Discussion on the treatment of vegetable production in the EW Healthy Rivers planning process.

Written by: Stuart Ford of the AgriBusiness Group
April 2015.

This discussion document is written in response to the existing Rule 7 in the CSG Overview of the stakeholder group's recommendations. In this rule it requires the vegetable sector to provide the WRC with benchmarked nitrogen outputs using Overseer. There is a suggestion it should also require all producers to achieve the 75 percentile Rule within 10 years.

1.1 The applicability of the use of Overseer to determine the N leaching figures in the Vegetable sector.

It is HortNZ's policy to work with Overseer to try and improve the accuracy of the N leaching figures produced by the tool. However when Councils seek to use Overseer as a tool to aid their legislative intentions in the vegetable sector HortNZ has some serious doubts about Overseers ability to accurately predict the performance of the sector.

In the report written by The AgriBusiness Group "Nutrient Performance and Financial Analysis of Lower Waikato Horticulture Growers" the authors identified a number of challenges related to modelling vegetable crops in Overseer which had a potential negative effect on our ability to accurately model the N leaching performance of the vegetable growing sector. In that report it commented on a review of the use of Overseer in the Arable and Horticultural sector as follows:

The Foundation for Arable Research[1] carried out an independent review of the use of OVERSEER in the arable sector, which incorporated consideration of the horticultural sector. It came up with the following conclusion:

OVERSEER® is the best tool currently available for estimating N leaching losses from the root zone across the diversity and complexity of farming systems in New Zealand. This review sets out a pathway for improving its fitness for this purpose in the arable sector (see recommendations). It also highlights that the new challenges facing OVERSEER® place demands on the development team and model owners that need to be acknowledged and resourced appropriately.

The review came up with the following recommendations which are relevant to the horticultural sector:

OVERSEER® crop model estimates of N leaching should be evaluated against measurements of N leaching to identify whether there are any systematic errors in predictions.

We note that this has been the subject of new projects facilitated and led by Horticulture New Zealand and the Foundation of Arable Research through the "Rootzone Reality" Programme establishing a national network of lysimeters. Of direct relevance is the extension of this project

[1] FAR (2013) : A peer review of OVERSEER in relation to modelling nutrient flows in arable crops.

in partnership with Auckland Council and Waikato Regional Council. The extension has led to a series of additional trial sites where groups of fluxmeters have been installed under cropping land in Pukekohe, Pukekawa and Matamata to directly measure nitrogen discharges below the rootzone. The work was commenced in 2014 with installation of sites. It will take at least 3-4 years to establish measurements that are useful. It will take additional time for the OVERSEER® owners to incorporate the new information into modelling predictions.

OVERSEER® crop model estimates of N leaching should be evaluated against predictions of longterm leaching produced by established, detailed research models e.g. APSIM.

Horticulture New Zealand, Foundation for Arable Research and the Fertliser Association of New Zealand has a contract with Plant and Food Research to test Overseer results in comparison with APSIM. The project has been implemented (start in early 2015) and is projected to deliver in October 2016. It will take additional time for the OVERSEER® owners to incorporate the new information into modelling predictions.

The testing outlined in recommendations (1) and (2) is likely to identify and justify areas for further development of OVERSEER® to improve N leaching predictions.

As far as we are aware none of the three recommendations made in that report have been completed. This is at least partially due to the development of Overseer being limited by the expenditure of capital and partially due to the low priority put on the development of vegetable production capability by Overseer.

So we still do not know whether there is any justification for the crop model estimates being used by Overseer and we have not had them verified by comparison to other means of modelling (APSIM).

Apart from the basic uncertainty around the accuracy of the crop model estimates used in Overseer there are also concerns about:

- The gross nature of the inputs used in entering data into Overseer (monthly data is the finest input timeframe) which are unable to accurately reflect the complexities of relatively fine scale vegetable production systems and

- The fact that Overseer is not currently capable of modelling all possible crop types. In a recent paper written for ECan (Hume)[2], Plant and Food identified that approximately half of the crops sown were not named as options in Overseer in an exercise in crop modelling in Canterbury. We would assume that this figure would be even more extreme in the high producing Waikato vegetable growing sector.

- The fact the Overseer is a long term averaging tool which has a fixed, and somewhat limited, array of long term climatic data which it uses to spread the climatic data entered over, which represents an average of thirty years data.

In the Hume paper it identified that:

[2] Hume et al 2015. MGM Technical Report Arable and Horticultural crop modelling**.** Report written by Plant and Food for ECan.

The following (1–21) are some examples of complexities that were encountered during the modelling in OVERSEER® and assumptions that were made. For each circumstance, the limitation is documented and the approach taken to address the limitation is detailed. This information was shared with OVERSEER® management to support future model improvements.

1. Substitute crops

Limitation: OVERSEER® is not currently capable of modelling all possible crop types grown in NZ. The crop types it does not specifically model are generally specialist vegetables or high value non-herbage seed crops. There is limited research knowledge around the growth and N status of these crops and the area grown in NZ cropping systems is comparatively small.

2. Double-sown crops

Limitation: Double-sowing of crops is a management practice that happens on-farm but cannot be modelled in OVERSEER®; more than one crop management option per month is not allowed therefore multiple crops cannot be grown concurrently.

3. Altering crop growth

Limitation: OVERSEER® assumes a default growth curve and harvest date for each crop which did not always match how growers managed their rotations. For example, this could be due to timing differences between varieties, or practices such as spraying off the tops of root vegetables and then storing in the ground for the following months.

4. Yield units

Limitation: OVERSEER® requires crop yields to be specified in tonnes per ha. However, some crops such as vegetables are counted by other units (e.g. number of heads, cobs, bunches in a crate) and thus growers could not always provide a yield in the appropriate units.

5. Crop failures

Limitation: In reality crops may fail in the field, resulting in poor yields or even a non harvestable crop. This is a particular problem for small scale horticultural crops. OVERSEER® does not model crop failure rates for crop blocks.

6. Monthly inputs

Limitation: Decisions had to be made on how to translate fine-scale (e.g. daily) crop management records into the monthly application scale that OVERSEER® works at. For example, in reality a grower may harvest a crop on 10 March and sow another on 24 March but multiple management actions (e.g. harvesting a crop and sowing another) within a month cannot be modelled in OVERSEER®.

7. Grazing

Limitation: For farms that graze stock for part or all of the year (e.g. mixed cropping/pastoral farms), unless the whole farm is modelled (not just crop blocks) stock enterprises cannot be modelled due to feed requirements of stock not being met in OVERSEER®. Many of the growers used imported animals to clean up blocks, but some also specialised in the buying and selling of animals, for example store lambs over winter.

8. Part paddock grazing

Limitation: OVERSEER® assumes even distribution of animals over a block that is being grazed. However in reality forages and fodders are likely to be break-fed.

*9. **Residue management options***
Limitation: OVERSEER® cannot model multiple residue management options for a single crop. There is also an assumption in the model that all forages, fodder, green manure and permanent pasture crop types have residues retained.

10. Grazing residues in months post-harvest
Limitation: OVERSEER® does not model grazing of crop residues in months following the final harvest month of a crop (e.g. cleaning up grain stubble and weeds). No animals can be on the block in months where there is no actual crop.

11. Sequential planting and harvesting
Limitation: A specific limitation for horticultural growers using OVERSEER® is the inability to model sequentially planted and harvested crops. This is because management inputs and reporting in the model occur at a whole block level. Crops in the survey that had staggered sowing dates (to varying extents) included broccoli, brussel sprouts, cabbage, carrots, cauliflower, leeks, onions, pak choi/shanghai, silverbeet, spinach, spring onions and sweetcorn.

12. Multiple vegetable harvests
Limitation: There are no harvest options in OVERSEER® for multiple harvests of vegetables crops, e.g. silverbeet in the survey was picked multiple times.

13. Irrigation
Limitation: Information collected from surveyed growers on irrigation included some or all of the following: irrigator type, return period, maximum application depth, number of applications and total seasonal application amount. These factors depend on seasonal conditions, water availability and farm-wide soil moisture priorities. Due to the long-term annual average climate data used in OVERSEER®, applying actual irrigation amounts was not seen as appropriate for the purposes of capturing typical rotation management and nutrient losses in Canterbury.

14. Nutrients
Limitation: Growers tend to use soil nutrient testing in autumn to determine fertiliser applications required for optimal plant growth in the coming season. However, rather than entering a soil mineral N test value in OVERSEER®, N available for plant growth from the various soil N pools is calculated based on management descriptions of the land use prior to the reporting year and long-term annual average conditions. Therefore, actual fertiliser applications may not align with what is required for the OVERSEER® modelled crops.

15. Variable rate management
Limitation: OVERSEER® cannot model variable rate fertiliser or irrigation applications as management occurs at a block scale.

16. Cultivation

Limitation: The options for cultivation in OVERSEER® (direct drilled, minimum till and conventional) are coarse in comparison with actual practices in cropping systems. The restriction of one management event modelled each month also limits the ability to accurately capture effects of cultivation on residue breakdown and nitrogen mineralisation.

17. Prior land use

Limitation: Land use prior to the two year rotation in the block is a modelled input in OVERSEER®, however the options are limited to pasture, fallow, grain crop, vegetable crop, first year of seed crop and second year of seed crop. OVERSEER® makes assumptions on most of the management of these prior crops. For example, the month of crop end is assumed by the model with grain and vegetable crops tending to 'end' earlier than required.

18. Long-term paddock history

Limitation: OVERSEER® requires the total number of years in pasture three to 12 years prior to the reporting year in the block to be recorded. This value affects the N mineralisation rate in the block, but was not always known or recorded in the farm surveys.

19. Variable and small crop areas

Limitation: A complexity particularly characteristic of horticultural growers is the fluidity of 'paddock' boundaries. Often small areas of crops are grown (e.g. 0.2 ha) or varying sized areas are used throughout the year for different purposes as space becomes available. Figure 3 shows a simple example of the dynamics of changing crop areas across consecutive seasons. OVERSEER® is currently designed to model larger areas and even combine paddocks into single blocks in the model based on similarities in soil, crop rotation and management of that rotation.

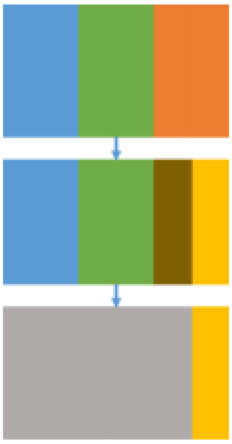

Figure 3: Simplified representation of how crop areas grown (therefore 'paddock' boundaries) may change across three consecutive seasons of the year. Each colour represents a different crop grown.

20. Leased blocks

Limitation: It is common for horticultural growers in particular to move disease-prone crops such as potatoes and broccoli around leased pastoral blocks. Complete paddock history is not always available, creating challenges for representing these situations in OVERSEER®.

21. Soil and climate information

Limitation: Growers provided basic soil information for the surveyed farms, but multiple soil types could occur across the blocks. OVERSEER® models long-term (30 year) annual average climate patterns which is information that a grower is unlikely to be able to provide.

While the principles for resolving the limitations of OVERSEER® modelling of crop blocks apply to both the horticultural and arable industries, the majority of them were issues more specific to the horticultural survey farms. Growers, particularly those in horticulture, have very dynamic, responsive management and rotation structures depending upon multiple factors (e.g. market and industry demand and prices, environmental conditions, crop establishment and health throughout growing season, disease and weeds, seasonal yields, and stock availability). The assumptions above allowed the consistent summarisation of 'typical' current practices in Canterbury within the constraints of the OVERSEER® model. Councils using OVERSEER® for regulatory purposes should consider the listed issues and, along with industry bodies (e.g. HortNZ and FAR), inform growers with guidelines and expectations for the modelling of their farms to ensure consistency of outputs across the industry.

The report when on to detail each of the work arounds which they developed to try and accurately come up with an N leaching figure which was best able to report the estimates made by Overseer.

As a response to all the challenges identified in the use of Overseer in the vegetable sector and because of our knowledge of the lack of accuracy in its use in determining an N leaching figure for the vegetable sector we believe that it would be worthwhile **investigating the use of an alternative tool (APSIM)** to provide the N leaching figure which is required by this legislative framework.

APSIM is a modular modelling framework developed by Queensland DPI, CSIRO and University of Queensland involving interacting sets of biophysical, management and data entry modules. The modular framework affords potential for new modules to be added to the model from various research initiatives or for parameters of varying soil or management activities to be shared. APSIM potentially offers several advantages over OVERSEER, including:

- Ability to integrate daily climate inputs;
- Ability to integrate dynamic management inputs;
- Finer temporal resolution in modelling processes and calculating outputs.

APSIM is increasingly being used in New Zealand to help understand and quantify farming practices and the efficacy of the program has been evaluated against the industry and government standard OVERSEER modelling platform. APSIM has been shown to provide comparable long-term results whilst also providing additional temporal information and agricultural process capability (Snow, et al., 2009; Cichota and Snow, 2010; Cichota, et al., 2012; Cichota, et al., 2013; Vibart, et al., 2015). In particular, the greater flexibility in development of management practices and the ability to incorporate time- sensitive and transient farming scenarios (such as variable fertiliser applications; changing practice with time and climatic variability) allow realistic farming scenarios to be developed and provides a solid platform for future impact predictions on a daily time-step.

APSIM has the following advantages;

- Data can be entered in daily time steps.

- The results of known research trials can be entered into its source code.
- Actual annual weather conditions can be entered into it.
- The algorithms used can be adjusted to reflect what is known about the growth habit of the crop.

The major disadvantage is that it requires a degree of specialist knowledge in terms of its set up and operation.

HortNZ are partners in an evaluation trial with FAR into the appropriateness of its use in New Zealand. This trial is being carried out by Crop and Food.

Therefore we would suggest that during the benchmarking period that an allowance be made for the Vegetable sector to carry out a trial on the applicability of the use of APSIM to best describe the N leaching performance of that sector.

1.2 The requirement for all growers to achieve the 75 percentile figure.

As it stands at present the proposed planning framework requires that the vegetable growers are required to achieve a cut back in the amount of N leached which is equivalent to all growers getting below the 75 percentile figure for vegetable growers, whatever that may be.

In work carried out for HortNZ [3] in 2014 The AgriBusiness Group the vegetable sector was split up into three representative rotations.

- Rotation one was designed to represent the more extensive rotation of major large scale crops such as potatoes, onions and carrots which make up approximately 50% of the land in horticulture production in Lower Waikato.
- Rotation 2 represents the more intensive rotation with the inclusion of more green crops such as broccoli and summer lettuce, which make up approximately 45% of the land in horticulture production.
- Rotation 3 represents a traditional market garden rotation, which are significantly more intensive and make up approximately 5% of land in horticulture production in Lower Waikato.

The results for the three rotations modelled in terms of N leaching were:

- Rotation 1 extensive production = 64 kg / ha / yr.
- Rotation 2 intensive production = 65 kg / ha / yr
- Rotation 3 market garden = 73 kg / ha / yr.

So the end result of the 75 percentile rule will be the requirement to reduce the N leaching performance on the market garden sector.

[3] The AgriBusiness Group (2014): Nutrient Performance and Financial Analysis of Lower Waikato Horticulture Growers

The results of the mitigation options that were able to be run in Overseer, which was a limited range of options, was that all options reduced the Gross Margin well below the breakeven situation. So effectively what the proposed plan as written would achieve would be the withdrawal of the market garden growers.

The area in which it is grown is unique in that it is below the line where the climate causes the disease pressure to be too high and above the line where frost exposure would limit production. This means that as written the plan would exclude the growing of all of the crops, including leafy greens that are grown there to supply the Auckland market from September through to February. This will result in the cost of these items rising considerably because they will either need to be supplied from imports or they will have to be grown in other marginal climates where the results will be variable as will the consistency of supply.

The theoretical choice of a cut off at the 75th percentile is very irrational from an economic perspective. What it achieves is a reduction in production from probably the most efficient producers in terms of economic efficiency as measured by EBIT / N leached to be replaced by very inefficient producers. This means that the gross returns from the policy framework are much lower than they would have been if an alternative reduction measure was chosen. This means that the economic performance of the total economy is sub optimal under the planning framework as presented.

It would be much more efficient to establish a planning framework which set a realistic target for reductions from the vegetable sector, having taken into account all the other factors relevant including the economic efficiency of their production, and allocated it to a Nitrogen User Group or farm enterprise groups for them to manage in the most efficient means.

Allocating a required N reduction target by the apparently random manner that is proposed at present is likely to be very inefficient and may not meet the Section 32 test of being the best means to achieve the objectives of the plan.