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Managing Nutrient Losses and Profitability for 95 Farms in Southland

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Summary

Farming is a balancing act between inputs and outputs to produce food efficiently and profitably, and fresh water is a vital component across the production system – for water takes and nutrient losses. Many farmers now adopt good management practices to manage their nutrient losses, but fewer go beyond this point because it usually impacts on farm profitability. Farmers generally have to absorb changes in profitability because they have little ability to influence product prices. This paper presents a summary of the results of research done by industry groups on the relationship between managing nutrient losses and farm profitability for Southland's agriculture sector. The findings have implications for assessments of productivity and sustainability.

Key Words

Water quality, Agriculture, Productivity, Sustainability, Southland

Introduction

Water, and the land it flows through, has a natural capacity to process (or attenuate) nutrients and other substances. When by-products from economic activity end up in water then this natural capacity is 'used' or taken up. The by-products add to concentrations and loads (or total amounts) of substances in the environment and can cause water quality issues. Although awareness of water quality issues has improved over recent years, the economy's use of fresh water (both for water takes and to receive by-products) continues to increase in Southland and elsewhere in New Zealand.

One reason is that standard assessments of an economic activity's productivity do not usually account for its use of natural resources over the longer term. In other words, such assessments are not complete, and do not necessarily reflect an activity's sustainability. Where a use of water is not accounted for, and it impacts on other values, then all of the community is, in effect, subsidising that activity. This is the case regardless of the economic sector being considered (e.g. agriculture, forestry, manufacturing, tourism or local government).

Many new initiatives are being introduced that are designed to improve how people use water - in this context, the 'use' of water is in its broadest sense, both as a water take and to receive by-products. At the centre of these efforts is the National Policy Statement for Freshwater Management (2017), which requires environmental 'limits' to be set on the use of freshwater for water quality and water quantity. In Southland, limits may require people to change the way they use water, which is likely to have economic impacts as they go through a period of transition. **The Southland Economic Project** is a joint initiative to develop ways of understanding such economic impacts so that information will be available during community processes.

This paper presents the results of research on the agriculture sector that industry groups have done as one part of **The Southland Economic Project**. Agriculture occupies 87% of the developed land in Southland and the aim of this research was to develop information on the effectiveness, and impacts on profitability, of managing nutrient losses within farm production systems. Mitigations for sediment and microbes were not included because of difficulties in estimating losses at a farm-scale. It was the first time these industry groups have all collectively been involved in research of this type, and it was the first time that such research has been done for farms across a region.

Similar information was not developed for the forestry sector, even though it makes up 9.9% of the developed land, because this sector generally has relatively low nutrient losses in Southland, and it was assumed that the effects of forestry on waterbodies would be managed under the proposed National Environment Standard for Plantation Forestry (2015).

The paper is a summary of a full report that highlights Southland's reliance on agriculture, compared to other regions, and develops a number of themes. One is the role Southland's environment has in the development of agriculture and forestry and, in turn, how this development has modified the environment over the years. Southland's water and land is highly connected, in comparison to most other regions. Water now flows more rapidly through the landscape than in the past, and there are fewer opportunities for the natural processing of nutrients carried in it. Other important themes are the complexity and diversity within agriculture, and the connections (and integration) between the different industries, both on-farm and between farms, which were an important consideration in this research.

Methodology

To develop information for agriculture, the industry groups surveyed a total of 95 farms across Southland: 46 drystock farms, 41 dairy farms (one farm was a composite based on real farm data), 4 arable farms, and 4 horticultural growers. This information was used as a set of case studies that explored:

1. A farm's estimated nitrogen and phosphorus losses and profitability; and
2. The effectiveness of mitigation measures (or actions) to manage nutrient losses and their impacts on profitability for a farm.

The farm case studies were created using a two stage process. In the first stage, two baseline files were developed for each farm using computer software programmes that estimated existing nutrient losses and profitability. In the second stage, the input data for each farm's nutrient budget and financial files were altered to simulate a range of on-farm mitigation scenarios. The software programmes used were OVERSEER® nutrient budget model (Version 6.2.1) for all 95 farms, FARMAX® for the operating profit of 87 pastoral farms, and Microsoft Excel® for the gross margins of the 8 arable farms and horticultural growers. Each industry group tailored this basic methodology to more accurately reflect the nature of its industry.

The OVERSEER® model was designed for testing the relative effects of possible changes in farm management on nutrient losses from a farm, which is how it was used in this research. The mitigations focused on those that were able to be modelled in OVERSEER® out of a wider set of possible mitigations. In general, the financial measures of 'profitability' used in this research were all before interest and tax payments. The measure used for the drystock farms was also before any payments for rent. Two key measures were identified for assessing policy impacts: an industry's land area and its number of farmers.

The farm case studies are a key input into **The Southland Economic Model for Fresh Water**, which is a regional model of Southland's economy being developed within **The Southland Economic Project**. This model will trace possible transitions pathways (or routes) as the economy evolves over time. It will be used to test the economic impacts of "what if" policy scenarios for achieving limits in each FMU. Additional work is being done on how the economy currently influences community outcomes in Southland to give some understanding of possible social impacts of policy.

Baseline Results

The baseline nutrient losses show each farm's estimated start point for the modelling of mitigation scenarios. Factors driving baseline losses include land use, farm management and environmental conditions (climate, topography and soils). A large number of diverse and often complex farms were included in this research that covered a large land area. Each farm had its own set of circumstances and the production systems were diverse and complex. Three sheep and beef farms were so complex they were unable to be modelled realistically in OVERSEER®.

These results indicate each industry's range of nutrient losses but not necessarily its distribution. Horticultural crops were modelled as three case studies within a sheep farm, reflecting how they occur in Southland and the rotational nature of the crops over time. **Figure 1** shows the baseline nitrogen losses for 90 case study farms, (three sheep and beef farms, one horticulture, and one arable property were unable to produce baseline results) and **Figure 2** shows the baseline phosphorus losses for 87 case study farms across the industries, (the four horticulture properties did not report phosphorus losses, as well as those mentioned previously).

Within an industry, there was no clear relationship between a farm's baseline nitrogen or phosphorus losses and its profitability. In other words, farms with lower nutrient losses were just as likely to be profitable as farms with higher nutrient losses. For example, the two most profitable dairy farms had reasonably low nutrient losses, the third farm had nutrient losses that were average for the 41 dairy farms, and the fourth most profitable dairy farm had relatively high losses. The results for the most profitable sheep and beef farms tell a similar story.

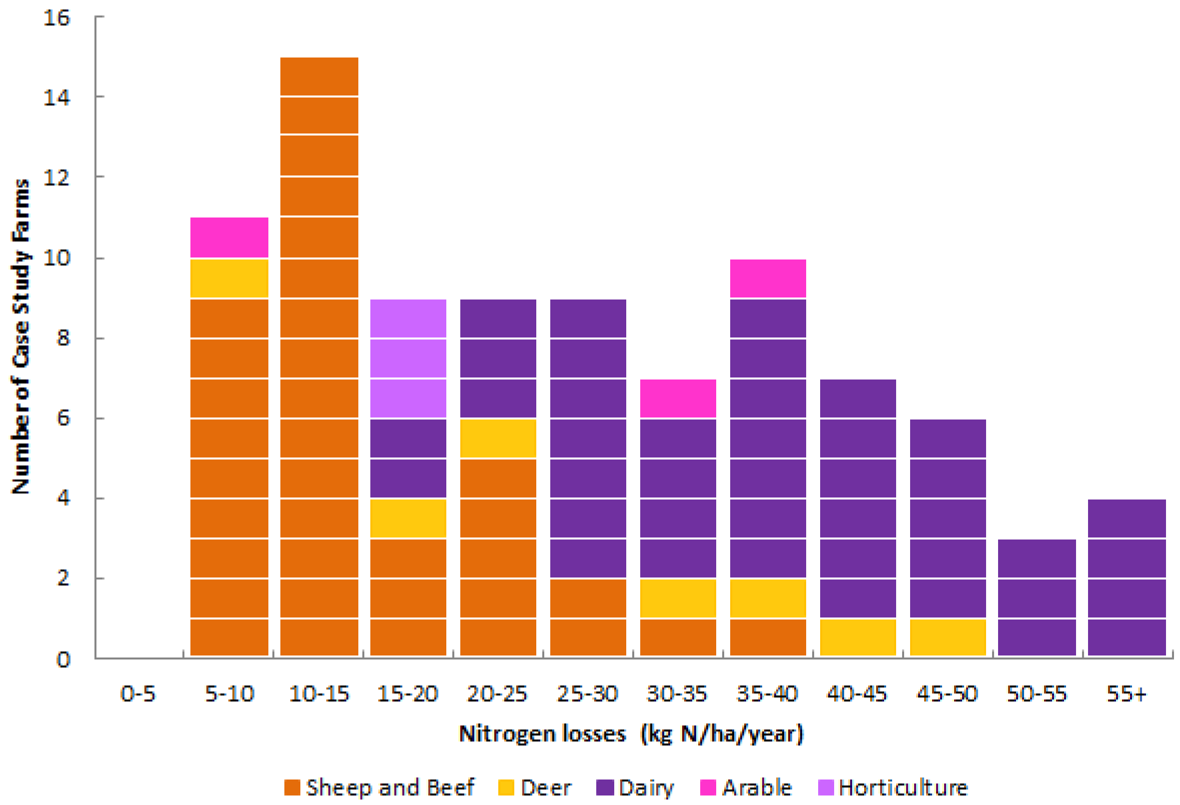

Figure 1: Baseline nitrogen losses for Southland case study farms

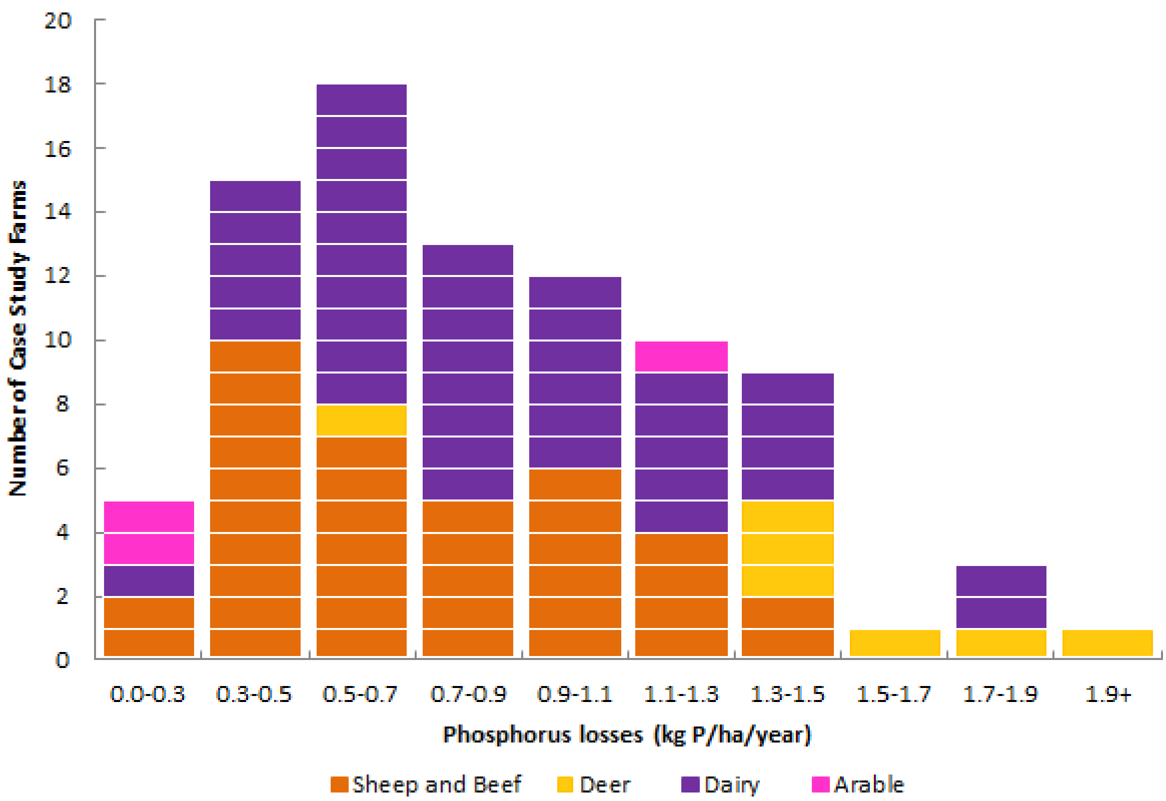

Figure 2: Baseline phosphorus losses for Southland case study farms

Mitigation Modelling

Each industry used the farm baseline files to model a set of industry specific mitigations. For the sheep and beef, deer, and arable farms, individual mitigations were modelled for nitrogen and phosphorus losses. For horticulture, individual mitigations were modelled for nitrogen losses only. For the dairy farms, combinations of mitigations were modelled to achieve percentage reduction targets in nutrient losses (e.g. from -10% to -40%) within the existing farm system. The results of this modelling show estimates of the effectiveness and impacts on profitability of different mitigation options in OVERSEER®, and are a reasonable indication of what could occur on-farm, although there are many other mitigations that could be applied. These results are summarised in each industry's section in Part C of the full report.

Key Findings

Based on the mitigations modelled, the key findings were:

1. The mitigations that were modelled usually reduced losses of one or both nutrients (by lesser or greater amounts) but also reduced profitability for most farms. The main reason that managing nutrient losses reduces profitability is that it changes the farm production system. While many farms have started adjusting their production systems to manage nutrient losses, they will need to continue managing their nutrient losses in the future, while maintaining profitability.
2. Some farms had less capacity to reduce nutrient losses than others according to OVERSEER® analysis. The main reasons were:
    a. those farms had low nutrient losses to start with (so the mitigations had little effect);
    b. the impacts of the mitigations on profitability were high;
    c. the mitigation options were not applicable to a farm; and/or
    d. the mitigation options were not sufficient to manage the farm's nutrient losses (given its soils and topography).
3. The effectiveness of specific mitigations varied by industry and nutrient. For example, reducing stocking rates was not well suited to drystock because stocking rates were generally within the carrying capacity of the land. On deer farms, managing fence pacing and wallowing was an effective mitigation for phosphorus losses but had limited success in reducing nitrogen losses.
4. Within most industries, farms with higher baseline nutrient losses tended to have more mitigation options, and these mitigations were usually more effective, than farms with lower baseline nutrient losses. However, this finding was not the case for the dairy industry. Some dairy farms had relatively high baseline nutrient losses for the industry and few mitigations. For these farms to achieve relatively low nutrient losses, they will need to consider other options, such as retiring land or a change in farm system.

5. The impacts on profitability of particular mitigations often varied by farm and industry. For example, for pastoral farming the mitigations that had the least impact often related to fertiliser use (timing and application rates), but similar mitigations had a considerable impact for cropping activities because of the close relationship between fertiliser and crop yields and quality. If fertiliser rates and applications do not meet a crop's requirements then growers are unlikely to grow a particular crop.

Main Limitations

The main limitations of this research are the effort required to survey and model a range of farm types, and the flexibility of any model in representing different farm types and mitigations.

The effort required to survey and model each farm meant that it was not practical to cover the full diversity and complexity of farming across Southland. As a result, the set of 95 farms is comprehensive but not fully representative of each industry. However, the sample size, and the process of working with industry, provides a good level of robustness and the use of this information will improve understanding. The necessity of using models for this research meant that aspects of some farms, and some mitigations, could not be represented. To a certain extent this limitation is unavoidable because no model can perfectly reflect reality. The models used in this research are continually being advanced and some of the challenges faced in this research have since been resolved, while others are under development.

The research was done to create a farm dataset for the Southland Economic Model for Fresh Water. As it stands, the dataset is a snapshot of a number of different farms in the 2013-14 year and estimates the effect and impacts of a range of mitigation scenarios. It does not consider how farmers will need to adapt over time, including policy implementation rates and mitigation adoption rates – these factors will be included when the dataset is used in the model. It also does not reflect any technological change and new opportunities that will arise as Southland transitions towards achieving the requirements of the National Policy Statement for Freshwater Management (2014). Consequently, a great deal of care needs to be taking when interpreting the research, and specific results should only be considered within the context given in the full report.

The full report (including references) is available at:

http://waterandland.es.govt.nz/setting-limits/research/southland-economic-project