

Department of Agricultural Sciences

14 August 2018

Office of Hon. Damien O'Connor
Minister of Agriculture
Private Bag 18041
Parliament Buildings
Wellington 6160

Cc: Hon. Simon Upton, Mr Bill Bayfield, Prof. Juliet Gerard,

Dear Mr O'Connor

Inappropriate use of Overseer distorts outcomes for sheep and beef farms

I want to draw your attention to negative perverse policy consequences that are resulting from the inappropriate design and use of the Overseer nutrient budget model [Overseer].

Overseer has developed with a focus to reduce nitrate leaching from New Zealand's diverse agricultural systems. However it is delivering wrong, unintended outcomes in some systems. My particular concern is that best management practices developed for sheep and beef farmers in summer dry eastern regions of the country are not accurately represented in the model. The use of Overseer in regulating sheep and beef systems in summer dry environments is leading to seriously flawed environmental and farming outcomes. This results from inappropriate assumptions associated with a lack of up to date peer reviewed science within the model.

Legume-based systems in dryland sheep and beef farming environments leach little nitrogen [N], but Overseer predicts they leach a lot. As a consequence of erroneous model outputs farmers are being advised to avoid legume-based pastures. The systems they are being advised to adopt are less sustainable, and take no account of soil carbon and animal health/quality or production.

Policy based on Overseer predictions is likely to worsen, rather than improve water quality and wider environmental outcomes. Such policy intervention logic is flawed. There is an

urgent need for a review of the science on which Overseer is based and any related policy processes that have resulted from it.

Environment Canterbury [ECan] for example is using Overseer as a quantitative legislative tool to reduce nitrate-leaching risk. Other councils are following ECan's framework. This approach to policy design and implementation will lead to perverse incentives being placed in front of farmers and their advisers. We risk destroying our credibility in and around our international red meat branding efforts.

Public good research, science and technology funding over many decades will have created much of the science used to inform the Overseer model. However, it lacks the proper accountability required back to the public domain. Further I consider that MPI is a conflicted Crown Policy Agency in the overall design and implementation of Overseer. It has invested heavily in the programme without ensuring robust peer reviewed processes are undertaken to inform model development.

As Professor of Plant Science at Lincoln University, my research team has spent 20 years in the development and adoption of legume-based pasture systems. These effectively combat climate change, increase water and nitrogen use efficiency and provide environmentally sustainable farm systems for sheep and beef farmers. We have demonstrated that these award-winning, low-cost, legume-based systems are economically, environmentally and socially acceptable. They have provided resilience to drought (*El Nino*) and earthquake prone land from Central Otago to Hawke's Bay. Their profitability and sustainability allows sheep and beef farms to remain viable without the need for large areas of irrigation, nor the input of inorganic nitrogen fertiliser. These farming systems have delivered c. 50-100% gains in red meat production per hectare and added c. \$350 M per annum to New Zealand's sheep and beef export receipts.

Unfortunately the science outputs and whole-farm systems developed and promoted by my team are not captured accurately in the Overseer nutrient budget model. Overseer has predominantly been calibrated for dairy systems. It is now being used across other farm systems as a regulatory tool. This is leading to detrimental economic, social and environmental sustainability of dryland farm systems.

In the most perverse, worst-case scenarios errors from Overseer are leading to recommendations to replace legume-based pasture systems with much less efficient and less effective grass-only systems. These create a dependence on high inorganic nitrogen fertiliser inputs. This will result in a greater degradation of the wider rural landscape and the loss of sustainable farming systems.

A fundamental tenant of quality science is that it should be peer reviewed and open to critique from respected independent scientists internationally.

The failure of the developers and owners of Overseer to publish the:

- Basis of the model,

- Originating science and evidence based reliability,
- Basis of any science or version updates, and
- Validation of changes made to the model,

Prevents specific criticisms of aspects within Overseer.

For context I have outlined a number of relevant technical issues by way of appendix. There are likely to be further inaccuracies within the Overseer model that independent scientists cannot see because the science within Overseer is largely unpublished and not peer reviewed.

Overseer has a technical advisory group, on face value to be seen to be providing scientific rigour to the model. Comments from one of its members in response to my concerns are noted:

I totally support your position on this. For what it is worth I am on the Technical Advisory Group for Overseer. Over two years we have meet twice and done nothing. All I have learned is that most of the sub models in Overseer have not been peer reviewed! I have tried to get the message through that while we vacillate farmers are being advised to make big decisions re their farming operations on the basis of, in most cases, an untested model.

I fear the lack of quality science informing Overseer outputs is analogous to the recent methamphetamine house contamination 'fiasco'. We are grateful for the scientific wisdom shown by the Prime Minister's Chief Science Adviser in promoting and persevering with the merit of a credible science-informed policy development and implementation process.

An advising industry is quickly developing around the use of Overseer to inform individual farm environment plans [FEPs]. Advisers are using the model with little knowledge of its underlying science because it is not in the public domain. These users have little scientific background to discriminate between realistic and unrealistic outputs and related outcomes. Their support of the Overseer model will grow as it becomes part of their business model and the bureaucracies that grow on the back of what is actually false information. Interestingly founding investors in Overseer are now developing large advisory teams on this very basis. Those same investors also sell large volumes of inorganic nitrogen fertilizer across New Zealand. It gives the public appearance of a conflict of interest.

If the current Overseer-based advice from FEPs continues, many very competent sheep and beef farmers who have transformed to efficient legume-based production systems are likely to be erroneously forced out of business. I sense a level of anger building among this cohort of farmers. They know their systems are more environmentally sensitive and resilient to climate extremes than the systems being advocated, and perhaps ultimately dictated, by Overseer outputs. I also fear the Overseer development team lacks the

scientific capacity to understand or acknowledge its shortcomings. Emphasis is now on software interface enhancement and user issues to create a more user friendly model [recent Budget funding of c. \$8m refers] – without adequately addressing or acknowledging science flaws. The ownership of Overseer also limits the ability of public good science to challenge, improve or highlight inaccuracies in the model. Left unchecked this situation will lead to further perverse outcomes across other primary sector industries.

I submit to you that the ability of Overseer to evaluate dryland sheep and beef farm systems must be urgently independently reviewed to prevent further damage. Failure to do so will result in negative environmental outcomes being further incorporated into legislation, rather than promotion of quality science-informed best management practices.

I welcome the opportunity to discuss this with you. I invite you to visit with me the farm systems we have developed and view their production and environmental enhancements. I fear that without Central Government intervention New Zealand is in danger of creating more environmental problems than are being solved by using an inaccurate model with a distorted focus on nitrate leaching.

Kind Regards

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Encl: Appendix.

Appendix

Overseer does not accurately reflect the biology, agronomy or farming practices of dryland sheep and beef farms. Farmers have adopted our legume-based pasture systems with little or no inorganic nitrogen fertiliser inputs. These same legumes are used to produce food for increasing vegan, vegetarian and environmentally astute consumers, but are being needlessly forced out of dryland farm systems and irrigated beef finishing systems.

Recent advice given for farm environment plans [FEPs] by consultants using Overseer in Canterbury is: *“to grow grass and use inorganic nitrogen fertiliser”*. Some farmers seeking to utilise water from the new Central Canterbury Plains irrigation scheme are now encouraged to over-irrigate and remove lucerne (a deep rooted, highly water efficient legume) from their pastures and replace it with perennial ryegrass and inorganic nitrogen fertiliser. This is contrary to our world-class legume-based sheep and beef systems. Legume dominant pastures reduce total greenhouse gas emissions per unit of farm output, and produce more food from less water (without using inorganic nitrogen fertiliser). At the same time they mitigate risk and create resilience against the impacts of climate change.

International audiences invite me to explain these systems as the most sustainable way to farm livestock while, perversely, Overseer is causing their removal in New Zealand.

This situation has been created because:

a) Overseer is a production-based fertiliser model adapted to focus on reducing nitrate leaching from dairy farm systems – predominantly validated for flat land grass (dominant) - based pastures and forage crops. These come with an unavoidable dependence on the application of inorganic nitrogen fertiliser. The Overseer model may reasonably predict nitrogen leaching from these intensive systems but the assumptions it contains are inaccurate for legume-based dryland pasture systems.

b) Overseer does not accurately represent the depth of plant roots [root zone], management practises or measured nitrogen leaching from lucerne or other legume-dominant pastures such as red and subterranean clovers. Overseer assumes leaching occurs when water-soluble nitrogen is lost from below the root zone. However, the Overseer documentation suggests it sets this root zone depth at 600 mm for grass and lucerne when grazed. When soil water [the medium of transport of nitrogen] drains below 600 mm it is considered to have leached [exited] from the system. However, grass monocultures routinely extract water down to at least 800 mm on very stony soils and over 1,000 mm on deeper soils.

For tap-rooted legumes like lucerne, extraction of water occurs routinely down to 3,000 mm and, reportedly to over 5,000 mm. This makes water drainage, and therefore any nitrogen leaching, highly unlikely in many low rainfall areas. Overseer does not reflect this.

c) Overseer does not account for productive and sustainable pastures based on a live-weight gain per unit of feed consumed, water used, inorganic nitrogen fertiliser required or greenhouse gases emitted. Legume-based systems are allowing landscape and regenerative farming systems to be developed. They produce higher animal growth rates per unit of nitrate leached, and methane or CO₂ equivalent released. Overseer does not account for these outcomes and unjustifiably penalises the systems because the herbage contains more nitrogen than grass monocultures. In our estimate it wrongly assumes that legume-based pastures high in protein [proxy for N] translates directly to a high N-leaching risk.

In legumes nitrogen is freely fixed from the atmosphere and the amount fixed reduces as the soil nitrogen concentration increases. A dynamic symbiotic biological relationship is at play. Overseer has not been designed to deal with this situation, and it absolutely does not account for greenhouse gases emitted in the off shore production of energy intensive urea [inorganic nitrogen fertiliser] and other inorganic fertilisers.

d) It is impossible to sustain 7.5 billion people on the planet without using nitrogen - but the sources of that nitrogen and its efficiency of use need to be considered, along with nitrate leaching in any sustainable farm system. Overseer has a focus on nitrate leaching. However, nitrogen is the most limiting nutrient to plant growth all the time – all agricultural systems require nitrogen in large quantities. For example, a grass based pasture growing 20 t DM/ha on the Canterbury Plains requires ~700 kg N/ha. To even begin to achieve such levels we have seen imported inorganic nitrogen fertiliser levels increasing from 20,000 to 450,000 tonnes over the last 25 years. In Canterbury its use on-farm has increased linearly by 8,500 t per year between 2002 and 2016. Despite these large numbers, most pastures in New Zealand remain nitrogen-deficient – except legume-based pastures, which have been adopted successfully by many dryland sheep and beef farmers. These are achieved with no inorganic nitrogen fertiliser inputs.

e) Overseer does not account for output per unit of nitrogen leached and does not accurately represent the low leaching associated with dryland (low rainfall) pasture production in drought-prone regions of the East Coast of New Zealand. For example, the nitrogen leaching data output from Overseer is a single value, with no quoted error term or indication of uncertainty. It has no account of whether 500 kg or 1,500 kg of meat, milk or grain has been produced from the farm. The use of an absolute nitrate value calculation based on inaccurate assumptions is leading to incorrect on-farm recommendations. This is accentuated by the fact that Overseer does not run on a daily time step. As a result, it cannot accurately reflect actual nitrogen leaching in low rainfall (300 – 700 mm/ Yr.) environments where tap rooted species may dry out the soil profile to eliminate the potential for any leaching in many years.

To overcome nitrogen deficiency on sheep farms, current recommendations based on outputs from Overseer encourage widespread aerial application of inorganic nitrogen fertiliser in hill country. This directly contradicts, and is anathema to, the results of my work, which over 20 years on thousands of hectares in Central Otago, Mackenzie Basin, Canterbury, Marlborough, Wairarapa and Hawke's Bay has shown strongly and clearly that legume-based pastures are the most effective. Such systems have increased water use efficiency and meat production per hectare by recognising nitrogen as the major limitation. Inorganic nitrogen fertiliser is not required at all. This

has allowed profitable farmers to invest in regenerating native landscapes, minimise vulnerable grazing practices, retire marginal land, and increase resilience towards the impact of climate extremes.

If the current Overseer-based advice from FEPs continues, sheep and beef farmers who have previously won Ministerial Green Awards for transforming to legume-based production systems, will be forced out of business. I sense anger building amongst the sheep and beef farmers I work with. They know their legume-based systems are more environmentally responsible and resilient to climate extremes than the systems being advocated by Overseer outputs.

I have previously outlined these concerns to the owners of Overseer. I have also provided evidence that legumes, such as lucerne, actually stop fixing nitrogen in the presence of soil nitrogen. Legumes have even been used to clean-up nitrogen leaching situations overseas because of their deep taproots. I have also advocated the use of lucerne to soak up nitrogen from municipal wastewater schemes and these have been successful. However, my concerns have not led to any change in the implementation of Overseer based outputs.

I urge you to investigate this issue and to advocate for a more accurate representation of total environmental footprints than is currently assessed by Overseer. I also suggest that Regional Councils be alerted to these inaccuracies to prevent further aberrant model-driven outcomes. I believe that use of Overseer for dryland sheep and beef farm compliance should cease until these inaccuracies are addressed and the science in Overseer has been properly peer reviewed. I recently highlighted the challenges facing dryland farmers and the solutions in an invited address I gave. This is a blueprint for sustainable on-farm development that Overseer is now undermining.

<https://blogs.lincoln.ac.nz/dryland/2017/09/14/ray-brougham-trophy-public-lecture-legumes-regenerate-pastures/>

In summary, I am concerned that a singular focus on nitrate leaching, predominantly under dairy cow urine patches, especially on stony soils, is leading to perverse damaging outcomes when applied to the dryland sheep and beef sector. The consequences will have even greater adverse environmental and political outcomes as they are reinforced through FEPs. There is an urgent need for an independent review of the science, application and outcomes resulting from Overseer being used as a policy instrument for dryland sheep and beef farms.

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