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OVERSEER SCENARIOS — CONSIDERING THE WHOLE SYSTEM

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Introduction

Currently, the OVERSEER[®] nutrient budget model (Overseer) is largely being used as a reporting tool. Thus, it is recording information about the current state of the farm and reporting indices such as maintenance fertiliser nutrient recommendations, amounts of N leached or P loss, and greenhouse gas emissions. These indices are increasingly contributing to nutrient management plans and are being used to support the implementation of regional council policy.

Once the indices for the current farm are known, frequently the next question is 'How do change these?'. This is becoming more important for the indices that are indicative of an environmental impact such as N leached or P lost, and as regional council policy requires mitigation of the adverse effects of agricultural land use on environmental quality.

Mitigation options

The Overseer model offers the ability to undertake scenario (what-if) analysis. Such analyses are usually done to mitigate the environmental impact of nutrient use.

To be able to change outputs, mitigation options are required. The Overseer pastoral model already contains a number of mitigation options (Table 1), and these are being extended in future releases of the model as more science becomes available.

Table 1. Mitigation options currently within the Overseer pastoral model

Nitrogen	Phosphorus
Nitrification inhibitors (DCD [®])	Reducing Olsen P
Restricted autumn/winter grazing	Reduced P fertiliser
- winter pads and animal shelters	Use of rock phosphate fertiliser
- standoff pads	Riparian strips
- grazing off	Improved effluent management
Low N feeds	
Reduced N fertiliser	
Constructed wetlands	
Improved effluent management	
	Greenhouse gas emissions
	Reducing N fertiliser
	Use of DCD
	Changing fuel and energy use
	Changing per animal efficiency

DCD = Dicyandiamide

It is not the intent of this paper to cover the individual mitigation options: rather it is to outline some principles to apply when using the Overseer model for scenario analysis, and in particular, why it is important to consider whole system consequences of changes when undergoing these scenario analyses.

Scenario analysis

When undertaking Scenario analysis, mitigation options can be split into 3 broad categories, namely:

Best management practices (BMPs)

those that have no effect on production

those that affect production

A fundamental assumption with the Overseer model is that farm management practices follow best practice. For example, fertiliser applications follow the Code Practice for Nutrient management, and effluent applications follow the DEC manual - Dairy farm effluent. Many of the BMPs are not included within the Overseer model as they involve subjective assessments, or are under short time frame management control. These aspects are better covered by methods such as nutrient management plans, farm walks and staff training.

Generally, making sure that BMPs are followed should be the first priority in any mitigation programme, as these are frequently the most cost-effective and they can have a large environment impact if not followed. Because of the underlying assumptions within Overseer, if BMPs are not followed then the environmental effects will be underestimated by Overseer and will not reflect the true farm situation.

The next two categories are those that can be investigated using the Overseer model. As a rule when implementing a mitigation option, it is important to consider the impact of any selected mitigation option on any other model inputs, and to consider the impact on whole farm management.

Because of the structure of the model, any impact on productivity (stock numbers, milk, wool, velvet, and meat production) should be considered carefully. Fig. 1 gives a schematic representation of the core framework of the nutrient models. Animal metabolisable energy (ME) intake is estimated using a metabolic model, the ME contribution from fodder crops and supplements is removed as this is known, and then pasture intake is estimated by dividing the difference by pasture ME content. Animal nutrient intake is estimated as the sum of intake from fodder crops and supplements, plus pasture DM intake multiplied by nutrient concentration in the pasture. The amount of nutrient that is excreted is animal nutrient intake less product nutrients. The distribution of excreta is then an input into the effluent management and transfer calculations.

For N, excreta can be split between dung and urine based on the N concentration in the diet. Urine N is the major source of leached N in pastoral systems. This framework also allows the impact of mitigation options such as changes in fertiliser amount or type or stock management, or the use of low N Supplement feeds, restricted grazing and DCD use on N and P losses, greenhouse gas emissions, effluent discharges, and maintenance fertiliser to be assessed. The disadvantage is the need to estimate the change in productivity when a mitigation option is selected.

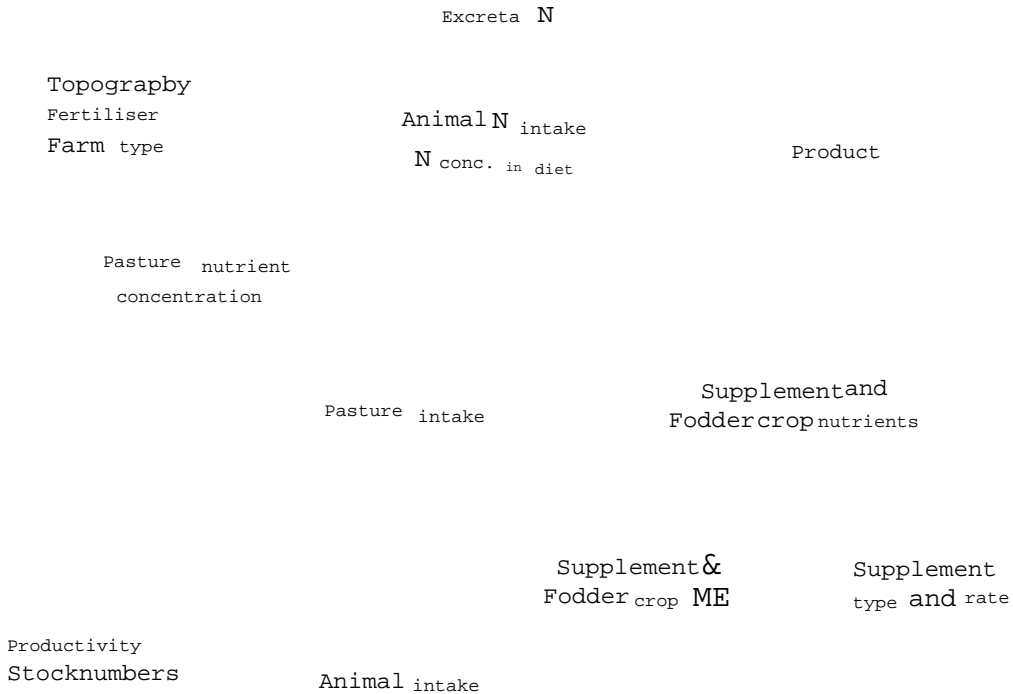


Fig 1. Schematic diagram of the estimation of animal excreta nutrients within the Overseer model

The Overseer model comprises 2 phases, the input/reporting phase and the scenario phase. Once a valid farm has been entered, a scenario can be created. Currently the model allows for three types of scenarios, namely a user-defined scenario, which is a copy of the existing farm that users can modify as desired, a scenario that is imported via a file, and a scenario using pre-set mitigation options.

Pre-set mitigation options are a range of options based on those listed in Table 1 and already take account of any productivity changes that may be associated with those options. A screenshot of the pre-set scenario selection option is shown in Fig. 2. Multiple scenarios can be selected. A user-defined scenario requires the user to assess the impact of the mitigation option on productivity.

The advantage of the pre-set mitigation options is that they allow mitigation options to be quickly created and analysed. However, my experience with working groups is that the user needs to consider the whole management system the axiom that a farmer never makes a decision in isolation is a good one.

Whole system analysis

Whole system analysis implies that the consequences of any mitigation option on the whole farm system needs to be considered when undertaking scenario analyses. The implication on productivity has been discussed above, but frequently other changes should also be considered.

For example, use of nitrogen fertiliser, the import of supplements to the farm, or the creation of feed pads, winter pads or animal shelters frequently requires the area that effluent is spread over to increase. The spreading of effluent over a wider area can also affect of the amount and type of fertiliser recommended for different blocks.



Fig. 2. Screen shot of the pre-set mitigation scenario options within Overseer model

Another example may be a dairy farmer who is looking to add an animal shelter to reduce the amount of N leaching. In the simplest analysis, an animal shelter can be added to the model and the impacted assess (Table 2). Note that the application rate of effluent is increasing, which indicates the probable need to modify the effluent management system: for example by increasing the effluent application area, and, given the amount of additional effluent applied in winter, the requirement for storage facilities.

However, the fact that an animal shelter is added may result in changes in management regime, or changes in pasture growth or harvesting efficiency. Much advertising material purports that increased animal production is a possible benefit of some mitigation options. If the addition of an animal shelter resulted in a 10% increase in animal production, then the effectiveness of that animal shelter in reducing N leaching is reduced slightly, but there is also an increase in greenhouse gas emissions. Note that the effluent application rate increased again due to the higher animal intake of nutrients.

The presence of an animal shelter, particularly that with a feeding systems that can be used in summer, may encourage the farmer to bring in supplements. This will result in increased production and hence the potential for N leaching, but the feed quality and N content will affect the size of the change.

Table 2: Example of the effect of incrementally adding an animal shelter, a 10% increase in production, and importing maize or grass silage on N leached, the rate of effluent applied to the effluent block, and methane and nitrous oxide (N₂O) emissions.

	N leached	Effluent N rate	Methane	NO _x
	kg N/ha/yr	kg N/ha/yr	CO ₂ equivalents/ha/yr	
Standard	64	154	6623	4348
+ animal shelter	48	266	6730	4348
+ 10% increase production	50	279	7040	4477
+ maize silage	50	402	7824	4402
or + grass silage	52	425	7868	4546

assumes the size of the effluent block remains constant, which is not good practice.

It is probably that all the above will occur (see Fig. 3.). Thus, the whole system analysis of the decision to use an animal shelter may result in a smaller decrease in N leached than if an animal shelter was modelled alone (Table 2). In addition, there was an increase in animal production, the requirement for capital expenditure on the effluent systems, a reduction in fertiliser nutrient requirements, and a change in cash flow patterns to allow for the purchase of supplements.

Add animal shelter

Bring in supplements

Change management regime

Change excreta ratio

Increased production

Change pasture growth or harvesting efficiency

Change in production

Change in N leaching

Fig 3. Schematic diagram of the type of changes that could occur when the mitigation option of adding an animal shelter is considered.

AS Farm management systems are complex. it means that the final management system adopted when a mitigation option is employed will depend on the farmer's skill, and social, economic and environment perspectives. Thus, it is likely that the outcome of implementing seemingly similar mitigation options could vary widely between farms.

It is recommended that an iterative procedure be followed when investigating mitigation options (Fig. 4). Thus, farm inputs are gathered to create a current farm nutrient budget, and then an iterative procedure is undertaken so that scenarios are created, evaluated, modified and then the impact on the nutrient budget reassessed. Mitigation options that require changes in animal management systems also need to be analysed carefully. Within the Overseer model, it is easy to modify animal numbers and the ratios between animal types, but consideration should also be given to the economic viability of these changes, and whether the changes are achievable given the management skills and/or desires of the farmer, etc. Analyses using additional models may be required if changes to stock policy are being considered.

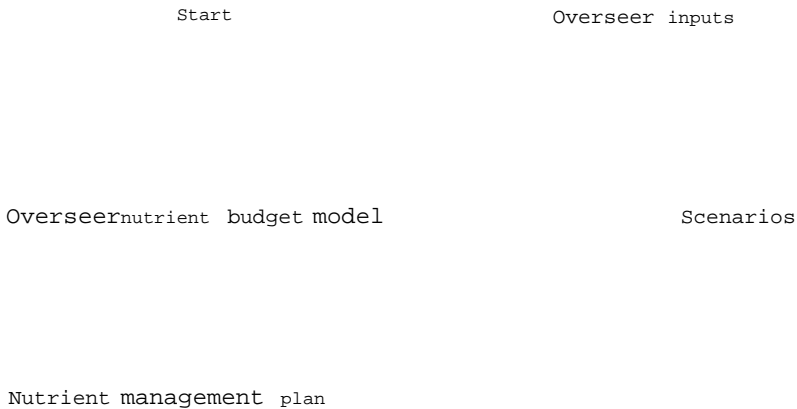


Fig 4. Schematic diagram of the iterative process when developing a nutrient management plan'

Conclusions

Overseer offers facilities to be able to undertake scenario analysis. The structure of the model is such that in many cases, this can be done quickly if any changes in productivity are taken into account. The Overseer model has tools to facilitate scenario analysis, and further development of these tools is seen as an important part of future development trends.

This paper also outlined the need to consider the impact of a mitigation option on the whole farm system and not in isolation. These can frequently be complex analyses that require a good understanding of farm systems. The example farm shown indicates that the impact of other farm decisions can reduce the effectiveness of the selected mitigation option, or result in an increased loss to air or water from another potential pollutant.