practice Management where it is seen to be applicable. Focus needs to be made on the extension process of getting the relevant information to farmers in a form easily understandable and in a way that encourages them to adopt the new practices for the benefit of lake water quality but not detrimentally affecting the profitability of their farms.

Appendix

Appendix 1: Nutrient Mitigation Research Summary

Environment Bay of Plenty

Report From:	Simon Park, Headway Ltd Consultant reporting to Rotorua Lakes Programme Manager
Date:	8 February 2008
File Reference:	3365 06 01

The Chairman and Members

Land Use Futures Board

Meeting of 15 February 2008

The purpose of this report is to provide a summary of current and recent research relevant to sustainable nutrient mitigation in the catchments of the Rotorua Lakes, as requested by the Board at its last meeting in December 2007.

The terms of reference for the Land Use Futures Board include the following:
The Board shall consider and advise on: Relevant nutrient mitigation research, both current work and potential i.e. gap analysis.

This report has been prepared to assist the Board by giving a summary of nutrient mitigation research. The summary is split into, research specific to the Rotorua lakes catchments and an overview of other New Zealand research initiatives, including relevant Waikato based work.

International research is not described. However, the knowledge from international work typically feeds into NZ-based research via literature reviews in peer-reviewed scientific journals.

Rotorua Specific Research

The table below summarises individual nutrient mitigation projects by stating the research objectives and any available key results. Many of the research projects are highly complex, with multiple objectives, stakeholders and funders. For the purposes of this report, the project description has been kept to a bare minimum.

For older Rotorua lakes research (1960s up to 2004), there is a comprehensive bibliography of published reports and papers by Claire Millar on www.envbop.govt.nz (look in the technical publications list in the Lakes web pages). This bibliography includes in-lake and groundwater research as well as land based research.

Table of Rotorua specific nutrient mitigation research

Project	Description	Results
Practical N and P mitigation options	SFF project with Ngati Whakaue Tribal Lands, science led by AgResearch. **Objectives:** ID critical source Areas for P and N loss and target improved management practices to reduce losses from these areas. Optimise production and environmental outcomes A second related SFF project has started, to continue to 2010.	First SFF project completed mid 2007, key dairy farm scenario results: ~50% N leaching reduction from nil N fertiliser use but profit down Maize silage, winter stand-off and winter feed-pad reduced N leaching and profit DCD 15% N leaching drop, possibly cost-neutral Optimised scenario reduced N leaching by 15% and increased profit by 19%. Sheep and beef farm modelling showed most options reduced profit with only slight reductions in N leaching.
On-Farm Biological Mitigation Options for Nutrient Management	SFF project with Ngati Whakaue Tribal Lands, science led by NIWA **Objective:** To assess practical on-farm methods that can reduce mobile nutrient flows, being: Grass filter strips Riparian management Constructed wetlands Aquatic plant harvesting, including watercress, from drains or streams	Ongoing 2006-2009 Initial steps: Select potential methods Establish sites

Project	Description	Results
Project Rerewhakaaitu: Phosphate Mitigation	SFF project managed by local farmers, science led by AgResearch. **Objective:** Improve pastoral management to protect the lake from P inputs while maintaining farm businesses Methods to be assessed include: Optimum Olsen P levels Regrassing to prevent particulate P loss Vegetated filter strips Waste products as P binders Soil conservation techniques Bunding causeways and tracks	Ongoing 2006-2009 Initial steps: Selection of BMPs and trial sites Overseer data for 12 farms Note: prior related SFF project focused on N leaching
Options for reduced N leaching on Rotorua dairy farms	Initiative by Rotorua dairy farmers supported by Dairy NZ, Fonterra and Federated Farmers. This work was led by Duncan Smeaton from AgResearch. **Objectives:** Assess each farm system for N loss, production and profitability, for current (2006) state and Rule 11 benchmark period (2001-2004) Assess nitrogen and economic impacts of a range of mitigation practices Compare results with targeted EBOP reductions	Sept 2006-2007 26 individual farm analyses remain confidential. Overall results indicate: average leaching 58kgN/ha/y Net catchment savings of 34 tons N without profit loss Longer term profit impacts uncertain Note: a few drystock farm assessments were funded by Meat & Wool – no results are available yet
OCTOPUS model	ENSIS-SCION initiative with Ngati Whakaue **Objective**: To assess long term land use change scenarios at the farm level with multiple visual GIS output layers	Started 2005, ongoing… Note: modelling is focused on NWTL's Wharenui Farm

Project	Description	Results
Birchalls Demonstration Herdhome	Five year project between Okaro dairy farmer and EBOP **Objectives:** Reducing nitrogen loss Education Research – this comprises: Recording the establishment, integration and management of a Herd Home system into an existing dairy management system. Features include: automated climate station monitoring, Herdhome usage recording Dairybase data entering Regular owner interviews	Ongoing from 2007 to 2012, key points are: 3 successful field-days Data collection ongoing Research programme not defined yet
Cost-effectiveness of Grazing Options for Rotorua Dairy Farms	An internal EBOP desk-top assessment. **Objectives:** Assess the potential cost-effectiveness of different methods to limit winter grazing of dairy cows within the catchment and hence reduce nitrogen losses to lakes catchments. Assess Net Present Value of grazing options Identify the need for further work	Completed October 2007 Key results: Alternative grazing options cost more than status quo, implying Herdhomes and other options were unlikely to be adopted without a financial incentive Herdhome used “full-time” was the most cost-effective option for reducing N leaching Uncertainties show need for more research and case studies, including Herdhomes
Gorse N leaching	ENSIS-SCION contract to EBOP **Objective:** Assess gorse N leaching from stands in Rotorua Lakes catchments	Completion due Feb 2008 Key interim result: N leaching up to 50kgN/ha/year
Lake Okaro wetland	NIWA contract to EBOP **Objective:** Assess the nutrient removal performance of the Lake Okaro constructed wetlands	Ongoing 2005 to Dec 2008 Results not yet available

Project	Description	Results
Landscape grass filter strips	Two related projects, with support of two farmers and EBOP contract to NIWA. **Objectives:** Test the persistence and management requirements of several possible Grass Filter Strips (GFS) species under grazing Assess reduction in sediment and nutrient loads	Started 2006 Data requires analysis Continuation not decided
Nutrient trading for Lake Rotorua	This is an ongoing initiative, considering options for a nutrient trading regime for Lake Rotorua, supported by EBOP and FRST. Research is led by Suzi Kerr from Motu Ltd. Key questions being investigated are: Which nutrients should be controlled under a trading cap? Should goals be defined in terms of nutrient loss (exports), nutrients entering the lake (inputs), or nutrient concentrations (stocks) in the lake? What do currently defined goals imply for trading caps? What periods of time and spatial zones should allowances apply to?	Ongoing research. See www.motu.org.nz for recent detailed research papers on potential nutrient trading options.

Other New Zealand Research Initiatives

New Zealand wide nutrient mitigation research is directed and/or funded by many different Government and private agencies, including:
Foundation for Science, Research and Technology (FRST) via a range of Crown Research Institutes (CRIs) and other research providers
MAF Policy and MAF's Sustainable Farming Fund
Sector groups such as: Dairy NZ; Meat and Wool NZ; Foundation for Arable Research; FertResearch and individual fertiliser companies; Deeresearch; etc
Universities, particularly Massey and Lincoln
Regional Councils

These "NZ-wide" research programmes and initiatives are briefly described in the table below. For space reasons and because the research is generally ongoing, specific results are not given. Many projects are inter-related, including with some Rotorua-specific projects. Please note that this is not a comprehensive list but it is intended to cover the most relevant research.

Project	Agency	Description
Sustainable Land Management and Climate Change Plan of Action.	MAF led	Broad Government initiative with policy, funding, leadership and research elements – latter includes: agriculture and forestry adaptation and mitigation potential of nitrification inhibitors and stand-off pads Research priorities due March 2008
Sustainable Water Programme of Action	MAF and MfE led, plus other Govt. departments and regional councils	Broad policy-focused central Government initiative Identification of freshwater research needs, including catchment management, was due December 2007
Integrated Research for Aquifer Protection, or IRAP	FRST funded, multiple CRIs and other agencies involved	Develop farm & aquifer scale models to predict groundwater quality outcomes User scenarios, BMPs & cumulative effects Includes Taupo pumice soil lysimeter work See www.irap.org.nz for details
Sustainable Land Use Research Initiative, or SLURI	FRST funded, multiple CRIs and other agencies involved	SLURI priorities for preserving and managing our soils: Soil functioning Managing land use Resilience under change Valuing natural capital Strategic land use management See www.sluri.org.nz for details
Dairy Industry Strategy for Sustainable Environmental Management	Dairy NZ, funded via industry levy to $5M/year	An industry-wide plan to improve environmental performance by research and education: Ten year implementation target, including developing mitigation tools capable of (relative to 2006): 50% reduction in N loss 50% reduction in P loss in heavy soils, 80% in free draining soils Programme includes Target catchments (below)
Target dairy catchments	Dairy NZ	Based on 2006 Dairy Environmental Strategy Target catchments are Lake Rotorua, Lake Brunner and Upper Waikato Builds on Fonterra's long-running 'Best Practice Catchments', including Toenepi (Waikato)
Prototype Farms Project	Dairy NZ and AgResearch	Tight-N, Super Productivity & Automatic farms Tight-N objective is 50% reduction in N

Project	Agency	Description
		leaching while maintaining “control” level production of 1200kgMS/ha/year Super Productivity objective is 1750kgMS/ha/year while maintaining “control” level N leaching
Precision fertiliser application	NZ Centre for Precision Agriculture, Massey University	Includes potential for aircraft and ground machines to accurately apply site-specific fertilizer rates See www.nzcpa.com
Wise use of N fertiliser on hill country	FertResearch led, plus Meat & Wool, SFF & others	Enhance long-term hill farm profitability whilst minimising environmental effects Due for completion March 2008 See www.wisenuse.co.nz
OVERSEER® upgrade	AgResearch, MAF and FertResearch	Ongoing development of model for farmers, advisors and policy makers Latest version, incorporating several new mitigation options, due March 2008
Energy Farming to Protect Lake Taupo	Lake Taupo Development Trust	Provide sustainable income for threatened farms Short rotation willow crop Includes a Rotorua trial site

Environment Waikato Report 2007/42

Environment Waikato has just published a comprehensive nutrient management review, titled "On farm nutrient management practice – research and applicability to upper Waikato". The full technical report (EW reference 2007/42), written by Helen Ritchie, can be found at www.ew.govt.nz
The report is focused on the hydro-lake catchments of the upper Waikato River. The broad similarity with Rotorua lakes catchments, in terms of soils, climate, farm systems and nutrient management issues, make this a useful and up-to-date research summary. The executive summary and a table of relevant research are attached as an appendix to this report.

Executive Summary and Table 1 excerpts from Environment Waikato's technical publication 2007/42 by Helen Ritchie:

Executive Summary

This study presents a review of research into options for on-farm nutrient management, identifying their relevance to the Upper Waikato and any gaps in existing information to guide policy development for this part of the region. On-farm practices were reviewed with a dual focus on their effectiveness in reducing nutrient losses from the farm system, and possible impacts (economic and practical) on the existing farm business operation. An additional focus was to identify factors that lead to differences in the range of environmental and on-farm economic impacts presented in the literature.

A review of literature and discussion with key specialists in this field has shown that:

A sound scientific research platform exists and principles have been identified for managing nutrient issues that can be transferred to this catchment.
Local climatic, soil and farm management variables will influence the magnitude of environmental gain from implementing different practices.
Nitrogen pathways and practices to reduce loss are well understood and there is a broad scientific consensus on their effectiveness. A possible exception is how much reduction in leaching and what pasture response will occur from using nitrification inhibitors in this area under different farm systems. There is also limited data on nitrogen losses under grazed winter crops in this region, and on the extent of land area under cropping in this catchment.
Phosphorus pathways are well understood, but the importance of particular sources and hotspots, and consequently the most effective ways to avoid losses, has to be assessed on a farm-by-farm basis. Excessive Olsen P levels can be identified from soil tests, and much overland runoff is observable by the farmer. Key sources can be seen by walking the farm in the rain to observe run-off or by checking for discharges to waterways following effluent irrigation.

The economic impacts of practices vary according to the details of each property, but a range of modelling has been done for Taupo, Toenepi, Rotorua and Hamilton farm systems that will have some relevance.
Beyond the scientific principles, the local issue needs to be clearly communicated. Of critical importance is assembling clear evidence showing that:
nutrient flows into the hydro lakes are increasing/are likely to increase further - what is happening
this will have a substantive effect - so what
land use change and intensification are linked to this effect - how this happens
within this, the greatest factors at play in this area/where nutrient contributions come from/relative importance of N and P losses - what influences it the most.

From this, the land use practices that have been identified through the literature can be applied to the Upper Waikato in a strategic way, focusing on what will make the most difference, where.
Applying this at a farm-scale level to some 'typical' farms of the area will help farmers to make the assessment of what will work for me.

The processes for engaging people in learning and action around these issues are reasonably well understood. However local information about different farmers' practices and how individual farm context affects farmers' choice of nutrient management practices may be a current knowledge gap.

A range of nutrient management practices are currently available. But there are only a few that are easily adopted into the farm system while having a positive impact on farm income and the environment. However, some practical options do exist within the current set of possibilities that can be promoted to farmers of the Upper Waikato catchment. The summary tables in this document outline what those practices are.

Table 1: Summary of research and relevance to Upper Waikato

Farm practice to reduce nutrient losses	Likely effectiveness in reducing nutrient loss	Range of economic impacts	Factors influencing impact in Upper Waikato
Nutrient budget and nutrient management plan	Could be large for small number of farms, mostly small-moderate (5-10%)	Positive, proportionate to the reduction in fertiliser	Current fertiliser, effluent, supplement and wintering practice
Wintering practices - wintering on pads - 'cut and carry' feed	For dairy, large potential reduction in N loss e.g. 30-60% from wintering on a pad. Level of gain depends on current wintering practice and what other changes are made as a result which may increase overall nutrient cycling	Large range of impacts from wintering pads but generally negative on Earnings Before Interest and Tax (EBIT) (4-15% drop).	Nutrient reduction depends on length of time/ season on pad. Economic impact depends on cost of pad, feed and labour, and cost of other wintering options. Benefit relies on feeding cows well/ utilising extra pasture grown.

Wintering practices - wintering off the farm	Effective but transfers the issue to another location	Often profitable with other system changes	System changes (e.g. calving earlier, milking longer, increasing stocking)
Wintering practices - winter forage crops	A high N-loss land use (less if on-off grazing)	Often incorporated into re-grassing sequence	Extent of crop area, fertiliser used and on-off grazing practices.
Effluent management - switching from ponds to land treatment	Can give a large reduction in P loss for those farms (60%).	If existing ponds are used for storage, a switch is possible for a minor drop in EBIT (1%) as nutrient 'credit' of land application offsets some of the cost	Number of dairy farms currently using pond systems.
Effluent management - better land application	Smaller reductions in overall N and P loss (0-10%)	Small economic benefit due to better use of nutrients	Extent of poor practice with current systems
Riparian management	Riparian strips prevent direct inputs and filter out particulate P (50-80%) but have less effect on dissolved P, so moderate gains overall for P (20-50%). Effectiveness can drop over time (e.g. after 20 years). Minor for N unless soils in riparian area are wet and act like wetlands (denitrification occurs).	Capital and maintenance costs (weeds, floods) but savings on stock losses and stock management time. Grants may assist e.g Clean Streams (35%) Overall impact can be positive if subdivision/ pasture utilisation improves.	Current stage of farm fencing/ subdivision; current stock access/ impacts to streams. Riparian strip width (5+ metres required for effective filtering). Eventual fate of stored P in the filter strip area. Extent of wet soils for N removal.
Nitrification inhibitors	Moderate to substantial reductions in N loss for dairy (15-30%) are possible, enhanced if stocking rates remain constant and other inputs drop	Increase in pasture growth (5-10%) may cover costs or give economic benefits if well utilised – EBIT gain of 1-15% under modelling	Depends on response in local conditions both for N leaching and pasture growth; and any other changes made to the farm system
Hotspots e.g. tracks and races, yards	Farm-specific but can be significant for P and N; can also be significant for faecal contamination	A cost to re-shape areas/ redirect effluent. Can save on ongoing costs e.g. track maintenance	Contour, runoff pathways, cut-offs/ diversion in place, time stock spend on the area, stock type
Wetlands	Effective if sufficiently large to retain water (e.g. 2-5% of catchment area can remove 50% of the N in the runoff)	Easy to fence existing wetlands on dairy farms. More costly to construct a wetland, but ongoing cost low.	Catchment water flows/ extent of wetlands, time water is retained in wetland
Feed manipulation - low-N/high sugar or high tannin feed, salt supplements	A range of alternatives still being researched	Different alternative feeds will have different effects on production	Depends on supplement reducing overall nutrients in the system.