Overseer

Overseer 6.6.0 – Full Impact Assessment

All analyses and publications · November 2026

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Introduction

Overseer 6.6.0 updates how crops take up nitrogen (N) from the soil. The crop coefficients (N concentrations, growth curves and root parameters) have been revised following an independent scientific review, and crop N uptake is now closely coupled to the mineral N available in the soil. The release also includes five corrections: the calculation of crop root biomass, the methane from outdoor pigs, the weighting of grazed crops in the digestibility of the animals' diet, two internal totals used for a model comment, and for the Grass-fed Standard report for dairy herds: both the time on wintering pads and the milking time.

This report assesses all these changes together, on every analysis in Overseer; this includes 195,590 analyses, of which 55,394 are publications. Following this release, users with crops may observe changes in modelled N losses and greenhouse gas (GHG) emissions, and small changes in phosphorus (P) losses on irrigated farms. Farms with outdoor pigs will see lower methane emissions, and dairy farms using a wintering pad may see less time with access to pasture in their Grass-fed Standard report. These differences reflect improvements to model representation and calculation methods rather than changes in farm performance or management practices.

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1. Updated crop coefficients — new functionality

Background

Overseer estimates the N taken up by each crop from the user's inputs (yield, sowing and end dates) and the crop's coefficients: the N concentration in the harvested product, stover and roots, and the profile of the crop's growth over time. These coefficients were reviewed by the Bioeconomy Science Institute (Khaembah et al., 2025), which used new documented experimental evidence to update the crop coefficients, including root parameters for each crop group.

What has changed

- The N concentrations of the harvested product and stover, the growth curve and the harvest stage have been revised for most crops.
- Each crop now has a root mass proportion and a root N concentration, and a maximum "luxury" N uptake (the N a crop can take up above its baseline demand when soil N is plentiful).
- The updated growth curves indicate earlier crop development for most crops. As crop cover is calculated from these curves, this also affects crop water use and the amount of irrigation applied by the model.
- Five crops have been added: annual/Italian ryegrass (forage crop system), pumpkin, leek, leafy lettuce and spring onion.

What remains unchanged

- Farms without crops are not affected by these changes.

- The current annual ryegrass crop, now named “Annual/Italian ryegrass - grazing system”, keeps its current (pastoral) calculation. The new forage crop system uses the new coefficients when users select it.

Impact for users

- Crops whose N uptake increases, mainly cereals (wheat, barley, oats), take more N from the soil and export more N in the harvested product. In most cases N loss decreases. It can increase when the crop is in the year before the reporting year (see the third point).
- Crops whose N uptake decreases, mainly kale, leave more mineral N in the soil. N loss usually increases.
- The timing of crops in the rotation also matters: a crop that takes up more N also returns more N in its residues and roots. If it is grown in the year before the reporting year, that N can be released and leach in the reporting year. Similarly, a crop that takes up its N earlier, or whose residues return to the soil before the drainage season, can leave more N to leach in the reporting year.
- Nitrous oxide from crop residues and from excreta changes with the N in residues and in the crops eaten by animals.
- On irrigated farms, the change in crop water use changes the irrigation applied, which slightly changes P loss and the CO2 from irrigation electricity.

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2. Dynamic crop N uptake — new functionality

What has changed

- The luxury N uptake of each crop now depends on the soil mineral N available: the crop and soil calculations are repeated until they converge. Crop uptake can stay at its maximum or be lower, never higher.
- Crop N uptake also changes the feed available to animals, their excreta and the effluent returned to the blocks. A second convergence loop iteratively recalculates the animal, effluent and crop components until their results converge.

Impact for users

- Where the soil mineral N is limited, crops take up less N, which slightly reduces the N in products, residues and grazed crops, and the nitrous oxide from residues and excreta.
- As the animal calculations are repeated, the energy content of the diet is recalculated, which slightly lowers enteric methane on farms with grazed crops.
- On a few farms, the repeated calculation changes the crop feed enough that the feed supplied no longer matches the animals’ requirements, and the analysis stops with a feed check message, as it would for inconsistent feed inputs.

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3. Bug fix — root biomass as a proportion of total crop biomass

Previous behaviour

The root proportion coefficient is defined as the share of the total plant biomass, roots included, that is in the roots. The model multiplied the above-ground biomass by this coefficient, so root biomass was underestimated (9.1% of total biomass instead of 10%).

Corrected behaviour

Roots now make up the stated proportion of the total plant biomass.

Impact for users

- Only analyses with crops are affected. Larger roots take up slightly more N while the crop grows and return more N in root residues afterwards, which increases nitrous oxide from crop residues. Changes in N loss are small.

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4. Bug fix — outdoor pig methane from dung and effluent counted twice

Previous behaviour

The methane from outdoor pig dung (pigs in huts) and from the outdoor pig effluent system (farrowing villages and barns) was added to totals that were not set back to zero. As the outdoor pig calculation runs twice for each analysis, this methane was counted twice.

Corrected behaviour

The totals are set back to zero at the start of each calculation, so this methane is counted once.

Impact for users

- Only analyses with outdoor pigs are affected: methane from outdoor pig dung and effluent halves, and total GHG emissions decrease accordingly. N loss and P loss are unchanged.

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5. Bug fix — grazed crops in the digestibility of the diet

Previous behaviour

The average digestibility of the crops eaten by an animal enterprise combined crops grazed in place, counted per hectare, with crops from other sources, counted as totals. Grazed crops carried too much or too little weight in the average.

Corrected behaviour

All crop sources are now combined as total dry matter.

Impact for users

- Only enterprises eating crops from several sources, or from crop blocks of different sizes, are affected. The amount of crop eaten is unchanged; methane from dung and effluent changes very slightly, up or down. N and P losses are unchanged.

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6. Bug fix — totals used for a model comment

Previous behaviour

Two totals, the nutrients eaten by each animal enterprise and the nutrients exported in its products, were not reset in the same way when a calculation is repeated. The comment "Total product loss is greater than nutrient intake" could then appear when it should not.

Corrected behaviour

Both totals are reset at the start of each calculation.

Impact for users

- Modelled results are unchanged; only the comment is affected.

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7. Bug fix — Grass-fed Standard: time on a wintering pad and time milking

The Grass-fed Standard report summarises the dairy herd's diet and location. For each month, it counts the hours a day the herd could be on pasture (24 hours less the time spent milking), then takes off the time spent on feed pads, wintering pads and stand-off pads. A day counts as a grazing day when the herd spends at least 8 hours on pasture.

Previous behaviour

- **Wintering pads.** The time on a wintering pad was calculated from the hours off the pad, so the milking time was taken out of the time on the pad instead of the time on pasture.
- **Milking time.** The milking time left out the time on the lanes to and from the farm dairy, and it was also taken off during the dry period.

Corrected behaviour

- **Wintering pads.** The time on a wintering pad is now the hours entered by the user, and the milking time is taken from the time on pasture.
- **Milking time.** The milking time now includes the time on the lanes as well as in the farm dairy, and it only applies to the share of each month the herd is lactating.

Impact for users

- Only the Grass-fed Standard report of dairy herds is affected; N loss, P loss and GHG emissions are unchanged by this correction.

- For herds using a wintering pad, the time with access to pasture decreases because the time on the pad now matches the hours entered. Days with fewer than 8 hours on pasture no longer count as grazing days.
- For herds using a feed pad or a stand-off pad, the change in milking time moves the time with access to pasture by a few tenths of a percentage point. In some herds on a pad in winter, days in the dry period now pass the 8-hour test and count as grazing days.

Summary

The update was tested on 195,590 analyses, publications included. The changes in N, P and GHG are on analyses with crops: no analysis without crops changes N loss. Separately, a bug correction lowers the methane emissions of the few farms with outdoor pigs, and another corrects the time on pads in the Grass-fed Standard report of dairy herds.

- **N loss:** unchanged (within ±0.05%) for 54.7% of the analyses compared, and within ±20% for 93.2%. N loss decreases on average (−2.5%), mostly on farms growing cereals, and increases mainly on farms growing kale.
- **P loss:** unchanged for 99.2% of the analyses. The small changes, mostly 0.1 kg P/ha, are on irrigated farms with crops, where the new crop growth curves change the irrigation applied.
- **GHG emissions:** unchanged (within ±0.05%) for 50.1% of the analyses, and within ±5% for 99.7% (mean −0.1%). The largest changes are increases in nitrous oxide from crop residues and decreases in methane on farms with outdoor pigs.
- **Grass-fed Standard:** the time with access to pasture decreases for 25,594 of the 117,624 dairy herds with a report, mostly by less than 0.5 percentage points; 818 herds change their grazing days.
- 72 dairy analyses with crops no longer produce a result because of existing feed checks.

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Impact on farm results

The impact of the change has been evaluated across 195,590 analyses.

Dairy analyses make up 65% of the analyses assessed, mixed livestock 24%, non-dairy animals 10% and crop and horticulture 2%. In total, 125,226 analyses (64.0%) show at least one change in their results.

General statistics

The global statistics of the variations in N loss, P loss and GHG emissions are summarised in the following table. Only analyses that include strictly positive results for N, P, and GHG emissions were retained.

Summary of the variations (%)

	N loss variation (%)	P loss variation (%)	GHG variation (%)
Min	−83.9	−100.0	−24.3
1st quartile	−2.9	0.0	0.0
Median	0.0	0.0	0.0
Mean	−2.5	0.1	−0.1
3rd quartile	0.0	0.0	0.1
Max	160.0	100.0	47.3

On average, across the 175,577 analyses with results both before and after, N loss decreases by 2.5%, P loss increases by 0.1% and GHG emissions decrease by 0.1%.

Analysis statistics

- Total number of tested analyses: 195,590
- Analyses with results before the update: 175,649
- Analyses with results after the update: 175,586
- Analyses with results before but not after the update: 72
- Analyses with results after but not before the update: 9
- Analyses with results before and after: 175,577

Analyses that now produce a result

- Analyses with results after the update and none before: 9

Analyses that no longer produce a result

- Analyses without results after the update: 72

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Messages

Message	Analyses	Farms
Feed: ME supplied in the shed, on pads and as crops exceeds animal ME requirements	31	15
Feed: supplements and crops fed on pads and in the paddock exceed estimated animal intakes	18	6
Feed: animals in the shed or on the feed pad but no supplements or crops fed to them	10	4
Feed: ME content of crops fed exceeds estimated ME requirements	6	3
Feed: more supplement fed on the wintering pad/animal shelter than the animals need	4	1
Feed: total feed under-estimated compared with animal requirements	2	2
Feed: ME content of farm-grown supplements exceeds estimated ME requirements	1	1

Observations

All 72 analyses without a result after the update are dairy analyses with crops (31 farms; 57 analyses and 15 publications). Every message is a feed check: the feed supplied (supplements and crops) no longer matches the animals' estimated requirements, mostly because the ME supplied in the shed, on pads and as crops exceeds the requirements, or the supplements and crops fed exceed the estimated intakes. The dynamic crop N uptake calculation requires the animal diet and associated feed calculations to be repeated. For some analyses where feed supply is already close to the model's limits, the repeated calculations can result in feed excesses or deficits that prevent the model from converging to a valid result. These analyses consequently trigger existing feed checks.

9 analyses now produce a result that they did not have with the previous version of the model: 8 publications on two dairy farms and one beef scenario.

Graphs of variations

In the following graphs, the variation in farm results is defined as the following ratio:

$$Variation = \frac{Value_{After} - Value_{Before}}{Value_{Before}}$$

The *Value* could be the N loss, P loss or the GHG emissions value.

N loss variation

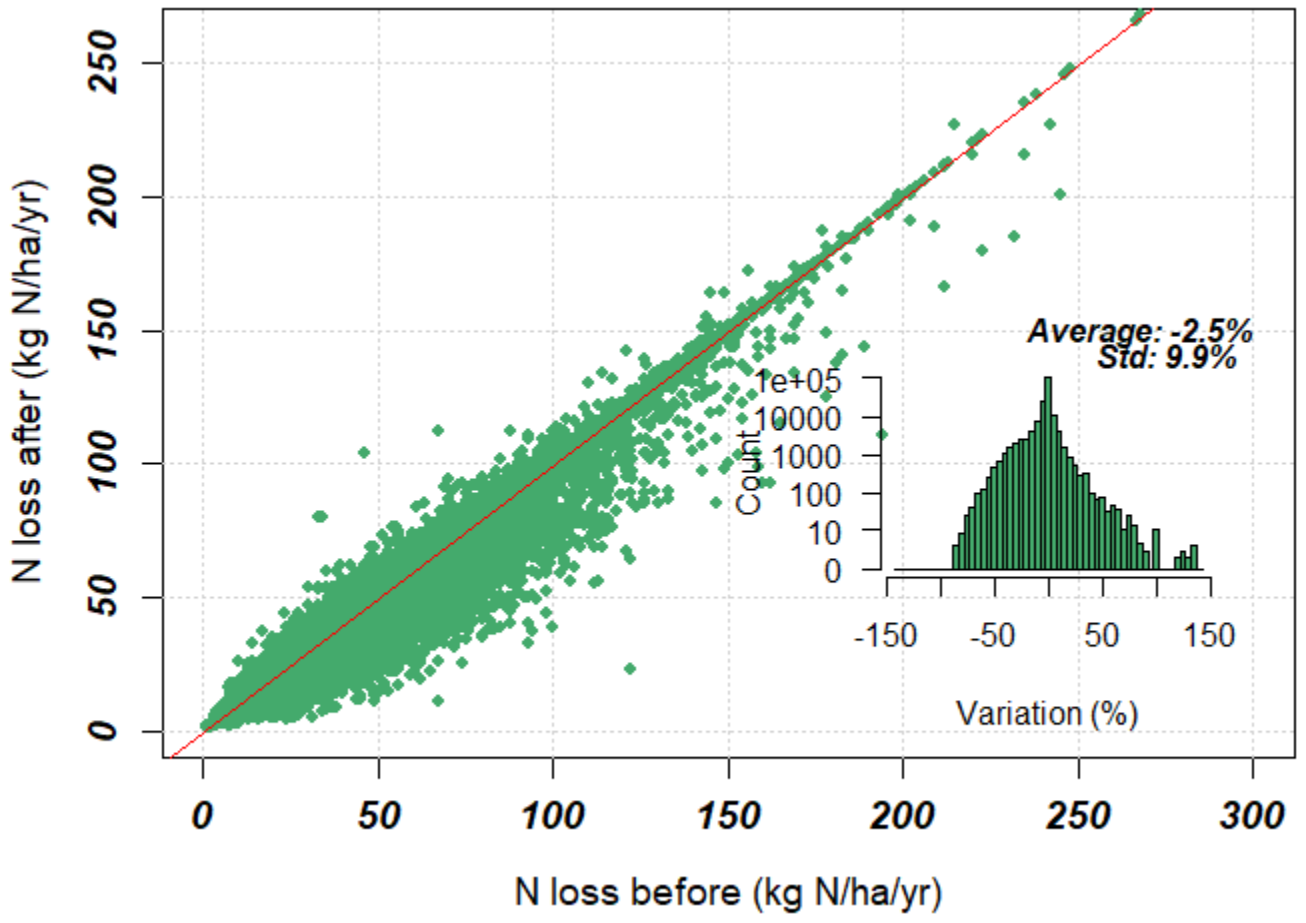


Figure 1: Total N loss variation

How to read this figure. *Each point compares the same analysis before and after the model update. Points on the red 1:1 line are unchanged; points above the line increased after the update; points below the line decreased after the update. The inset histogram shows the distribution of percentage changes.*

NLossPerHa*: Total modelled nitrogen loss per hectare, expressed as kg N/ha/year. This includes nitrogen lost to water and relevant loss pathways aggregated in the model output.*

The mean variation is −2.5%, ranging from −83.9% to +160%.

Out of 175,398 analyses (with strictly positive N loss values before and after the update):

- 42,179 (24%) show a positive or negative variation greater than 5%,
- 23,624 (13.5%) show a positive or negative variation greater than 10%,
- 11,854 (6.8%) show a positive or negative variation greater than 20%.

Distribution of N loss variation by range

Variation range	Number	Frequency (%)
< −100%	0	0.0
−100% to −75%	23	0.0
−75% to −50%	820	0.5
−50% to −25%	6,904	3.9
−25% to −15%	5,637	3.2
−15% to −5%	18,465	10.5
−5% to −0.05%	25,323	14.4
−0.05% to 0.05%	95,969	54.7
0.05% to 5%	11,156	6.4
5% to 15%	8,045	4.6
15% to 25%	1,908	1.1
25% to 50%	962	0.5
50% to 75%	148	0.1
75% to 100%	29	0.0
> 100%	9	0.0

N loss variation magnitude

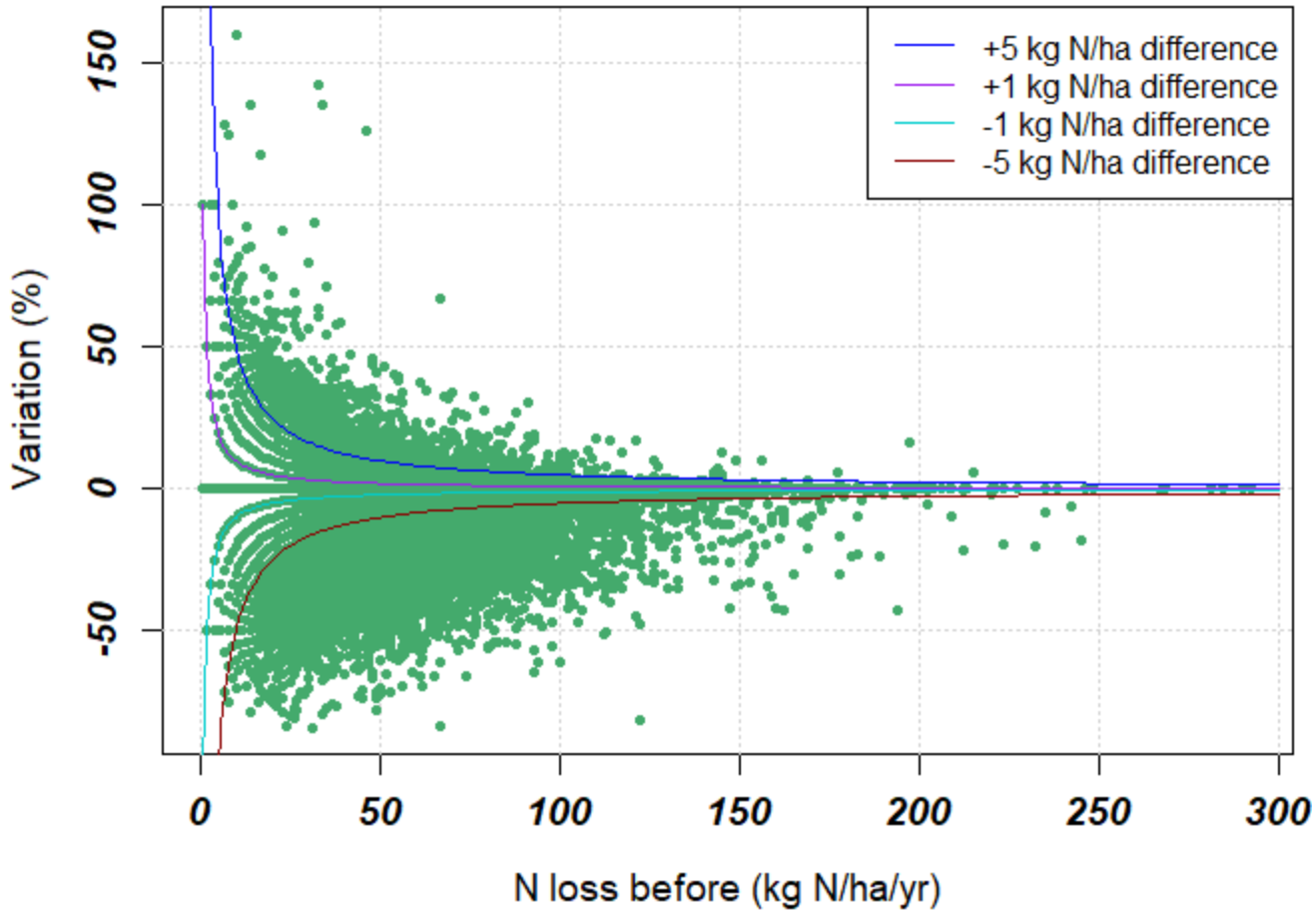


Figure 2: Total N loss variation magnitude

How to read this figure. *The y-axis shows the percentage change in N loss, while the x-axis shows the baseline N loss before the update. The reference curves show the percentage change that would be produced by fixed absolute differences of ±1 and ±5 kg N/ha/year.*

About half of the analyses (54.7%) show no change in N loss (between −0.05% and +0.05%), 76.0% change by less than 5% and 93.2% by less than 20%. All the analyses whose N loss per hectare changes have crops, on crop blocks or as fodder crops on pastoral blocks; none of the 49,603 analyses without crops changes. Of the 79,429 analyses whose N loss per hectare changes, 57,172 decrease and 22,257 increase, and 38,150 of them differ by exactly 1 kg N/ha, the precision of the reported value. Large percentages at low N loss (Figure 2) are mostly small absolute changes.

Largest positive N loss variation

This section highlights the most significant positive changes in N loss: changes that exceed 5% and a difference of more than 5 kg N/ha.

In total, 1,684 (1%) analyses meet these criteria.

Analyses meeting the criteria, by farm type

Farm type	Analyses
Mixed	1,351
Dairy	176
Non-dairy animals	95
Crop and horticulture	62

Analyses meeting the criteria, top 10 regions

Region	Analyses
Canterbury	1,554
Manawatū-Whanganui	25
Southland	25
East Coast (North Island)	21
Central Plateau	19
Waikato / Coromandel	11
West Coast (South Island)	11
Otago	7
Northland	4
Nelson	3

Most of these increases are on farms growing kale (98% of them, compared with 40% of the analyses with crops). With the new coefficients, kale takes up less N than before, so more mineral N is left in the soil and leached, typically +8 kg N/ha/year. The increase is largest where kale is sown and grazed within the reporting year. A few increases are on vegetable rotations, where a lower harvest index returns more stover to the soil, and on green manure crops incorporated in the reporting year.

Largest negative N loss variation

This section highlights the most significant negative changes in N loss: changes below −5% and an absolute difference of more than 5 kg N/ha.

In total, 12,914 (7.3%) analyses meet these criteria.

Analyses meeting the criteria, by farm type

Farm type	Analyses
Mixed	11,119
Crop and horticulture	1,218
Dairy	553
Non-dairy animals	24

Analyses meeting the criteria, top 10 regions

Region	Analyses
Canterbury	11,746
Southland	367
Waikato / Coromandel	331
West Coast (South Island)	98
Manawatū-Whanganui	94
East Coast (North Island)	86
Otago	68
Central Plateau	25
Wellington	20
Taranaki	17

Most of these decreases are on farms growing cereals (92% grow wheat, barley, oats, triticale or rye corn, and 95% cereals or maize, compared with 36% of the analyses with crops). The new coefficients roughly double the N uptake of wheat and raise that of other cereals: more N is removed in the grain and less mineral N is left to leach, typically −11 kg N/ha/year. On a few arable farms with high yields the extra uptake is drawn from the soil organic N, which makes the N surplus strongly negative.

P loss variation

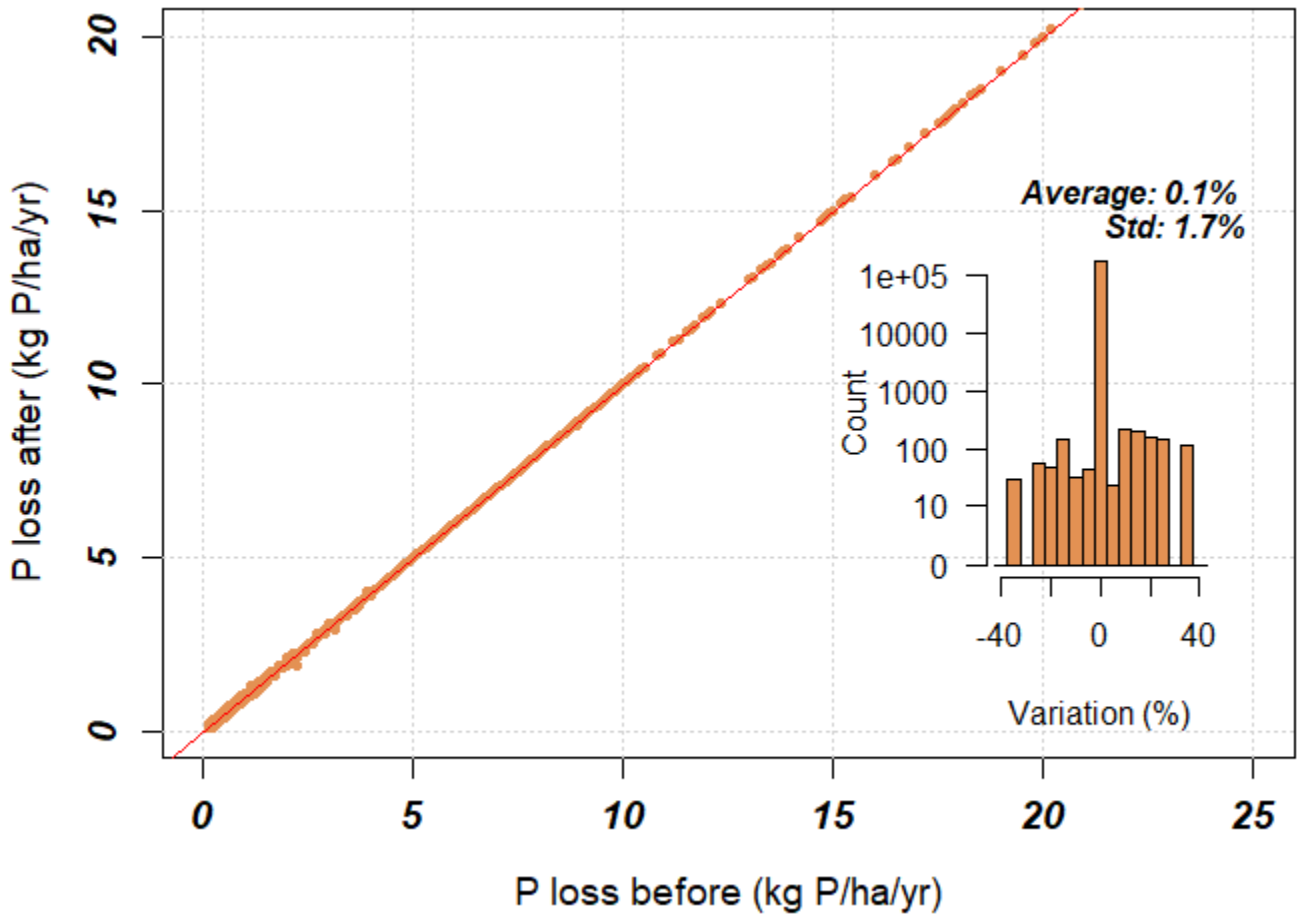


Figure 3: Total P loss variation

How to read this figure. *Each point compares modelled P loss for the same analysis before and after the update. The red 1:1 line represents no change; points close to this line indicate stable modelled P loss.*

PLossPerHa*: Total modelled phosphorus loss per hectare, expressed as kg P/ha/year.*

The mean variation is 0.1%, ranging from −50% to +100%.

Out of 175,398 analyses (strictly positive values for P loss):

- 1,403 (0.8%) show a positive or negative variation greater than 5%,
- 1,293 (0.7%) show a positive or negative variation greater than 10%,
- 570 (0.3%) show a positive or negative variation greater than 20%.

P loss variation magnitude

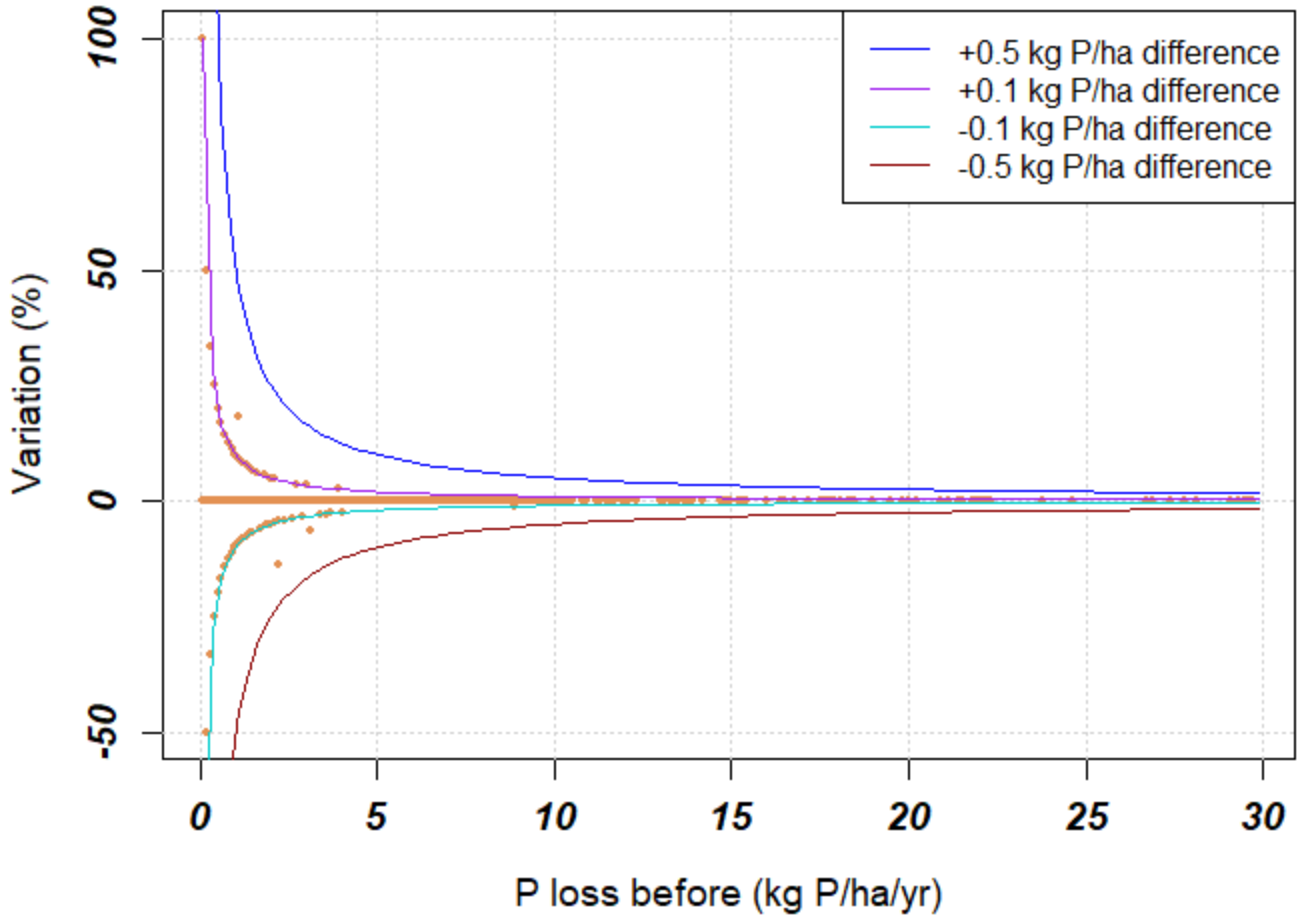


Figure 4: Total P loss variation magnitude

How to read this figure. *The percentage variation is plotted against the baseline P loss. The reference curves show the percentage change corresponding to fixed absolute differences of ±0.1 and ±0.5 kg P/ha/year, which helps distinguish large percentage changes from materially large absolute changes.*

Distribution of P loss variation by range

Variation range	Number	Frequency (%)
< −100%	0	0.0
−100% to −75%	0	0.0
−75% to −50%	49	0.0
−50% to −25%	87	0.0
−25% to −15%	131	0.1
−15% to −5%	114	0.1
−5% to −0.05%	22	0.0
−0.05% to 0.05%	173,969	99.2
0.05% to 5%	4	0.0
5% to 15%	324	0.2
15% to 25%	406	0.2
25% to 50%	221	0.1
50% to 75%	0	0.0
75% to 100%	71	0.0
> 100%	0	0.0

P loss is unchanged for 99.2% of the analyses (between −0.05% and +0.05%). Only 1,429 analyses (0.8%) change their P loss per hectare, almost all by 0.1 kg P/ha, the precision of the reported value, and by 0.3 kg P/ha at most.

The crop coefficients do not change P loss directly; the change comes from irrigation. 95% of the analyses whose total P loss changes are irrigated. The new growth curves change the crop cover over the season, so the crop's water use (evapotranspiration) and the irrigation applied by demand-based schedules change. P loss from the soil depends on the water surplus from rainfall plus irrigation, so more irrigation gives slightly more P loss, and less irrigation slightly less, even where drainage is unchanged. Irrigation applied at a fixed amount changes far less often. On non-irrigated dairy farms spreading effluent, the repeated animal and effluent calculations change total P loss by less than 1%, with no change per hectare.

Largest P loss variation

This section highlights the most significant changes in P loss: changes in the farm's total P loss that exceed ±5%, with a difference in P loss of more than 0.1 kg P/ha. The percentage is calculated on the total P loss rather than on the P loss per hectare, which is rounded to 0.1 kg P/ha and so gives large percentages for small values.

In total, 110 (0.1%) analyses meet these criteria.

Analyses meeting the criteria, by farm type

Farm type	Analyses
Mixed	82
Crop and horticulture	12
Dairy	11
Non-dairy animals	5

Analyses meeting the criteria, top 10 regions

Region	Analyses
Canterbury	102
Otago	6
East Coast (North Island)	2

All 110 analyses in this table are irrigated farms with crops (mostly fodder crops such as kale and fodder beet, cereals and vegetables), and 108 of them change by 0.1 kg P/ha, the precision of the reported value. The cause is the change in irrigation described above: the new crop growth curves change crop cover and water use, so the irrigation applied and the water surplus change, and so does P loss. P loss increases in 89 of them and decreases in 21.

GHG emission variation

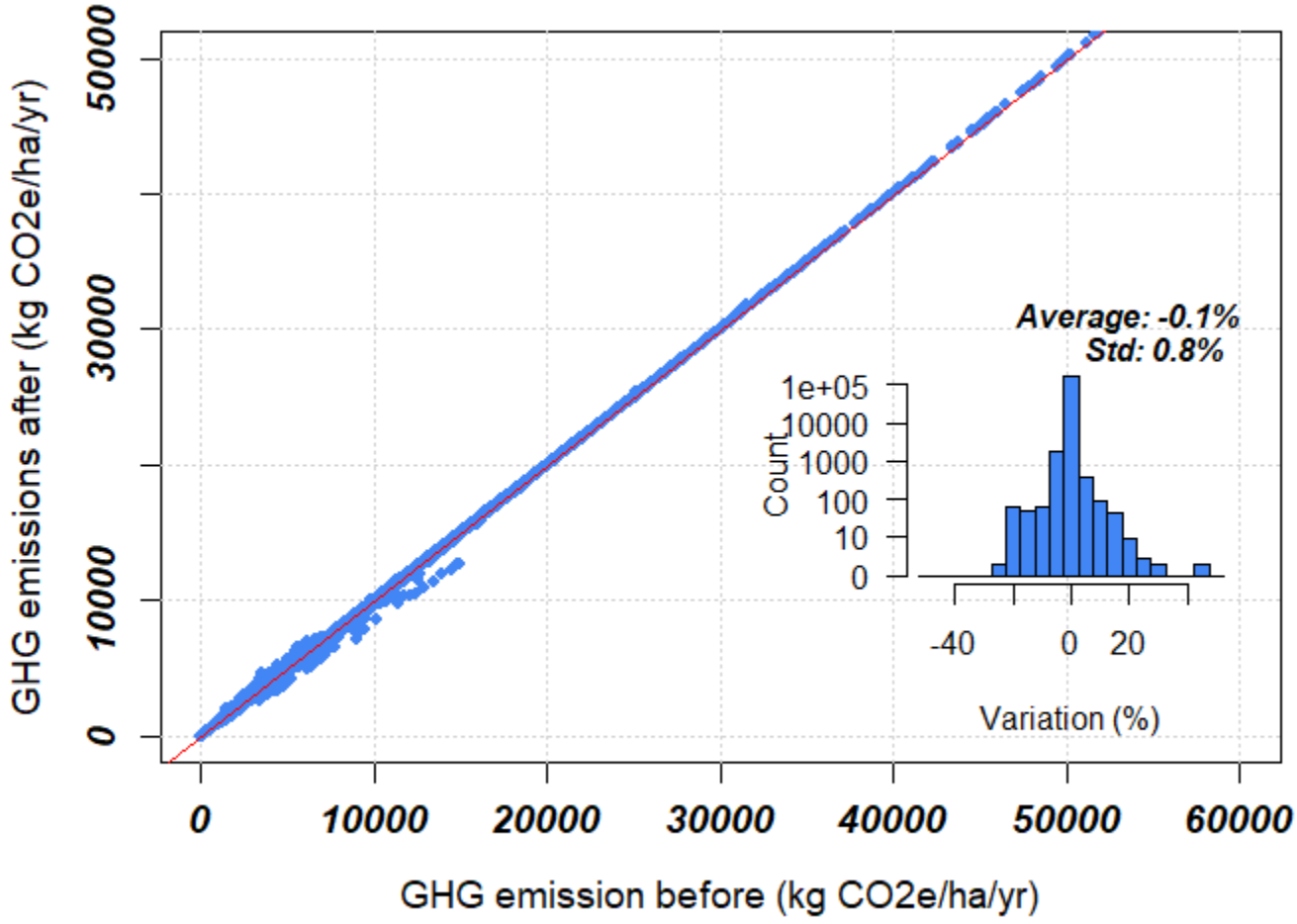


Figure 5: Total GHG emissions variation

How to read this figure. *Each point compares total GHG emissions before and after the update for the same analysis. The red 1:1 line indicates no change. Points below the line indicate lower modelled emissions after the update.*

GHGPerHa*: Total modelled greenhouse gas emissions per hectare, expressed as kg CO2e/ha/year. This aggregates methane, nitrous oxide, carbon dioxide, and embodied emissions reported in CO2 equivalent units.*

The mean variation is −0.1%, ranging from −24.3% to +47.3%.

Out of 175,398 analyses (strictly positive values for GHG emissions):

- 572 (0.3%) show a positive or negative variation greater than 5%,
- 242 (0.14%) show a positive or negative variation greater than 10%,
- 36 (0.02%) show a positive or negative variation greater than 20%.

Distribution of GHG emission variation by range

Variation range	Number	Frequency (%)
< −100%	0	0.0
−100% to −75%	0	0.0
−75% to −50%	0	0.0
−50% to −25%	0	0.0
−25% to −15%	97	0.1
−15% to −5%	262	0.1
−5% to −0.05%	41,178	23.5
−0.05% to 0.05%	87,869	50.1
0.05% to 5%	45,779	26.1
5% to 15%	182	0.1
15% to 25%	29	0.0
25% to 50%	2	0.0
50% to 75%	0	0.0
75% to 100%	0	0.0
> 100%	0	0.0

GHG emissions variation magnitude

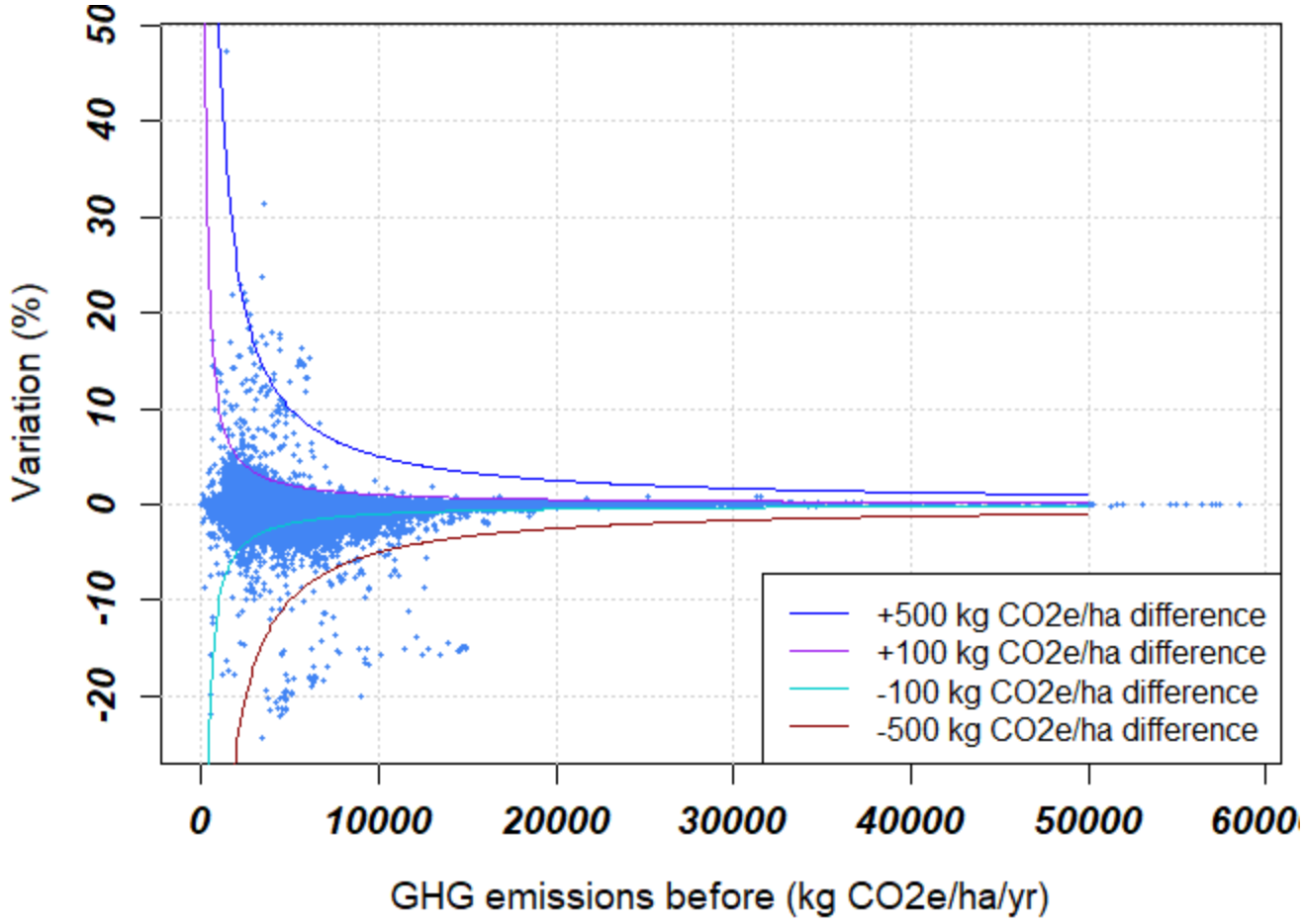


Figure 6: Total GHG emissions variation magnitude

How to read this figure. *The y-axis shows percentage change in total GHG emissions. The reference curves show the percentage change associated with fixed absolute differences of ±100 and ±500 kg CO2e/ha/year.*

About half of the analyses (50.1%) show no change in GHG emissions (between −0.05% and +0.05%), and 99.7% change by less than 5%. The changes come from:

- nitrous oxide from crop residues, which follows the N in crop residues and roots: higher where crops take up more N (cereals, vegetables, green manures), lower on kale;
- nitrous oxide from excreta, which follows the N in the crops eaten by grazing animals, and indirect nitrous oxide, which follows N leaching;
- enteric methane, slightly lower on farms with grazed crops (46,270 decreases, mostly of 1 kg CO2e/ha), as the energy content of the diet is recalculated;
- methane from outdoor pig dung and effluent, which halves;
- CO2 on irrigated farms, through the irrigation electricity (a few kg CO2e/ha at most).

Largest GHG emissions variation

This section highlights the most significant changes in GHG emissions: changes that exceed ±5% and an absolute difference of more than 125 kg CO2e/ha.

In total, 512 (0.3%) analyses meet these criteria.

Analyses meeting the criteria, by farm type

Farm type	Analyses
Mixed	213
Crop and horticulture	212
Non-dairy animals	87

Analyses meeting the criteria, top 10 regions

Region	Analyses
Canterbury	317
Manawatū-Whanganui	113
Otago	34
Waikato / Coromandel	16
Northland	13
East Coast (North Island)	10
Marlborough	4
Auckland	2
Southland	2
Wellington	1

About 37% of the analyses in this table increase. Almost all of these increases are nitrous oxide from crop residues on arable and vegetable rotations, cereals, maize and green manures (+130 to +1,100 kg CO2e/ha/year): the new coefficients put more N in residues and roots, which return to the soil.

About 63% decrease. Half of the decreases are farms with outdoor pigs, where methane from dung and effluent halves (up to −2,240 kg CO2e/ha/year). The other decreases are mostly on rotations with kale, where less N in the crop means less nitrous oxide from residues, excreta and leaching.

CH4 emissions

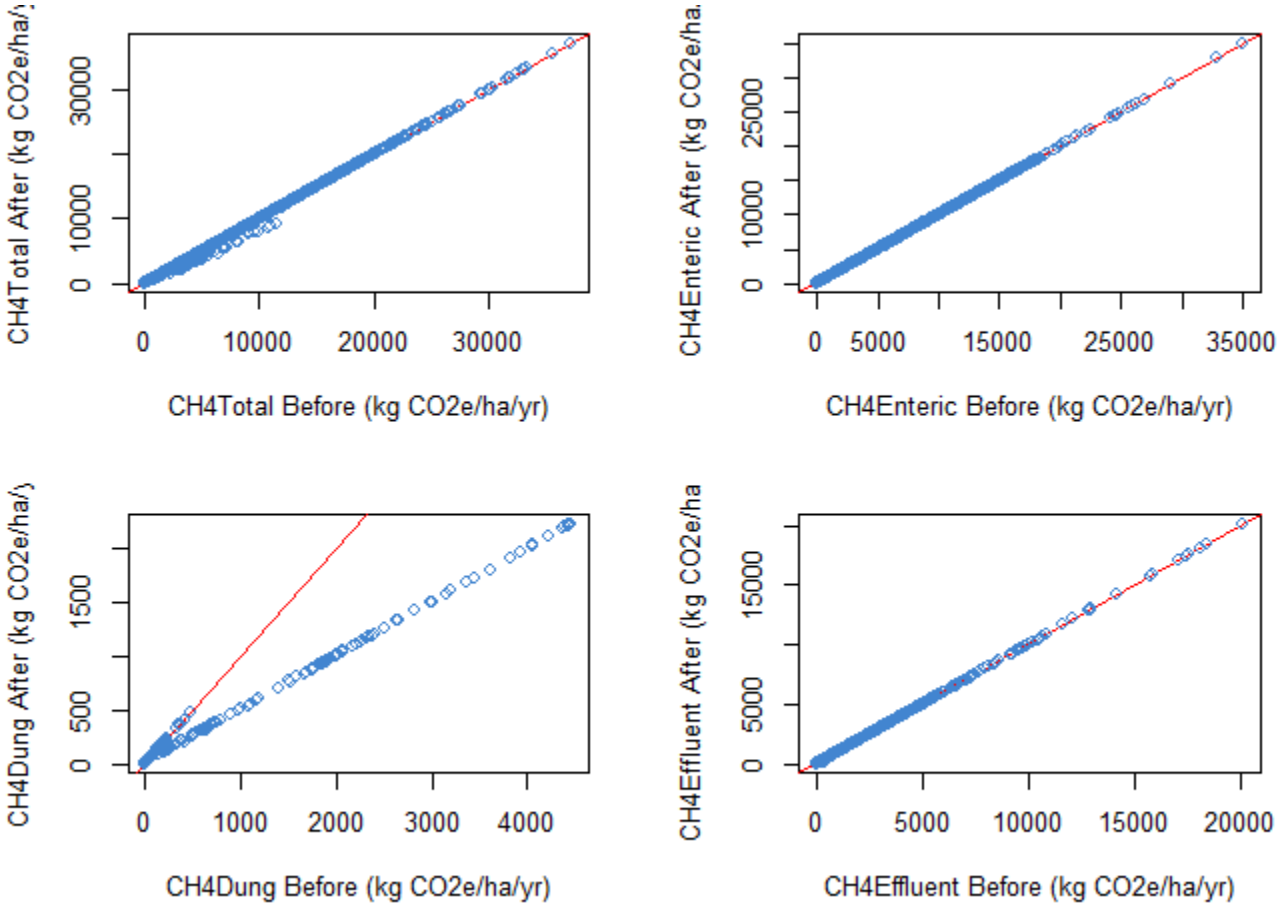


Figure 7: CH4 emissions variation

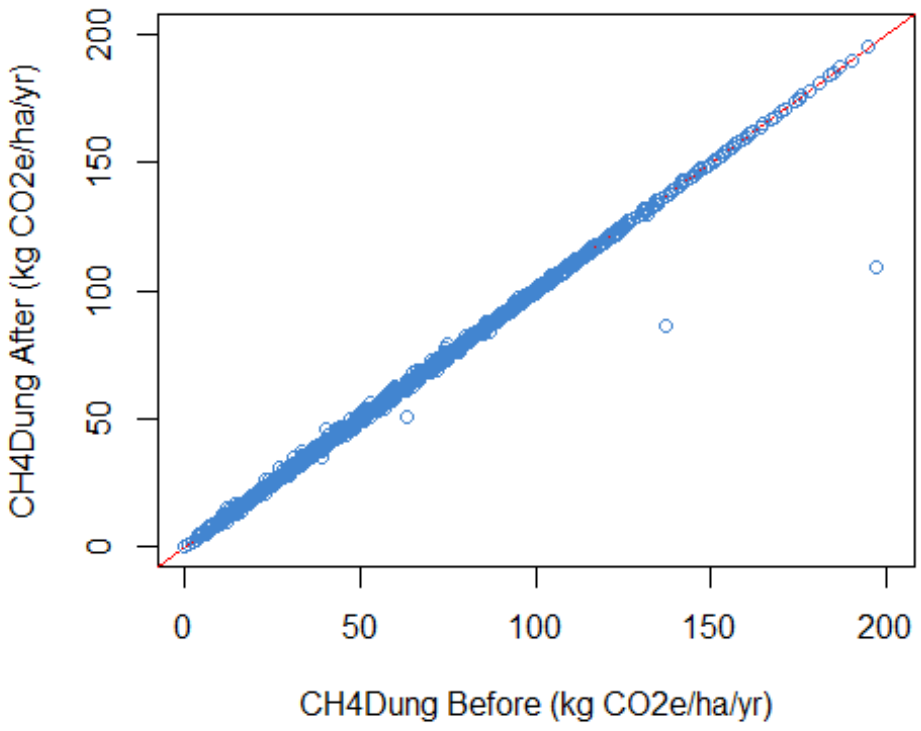


Figure 7b: CH4 dung variation, zoom on 0-200 kg CO2e/ha/yr (most analyses)

176,236 of the 176,453 analyses (99.9%) have dung CH4 of 200 kg CO2e/ha/yr or less, before and after the update.

How to read this figure. *Each panel compares one methane-emission component before and after the update. A shift below the red line indicates a reduction in that component after the update.*

CH4Total*: Total methane emissions, expressed as CO2equivalent per hectare/year. This includes enteric methane, dung-related methane, and effluent-related methane.*

CH4Enteric*: Methane emissions from enteric fermentation by animals. Enteric methane is calculated from dry matter intake and an enteric methane emission factor.*

CH4Dung*: Methane emissions from dung/manure decomposition, excluding the effluent-system component where this is reported separately.*

CH4Effluent*: Methane emissions associated with dung/excreta managed through the effluent system, including effluent storage and treatment pathways.*

In the CH4 dung panel of Figure 7, the line of points well below the red 1:1 line is the outdoor pig correction: 203 analyses (22 farms) with an outdoor pig enterprise, whose dung CH4 halves (median ratio after/before 0.50, up to about 4,460 → 2,230 kg CO2e/ha/yr). Dung and effluent methane from outdoor pigs was counted twice in the previous version; it is now counted once. Those few high values set the scale of the panel, so Figure 7b zooms on the 0-200 kg CO2e/ha/yr range where most analyses lie. The larger dung CH4 values that do not change (about 200-470 kg CO2e/ha/yr) are beef feedlots.

Enteric methane decreases slightly on farms with grazed crops (46,270 analyses, mostly by 1 kg CO2e/ha/year), as the repeated animal calculations recalculate the energy content of the diet.

N2O emissions

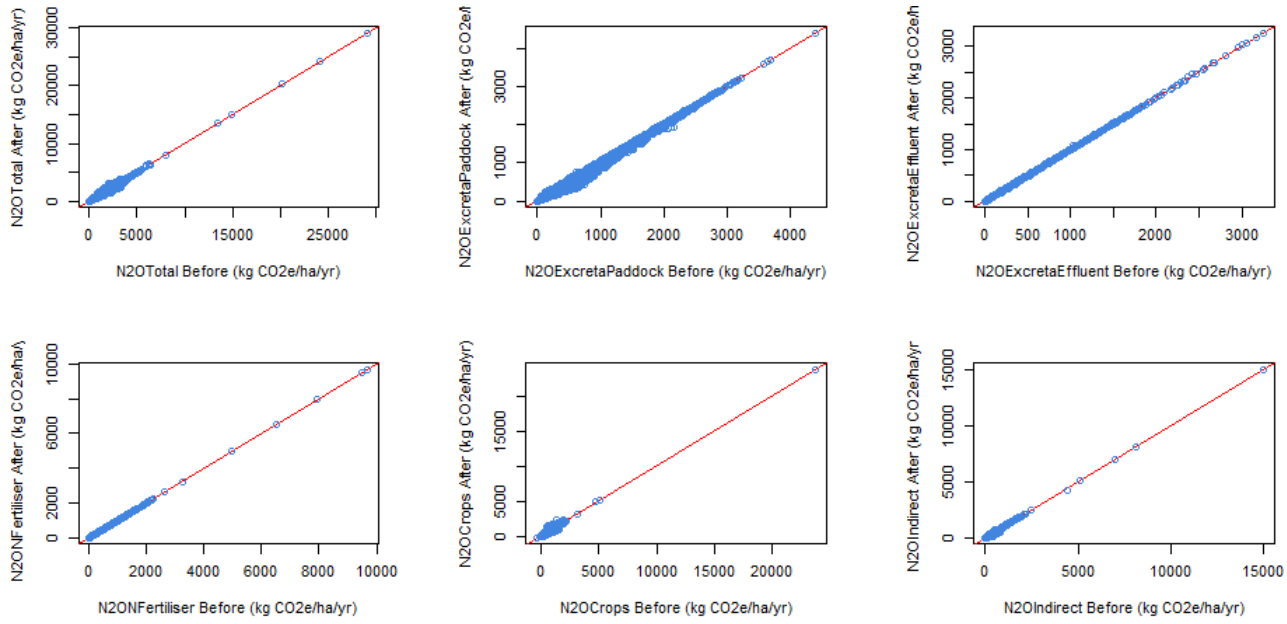


Figure 8: N2O emissions variation

How to read this figure. *Each panel compares one nitrous oxide emission component before and after the update. Points close to the red line indicate that the component was unchanged by the update.*

N2OTotal*: Total nitrous oxide emissions, expressed as CO2equivalent per hectare/year in the impact plots. This includes direct and indirect N2O sources.*

N2OExcretaPaddock*: Nitrous oxide emissions from animal excreta deposited directly onto paddocks or pasture.*

N2OExcretaEffluent*: Nitrous oxide emissions associated with effluent, including emissions from effluent management and/or land-applied effluent.*

N2ONFertiliser*: Nitrous oxide emissions from nitrogen fertiliser inputs added to soil.*

N2OCrops*: Nitrous oxide emissions associated with crop residues, cultivation, or crop-related nitrogen inputs.*

N2OIndirect*: Indirect nitrous oxide emissions associated with nitrogen lost from the farm through volatilisation and leaching pathways.*

Nitrous oxide from crop residues increases in 63,941 analyses and decreases in 37,708: it follows the N in crop residues and roots, which increases for most crops (and for all crops through the root biomass correction) and decreases for kale. Nitrous oxide from excreta on paddocks changes with the N in the crops eaten by grazing animals (71,697 increases, 35,656 decreases). Indirect nitrous oxide follows N leaching and mostly decreases (64,781 decreases, 41,568 increases). Nitrous oxide from N fertiliser is unchanged.

CO2 emissions

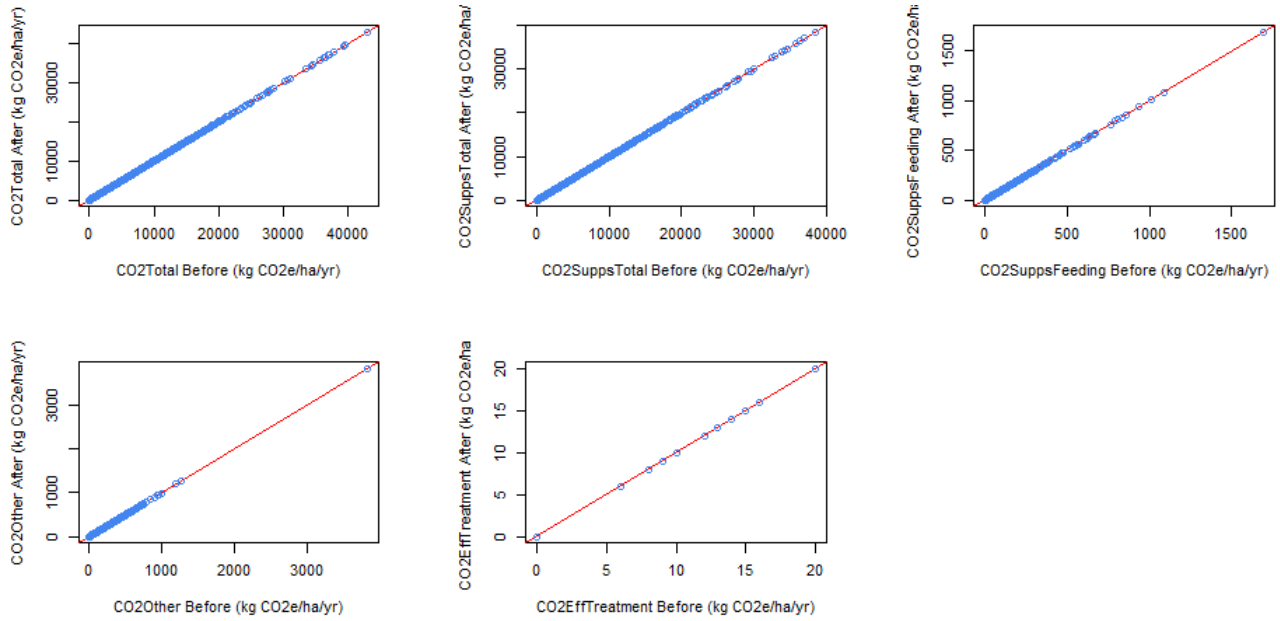


Figure 9: CO2 emissions variation

How to read this figure. *Each panel compares one CO2 or embodied-CO2 emission category before and after the update. Points close to the red line indicate no material change.*

CO2Total*: Total carbon dioxide and embodied carbon dioxide emissions, expressed as CO2equivalent per hectare/year in the impact plots.*

CO2SuppsTotal*: CO2equivalent emissions from supplements: supplements imported, fuel used to make supplements, and fuel used to feed them out.*

CO2SuppsFeeding*: CO2equivalent emissions from the fuel used to feed out supplements (part of CO2SuppsTotal).*

CO2Other*: Aggregate CO2equivalent emissions from minor Other CO2 sources, including animal health products, refrigerant losses, plastics, re-grassing, parasite control products, chemical sprays, other farm chemicals, effluent treatments, and residual other CO2 items.*

CO2EffTreatment*: Carbon dioxide or embodied CO2equivalent emissions associated with effluent treatment.*

CO2 changes in about 16,000 analyses, 99% of them irrigated, by −32 to +43 kg CO2e/ha/year. The CO2 categories shown here (supplements, effluent treatment, other) hardly change: the change is in the electricity used for irrigation, which Overseer estimates from the irrigation applied when the farm's electricity use is not entered. It follows the same change in irrigation as P loss. Where the farm's electricity use is entered, total electricity emissions do not change.

NCE and surplus

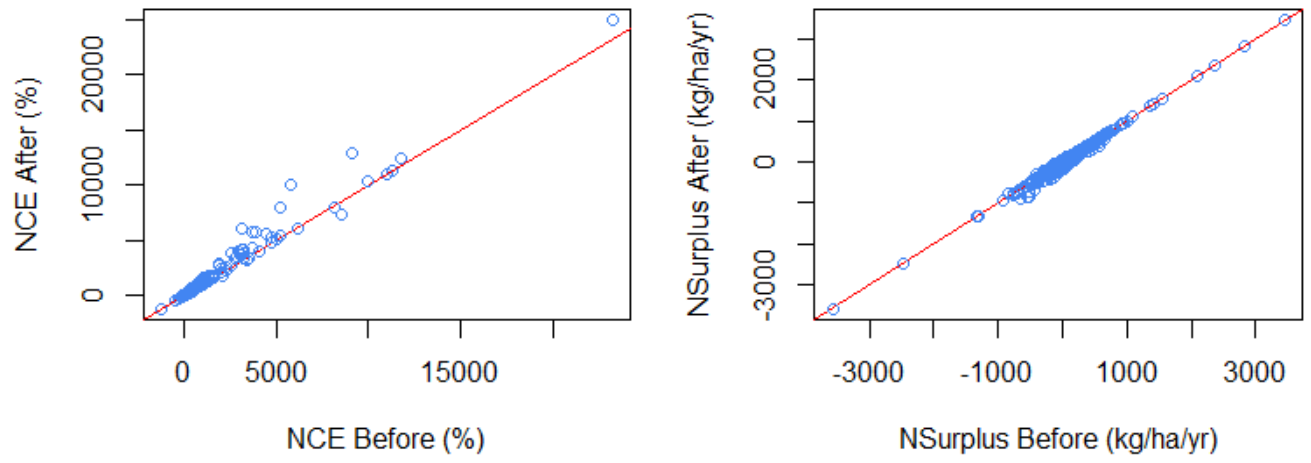


Figure 10: NCE and N Surplus

How to read this figure. *NCE is plotted as a percentage, whereas N surplus is plotted as a mass of nitrogen per hectare per year. Points close to the red line indicate that the nitrogen-use indicators were stable after the update.*

NCE*: Nitrogen Conversion Efficiency: the percentage of estimated nitrogen removed in products relative to the estimated nitrogen inputs used for production.*

NSurplus*: Nitrogen surplus: estimated nitrogen inputs used for production minus estimated nitrogen removed in products. Inputs include sources such as fertiliser, imported feed, irrigation water, and clover fixation; removals include products such as milk, meat, wool, and crops.*

NCE increases in about 42,000 analyses and decreases in about 2,100, and N surplus mostly decreases (typically −2 kg N/ha/year): with the new coefficients, more N is removed in harvested crops and supplements while N inputs are unchanged. On some arable farms with a very small N input, NCE reaches very high values; these are not meaningful and reflect the small denominator.

Nitrogen budget

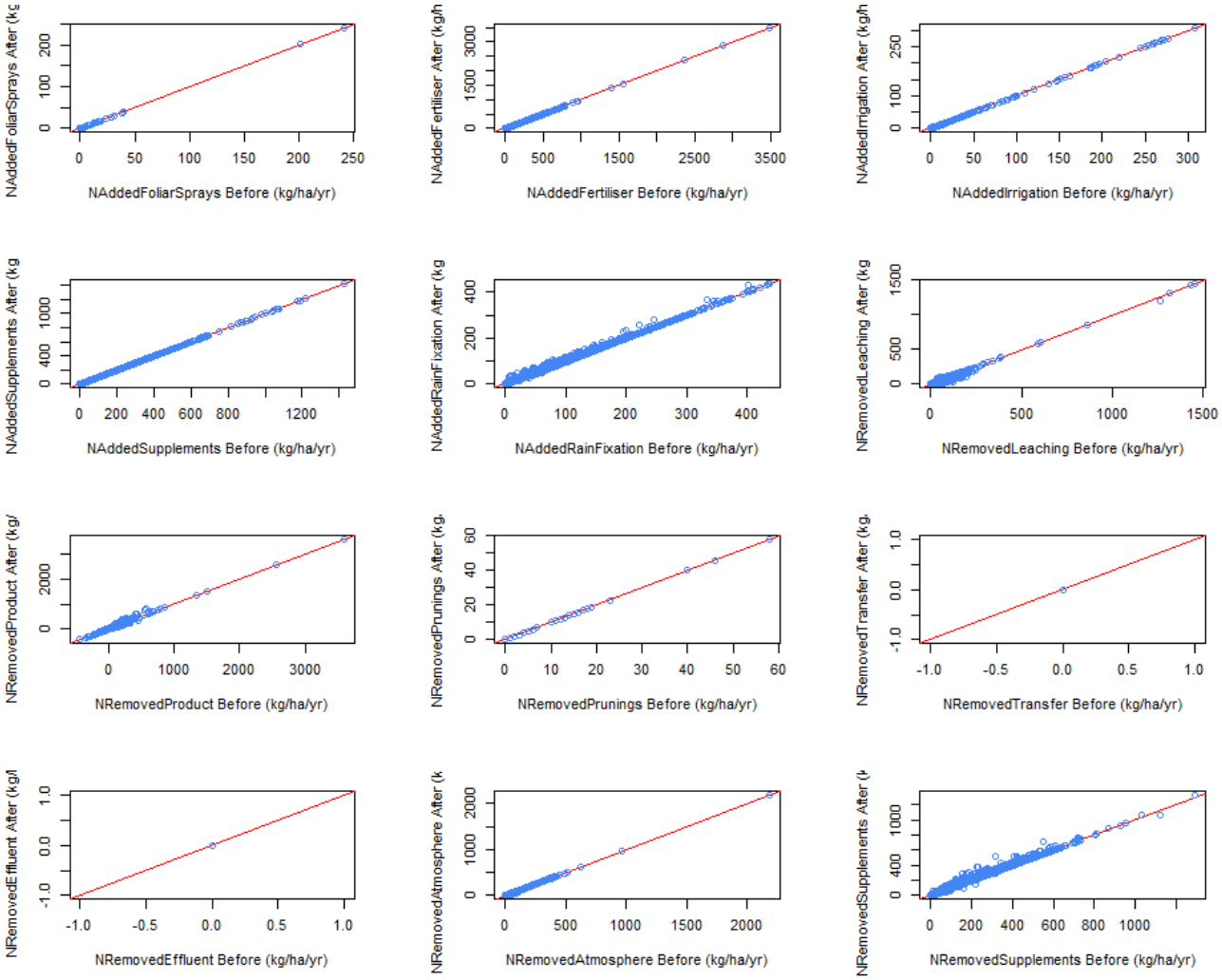


Figure 11: Nitrogen budget

How to read this figure. *Each panel compares one nitrogen-budget input or removal category before and after the update. The red line indicates no change in the category. The purpose of these plots is to check whether the update changed any specific budget pathway, even when total N loss changed very little.*

NAddedFoliarSprays*: Nitrogen added in foliar sprays, mainly relevant to fruit crop blocks where sprays are included in the nutrient budget.*

NAddedFertiliser*: Nitrogen added as fertiliser, organic material, imported effluents, and related fertiliser-type nutrient inputs. For N specifically, this primarily represents fertiliser and organic/effluent N additions.*

NAddedIrrigation*: Nitrogen added in irrigation water.*

NAddedSupplements*: Nitrogen imported onto the farm in supplements, including brought-in supplements, stored supplements fed out, farm-grown supplements fed on the block, crops fed, and animal health supplements where included.*

NAddedRainFixation*: Nitrogen added through rainfall deposition and biological nitrogen fixation, especially clover or other N-fixing sources.*

***NRemovedLeaching**: Nitrogen removed from the root zone or farm system through leaching, including urine-patch and background leaching where aggregated.*

***NRemovedProduct**: Nitrogen removed in products sold or exported from the farm system, such as milk, meat/liveweight, wool, velvet, crops, fruit, or other products.*

***NRemovedPrunings**: Nitrogen removed in prunings, mainly relevant to fruit crop blocks.*

***NRemovedTransfer**: Net nitrogen transfer by animals between blocks or structures, such as nutrients consumed on one block and deposited elsewhere via excreta, including transfers involving pads, lanes, races, farm dairies, and wintering pads.*

***NRemovedEffluent**: Nitrogen removed from the farm in exported effluent.*

***NRemovedAtmosphere**: Nitrogen lost to the atmosphere, including volatilisation and denitrification losses. Denitrification includes nitrous oxide emissions.*

***NRemovedSupplements**: Nitrogen removed as supplements, fodder crops, crop residues, or similar material removed from a block or exported from the farm.*

N inputs from fertiliser and supplements are unchanged. N removed in products and in supplements (crops harvested or grazed off) increases for most analyses with crops, and N removed by leaching and to the atmosphere mostly decreases, consistent with the higher crop N uptake. N added in rain is unchanged, as it is a fixed amount; the N fixed from the atmosphere by clover and other legumes changes slightly, in both directions.

Nitrogen pools

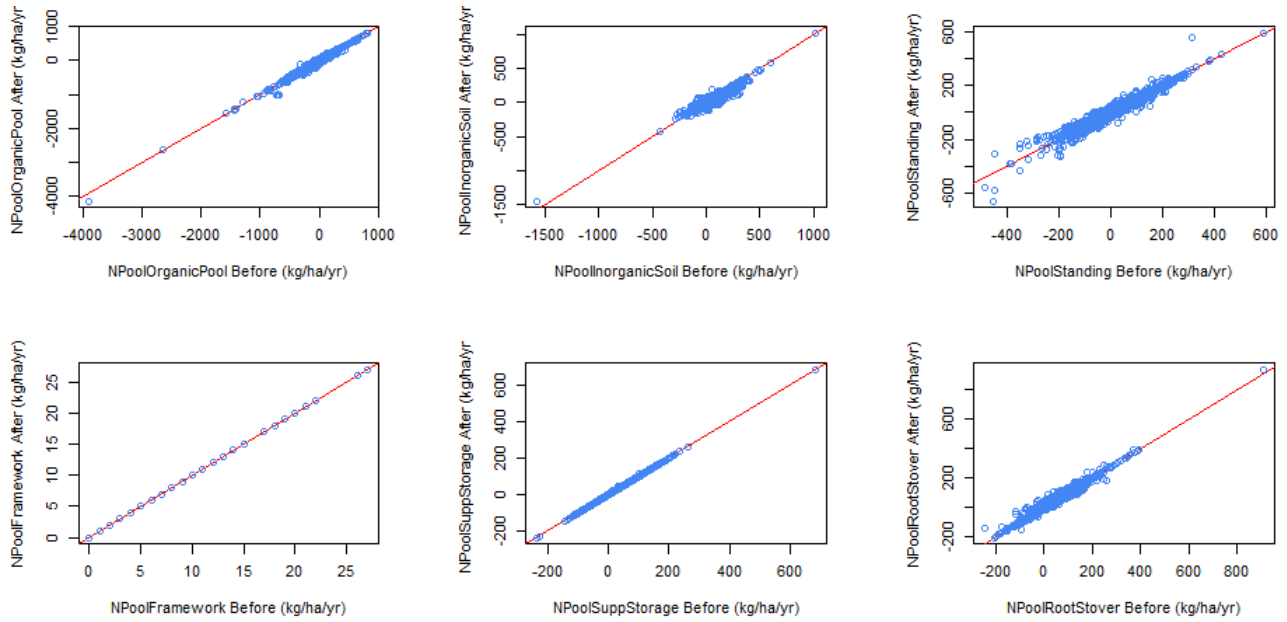


Figure 12: Nitrogen pools

***How to read this figure.** Each panel compares the change in a nitrogen pool before and after the update. Points close to the red line indicate that the update did not materially alter that pool.*

***NPoolOrganicPool**: Change in nitrogen held in the organic pool, including net immobilisation/mineralisation into soil organic matter and, where relevant, accumulation in effluent storage ponds.*

***NPoolInorganicSoil**: Change in the plant-available inorganic soil nitrogen pool, representing the inorganic/mineral N pool balance after additions, removals, and transformations.*

***NPoolStanding**: Change in nitrogen held in standing plant material between the beginning and end of the reporting year.*

***NPoolFramework**: Nitrogen accumulated in perennial crop framework, especially above- and below-ground fruit crop framework growth.*

***NPoolSuppStorage**: Change in nitrogen held in stored supplements, reflecting changes in supplement storage over the reporting period.*

***NPoolRootStover**: Change in nitrogen held in root and stover residues between the beginning and end of the reporting year.*

N in root and stover residues mostly increases, as larger roots and residues return more N to the soil. Inorganic soil N mostly decreases, as crops take up more of it. The organic and standing plant pools change in both directions, depending on when crops are grown and grazed or harvested in the rotation.

Grass-fed Standard (dairy herds)

The Grass-fed Standard report of the dairy herd is available before and after the update for 117,624 analyses. Dairy replacements are not included. The report gives the days the herd is on the farm, the grazing days (days with at least 8 hours a day on pasture), the percentage of time with access to pasture and the percentage of the diet from grass-fed feed.

Grass-fed Standard figures that changed, out of 117,624 dairy analyses

Measure	Changed	Increased	Decreased
Days on farm	0	0	0
Grazing days	818	158	660
Time with access to pasture (%)	25,834	240	25,594
Diet from grass-fed feed (%)	3,179	1,302	1,877

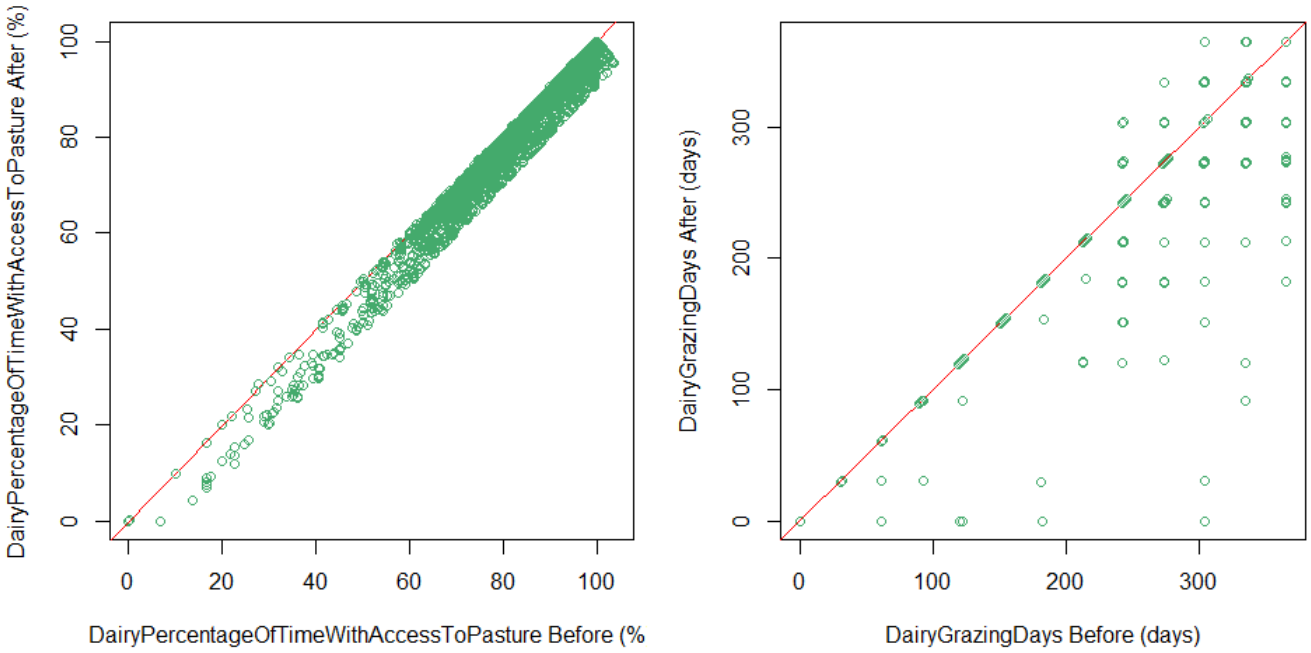


Figure 13: Grass-fed Standard, time with access to pasture and grazing days

How to read this figure. *Each point compares the same dairy herd before and after the update. Points on the red 1:1 line are unchanged; points below the line decreased after the update.*

DairyPercentageOfTimeWithAccessToPasture*: Grass-fed Standard: percentage of the dairy herd's time on the farm, less milking time, that is not spent on a feed pad, wintering pad or stand-off pad.*

DairyGrazingDays*: Grass-fed Standard: days on which the dairy herd has at least 8 hours on pasture, once milking time and time on pads are taken off.*

Distribution of the change in time with access to pasture

Change (percentage points)	Number	Frequency (%)
< −5	2,096	1.8
−5 to −2	2,171	1.8
−2 to −1	1,961	1.7
−1 to −0.5	1,882	1.6
−0.5 to −0.1	17,484	14.9
unchanged	91,789	78.0
0.1 to 0.5	231	0.2
> 0.5	9	0.0

Change in grazing days (days with at least 8 hours on pasture)

Change in grazing days	Analyses
Fewer: 120 to 304 days (4 to 10 months)	123
Fewer: 88 to 92 days (3 months)	59
Fewer: 60 to 62 days (2 months)	159
Fewer: 30 or 31 days (1 month)	316
Fewer: 1 day	3
More: 30 or 31 days (1 month)	92
More: 61 days (2 months)	66

Days on the farm. Unchanged for all 117,624 dairy herds, as expected.

Time with access to pasture. Of the 117,624 herds, 25,834 (22.0%) show a change and 91,789 (78.0%) are unchanged. Almost all changes are decreases (25,594, against 240 small increases of at most 0.8 percentage points). Most decreases are small: 17,484 are between −0.1 and −0.5 percentage points, and 2,096 exceed −5 percentage points, down to −11 percentage points. The largest decreases are herds that spend long hours on a covered wintering pad for much of the year: their time on the pad used to be shortened by the milking time. The small increases are herds on a feed pad or stand-off pad: no milking time is now taken off during the dry period.

Grazing days. 818 herds (0.7%) change their grazing days: 660 decreases and 158 increases. A day counts as a grazing day when the herd has at least 8 hours on pasture. Decreases are herds on a wintering pad or a stand-off pad during the milking period, where the hours left on pasture once milking (farm dairy and lanes) is taken off now fall below 8 hours a day. Increases are herds on a pad in winter, where days in the dry period now reach 8 hours because no milking time is taken off.

123 analyses (20 farms) lose more than 100 grazing days. The analyses checked against their inputs all follow the same pattern: the herd spends 14 to 16 hours a day on a wintering pad, with the hours on the pad entered during the milking period. Before the correction, all 8 to 10 hours off the pad counted as time on pasture, so these days passed the 8-hour test. Now the milking time comes out of those hours, which leaves fewer than 8, and the lost days add up over the milking period. Days in the dry period still count, as no milking time is taken off. Days with more than 16 hours a day on the pad already failed the test before the correction. The largest change, from 304 to 0 grazing days, is a proposed dairy system with the herd on a covered wintering pad 16 hours a day in ten months and all day in the other two.

Diet from grass-fed feed. The share of the diet from grass-fed feed changes in 3,179 herds, all on farms with crops, by −0.2 to +1.1 percentage points. This is not part of the Grass-fed Standard correction: the repeated crop N calculation of the dynamic crop N uptake slightly changes the crops available as feed and so the diet, which also slightly changes enteric methane in most of these herds.

Conclusions

The 6.6.0 changes mainly affect farms with crops, on crop blocks or as fodder crops on pastoral blocks: farms without crops show no change in N loss. On farms with crops, N loss decreases on average, mainly where cereals are grown, and increases mainly where kale is grown; the timing of crops in the rotation decides the direction for some rotations. Nitrous oxide from crop residues increases on most arable and vegetable rotations. P loss changes very little, through the irrigation applied to crops. A bug correction also lowers the GHG emissions of the few farms with outdoor pigs, whose methane from dung and effluent halves, and another reduces the time with access to pasture in the Grass-fed Standard report of dairy herds using a wintering pad. The main variations identified in this assessment are consistent with the changes implemented in version 6.6.0. 72 dairy analyses with crops will need their feed inputs reviewed to produce a result.

Overseer

Appendix: glossary of plotted variables

This glossary defines the variables plotted in the impact-assessment graphs. The same definitions are also shown in shortened form near the relevant graphs so that the figures can be read without referring back to the appendix.

Variable	Definition
NLossPerHa	Total modelled nitrogen loss per hectare, expressed as kg N/ha/year. This includes nitrogen lost to water and relevant loss pathways aggregated in the model output.
PLossPerHa	Total modelled phosphorus loss per hectare, expressed as kg P/ha/year.
GHGPerHa	Total modelled greenhouse gas emissions per hectare, expressed as kg CO2e/ha/year. This aggregates methane, nitrous oxide, carbon dioxide, and embodied emissions reported in CO2equivalent units.
CH4Total	Total methane emissions, expressed as CO2equivalent per hectare/year. This includes enteric methane, dung-related methane, and effluent-related methane.
CH4Enteric	Methane emissions from enteric fermentation by animals. Enteric methane is calculated from dry matter intake and an enteric methane emission factor.
CH4Dung	Methane emissions from dung/manure decomposition, excluding the effluent-system component where this is reported separately.
CH4Effluent	Methane emissions associated with dung/excreta managed through the effluent system, including effluent storage and treatment pathways.
N2OTotal	Total nitrous oxide emissions, expressed as CO2equivalent per hectare/year in the impact plots. This includes direct and indirect N2O sources.
N2OExcretaPaddock	Nitrous oxide emissions from animal excreta deposited directly onto paddocks or pasture.
N2OExcretaEffluent	Nitrous oxide emissions associated with effluent, including emissions from effluent management and/or land-applied effluent.
N2ONFertiliser	Nitrous oxide emissions from nitrogen fertiliser inputs added to soil.
N2OCrops	Nitrous oxide emissions associated with crop residues, cultivation, or crop-related nitrogen inputs.
N2OIndirect	Indirect nitrous oxide emissions associated with nitrogen lost from the farm through volatilisation and leaching pathways.
CO2Total	Total carbon dioxide and embodied carbon dioxide emissions, expressed as CO2equivalent per hectare/year in the impact plots.
CO2SuppsTotal	CO2equivalent emissions from supplements: supplements imported, fuel used to make supplements, and fuel used to feed them out.
CO2SuppsFeeding	CO2equivalent emissions from the fuel used to feed out supplements (part of CO2SuppsTotal).
CO2Other	Aggregate CO2equivalent emissions from minor Other CO2 sources, including animal health products, refrigerant losses, plastics, re-grassing, parasite control products, chemical sprays, other farm chemicals, effluent treatments, and residual other CO2 items.
CO2EffTreatment	Carbon dioxide or embodied CO2equivalent emissions associated with effluent treatment.
NCE	Nitrogen Conversion Efficiency: the percentage of estimated nitrogen removed in products relative to the estimated nitrogen inputs used for production.
NSurplus	Nitrogen surplus: estimated nitrogen inputs used for production minus estimated nitrogen removed in products. Inputs include sources such as fertiliser, imported feed, irrigation water, and clover fixation; removals include products such as milk, meat, wool, and crops.
NAddedFoliarSprays	Nitrogen added in foliar sprays, mainly relevant to fruit crop blocks where sprays are included in the nutrient budget.
NAddedFertiliser	Nitrogen added as fertiliser, organic material, imported effluents, and related fertiliser-type nutrient inputs. For N specifically, this primarily represents fertiliser and organic/effluent N additions.

Variable	Definition
NAddedIrrigation	Nitrogen added in irrigation water.
NAddedSupplements	Nitrogen imported onto the farm in supplements, including brought-in supplements, stored supplements fed out, farm-grown supplements fed on the block, crops fed, and animal health supplements where included.
NAddedRainFixation	Nitrogen added through rainfall deposition and biological nitrogen fixation, especially clover or other N-fixing sources.
NRemovedLeaching	Nitrogen removed from the root zone or farm system through leaching, including urine-patch and background leaching where aggregated.
NRemovedProduct	Nitrogen removed in products sold or exported from the farm system, such as milk, meat/liveweight, wool, velvet, crops, fruit, or other products.
NRemovedPrunings	Nitrogen removed in prunings, mainly relevant to fruit crop blocks.
NRemovedTransfer	Net nitrogen transfer by animals between blocks or structures, such as nutrients consumed on one block and deposited elsewhere via excreta, including transfers involving pads, lanes, races, farm dairies, and wintering pads.
NRemovedEffluent	Nitrogen removed from the farm in exported effluent.
NRemovedAtmosphere	Nitrogen lost to the atmosphere, including volatilisation and denitrification losses. Denitrification includes nitrous oxide emissions.
NRemovedSupplements	Nitrogen removed as supplements, fodder crops, crop residues, or similar material removed from a block or exported from the farm.
NPoolOrganicPool	Change in nitrogen held in the organic pool, including net immobilisation/mineralisation into soil organic matter and, where relevant, accumulation in effluent storage ponds.
NPoolInorganicSoil	Change in the plant-available inorganic soil nitrogen pool, representing the inorganic/mineral N pool balance after additions, removals, and transformations.
NPoolStanding	Change in nitrogen held in standing plant material between the beginning and end of the reporting year.
NPoolFramework	Nitrogen accumulated in perennial crop framework, especially above- and below-ground fruit crop framework growth.
NPoolSuppStorage	Change in nitrogen held in stored supplements, reflecting changes in supplement storage over the reporting period.
NPoolRootStover	Change in nitrogen held in root and stover residues between the beginning and end of the reporting year.
DairyPercentageOfTimeWithAccessToPasture	Grass-fed Standard: percentage of the dairy herd's time on the farm, less milking time, that is not spent on a feed pad, wintering pad or stand-off pad.
DairyGrazingDays	Grass-fed Standard: days on which the dairy herd has at least 8 hours on pasture, once milking time and time on pads are taken off.