Release Notes – for Overseer version 6.3.3

Version 6.3.3 corrects some modelling implementation errors with fertiliser applications, irrigation and how end weights are handled for some animal mobs.

It also updates the emission factors that are used to calculate farm GHG emissions.

This note explains the changes and the impact of them on the modelled results.

Contents

1. Overall impact

Using the farm information held in OverseerFM we can identify the proportion of farms that had changes to their results as a result the changes in this version release.

In the table below, each row shows the percentage of farms that had a change in results in the range specified.

% change	N loss/ha	P loss/ha	GHG/ha
>10% increase	0.3%	0.4%	4%
0 to 10%	10.3%	1.0%	47%
no change	86.7%	98.3%	1%
0 to -10%	2.5%	0.1%	48%
> 10% decrease	0.2%	0.2%	1%

Because we have changed most of the emissions factors, we expected to see a high proportion of farms showing changes in GHG emissions estimates. Only 1% of farms have not seen a change in GHG emissions and most changes are within a 10% increase or decrease. See section 5 for details about the changes.

Only the farms with specific data entries that have been affected by the fertiliser, irrigation and animal weight changes outlined below will show differences in N and P loss. We can see that just under 87% of farms have not had a change in N-loss and just over 98% of farms have not had a change in P-loss. Less than 1% of farms will have a significant increase or decrease in N and P losses (over 10% change). If your results are in this category and you have not been contacted by us, please contact the helpdesk.

2. Fertiliser applications using tonnes/kgs

When adding fertiliser to pasture blocks, the amount of fertiliser should only be applied to the area of pasture excluding any fodder block rotations. These fodder rotations should be fertilised separately.

Fertiliser applications entered as tonnes or kilograms that are applied to more than one block or soil are converted to kg/ha by the system before calling the model. If a pasture block that is being fertilised has fodder crop blocks rotating through it, this conversion included the fodder block area and so the incorrect area was used in the calculation.

In some cases, users may have thought that by fertilising the pasture block, OverseerFM does include the fodder block and so this fix will have incorrectly changed the result for the farm. Messaging has been added to the fertiliser screens to explain this, but this should be checked by users and appropriate changes made.

Impact

There are a small number of farms that have relatively large fodder crop rotations as a proportion of the farm and have added fertiliser in this way.

There are approximately 1200 analyses that have entered fertiliser by tonnes or kgs and have fodder blocks on the farm. We assessed the changes for 1000 of these analyses which represents 402 farms. Of the 402 farms, 160 had no change and 280 had change by less than 1%. There are a few farms that have had a significant change and the consultants working on these farms have been contacted.

3. Rounding of irrigated area of blocks

When calculating the irrigated area of a block based on a drawn irrigation area, the system is rounding the value to a whole number and so resulting allocation of area to irrigation can be slightly off. We have changed this to now keep decimal places to make it more precise.

Impact

This change has very little impact. The maximum change for existing farms was 0.5%.

4. Sheep birthing proportions

A review of the code identified a defect affecting the way proportions were being allocated to twins and triplets when calculating ME requirements of sheep. This has been corrected.

Impact

Little impact is seen from this correction. A single analysis saw a 1.5% decrease in N-loss results, some will see a loss of between 1 and 0.5%.

5. End weights for mobs

Where "end weight for unsold animals in June" is entered for a mob and animals are sold using default weight during the year, the model used the end weight as the final weight of the animals being sold, which over-estimated the weight of those animals.

The end weight on a mob will now only be applied to any animals that remain on the farm at the end of June. If default weight is used for any sales prior to June, the model will calculate the weight based on a typical weight gain from on the starting weight of the mob. Users are advised to enter weight at sale if it is known.

Use of end weight on mobs maybe be ambiguous to some users, particularly if all animals are sold prior to June. Some messaging has been added to better explain how it is used.

Impact

A relatively low number of farms are affected by this change, but for a few it can make a reasonable difference to the results. Those consultants working with the farms most affected are being contacted.

6. Updates to the emission factors for calculating farm GHG emissions

A review of the emission factors used by OverseerFM identified updates are needed to align with new data. The full table of changes and the source references for the changes are listed in Appendix A.

Significant changes have been made to emissions factors for soya bean meal, fishmeal, refrigerant and kumara (which previously used potato).

What are the GHG emissions in Overseer?

OverseerFM estimates greenhouse gas (GHG) emissions for the farm. These are presented as individual emissions per source (e.g. enteric methane per enterprise, N_2O from N fertiliser) and per product (e.g. per kg of meat or milk).

Because Overseer is a farm scale model, the modelling accounts for all direct and embodied GHG emissions up to the point that the product is ready to leave the farm for processing. This includes embodied emissions of feeds and fertiliser brought into the farm and the emissions of the activities undertaken on farm.

The paper GREENHOUSE GAS FOOTPRINTING USING OVERSEER® – 'THE WHOLE PICTURE' David Wheeler, S Ledgard and M Boyes (2011) describes the methods used to allocate total farm GHG emissions to a product footprint and to calculate the farm emissions on an area basis.

http://flrc.massey.ac.nz/workshops/11/Manuscripts/Wheeler_1_2011.pdf

Equation Update

As part of the review of emissions factors, an equation was also identified for updating.

The old equation to allocate between milk and meat on a dairy farm was AF = 1 – 5.7717*R

The updated allocation now accounts for the CO_2 from crop burning, aligned with the NZ National Inventory (section 2.4) from the source IDF (2015).

The new allocation equation is AF = 1-6.04*R

Where AF = allocation factor to milk

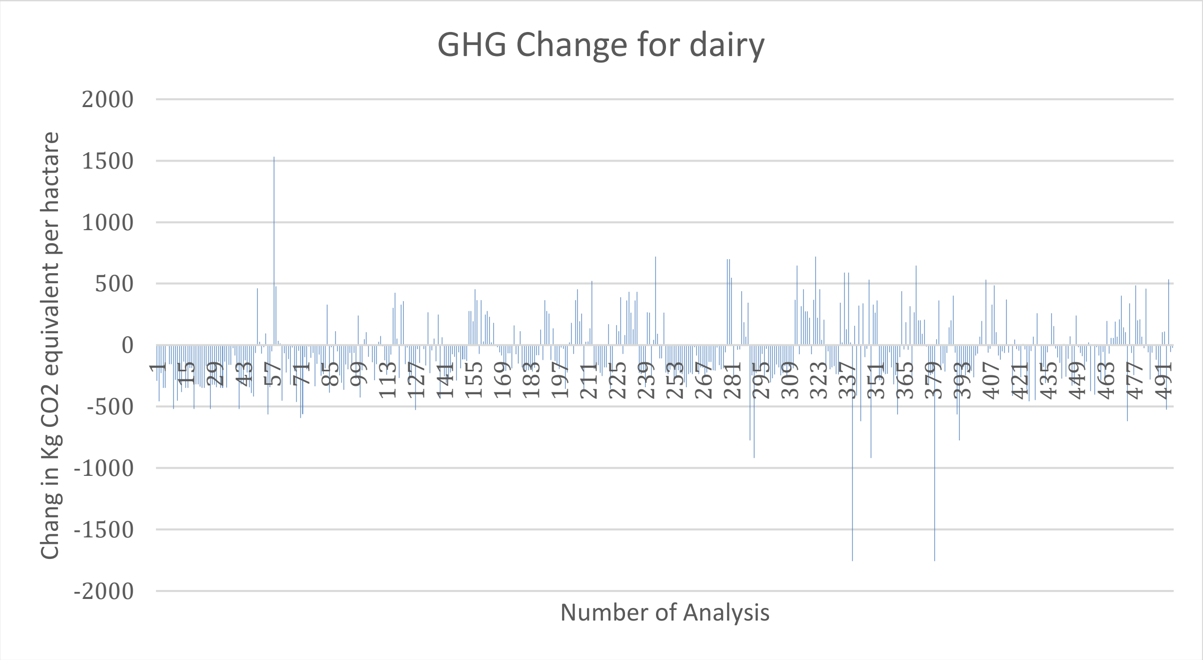
R = kg liveweight sold/kg Fat and Protein Corrected Milk (FPCM)

Impact

The following charts show the differences in Kg's of CO_2e per hectare for sample sets of farms that are in OverseerFM. There are a small number of farms that have a significant increase as a result of using large amounts of soya bean meal as a feed supplement.

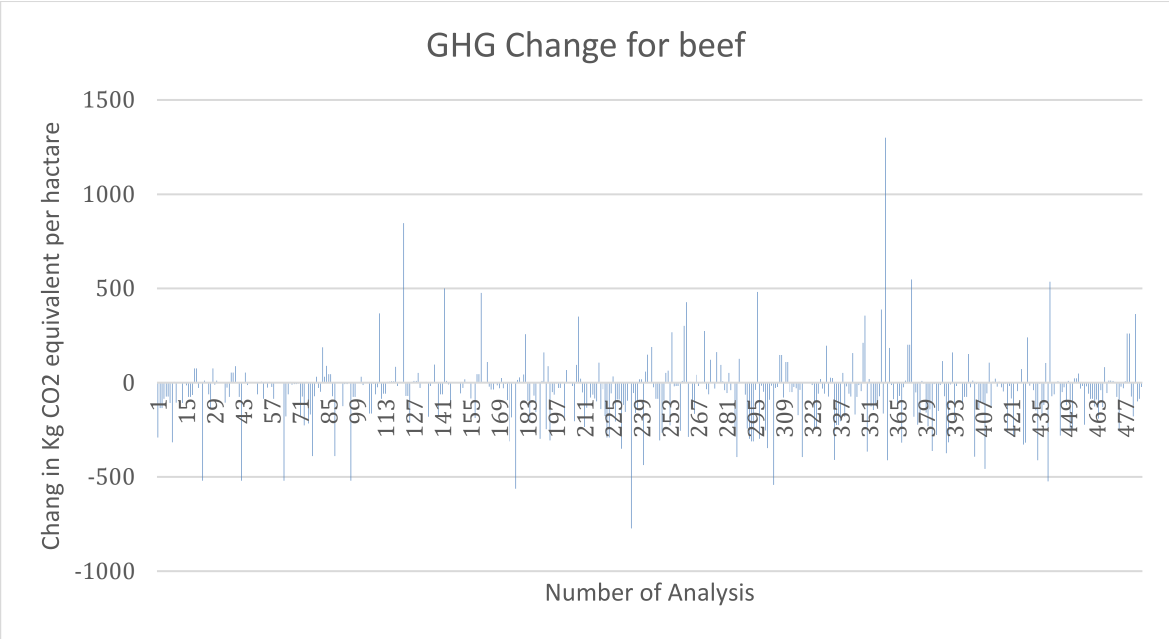
Farms with Dairy Enterprises

Of the 500 sample farms two have large amounts of soya bean meal and so had changes of 11,000 and 17,000 Kg CO_2e. The rest of the farm changes are shown in the chart below.



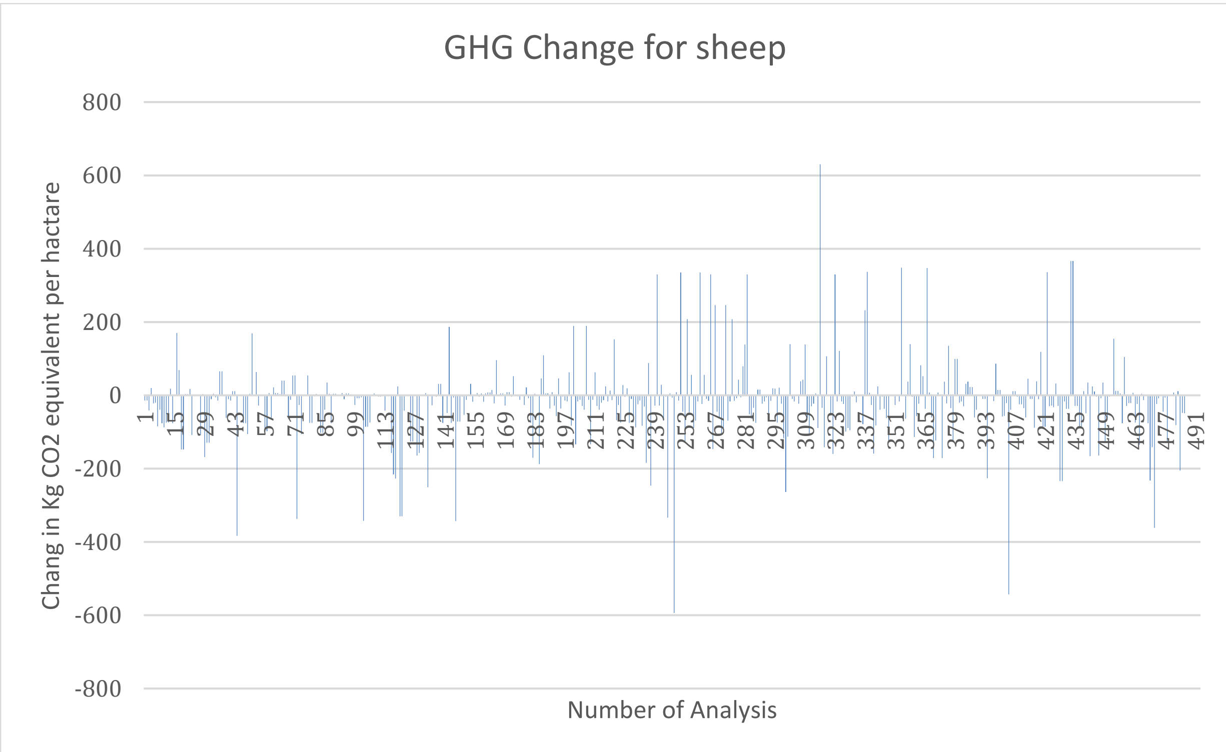
Farms with Beef Enterprises

Of the 500 sample farms four analyses (3 farms) that have large amounts of soya bean meal and so had changes of 12, 11, 7 and 4 thousand Kg CO_2e. The rest of the farm changes as shown in the chart below.



Farms with Sheep Enterprises

Of the 500 sample farms one analyses has a large amount of soya bean meal and so had a change of 2 thousand Kg CO_2e. The rest of the farm changes as shown in the chart below.



Carbon TMC Section	Input	Units	Old Emission Factor	New Emission Factor	Source
Table 1	Electricity				
	Electricity	kg CO2 equivalents / kWh	0.27	0.143	grid mix from MBIE 2018, modified ecoinvent v3.5 process
Table 2	Fuel				This table was updated using the previous processes.
	Diesel	kg CO2 equivalents / litre	2.989	2.988	
	Petrol	kg CO2 equivalents / litre	2.773	2.845	
	Engine Oil	kg CO2 equivalents / litre	0.79	1.08	
	Aviation fuel	kg CO2 equivalents / litre	2.608	2.89	
Table 3	Transport				
	Truck (50% loading)	kg CO2 equivalents / tkm	0.093	0.093	Nebel 2008, using updated emission factors
	Truck (85% loading)	kg CO2 equivalents / tkm	0.065	0.064	Nebel 2008, using updated emission factors
	Rail	kg CO2 equivalents / tkm	0.025	0.0389	Ecoinvent v3.5
	Shipping	kg CO2 equivalents / tkm	0.0132	0.0089	Ecoinvent v3.5
	Transport, lorry 3.5-7.5t, EURO6	kg CO2 equivalents / tkm	0.5514	0.4075	Ecoinvent v3.5
	Transport, lorry 7.5-16t, EURO6	kg CO2 equivalents / tkm	0.2912	0.175	Ecoinvent v3.5
	Transport, lorry 16-32t, EURO6	kg CO2 equivalents / tkm	0.137	0.1349	Ecoinvent v3.5
	Transport, lorry >32t, EURO6	kg CO2 equivalents / tkm	0.0924	0.068	Ecoinvent v3.5
Table 12	Imported Supplements				
Hay	Pasture good quality hay	kg CO2 equivalents/kg DM	0.129	0.18	Ledgard and Falconer, 2015
	Pasture average quality hay	kg CO2 equivalents/kg DM	0.129	0.18	Ledgard and Falconer, 2015
	Pasture poor quality hay	kg CO2 equivalents/kg DM	0.129	0.18	Ledgard and Falconer, 2015
	Lucerne good quality hay	kg CO2 equivalents/kg DM	0.129	0.18	no new data on this, so could assume it is the same as pasture hay
	Lucerne average quality hay	kg CO2 equivalents/kg DM	0.129	0.18	no new data on this, so could assume it is the same as pasture hay

	Lucerne poor quality hay	kg CO2 equivalents/kg DM	0.129	0.18	no new data on this, so could assume it is the same as pasture hay
Silages	Pasture good quality silage	kg CO2 equivalents/kg DM	0.15	0.201	Ledgard and Falconer, 2015, updated with new emission factors
	Pasture average quality silage	kg CO2 equivalents/kg DM	0.15	0.201	Ledgard and Falconer, 2015, updated with new emission factors
	Pasture poor quality silage	kg CO2 equivalents/kg DM	0.15	0.201	Ledgard and Falconer, 2015, updated with new emission factors
	Baleage	kg CO2 equivalents/kg DM	0.15	0.201	Ledgard and Falconer, 2015, updated with new emission factors
	Maize silage	kg CO2 equivalents/kg DM	0.171	0.174	Ledgard and Falconer, 2015, updated with new emission factors
	Cereal silage	kg CO2 equivalents/kg DM	0.15	0.209	Ledgard and Falconer, 2015, updated with new emission factors
	Triticale silage	kg CO2 equivalents/kg DM	0.211	0.185	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Lucerne silage	kg CO2 equivalents/kg DM	0.15	0.15	no new data on this, so could assume it is the same as previous value
	Barley milky dough silage	kg CO2 equivalents/kg DM	0.15	0.209	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
Straws	Barley straw	kg CO2 equivalents/kg DM	0.025	0.049	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Wheat straw	kg CO2 equivalents/kg DM	0.025	0.048	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Oat straw	kg CO2 equivalents/kg DM	0.025	0.033	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Ryegrass straw	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low

					embodied emissions.
	Pea straw	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Corn stover	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
Green feeds	Annual ryegrass	kg CO2 equivalents/kg DM	0.844	0.844	no new data on this, so could assume it is the same as previous value
	Turnips	kg CO2 equivalents/kg DM	0.531	0.264	Ledgard and Falconer, 2015, updated with new emission factors
	Kale	kg CO2 equivalents/kg DM	0.292	0.220	Ledgard and Falconer, 2015, updated with new emission factors
	Rape	kg CO2 equivalents/kg DM	0.396	0.353	Ledgard and Falconer, 2015, updated with new emission factors
	Oats leafy	kg CO2 equivalents/kg DM	0.196	0.231	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Oats milky dough	kg CO2 equivalents/kg DM	0.196	0.231	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Sorghum	kg CO2 equivalents/kg DM	0.196	0.199	proxy: maize green feed
	Japanese millet	kg CO2 equivalents/kg DM	0.196	0.199	proxy: maize green feed
	Maize green feed	kg CO2 equivalents/kg DM	0.196	0.199	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Sulla	kg CO2 equivalents/kg DM	0.55	0.55	no new data on this, so could assume it is the same as previous value
Grains Grain/pulses	Barley grain	kg CO2 equivalents/kg DM	0.47	0.356	Ledgard and Falconer, 2015, updated with new emission factors
	Wheat grain	kg CO2 equivalents/kg DM	0.47	0.343	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5

	Oats grain	kg CO2 equivalents/kg DM	0.47	0.423	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Maize grain	kg CO2 equivalents/kg DM	0.47	0.267	AgResearch supplementary feed models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Peas	kg CO2 equivalents/kg DM	0.55	0.55	no new data on this, so could assume it is the same as previous value
	Soya bean meal	kg CO2 equivalents/kg DM	0.55	5.417	assume imported from Argentina, using an AgriFootprint model with transport to NZ included
Vegetables	Potatoes	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Onions	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Cabbage	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Carrots	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Kiwifruit	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Squash	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Apples	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Apple pomace	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Grape pomace	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.
	Citrus pulp	kg CO2 equivalents/kg DM	0.025	0.025	assumed to be waste and hence have low embodied emissions.

Byproducts	Brewers grain	kg CO2 equivalents/kg DM	0.45	0.003	Ledgard and Falconer, 2015, updated with new emission factors
	Bran	kg CO2 equivalents/kg DM	0.197	0.192	modified Wheat Bran process (ecoinvent v3.5) using NZ specific inputs
	Pollard	kg CO2 equivalents/kg DM	0.197	0.192	proxy: wheat bran
	Avonfeed	kg CO2 equivalents/kg DM	0.197	0.147	modified ecoinvent v3.5 process (By-product of the production of maize flour) using NZ specific inputs
	Lucerne meal	kg CO2 equivalents/kg DM	0.505	0.129	proxy: lucerne hay (based on old data)
	Molasses	kg CO2 equivalents/kg DM	0.099	0.181	assume imported from Australia, using a modified AgriFootprint model with transport to NZ included
	Palm kernel meal	kg CO2 equivalents/kg DM	0.338	0.502	Ledgard and Falconer, 2015, updated with new emission factors
	Canola	kg CO2 equivalents/kg DM	0.505	0.267	using a modified Australian model in the AusAgLCI life cycle inventory project (https://www.agrifutures.com.au/wp-content/uploads/publications/14-046.pdf)
	Copra	kg CO2 equivalents/kg DM	0.197	0.197	no new data on this, so could assume it is the same as previous value
	Cottonseed meal	kg CO2 equivalents/kg DM	0.505	0.35	using new emission factors from ecoinvent v3.5
	Fishmeal	kg CO2 equivalents/kg DM	6.681	1.3	using new emission factors from ecoinvent v3.5
	Proliq	kg CO2 equivalents/kg DM	0.505	0.505	no new data on this, so could assume it is the same as previous value
	Corn grits/hominy	kg CO2 equivalents/kg DM	0.197	0.147	proxy: Avonfeed
Table 13	User defined imported supplements				
	Grass silage	kg CO2 equivalents/kg DM	0.15	0.201	Ledgard and Falconer, 2015, updated with new emission factors
	Maize & Cereal Silage	kg CO2 equivalents/kg DM	0.171	0.174	Ledgard and Falconer, 2015, updated with

					new emission factors
	Concentrates	kg CO2 equivalents/kg DM	0.15	0.356	Ledgard and Falconer, 2015, updated with new emission factors
	Whole grain	kg CO2 equivalents/kg DM	0.47	0.347	Ledgard and Falconer, 2015, updated with new emission factors
	Other (Palm Kernel)	kg CO2 equivalents/kg DM	0.3378	0.502	Ledgard and Falconer, 2015, updated with new emission factors
Table 14	Exported supplements for the area report				
	Hay	kg CO2 equivalents/kg DM	0.129	0.18	Ledgard and Falconer, 2015, updated with new emission factors
	Silages	kg CO2 equivalents/kg DM	0.15	0.201	Ledgard and Falconer, 2015, updated with new emission factors
	Baleage	kg CO2 equivalents/kg DM	0.15	0.201	Ledgard and Falconer, 2015, updated with new emission factors
Table 15	Fertiliser products	All fertiliser data was based on previous NZ data with minor modifications only, using updated emission factors (but note not updated according to current sources and manufacturing processes)			
	Urea	kg CO2 equivalents/kg	1.06	1.06	
	Calcium ammonium nitrate (CAN)	kg CO2 equivalents/kg	1.93	1.85	
	Sulphate of ammonia (SOA)	kg CO2 equivalents/kg	0.61	0.54	
	NZ Single superphosphate (SSP)	kg CO2 equivalents/kg	0.22	0.22	
	KCl	kg CO2 equivalents/kg	0.58	0.53	
	K2SO4	kg CO2 equivalents/kg	0.77	0.77	
	DAP	kg CO2 equivalents/kg	1.12	1.06	
	Triple superphosphate (TSP)	kg CO2 equivalents/kg	0.6	0.96	
	PR	kg CO2 equivalents/kg	0.32	0.24	
	Elemental S	kg CO2 equivalents/kg	2.33	2.33	
	MgO	kg CO2 equivalents/kg	2.82	2.82	
Table 17	Lime	kg CO2 equivalents/kg lime	0.004	0.004	Ledgard et al. (2011)
Table 19	Parasite control	based on an update of previous processes; relatively old data			
	Sheep	kg CO2 equivalents/animal	0.010001	0.01163773	

	Beef and dairy	kg CO2 equivalents/animal	0.005604	0.006521333	
	Deer and other, Outdoorpig	kg CO2 equivalents/animal	0.000075	0.000087	
	Dairy goat	kg CO2 equivalents/animal	0.00016	0.000185973	
	active ingredient	kg CO2 equivalents	7.42	10.07	using new emission factors from ecoinvent v3.5
Table 20	Bactericide, fungicide, herbicide and insecticide use				
	Pastoral	The only changes throughout this Table are updates of emission factors using the previous processes			
	Dairy	kg CO2 equivalents/ha	1.9	2.7	
	Dairy replacements	kg CO2 equivalents/ha	0.5	1.18	
	Sheep and beef	kg CO2 equivalents/ha	0.5	1.18	
	Deer and other	kg CO2 equivalents/ha	0.5	1.18	
	Forestry	kg CO2 equivalents/ha	2	3	
	Cut and carry	kg CO2 equivalents/ha	0.5	1.18	
	Fruit crops				
	Kiwifruit	kg CO2 equivalents/ha	179	243	
	Apples	kg CO2 equivalents/ha	267	363	
	Grapes (wine)	kg CO2 equivalents/ha	82	111	
	Peaches/Nectarines	kg CO2 equivalents/ha	339	460	
	Avocado	kg CO2 equivalents/ha	232	315	
	Vegetables				
	Carrots	kg CO2 equivalents/ha	113	153	
	Cauliflower/Cabbage/Brussels sprouts, Broccoli	kg CO2 equivalents/ha	90	122	
	Cucumber, Capsicum	kg CO2 equivalents/ha	151	204	
	Kumara	kg CO2 equivalents/ha	52	70	
	Lettuce	kg CO2 equivalents/ha	129	175	
	Onion/garlic	kg CO2 equivalents/ha	205	279	
	Peas, Beans, Lentils	kg CO2 equivalents/ha	25	33	
	Potatoes, Beets	kg CO2 equivalents/ha	147	199	

	Pumpkins	kg CO2 equivalents/ha	76	103	
	Silver beet, Spinach	kg CO2 equivalents/ha	65	88	
	Squash	kg CO2 equivalents/ha	100	136	
	Sweet corn	kg CO2 equivalents/ha	41	56	
	Tomatoes (outdoors)	kg CO2 equivalents/ha	157	213	
	Average	kg CO2 equivalents/ha	104	141	
	Fodder and green feed				
	Cereal silage or baleage	kg CO2 equivalents/ha	6	8	Annual ryegrass, Forage barley spring, Forage oats spring, Forage oats autumn, ryecorn spring, ryecorn autumn, Triticale spring, Triticale autumn
	Forage brassica	kg CO2 equivalents/ha	14	19	Lupin, Mustard, Oats and rye, Phacelia, Fodder beets, Kale, Raoe, Swedes, Turnip bulb, Turnip leafy
	Maize silage or baleage	kg CO2 equivalents/ha	29	39	
	Average	kg CO2 equivalents/ha	16	22	
	Grain				
	Barley	kg CO2 equivalents/ha	16	22	
	Maize-grain	kg CO2 equivalents/ha	29	39	
	Oats	kg CO2 equivalents/ha	4	64	
	Wheat	kg CO2 equivalents/ha	20	27	
	Average	kg CO2 equivalents/ha	17	24	
Table 21	Other chemicals				
	Acids and alkalis	kg CO2 equivalents/kg active ingredient	0.6	2.05	using new emission factors from ecoinvent v3.5
	Animal remedies (drench, bloat aids)	kg CO2 equivalents/kg active ingredient	13	13	Wells, 2001
	Other chemicals	kg CO2 equivalents/kg active ingredient	13	13	Wells, 2001
Table 22	Plastics				

	On-farm supplement wrap	kg CO2 equivalents/kg DM	0.01237	0.01321	using new emission factors from ecoinvent v3.5
	HDPE plastics Dairy	kg CO2 equivalents/ha	1.26	1.30	using new emission factors from ecoinvent v3.5
Table 24	Seed				
	Seed	kg CO2 equivalents/kg seed	0.6	0.983	AgResearch carbon footprint models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
Table 26	Pasture eaten while wintering off				
	Pasture eaten while wintering off	kg CO2 equivalents/kg DMI	0.088	0.064	AgResearch carbon footprint models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
Table 27	Pasture eaten while replacements are grazed off-farm				
	Pasture eaten while replacements are grazed off-farm	kg CO2 equivalents/kg DMI	0.0574	0.050	AgResearch carbon footprint models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
Table 28	Re-grassing pasture after growing fodder crops				
	Re-grassing (exclude N2O from crop residue)	kg CO2 equivalents/ha	496	393	AgResearch carbon footprint models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Re-grassing (include N2O from crop residue)	kg CO2 equivalents/ha	1540	1437.1	AgResearch carbon footprint models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Re-grassing (exclude N2O from crop residue, include maintenance fertiliser)	kg CO2 equivalents/ha	2679	3740.5	AgResearch carbon footprint models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
	Re-grassing (include N2O from crop residue and maintenance fertiliser)	kg CO2 equivalents/ha	3201	4262.4	AgResearch carbon footprint models, using NZ specific inputs and background emission factors from Ecoinvent v3.5
Table 33	Refrigerant	kg CO2 equivalents/litre of milk	0.002371	0.000865	using new emission factors from ecoinvent v3.5

References:

Ledgard, S. F. and Falconer, S. J. (2015). Total Greenhouse Gas Emissions from Farm Systems with Increasing Use of Supplementary Feeds across Different Regions of New Zealand. Report for MPI. RE500/2015/033. AgResearch, Hamilton, New Zealand. 70p.

Ecoinvent Reference: Wernet, G.; Bauer, C.; Steubing, B.; Reinhard, J.; Moreno-Ruiz, E. and Weidema, B. (2016). The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment 21. 1218-1230.

AgriFootprint Reference: Durlinger, B., Tyszler, M., Scholten, J., Broekema, R., Blonk, H., & Beatrixstraat, G. (2014, October). Agri-Footprint; a Life Cycle Inventory database covering food and feed production and processing. In Proceedings of the 9th International Conference on Life Cycle Assessment in the Agri-Food Sector (Vol. 2009, pp. 310-317).