NITROGEN MANAGEMENT FOR ENVIRONMENTAL ACCOUNTABILITY – TOOLS TO ASSIST SMART DECISION MAKING

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Introduction

For a number of years industry has recognised the need to have tools that will allow them to make smart decisions in relation to the use of nitrogen fertilisers in the production of horticultural (winegrapes, fruit and vegetables) and arable crops. Efficient and effective use of fertilisers is imperative. If growers apply excess fertiliser the cost of the input is not recovered in increased yield and the cost of this input continues to increase. Further, if nitrogen applied to land is not used during the growth period of the crop it remains in fallow soil and during periods of significant rain can be leached resulting in adverse impacts on water quality.

Fertiliser application rates vary considerably across the horticulture and arable industry and in some cases within sectors depending on the region. In the past fertilisers like other agrichemicals have been applied in a risk adverse approach, that is used as an insurance policy rather than on a careful consideration of inputs and outputs. Over the last two decades a number of tools have been developed to assist decision making regarding rate, timing and method of nitrogen application. These tools have been possible mainly as a result of science outcomes from the Foundation for Research, Science & Technology programs that developed the mechanistic models - the LUCI framework model (arable and vegetable) and SPASMO (fruit). These tools have varied greatly from grower guides (e.g. peas) to complex computer based models (e.g. the potato calculator). While these tools have been extremely useful in providing advice and guidance to growers of individual crops they did not allow for integration of activities across an entire property – something that growers of rotational crops and regional councils considered necessary. Nitrogen Management for Environmental Accountability (NMEA) was funded by MAF Sustainable Farming Fund (SFF) to achieve this objective.

Methodology

Given the complexity of the project resulting from the large number of industries and regional councils involved a scoping study was done to determine the requirements of the tool to be developed. This scoping study commonly referred to as 'Milestone Zero', culminated in a very useful report that can be found at http://www.maf.govt.nz/sff/about-projects/search/05-004/index.htm which summarises nitrogen use and how it is influenced by:

- Current Regional Plan rules
- Future directions of Regional Councils
- Private standards
- Current management practices
- Existing nutrient management tools

The findings of this report were workshopped by industry and regional councils and an agreed objective for the resulting project was to produce a scientifically robust, user friendly tool that can be used to accurately predict nitrogen leaching from a wide range of crops throughout New Zealand under specified management practices. It was agreed that the tool should:

- Provide assurances to regional councils that horticulture and arable activities are being managed sustainably using best management techniques
- Alert growers and farmers to any potential loss (and therefore profit loss due to wastage) of nitrogen from their systems.

A successful MAF SFF application was developed by a 'Community Group of Interest' consisting of the Fresh Vegetable, Potato and Process Vegetable Product Groups, Foundation for Arable Research, Pipfruit New Zealand, Summerfruit New Zealand, New Zealand Citrus Growers, Sustainable Winegrowers New Zealand, Zespri (on behalf of the kiwifruit industry), Avocado Industry Council, Kabocha Council, FertResearch, Environment Canterbury, Hawke's Bay Regional Council, Environment Waikato, Marlborough District Council, Tasman District Council, Environment Bay of Plenty, Horizons District Council, Greater Wellington Regional Council, Northland Regional Council, Auckland Regional Council and Otago Regional Council.

Crop & Food Research were contracted to deliver the tool with sub-contracts to key researchers at HortResearch and AgResearch. OVERSEER®, an existing nutrient budget model, was viewed as the preferred delivery vehicle for the new tool. OVERSEER® was developed by an ownership group consisting of MAF, AgResearch and FertResearch) and has an existing reputation of reliability with Regional Councils and the sheep, beef and dairy sectors. OVERSEER® already had some existing horticultural and arable components but improvements were needed to meet end user requirements.

A series of simulations were run using LUCI and SPASMO at different locations with different soil types and different irrigation and nitrogen applications. These results were analysed to create simplified generic mechanisms for calculating water and nitrogen balances on a monthly time step. The equation derived for prediction leaching could explain 90% of the simulated variation in leaching given the correct estimations of leaching and the correct mineral nitrogen status.

Other mechanisms for calculating drainage (evaporation, and transpiration) and mineral nitrogen status (crop nitrogen uptake, residue mineralisation, organic matter mineralisation) were also derived to enable the calculation of nitrogen leaching from any crop rotation and management regime. These mechanisms are detailed diagrammatically in Figure 1.

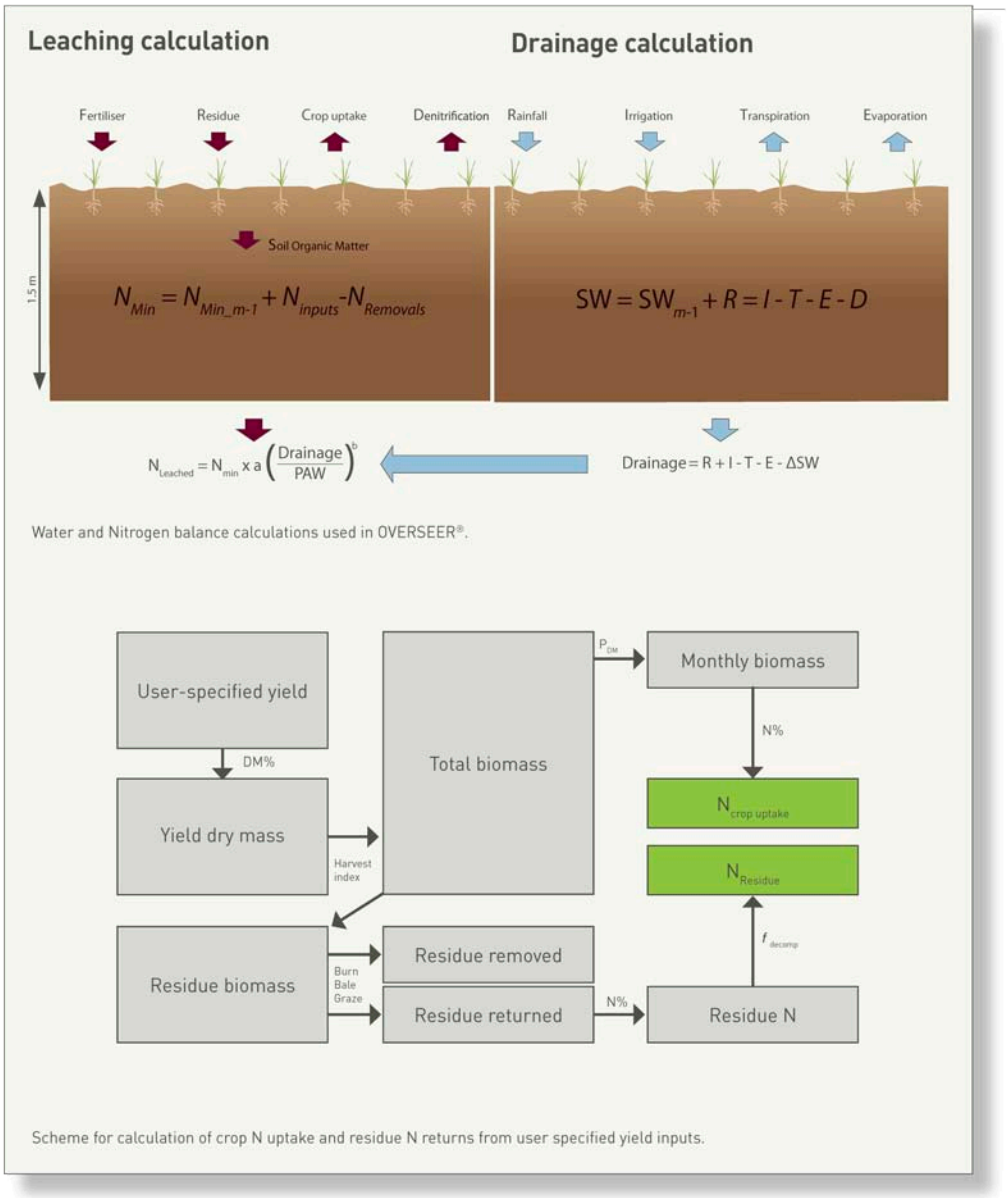

Figure 1

Outputs from the upgraded OVERSEER® model have been back validated against outputs from the parent models as well as experimental leaching data showing very good agreement in both tests. Figure 2 shows the relationship between observed and predicted leaching from an experiment containing two rotations. The first rotation was potatoes followed by a winter fallow and spring sown peas (Po-Fa-Pe) and the second was potatoes followed by autumn sown wheat (Po-Wheat). A factorial experiment with two levels of irrigation and three levels of nitrogen fertiliser application was applied to each rotation. There were no differences in leaching between the two rotations because all leaching occurred during the potato crop when both rotations were the same. The model predicted that there would be no differences between the two rotations and also the response of leaching to nitrogen fertiliser and irrigation treatments.

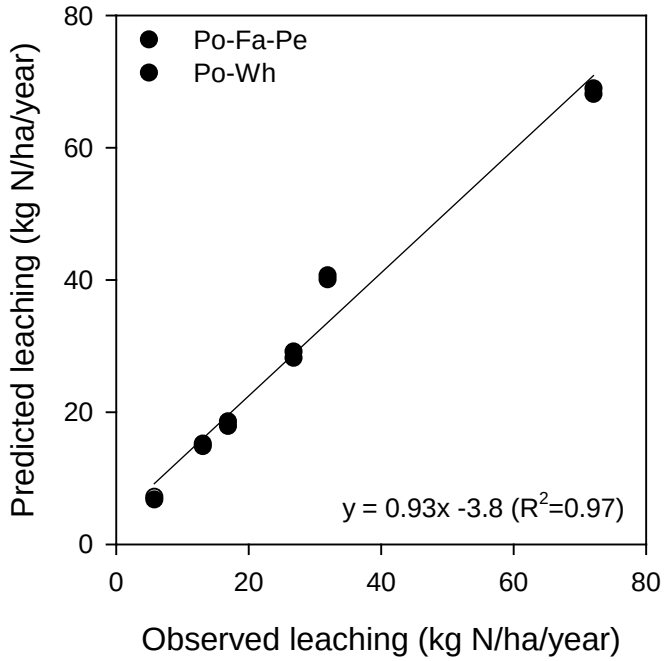

Figure 2.

Future Work

The project currently has four months to run. Official release of the upgraded OVERSEER® will occur before the end of March 2009. The Project Team has been discussing how to achieve uptake of the tool by growers and recognition by regional councils.

The preferred option of an industry endorsed training program is for specialist staff from Massey and Lincoln to design a course and develop resources appropriate for the target audience. A two day course has been proposed. Day 1 will cover the theory of nutrients and nutrient cycles, nutrient demands of target crops and an overview of the OVERSEER® nutrient budget model. Day 2 will involve participants doing case studies for their crops of interest, followed by an assessment. Initial delivery will be done later in 2009 by staff from Massey and Lincoln in the following regions identified by the Project Team: Pukekohe/Hamilton, Hawke's Bay, Tauranga, Ohakune, Horowhenua, Nelson/Blenheim, Christchurch and Cromwell. It is proposed that invitations will be extended to key growers and consultants in the regions and the courses will also be widely advertised in the Grower magazine. Delivery of the training program is subject to the required funding being obtained and an application has been submitted to MAF SFF for assistance.

Horticulture New Zealand has been advocating that best management practices should be encouraged by permitted activity status for land use activities controlled by government regulation. The horticulture industry has an existing quality assurance program, New Zealand Good Agriculture Practice (NZGAP), that can be used as the audited self management vehicle for the tools developed under NMEA.