IN THE MATTER	of the Resource Management Act 1991 (**RMA**)
AND	
IN THE MATTER	of Canterbury Land and Water Regional Plan: Plan Change 5
BETWEEN	**Ravensdown Limited** Submitter
AND	**COMMISSIONERS OF THE CANTERBURY REGIONAL COUNCIL** Local Authority

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PRIMARY EVIDENCE OF ALISTER METHERELL ON BEHALF OF RAVENSDOWN LIMITED

Dated: 22 July 2016

INTRODUCTION

Qualifications and experience

1. My name is Dr Alister Metherell. I am the Decision Support Manager for Ravensdown Limited (Ravensdown). I have a Bachelor of Agricultural Science degree (1st Class Honours) from Lincoln College, University of Canterbury, a Graduate Diploma in Applied Computing from Lincoln University, and a Doctor of Philosophy degree in Agronomy, from Colorado State University.

2. Prior to 2004 I worked for AgResearch as a Senior Scientist where I lead the development of dynamic nutrient cycling - econometric fertiliser advice models for P, K and S for grazed pasture (Outlook and AgResearch PKS Lime) and the integration of these models with the initial version of the Overseer nitrogen nutrient budget model to create Overseer 3.

3. Since 2004 I have worked for Ravensdown where I have been responsible for the integration of Overseer within Ravensdown's IT systems, and have provided advice to Ravensdown staff in the use and interpretation of Overseer. I have also provided considerable feedback to the Overseer development team about bugs in the software and suggested improvements to it.

4. At various times in my career I have provided formal and informal advice to the Canterbury Regional Council (Council) to assist in policy development, including in the development of the 'look-up table' report *"Estimating nitrate-nitrogen leaching rates under rural land uses in Canterbury" (Lilburne et al, 2010)*. In 2012 I was invited to be a member of the Expert Working Group for the Foundation for Arable Research Review of the Overseer® model. Since 2014 I have been an inaugural member of the Overseer Users Advisory Group. I have also represented Ravensdown at the Council's Overseer working group during 2014 – 2015.

5. During 2014 – 2015 I assisted Dairy NZ staff in providing and analysing datasets for the Matrix of Good Management project and attended some of the dairy industry project meetings. From September 2015 through to

December 2015 I represented the Fertiliser Association of NZ at a number of meetings specifically to discuss and to attempt to develop a consensus for the pastoral nitrogen fertiliser proxy. I was instrumental in showing the weaknesses of the original proposal to use APSIM modelling to determine the N fertiliser requirement for pastoral production estimated by Overseer, after which the APSIM approach was ruled out by all parties involved in the discussion.

6. Over my career I have been greatly involved in the development and implementation of decision support models for fertiliser advice and nutrient cycling. This began with the implementation and improvement of MAF's computerised fertiliser advisory service (CFAS) and the development of fertiliser advice models for arable crops in the 1980's. This was followed by a PhD on "Simulation of Soil Organic Matter Dynamics and Nutrient Cycling in Agroecosystems" which included redevelopment of the internationally used CENTURY Soil Organic Matter model. I then worked on AgResearch's Outlook, AgResearch PKS Lime and Overseer 3 models.

7. My research interests included soil science, especially soil organic matter, soil fertility, and fertilisers; trace element requirements for pastures and livestock; simulation modelling; decision support systems; precision agriculture and sustainable land management. I am either the senior author or a contributing author of 25 refereed Scientific Journal or Conference papers, a further 55 scientific or extension conference papers, 4 book chapters, 2 technical manuals and 11 research reports.

8. In my current role, I am responsible for development and management of the agronomic decision support systems used by Ravensdown field staff and environmental consultants.

Code of Conduct

9. Notwithstanding that this is a Regional Council hearing, I have read the Environment Court Code of Conduct for expert witnesses and agree to comply with it. I confirm that I have not omitted to consider materials or facts known to me that might alter or detract from the opinions I have expressed.

Background to evidence preparation

10. My evidence will cover the following matters:

(a) Correction;
(b) Generic issues with the use of the Overseer model and Good Management Practice (GMP) proxies in comparing N losses from nutrient budgets representing farm practice in a specific period with GMP N loss values;
(c) The impact of uncertainty on the modelled N requirement;
(d) Issues with the pastoral fertiliser P proxy;
(e) Issues with the crop nitrogen fertiliser proxy;
(f) Issues with the pasture nitrogen fertiliser proxy;
(g) Analysis of the Schedule 28 GMP proxies using data from real farms;
(h) The relationship between a simple N surplus calculation and N leaching predicted by Overseer 6.2.1;
(i) Conclusions.

EXECUTIVE SUMMARY

11. The following are the key conclusions of my evidence:

a) In my opinion, the derivation and use of the nitrogen fertiliser proxies described in PC5 schedule 28 for both crops and pasture are flawed and as a consequence many farms following good management practices will not be able to comply with the GMP N loss value derived.
b) The fertiliser proxy should be replaced with an alternative methodology based on a simple calculation of N surplus.
c) The target soil test levels used in the pastoral phosphorus fertiliser proxy need to be aligned with the accepted agronomic target ranges.

CORRECTION

12. In my comments included as an attachment to Ravensdown's submission, there was an error in the first sentence of the 4th key bullet point (on the first page) which read: *"… with no N fertiliser required below about 8070 kg DM / ha / year up to 450 kg N / ha / year at 18450 kg N / ha / year."*

13. This statement should read *“with no N fertiliser required below about 8070 kg DM / ha / year up to 450 kg N / ha / year at 18450 kg ~~N~~DM / ha / year.”*

GENERIC ISSUES WITH THE USE OF THE OVERSEER MODEL AND GOOD MANAGEMENT PRACTICE (GMP) PROXIES IN COMPARING N LOSSES FROM NUTRIENT BUDGETS REPRESENTING FARM PRACTICE IN A SPECIFIC PERIOD WITH GMP N LOSS VALUES

14. Overseer “actual” nutrient budgets are an amalgam of actual farm production and farm input data for a specific year or period, long term average climate records and, if relevant, predicted irrigation based on the long term climate record. Hence the design of both Overseer and therefore the Farm Portal GMP model mean that neither can accurately represent nutrient cycling on a farm in a specific year, when seasonal and economic considerations will be the important determinants of N fertiliser use on both crops and pastures.

15. There are some farm systems for which it is impossible or extremely difficult to model accurately in Overseer. These include systems which are not currently included in the Overseer model including outdoor pigs and free range poultry, and many mixed farming systems (crops, fodder crops, hay and silage and animal grazing) where Overseer currently has problems in solving for a valid feed budget. For these farms it is not possible to create a valid nutrient budget for use in the Farm Portal, and it is my opinion that there needs to be an alternative method for consenting for these farms.

16. The Overseer crop and pasture nitrogen models upon which the GMP N fertiliser proxies are based, were never intended to be or designed for use as fertiliser requirement models. (Note that the Overseer P, K and S models were originally designed as fertiliser requirement models). The Overseer nitrogen model predicts long term (multi-year), average nutrient flows within the farm system, including losses to the environment at the farm scale. In contrast nitrogen management in arable cropping uses different models to assess fertiliser requirement using within-season, real-time tailoring of fertiliser inputs according to soil fertility, crop needs, and weather. Tactical planning tools such as the ‘Wheat Calculator’ and ‘AmaizeN’ have been developed to assist with this. On pastoral farms nitrogen fertiliser is primarily used as a tactical tool to provide extra pasture feed to overcome feed

shortages at critical times of the year. Overseer is not used to make assessments for nitrogen fertiliser recommendations. Because of this distinction, it is not appropriate to reverse engineer Overseer to develop a simple GMP fertiliser recommendation.

17. The amounts and timing of N fertiliser for pasture production are determined by feed budgeting and the likely N response which depends on current environmental conditions. N fertiliser and supplementary feed are used interchangeably depending on current economic and environmental conditions. For high production, irrigated Canterbury dairy farms the favourable economics of N fertiliser responses have resulted in N fertiliser being used in multiple applications over the growing season to achieve production levels not achievable by grass-clover alone. However, the total amount used in a particular year is still highly dependent on seasonal and economic factors.

THE IMPACT OF UNCERTAINTY ON THE MODELLED N REQUIREMENT

18. There is inherent uncertainty in the estimates from any model, due to uncertainty in the input data, internal model parameters, and the relationships used in the model. An uncertainty analysis of the proposed N modelling proxies, albeit with a low level of uncertainty in the key input parameters, results in the final estimate of N fertiliser requirement having a much higher degree of uncertainty with a substantial range in the estimated N fertiliser requirement. This indicates the actual N fertiliser requirement on a specific farm in a specific year could be quite different to the value calculated in the Farm Portal. So even for a farm operating at GMP, this will then impact significantly on the difference between N loss from an actual nutrient budget and the GMP N loss value produced by the Farm Portal.

ISSUES WITH THE PASTORAL FERTILISER P PROXY

19. The pastoral phosphorus fertiliser proxy is based on target soil test levels (Table 1) which are different from the critical levels for pasture production

(Table 1 in Edmeades *et al*, 2006) (Table 2) and the accepted agronomic target ranges for sheep and beef farms presented in Morton and Roberts (2009) (Table 3). Target soil test levels are presented as ranges because of the variability in the data on which these ranges are based and because there is no precise soil nutrient level, in all situations (paddocks, farms, locations, years etc), that will guarantee a particular pasture production.

Table s28.3 Target Olsen P Values at Good Management Practice

Pastoral system	Target Olsen P Level
Dairy Pasture	30 for ash and sedimentary soils, 45 for peat and pumice
Sheep, Beef and Deer Pasture on Flat Land	20
Sheep, Beef and Deer on Cultivatable Downs	20
Sheep, Beef and Deer on High and Hill Country	15

Table 1 …Schedule 28 Olsen P values

Table 1 Estimated relative pasture production at Olsen P (0–75 mm, µg P cm^{-3} dried and sieved soil) levels of 25 and 50 and critical level required to achieve 97% maximum production, for the major soil groups in New Zealand (numbers in brackets are the confidence intervals ($P < 0.05$)).

	Relative pasture production		Critical
Soil group	Olsen P 25	Olsen P 50	level
Pumice	89 (88–91)	97 (95–98)	50 (43–61)
Volcanic	92 (88–94)	99 (98–100)	32 (27–38)
Peat[1]	95	99	40 (35–45)
Sedimentary	95 (93–97)	100	30 (26–32)
Recent soils	97 (96–98)	99 (98–100)	25 (20–30)
Podzols	96 (94–99)	100	25 (22–30)
Sands	100	100	12 (10–15)

[1]From O'Connor et al. (2001).

Table 2 - Critical levels required to achieve 97% maximum pasture production for the major soil groups in New Zealand (from Edmeades *et al*, 2006).

The Olsen P levels which will sustain near-maximum pasture production are

Soil	*Target Olsen P*
Ash	20-30
Sedimentary	20-30
Pumice	35-45
Peat	35-45

Table 3 - Target Olsen P ranges for sheep and beef production for the major soil groups in New Zealand (from Morton and Roberts (2009)

20. In my attachment to the Ravensdown submission I noted that "Overseer maintenance P used in the model has been changed by Overseer developers without notification, explanation or justification. This includes an interaction with nitrogen as noted in "Addendum to MGM Overview report: OVERSEER® version change 6.2 to 6.2.1." Since then the fertiliser industry has recently been working with the Overseer management and developers to remove the undocumented interaction of maintenance P requirement with the nitrogen model. Hence if the upper level of the accepted agronomic target range is used as an Overseer input, the Overseer maintenance P from the next version of the Overseer model will provide an acceptable pastoral phosphorus fertiliser proxy.

ISSUES WITH THE CROP NITROGEN FERTILISER PROXY

21. A large number of issues with the Crop Nitrogen fertiliser proxy were raised in my attachment to the Ravensdown submission *"ECan Plan change 5 – Schedule 28 Good Management Practice Modelling Rules - Comment on Fertiliser modelling rules. Alister Metherell, Ravensdown, 7 March 2016".* In particular, I identified that the Overseer crop nitrogen model was not designed to be and has never been used as an N fertiliser requirement model. There is a high level of uncertainty in most of the parameters estimated by Overseer and included in the N*nonfert* component of the GMP N fertiliser proxy. The GMP N fertiliser proxy also includes an unjustified arbitrary cut off with a minimum application of 46 kg N / ha. These concerns are borne out by the evaluation of the proxy using data from real farms. See "Results for the effect of GMP proxies on block level N fertiliser input for crops" below.

ISSUES WITH THE PASTORAL NITROGEN FERTILISER PROXY

22. In my attachment to the Ravensdown submission *"ECan Plan change 5 – Schedule 28 Good Management Practice Modelling Rules - Comment on Fertiliser modelling rules. Alister Metherell, Ravensdown, 7 March 2016"* I presented equations based on data in Snow et al (2016) which indicated that the pastoral N fertiliser proxy would result in no N requirement below 8073 kg DM / ha. I have since been able to use the ECan GMP tool (https://farmportal.ecan.govt.nz/GMPTool) to further investigate the pastoral N fertiliser proxy. Analysis of that data derived from Overseer files run through the GMP tool has shown results inconsistent with the data presented in Table 3 in Snow *et al* (2016), and with our interpretation of the N fertiliser proxy based on the equations and parameter values presented in Schedule 28. From the GMP tool results, it appears that no N fertiliser is required below about 10500 kg DM / ha, with a linear increase to 450 kg N / ha at about 26900 kg DM / ha (Figure 1a). The points below the line will mainly be effluent blocks where the N fertiliser proxy will reduce the fertiliser input. Other variations will be due to the small amount of N in irrigation water.

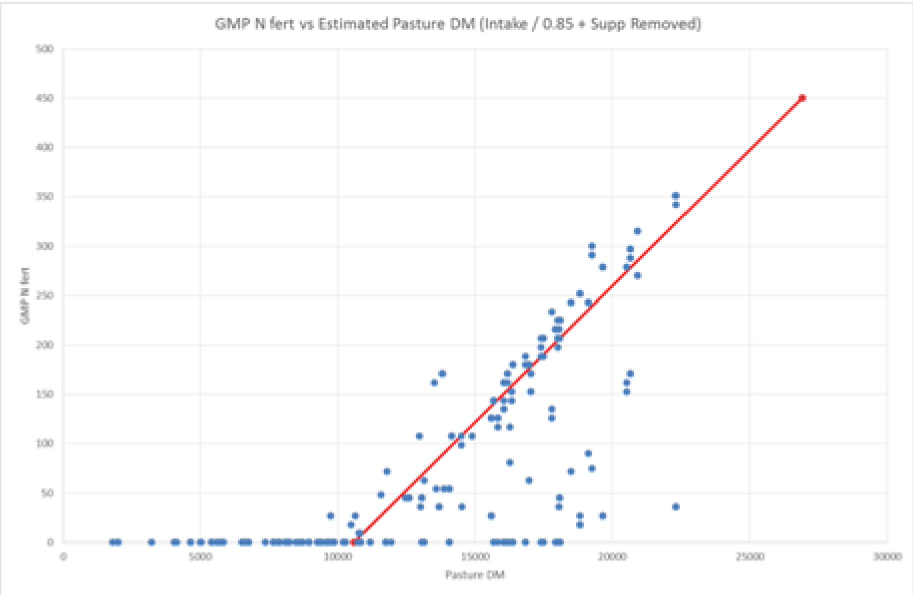

Figure 1a. The relationship between GMP N fertiliser rates and pasture production derived from GMP tool results.

23. In order to resolve the discrepancies between the GMP portal, Schedule 28 and the technical documentation in Snow et al (2016) I requested from ECan Officers the algorithm or code for the nitrogen fertiliser calculations. However,

my request was turned down, citing that all relevant information was contained as part of the supporting technical documents.

24. The proposed pastoral Nitrogen fertiliser proxy in Schedule 28 is primarily driven by the Overseer estimated pasture production. This means that the Farm Portal model will not calculate a nitrogen fertiliser requirement for pasture production less than approximately 8000 kg DM / ha (or 10500 kg DM / ha based on GMP tool results). In my opinion this is technically unfounded as there are many trials (e.g. Gillingham et al, 2008) which show a large and highly economic nitrogen response on dryland sites with annual pasture production less than 8000 kg DM / ha / year. Conversely the Farm Portal model calculates up to 450 kg N / ha required for high producing dairy farms. The Lincoln University Demonstration Dairy Farm has been able to achieve very high production with only 173 kg DM / ha and analysis of the dairy dataset (Pinxterhuis et al, 2015) shows that there are very few farms using more than 300 kg N / ha. In my view it seems more likely that the modelling in behind the Farm Portal is overestimating the requirement for nitrogen fertiliser on high producing farms, with high production being driven by the inherent properties of the farm such as the soil types, climate and irrigation system, and by farm management practices, such as good feed utilisation.

25. Research has shown that the grass component of grass – clover pastures is nitrogen deficient (see expert evidence from Dr Ledgard), so provided that pasture growth is not restricted by cold soil temperatures (<5°C), water logged soils or dry conditions the application of nitrogen fertiliser at moderate rates (less than 50 kg N / ha / application) will give a pasture response and direct leaching of nitrogen from the fertiliser application will be negligible. The greatest environmental effect resulting from fertiliser application is from the increased amount of feed grown and eaten by livestock, as this typically results in an increase in nitrogen excreted in urine. This is very similar to the effect of importing supplementary feed on the farm.

26. In fact, nitrogen fertiliser and supplementary feed are usually regarded as alternative methods of increasing animal production and are evaluated based on economic criteria. There is a small increase in the nitrogen concentration in pasture after nitrogen fertiliser application also resulting in a minor increase

in N excretion. However, increased N loss from pasture receiving nitrogen fertiliser is primarily from the increased livestock carrying capacity and increase in urine deposits. Given it is animal feed intake and stocking rate driving the N loss, in my opinion it is totally incongruous that the Schedule 28 modelling proxies place no accountability on the import of supplementary feed to a farm, but disproportionately places the onus on the nitrogen fertiliser input.

ANALYSIS OF THE SCHEDULE 28 GMP PROXIES USING DATA FROM REAL FARMS

27. To investigate the impact of the Schedule 28 GMP proxies on real farms I used “Baseline” or “Actual” nutrient budgets recently completed by the Ravensdown Environmental consultancy team from 52 Canterbury farms. These farms are not necessarily representative of all Canterbury farms. However, the nutrient budgets produced have followed a robust process and are useful for comparing real farm examples with the GMP proxy rules and GMP N loss values derived using the currently proposed Farm Portal. The nutrient budgets were completed in accordance with the Best Practice Data Input Standards and reviewed by a Certified Nutrient Management Advisor. They accurately represent farm practice on each farm for the period that they were prepared for, which ranged from 2009-2010 to 2014-2015. They met the criteria for use in the Farm Portal with S-map soil properties and Overseer climate tool values for rainfall, temperature and PET. In the dataset there were 33 dairy farms, 3 arable cropping farms, and 16 livestock farms including sheep, beef, deer and dairy support. This dataset provided 378 pasture blocks, 151 cropping blocks and 16 fodder crop blocks (Table 4). Approximately 70% of the blocks were irrigated.

Table 4. Count of Block types and Irrigation systems in the dataset

Irrigation System	Block type	

	Cropping	Fodder	Pastoral	Total
Border dyke			46	46
Linear and Centre Pivot	16	2	59	77
Spraylines		2	63	65
Travelling irrigator	97	1	87	185
Dryland	38	11	123	172
Total	151	16	378	545

28. These files were entered into the ECan GMP tool (https://farmportal.ecan.govt.nz/GMPTool) to generate Actual N loss (as estimated by an OVERSEER nutrient budget) and GMP N loss values with all GMP modelling proxies applied and with each of the GMP proxy groups (cultivation and cover crops; effluent and silage; fertiliser; irrigation; and soil compaction, stock access and runoff) applied. The Overseer files generated by the GMP tool were downloaded and uploaded into Ravensdown's Overseer database. Overseer results at farm and block level from these files were then extracted for further analysis.

Results for the effect of GMP proxies on farm level N loss

29. Figure 1 shows the impact of the proposed GMP proxies on farm level N loss. The graph compares actual N loss from the original nutrient budget (on the x-axis) with the GMP N loss from the Farm Portal (on the y-axis). The graph shows a 1:1 line and a linear trend line and regression equation for GMP N loss versus Actual N loss. Almost all data points are below the 1:1 line, meaning that for these farms GMP N loss is lower than the farm's Overseer "Actual" nutrient budget N loss. The regression equation indicates that the average GMP N loss is 55% of Overseer "Actual" nutrient budget N loss.

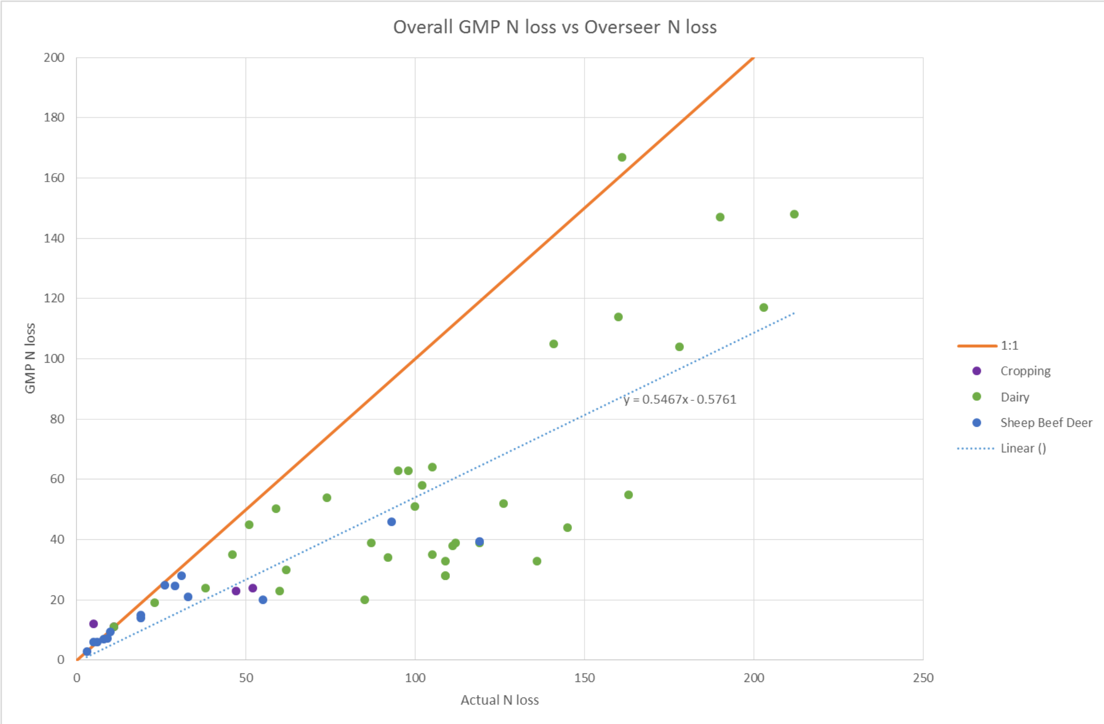

Figure 1. The effect of the combined GMP proxies on farm level N loss

30. From this sample of nutrient budgets the results indicate that the on-farm impact is large, with on average a 45% reduction in current N loss being required to reach the proposed GMP level. This impact is across all farm types. Some will have to reduce by a much larger percentage in order to comply with the proposed regulations. It is my opinion that if the proposed proxies are implemented there will be some farms that will only be able to comply with the GMP N loss rate produced by the Farm Portal if they undergo a significant farm system change or by requiring significant capital investment. This is in contrast to the assumption in the farm portal that the same level of farm production can be achieved with simple modifications to fertiliser and irrigation management suggested by the relevant proxies.

31. Figure 2 shows that the fertiliser proxies result in GMP N loss being lower than Overseer “Actual” nutrient budget N loss on almost all of the sample farms, across all farm types. The proposed GMP fertiliser proxies will require an average reduction of 19% in farm N loss, with the impact being much larger on two farms with dairy grazing using winter crops.

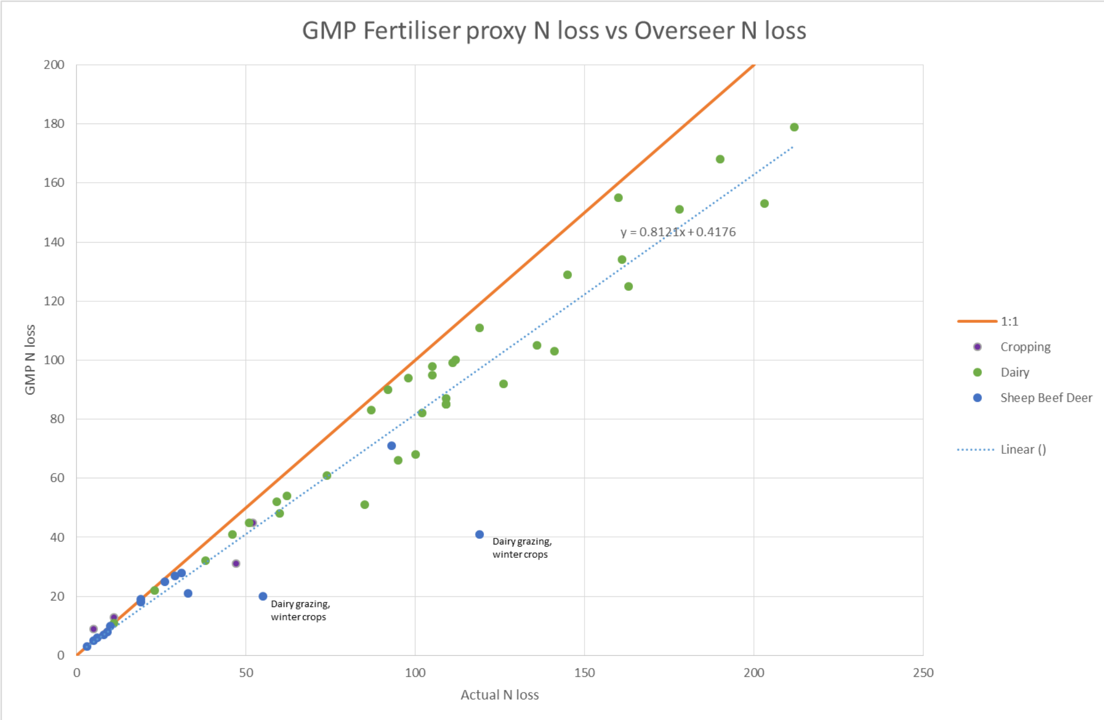

Figure 2. The effect of the fertiliser GMP proxies on farm level N loss

32. Figure 3 shows that the irrigation proxy results in GMP N loss being lower than the Overseer "Actual" nutrient budget N loss on a large proportion of the sample farms. On some farms a reduction in N loss of over 50% would be required to meet the impact of the irrigation proxy. This level of reduction signals a very significant farm system change and investment in precision irrigation equipment.

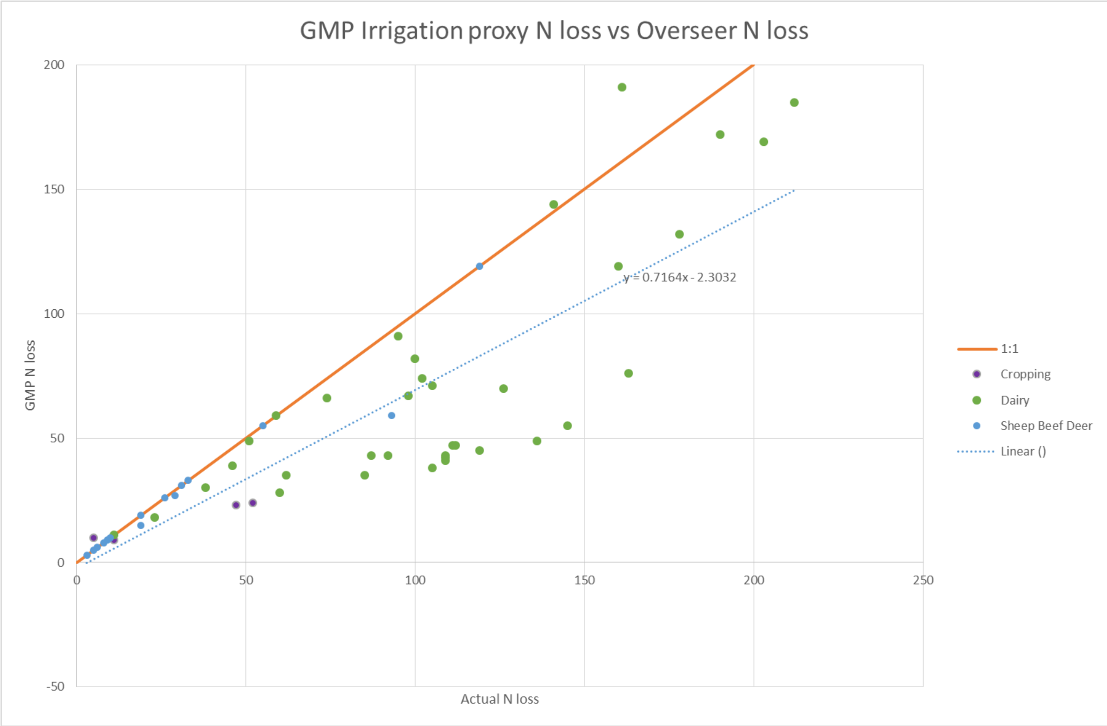

Figure 3. The effect of the irrigation GMP proxy on farm level N loss

33. Figures 4, 5 and 6 show, respectively, the effect of the effluent and silage group of GMP proxies, the soil compaction, stock access and runoff group of GMP proxies, and the cultivation and cover crop group of GMP proxies on farm level N loss. All of these show that in the sample farms these proxies have a negligible impact on GMP N loss. This also implies that there is no opportunity for the farmer to reduce the overall GMP N loss through improvement in these aspects of farm management. Hence the assumptions about fertiliser requirements and irrigation management in those two sets of proxies are extremely important as any errors or inadequacies have a significant impact on the derived estimates of GMP N loss.

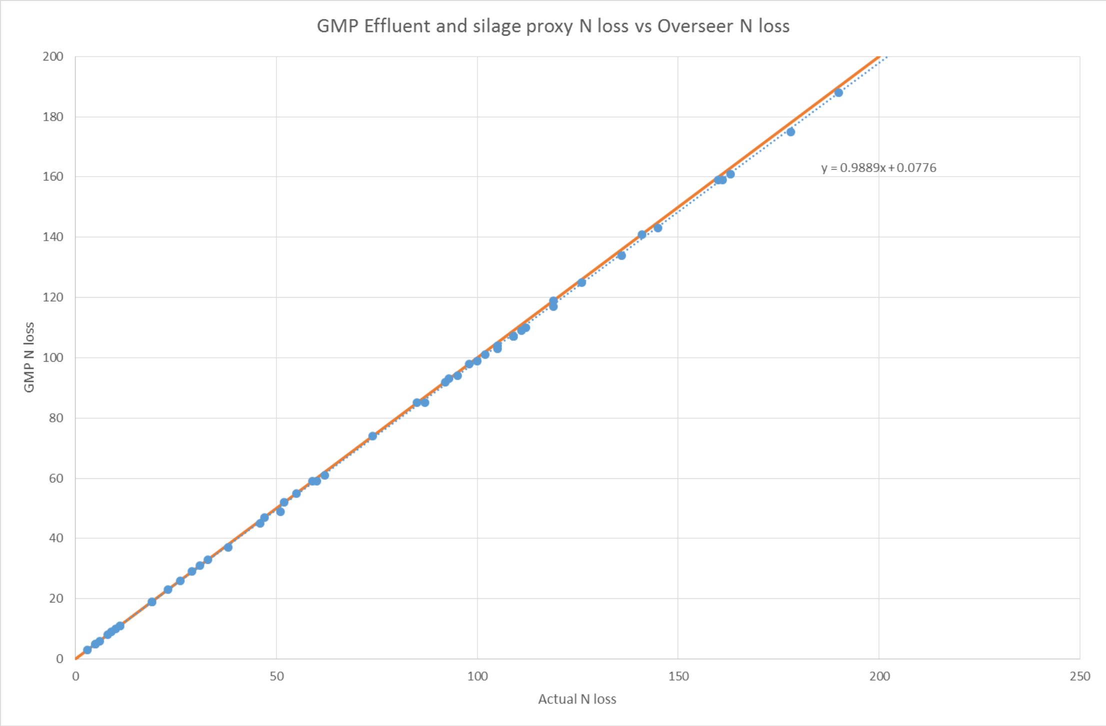

Figure 4. The effect of the effluent and silage group of GMP proxies on farm level N loss.

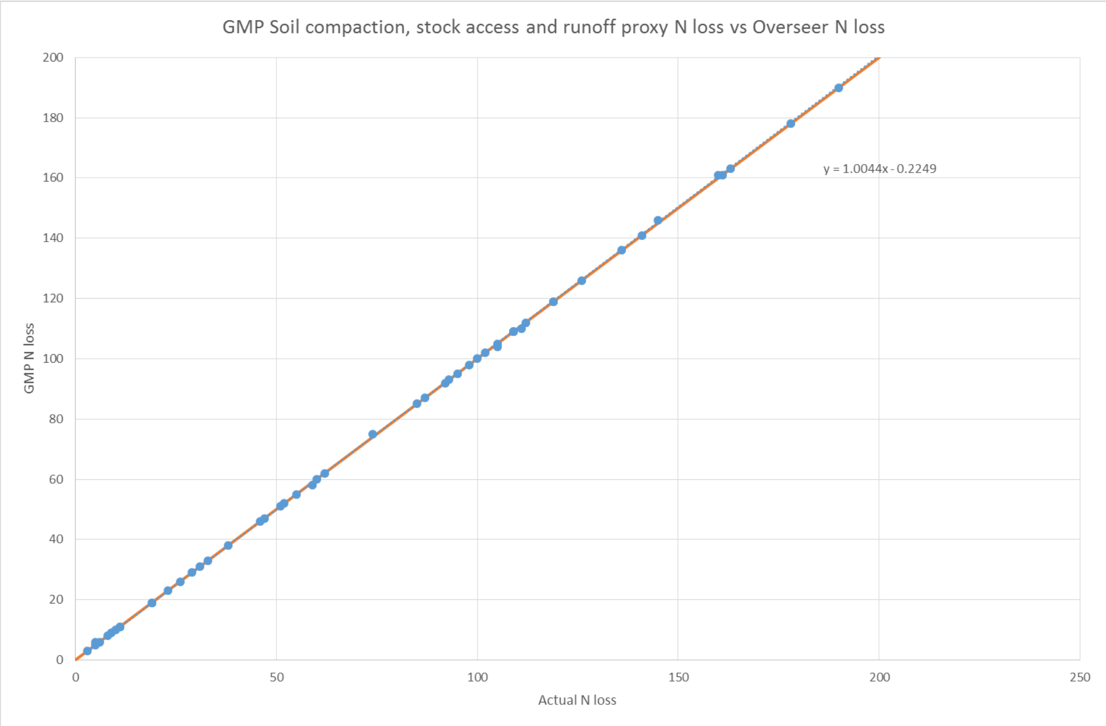

Figure 5. The effect of the soil compaction, stock access and runoff group of GMP proxies on farm level N loss.

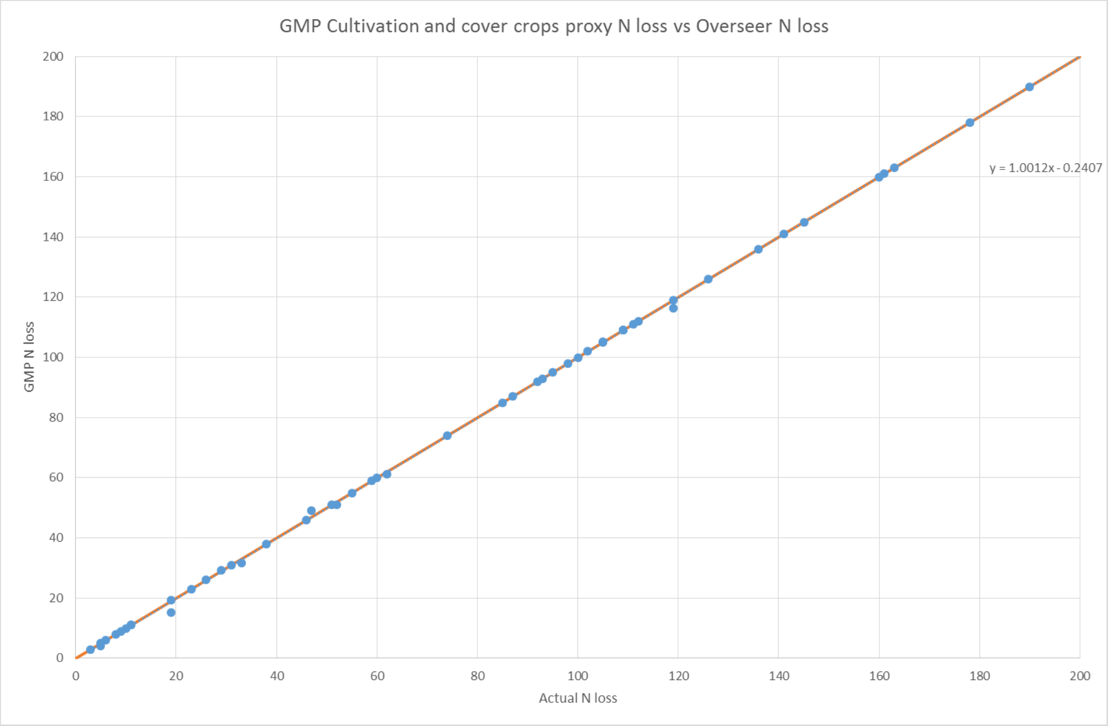

Figure 6. The effect of the cultivation and cover crop group of GMP proxies on farm level N loss.

Results for the effect of GMP proxies on farm level N fertiliser input

34. Figure 7 shows that for the sample farms there is no relationship between actual N fertiliser usage and GMP N fertiliser requirement calculated using the Schedule 28 proposed N fertiliser proxy.

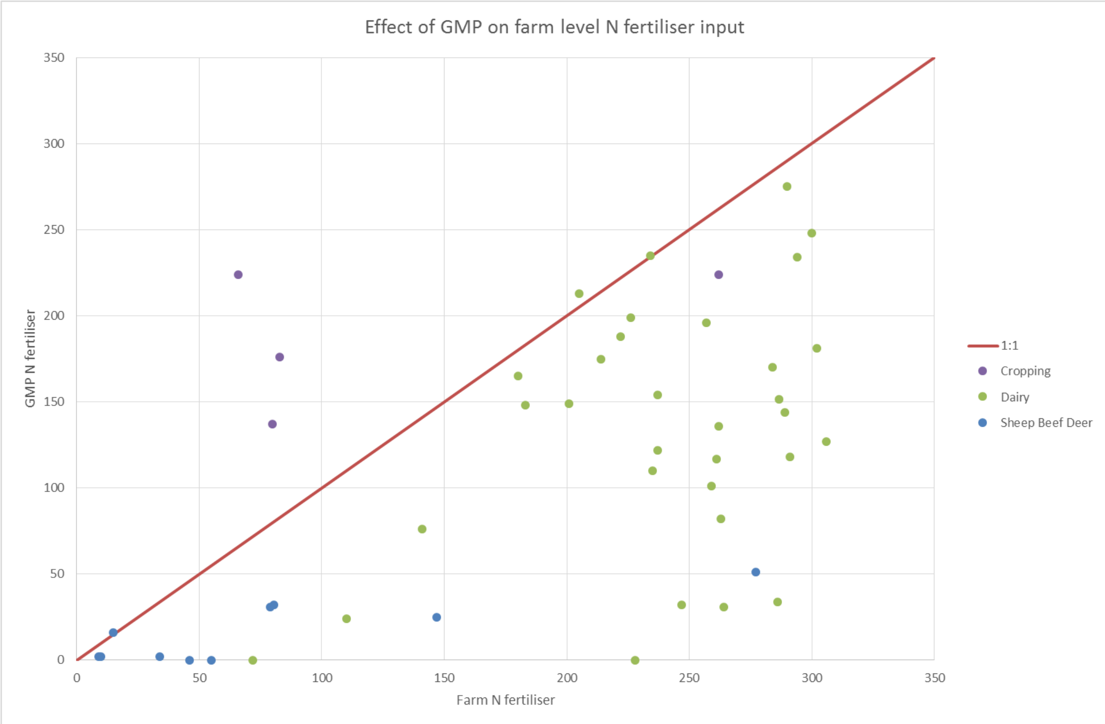

Figure 7. The effect of the GMP fertiliser proxy on farm level N fertiliser "required" compared to actual N usage for 3 farm types.

35. Most farms use considerably more N fertiliser than predicted by the proposed proxy. On dairy farms the difference was up to 252 kg N / ha and on sheep / beef / deer / dairy grazing farms the difference was up to 226 kg N / ha. On cropping farms the difference ranges from 38 kg/ha more to 158 kg / ha less than predicted by the Farm Portal at GMP. There are some farms where the proxy predicts nil or almost nil N fertiliser is required to maintain current production levels. This includes two dairy farms with relatively low levels of milk production per ha (700 to 740 kg MS/ha) and current usage of 72 and 228 kg N / ha, and a number of sheep beef and deer farms that had used up to 55 kg N / ha. A relatively low level of farm production with pasture growth less than 8000 kg DM / ha / year, as is typical for many dryland farms, does not preclude N fertiliser being used to boost production in a manner which provides good economic returns with minimal environmental impact. The GMP fertiliser proxy results in no N applied.

36. While the results for farms in this sample mostly show that the N fertiliser proxies under-predict N usage, the results for the Lincoln University Dairy farm presented in my comments attached to Ravensdown's submission show that the reverse situation may also occur with GMP N fertiliser rates derived

by the Farm Portal greatly exceeding actual usage. In my opinion these results, which show wide discrepancies between actual N usage and the GMP N fertiliser proxy predicted N requirement, cast serious doubt on the validity of the N fertiliser proxies when applied to a specific farm.

Results for the effect of GMP proxies on block level N fertiliser input for pasture

37. Figure 8 presents similar results at a block level for the pastoral blocks on all 3 farm types. On most pastoral blocks there is considerably more N fertiliser used than predicted by the N fertiliser proxy. There are a large number of blocks where the N proxy predicts that no N fertiliser is required, but N fertiliser has been used. This is particularly the case on sheep / beef / deer / dairy grazing farms where there is a cluster of (blue) points on the x – axis with N fertiliser rates up to 100 kg N / ha / yr. Conversely there were a few blocks where no N fertiliser had been used but the proxy predicted up to 216 kg N / ha required. This reinforces my view on the validity of the N fertiliser proxies.

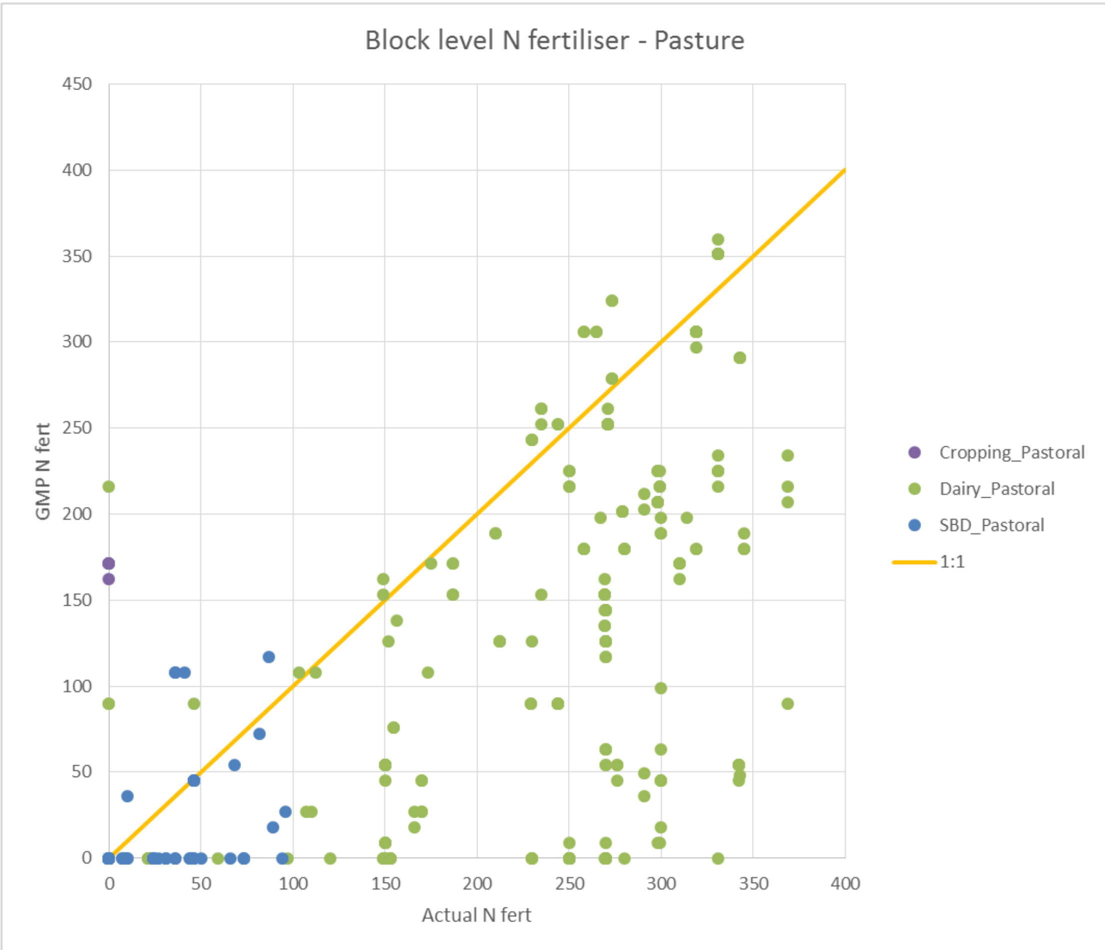

Figure 8. The effect of the combined GMP proxies on block level N fertiliser for pastoral blocks for 3 farm types compared to actual N usage.

Results for the effect of GMP proxies on block level N fertiliser input for crops

38. Figure 9 shows that the GMP proxies for cropping blocks produce N fertiliser “requirements” which bear no relationship at all with actual N usage. Some of the points on the y-axis where no N fertiliser was used, but the GMP proxy predicts requirements of up to 400 kg N / ha, are for pasture or legume phases of a cropping rotation, where N fertiliser is not usually applied as these phases aim to maximise the benefit of symbiotic nitrogen fixation. Extremely high N fertiliser rates of over 600 kg N / ha are predicted for some crops where actual N used was in the range of 100 to 180 kg N / ha. These included a ryegrass seed crop for which recommendations are for less than 200 kg / ha and a 9.5 t/ha wheat crop following a small seed crop, for which the maximum N fertiliser recommendation would be 150 kg N /ha, both of which might be reduced on the basis of soil mineral N testing.

39. In my opinion these examples, showing such large variability between the derived GMP fertiliser recommendation and current practice, reinforce that the Schedule 28 cropping N fertiliser proxy is seriously flawed. Where this variability gives rise to excessive N fertiliser estimates, farmers will have no difficulty complying with the rules. Where the variability results in very low GMP N loss values being derived by the Farm Portal, farms following GMP will not be able to comply.

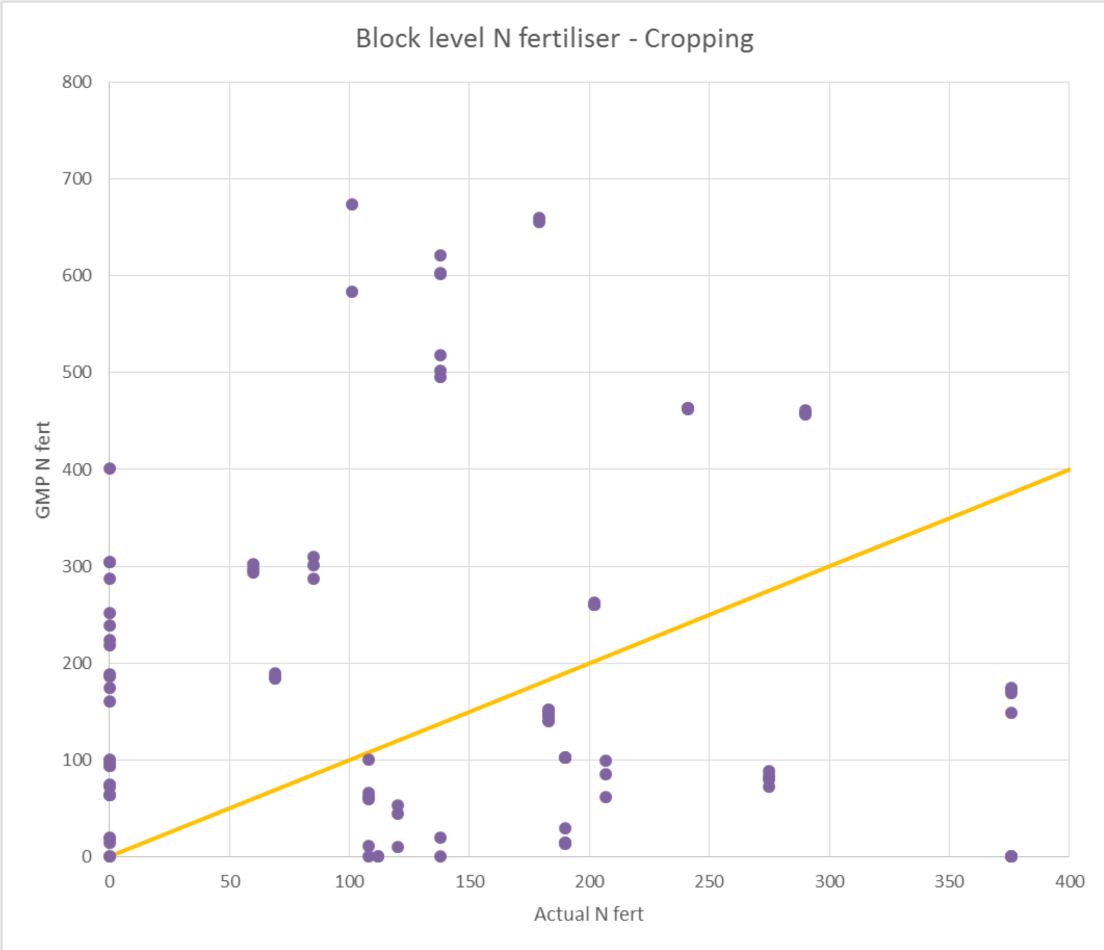

Figure 9. The effect of the combined GMP proxies on block level N fertiliser for cropping blocks on cropping farms.

40. Figure 10 also shows that there is no relationship between predicted and actual N fertiliser usage for fodder crops entered in Overseer as multi-year cropping blocks. For fodder crops entered in Overseer as fodder blocks, which by definition are a single year of crop in a long term pasture, the GMP proxy apparently does not allow for any N fertiliser input. Presumably this is because of the high level of N mineralisation expected when a pasture paddock is cultivated. In reality, because poorly performing pasture paddocks are often chosen for fodder crops as part of a pasture renewal cycle, fodder crop establishment may be by spray out followed by direct drilling with no cultivation and because it is extremely important to ensure animal feed supply with a good fodder crop, almost all farmers will apply some N fertiliser to a fodder crop. The lack of any relationship between farm practice in fertiliser use and the proxy GMP fertiliser values, in particular, the large variability in GMP fertiliser values and also the large number set at zero, signals a

significant problem with the proxy model. Where the variability results in very low GMP N loss values being derived by the Portal, farms following GMP will not be able to comply.

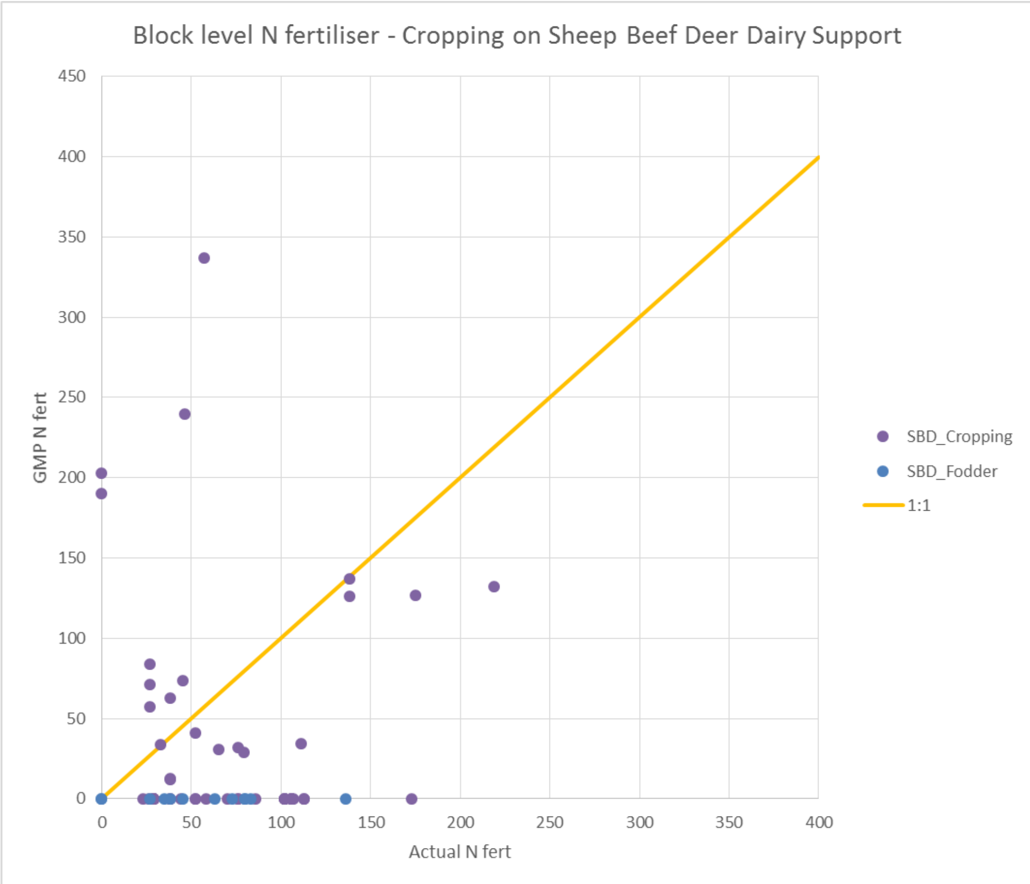

Figure 10. The effect of the combined GMP proxies on block level N fertiliser for fodder crop blocks on sheep / beef /deer and dairy support farms, which have been entered in Overseer as either cropping blocks or fodder crop blocks.

Results for the effect of GMP proxies on block level irrigation

41. Figure 11 shows that there is very little relationship between irrigation inputs modelled in Overseer using either actual farm irrigation records or Overseer predictions based on the Overseer irrigation model and the irrigation requirement predicted using the GMP irrigation proxy. It has already been demonstrated in Figure 3 that the irrigation proxy has a very significant effect on the N loss values derived by the Farm Portal. The very significant variability demonstrated here will inevitably give rise to highly variable GMP N loss values being derived by the Farm Portal. Many farms operating at GMP will not be able to comply with rules because the farm nutrient budget N

loss will be at variance with the GMP N loss value, for no reason other than the wide variability in the Farm Portal outputs.

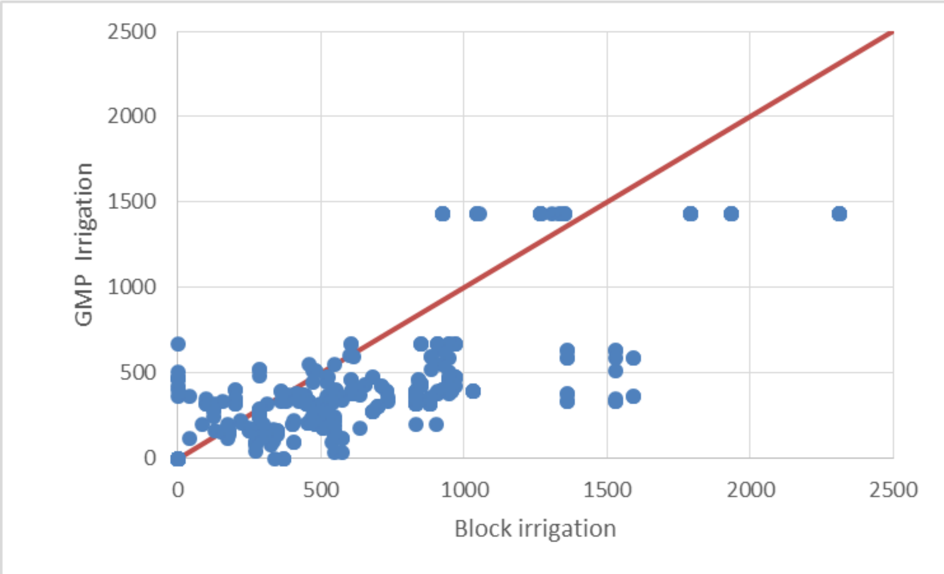

Figure 11. The effect of the combined GMP proxies on block level irrigation estimates compared to the irrigation amount either entered in to Overseer or calculated by Overseer based on actual farm practice

THE RELATIONSHIP BETWEEN A SIMPLE N SURPLUS CALCULATION AND N LEACHING PREDICTED BY OVERSEER 6.2.1

42. As an alternative to the PC5 N fertiliser proxies, the Fertiliser and Dairy industries are proposing the use of a simple farm level N surplus calculation with a sliding cap to reduce total N inputs on farms where the N inputs from fertiliser and supplementary feed are considerably greater than N outputs in the various forms of farm produce including milk, meat, wool, grain, hay and silage. A simple N surplus can be calculated by using some of the outputs of an Overseer nutrient budget, but for this proposal for use in the fertiliser proxy this will be different to the N surplus reported by Overseer which includes N fixation and N input from rain and irrigation. N fixation is not included in this proposed fertiliser proxy because there is much more uncertainty in its estimation than the other components and it is also much more subject to change between Overseer versions as happened for many nutrient budgets in the change from Overseer 6.2.1 to 6.2.2. Irrigation N is also not included because of the uncertainty in its estimation. Almost all nutrient budgets use the Overseer default N concentration in irrigation water instead of farm or

irrigation scheme measured values and the volume of irrigation water is usually an estimate based on Overseer typical climate and Overseer modelled irrigation requirement. The alternative N surplus proxy approach is discussed in more detail in the expert evidence of Dr Bruce Thorrald for DairyNZ.

43. Figure 12 shows the relationship between N surplus and Overseer 6.2.1 prediction of farm level N loss to water, for the same set of farms as used in the analyses presented above. It can be seen that farms with a relatively high N surplus are likely to have a high level of N leaching. Hence a reduction in N input on these farms is likely to have the greatest benefit in reduced N leaching. It is also likely that a reduction in N input on these farms can be achieved with a lower impact on farm production than on farms with a lower level of N surplus.

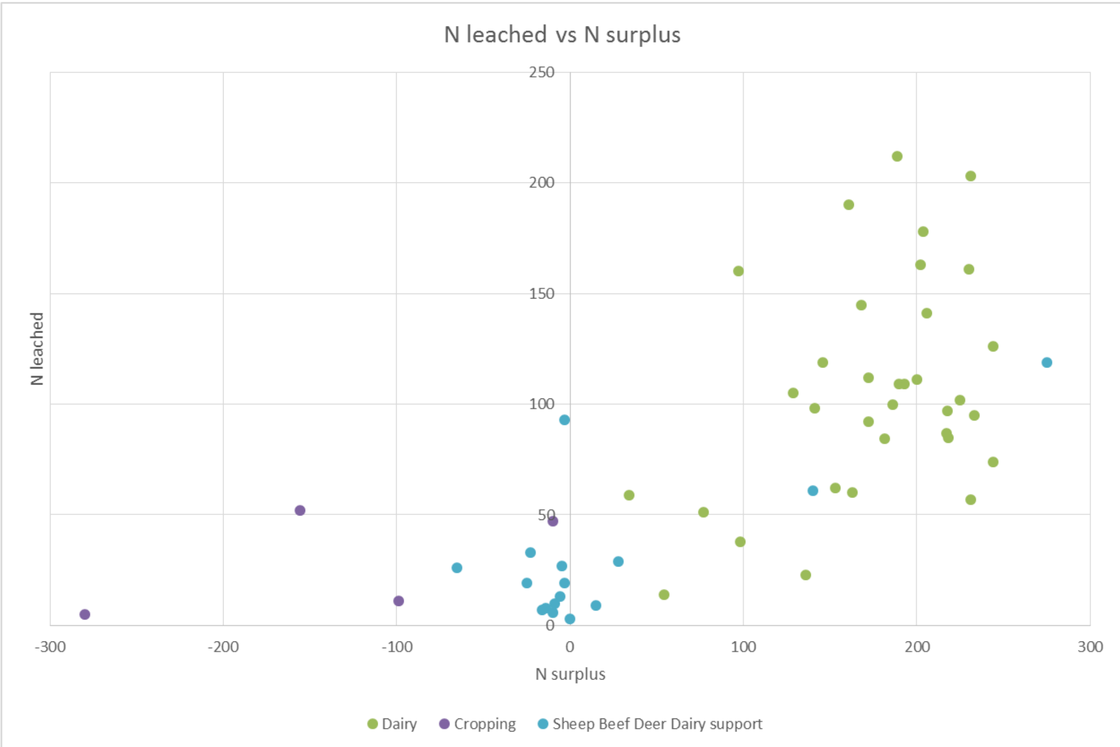

Figure 12. The relationship between a simple N surplus calculation (N surplus = N fertiliser + N supplements – N Product – N Exported effluent – N supplements and crop residues removed) and Overseer 6.2.1 prediction of farm level N loss to water

CONCLUSIONS

44. In my opinion, the derivation and use of the nitrogen fertiliser proxies described in PC5 schedule 28 for both crops and pasture are flawed and as

a consequence many farms following good management practices will not be able to comply with the GMP N loss value derived.

45. The nitrogen fertiliser proxies for both pasture and crops should be replaced with an alternative methodology based on a simple calculation of N surplus.

46. The target soil test levels used in the pastoral phosphorus fertiliser proxy need to be aligned with the accepted agronomic target ranges.

Alister Metherell

22 July 2016

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