Independent
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Updated: Review of Models Calculating Farm Level GHG Emissions #2

Prepared for He Waka Eke Noa

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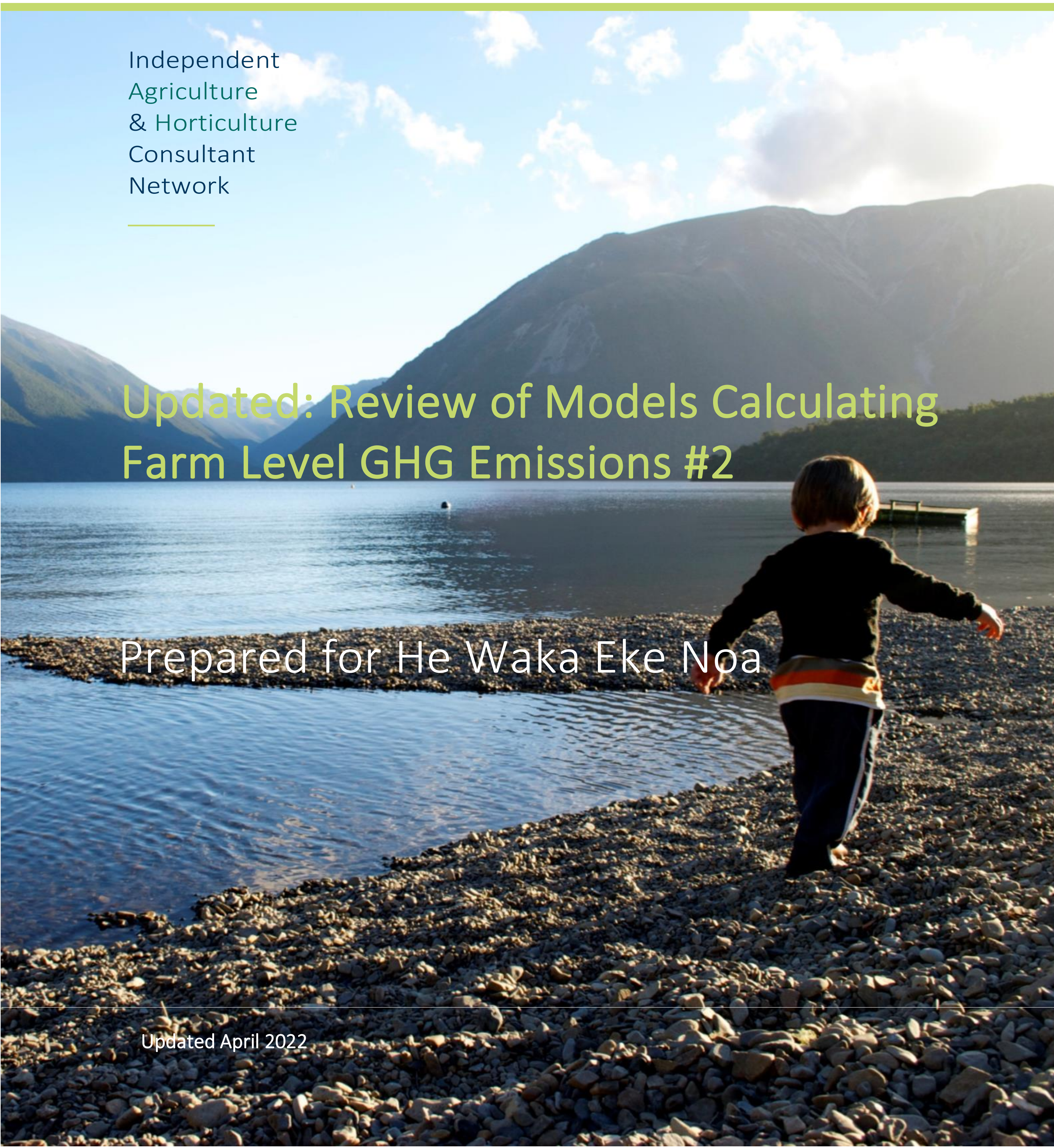

Authors:
Phil Journeaux, AgFirst Waikato
Louis Batley, AgFirst Manawatu-Whanganui
Erica van Reenen, AgFirst Manawatu-Whanganui

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Abbreviations

% methane – this refers to the percentage of methane in terms of total greenhouse gases, which is a combination of methane and nitrous oxide.

AR4 – Fourth Assessment Report by the IPCC.

B+LNZ – Beef + Lamb New Zealand.

CH_4 – Methane.

CO_2 – Carbon dioxide.

CO_2 e – Carbon dioxide equivalents. Often expressed in kilograms (kg CO_2 e) or tonnes (t CO_2 e).

DMI – Dry Matter Intake. Amount of feed animal intakes. See KgDM.

FAR – Foundation for Arable Research

GWP_{100} – Global Warming Potential at 100 years. This is the metric used in the Fourth Assessment Report (AR4) by the Intergovernmental Panel on Climate Change (IPCC).

GHG – greenhouse gas.

ha – hectares.

KgDM – Kilograms of Dry Matter. Unit used to measure feed quantity.

kg/ha CH_4 - kilograms per hectare of methane. This metric is calculated by the total amount of methane produced on-farm divided by the total farm area.

kg/ha N_2O – kilograms per hectare of nitrous oxide. This metric is calculated by the total amount of nitrous oxide produced on-farm divided by the total farm area.

KgMS – kilogram of milk solid. The solid constituents of milk. It is used as a production metric on dairy farms.

ME – Metabolisable Energy. Unit for assessing feed quality and expressed as units of metabolisable energy per kilogram of dry matter in feed.

MfE – Ministry for the Environment.

MPI – Ministry for Primary Industries.

N – Nitrogen. Fertiliser component and a proxy to measure the protein content of a feed.

N_2O – Nitrous oxide.

S&B – Sheep and Beef.

1.0 EXECUTIVE SUMMARY

This report is the second of two reports commissioned by He Waka Eke Noa, as part of their five-year programme to implement a framework by 2025 to reduce agricultural greenhouse gas emissions and build the agriculture sector's resilience to climate change.

The programme has two early emissions reporting milestones:

- By the end of 2021, a quarter of farms in Aotearoa New Zealand know their annual total on-farm greenhouse gas emissions. In practice this means a person responsible for farm management holds a documented annual total of on-farm greenhouse gas emissions, *by methods and definitions accepted by the He Waka Eke Noa Steering Group.*

- By the end of 2022, 100 percent of farms know their annual total on-farm emissions.

In order to achieve these milestones, a draft set of minimum specifications for methods was developed by the Emissions Reporting Workstream of He Waka Eke Noa. In addition, a set of recommendations on presentation of the results were developed. An initial report (GHG-Model-Assessment-Report-25-March.pdf (hewakaekenoa.nz))was commissioned to assess the performance of seven models and calculators capable of calculating biological greenhouse gas (GHG) emissions against the set of draft minimum requirements for methods, and the recommended presentation of results. A further four models are assessed in this report. Three of these models were assessed in 2021 and an additional model was added to the updated report in 2022.

The methodology of assessment meant that the details of eight farming systems were provided by the relevant industry body to the model providers, who then ran the details of the farms through their models and provided a summary of inputs and outputs to be assessed. This report covers a second group of GHG calculators/tools, following on from the first assessment reported on in February 2021.

Models by farm type assessed in this report are summarised below:

Models	Waikato Dairy	Canterbury Dairy	High Country S&B	Southland Intensive S&B	S&B with dairy grazers	Deer	Arable Cropping
ProductionWise (FAR)							✓
Toitū farm emanage[1]	✓	✓	✓	✓	✓	✓	✓
B+LNZ GHG Calculator (B+LNZ)			✓	✓	✓	✓	
MyImprint Farm	✓	✓	✓	✓	✓	✓	

These were then assessed relative to the minimum requirements (Section 3.0), and the clarity of the outputs.

[1] Toitū farm emanage uses the on-farm GHG footprint and carbon sequestration estimates by OverseerFM

Collation of the resulting GHG emission figures for the same farm type across the different models (Section 6) showed some degree of variation across the different models. In part this is due to differences within models around key factors such as Dry Matter Intake (DMI), Metabolisable Energy (ME) and the percentage of nitrogen (% N) values of feed.

There were also some minor presentational issues with some of the models, e.g. not recording farm location or the area of the farm, which are currently part of the recommendations for presentation.

Forestry sequestration is included within three of the tools (B+LNZ GHG Calculator, Toitū farm emanage and MyImprint Farm). The forestry sequestration calculation methods for these three tools, as well as two of the tools assessed in the previous report, include sequestration rates and vegetation types outside of the current ETS rules. We consider that this may cause confusion and/or raise expectations about what will be accepted under the future pricing scheme. However, the He Waka Eke Noa minimum requirements include the expectation that peer-reviewed research is used to establish sequestration rates, rather than ETS rules. Evaluation of the underpinning research was outside the scope of this assessment.

Note that Toitū farm emanage uses OverseerFM as the base tool for calculating GHG emissions, and some aspects were therefore assessed as the same as OverseerFM (in the first report).

Classification of the models, as to their level of 'detailedness' is:

	Simple	Detailed
ProductionWise (FAR)	✓	
Farm emanage (Toitū)		✓
B+LNZ GHG Calculator (Beef + Lamb New Zealand)	✓	
MyImprint Farm	✓	

Coverage of the models by farm type are:

	Dairy	Sheep & Beef	Deer	Arable
ProductionWise				✓
Toitū farm emanage	✓	✓	✓	✓
B+LNZ GHG Calculator		✓	✓	
MyImprint Farm	✓	✓	✓	

Table 1: Summary of model outputs compared with inputs

Emissions source	Enteric Methane (CH_4)	Effluent Storage and dung deposited onto land (CH_4)	Total Methane from livestock	Effluent Storage (not effluent applied to land) (N_2O)	Agriculture Soils (N_2O): Simple Tools (single value encompassing direct & indirect)	Agriculture Soils (N_2O): Intermediate & Detailed tools: separates direct from Indirect (leaching)	Agriculture Soils (N_2O): Intermediate and Detailed tools: separates direct from Indirect (volatilisation)	Total Nitrous Oxide Emissions from livestock and fertilizers	CO_2 from application of Urea fertiliser to soil (if included in tool)
ProductionWise	NA	NA	NA	NA	NA	✓	NA	✓	✓
Toitū farm emanage	✓	✓	✓	✓	NA	NA	✓	✓	✓
B+LNZ GHG Calculator	✗	✗	✓	NA	NA	✓	NA	✓	✓
MyImprint Farm	✓	✓	✓	✓	✓	NA	NA	✓	✓

Table 2: Summary of models relative to draft minimum specifications and recommended presentation (detailed in section 3).

	Draft Minimum Specs for Methods				Presentation (area, address, system, context)					
	Valid emission factors (referenced)	Minimum inputs (livestock/fertiliser)	Model Structure/ equations	NZ Peer reviewed research for mitigation or sequestration	Reporting of GHG - metrics used	Area	Address or unique identification number	Farm system	HWEN context & sequestration statement	Tag if mitigations used are not in the NZI
ProductionWise	✓	✓	NIS	NIP	✓	✓	✓	✓	✗	NA
Toitū farm emanage	✓	✓	NIS	NIP	✓	✓	✓	✓	✗	NA
B+LNZ GHG Calculator	✓	✓	NIS	NIP	✗	✓	✓	✓	✗	NA
MyImprint Farm	✓	✓	NIS	NIP	✓	✓	✓	✓	✗	NA

Key: ✓ = meets specification or recommendation ✗ = does not meet specification or recommendation NIP = No information provided NIS = Not in scope NA = not applicable

Based on the data supplied, all tools appear to adequately calculate farm-level GHG emissions.

In noting this, not all models met the recommendations on presentation of results:

(i) B+LNZ GHG Calculator did not report total methane and nitrous oxide in carbon dioxide equivalents. The tool does provide a total GHG figure of the merged methane, nitrous oxide, and carbon dioxide under the AR4 reporting into a single figure, which is expressed as carbon dioxide equivalents.

(ii) ProductionWise did not include a farm address or unique farm identifier.

(iii) None of the tools provided context around He Waka Eke Noa, except for MyImprint Farm (which had the assessment completed a year after the other tools in this report when there was more information available to them).

2.0 BACKGROUND

He Waka Eke Noa is an Industry/Government/Iwi five-year programme that is working together to implement a framework by 2025 to reduce agricultural greenhouse gas emissions and build the agriculture sector's resilience to climate change.

Through this framework farmers and growers will be empowered to measure, manage, and reduce on-farm emissions; recognise, maintain or increase integrated sequestration on farms; and adapt to a changing climate.

As part of this programme, methods and definitions accepted by He Waka Eke Noa for farm-scale reporting for GHG emissions (from livestock and synthetic nitrogen (N) fertiliser), must be established within a timeframe which enables, by December 2021, 25% of farms to hold a documented annual total of GHG emissions, and by December 2022, 100% of farms.

Tools for estimating and reporting farm scale GHG emissions will be necessary to meet these milestones. An assessment of the available stock of tools is required to ensure reporting can be achieved reliably while meeting accepted methods and definitions for reporting GHG emissions.

For the He Waka Eke Noa programme, on-farm greenhouse gas emissions sources are livestock (ruminant animals, pigs, horses, or poultry) and fertiliser (synthetic fertiliser containing nitrogen)[2]. Therefore, the greenhouse gases which the on-farm reporting tool will need to include as a minimum are livestock (methane and nitrous oxide) and fertiliser (nitrous oxide and carbon dioxide).

3.0 OBJECTIVES

The objectives of the review therefore were to assess the performance of the various models against the draft minimum requirements as specified by He Waka Eke Noa[3]:

1. Draft method requirements:

   (i) Use emission factors sourced from the National Inventory, or another valid source (e.g. International default).

   (ii) Minimum set of required inputs:

   - Livestock numbers (by species) either using monthly values or for simple tools a weighted annual average.
   - Amount of synthetic nitrogen fertiliser.

[2] As defined in the Climate Change Response Act 2020

[3] Note that this report has used the same requirements as the first report to maintain consistency. The He Waka Eke Noa Steering Group has made some minor wording changes to the requirements, such as objective 1 iv.

(iii) Have a logical and internally consistent model structure and set of equations which reference appropriate sources of key parameters, algorithms, and data inputs[4].

(iv) Use peer-reviewed research to accompany any methods for mitigation or sequestration of emissions. For mitigations and sequestration, the peer-reviewed research must be relevant to New Zealand farming systems.

2. Recommendations on presentation of on-farm GHG emissions requirements:

(i) Greenhouse gas emissions should be displayed as separate gases (methane, nitrous oxide, and carbon dioxide) and are encouraged to be displayed as a weight of gas.

(ii) Total greenhouse gas emissions should also be displayed in the Global Warming Potential (GWP_{100}) values from the Fourth Assessment Report for consistency with New Zealand's National Inventory Reporting: carbon dioxide (1); nitrous oxide (298); methane (25).

(iii) Alternative equivalency metrics may also be provided:

(iv) The current use of GWP_{100} does not pre-empt future recommendations by He Waka Eke Noa Steering Group on a metric that may be adopted as part of the He Waka Eke Noa Programme, in particular, as part of any farm level emissions pricing scheme.

(v) Greenhouse gas emissions should be reported from livestock and fertiliser as set out in Table 3 below.

3. Recommendations on presentation of information to the farmer[5]:

(i) Total area of farm

(ii) Physical address or unique farm identifier of the property and the person who is responsible for providing the on-farm data which has been used by the tool.

(iii) Type of agricultural farm (e.g. dairy, beef, lamb, cropping, mixed etc.).

(iv) Context for greenhouse gas emissions in terms of the He Waka Eke Noa Primary Sector Climate Change Partnership, including a statement that He Waka Eke Noa is working on determining methods for calculating on-farm sequestration by 2022 (and which may vary from those currently incorporated in the tool).

(v) A tag or disclaimer if mitigations are used which are not incorporated in the New Zealand Greenhouse Gas Inventory.

[4] It was not possible to 'deconstruct' the models supplied to determine equations/algorithms which drove the models, and in several cases the authors only had the outputs from the models. In this respect, it was not possible to determine model structure and any internal consistencies.

[5] The workstream is aware of the need to assure farmers that their privacy is protected. The report to the farmer however would ideally include all the specified information. Any information exchanged between farmers and tools providers will be subject to privacy and confidentiality agreements between those parties, if applicable.

The models/calculators are then classified as:

- Simple tools – uses standard input metrics.
- Intermediate tools – uses national average assumptions
- Detailed tools – uses detailed farm specific activity data and additional sophistication.

Table 3: *Emissions sources as an output of the tool*

Emissions source[6]	Enteric Methane (CH_4)	Effluent Storage and dung deposited onto land (CH_4)	Total Methane from livestock	Effluent Storage (not effluent applied to land) (N_2O)	Agriculture Soils (N_2O)			Total Nitrous Oxide Emissions from livestock and fertilizers	CO_2 from application of Urea fertiliser to soil (if included in tool)
					Simple Tools (single value encompassing direct & indirect)	Intermediate & Detailed tools: separates direct from Indirect (leaching)	Intermediate and Detailed tools: separates direct from Indirect (volatilisation)		
Livestock Emissions									
Dairy Cattle	✓	✓	✓	✓	✓	✓	✓	✓	✗
Beef Cattle	✓	✓	✓	✗	✓	✓	✓	✓	✗
Sheep/lambs	✓	✓	✓	✗	✓	✓	✓	✓	✗
Deer	✓	✓	✓	✗	✓	✓	✓	✓	✗
Swine	✓	✓	✓	✓	✓	✓	✓	✓	✗
Poultry	✗	✓	✓	✓	✓	✓	✓	✓	✗
Horses	✓	✓	✓	✗	✓	✓	✓	✓	✗
Llama and alpaca	✓	✓	✓	✗	✓	✓	✓	✓	✗
Other Livestock Emissions	✓	✓	✓	✓	✓	✓	✓	✓	✗
Fertiliser Emissions									
Total Synthetic Nitrogen Fertiliser	✗	✗	✗	✗	✓	✓	✓	✓	✓

[6] Note that output reports do not need to cover all these types of livestock. Where a tool is designed only for a particular sector, only that row would be included in the output.

4.0 METHODOLOGY

The tool providers for this round of assessment were Beef + Lamb New Zealand (B+LNZ) with the tool B+LNZ GHG Calculator, the Foundation for Arable Research (FAR) with their tool ProductionWise, and Toitū with the tool Toitū farm emanage, which is also a carbon certification programme (in conjunction with OverseerFM). MyImprint was also assessed in 2022 with their tool MyImprint Farm.

Eight farm types were specified, with the details of the farms provided by the relevant industry body (e.g. Dairy NZ provided the details for the dairy farms, B+LNZ the details for the sheep and beef farms, Deer Industry New Zealand, the details for the deer farm, etc). The data for the ruminant livestock and arable farms was standardised by AgFirst and sent out to the tool providers, apart from Toitū which used data from OverseerFM, which had modelled the farms in the previous round. The standardised data were provided to the two model providers who then in turn provided the relevant input/output data from their models relative to the farm type modelled.

ProductionWise is considering the addition of an animal component to the tool. The only detailed tool to model the GHG emissions from an arable farm was the OverseerFM tool, which was assessed in the first report. The OverseerFM file was manipulated to compare a farming system with and without animals[7]. The results were then compared to assess the viability of the model with and without animals.

B+LNZ GHG Calculator, Toitū farm emanage **and MyImprint Farm** provided the electronic files of their models, while ProductionWise provided a copy of the model output/report.

Table 4: Farm types modelled by model

Models	Waikato Dairy	Canterbury Dairy	High Country S&B	Southland Intensive S&B	S&B with dairy grazers	Deer	Arable Cropping (without animals)	Arable Cropping (with animals)
B+LNZ GHG Calculator			✓	✓	✓			
FAR – Production Wise							✓	✓[8]
Toitū farm emanage[9]	✓	✓	✓	✓	✓	✓	✓	✓
MyImprint Farm	✓	✓	✓	✓	✓	✓		

Assessment of the models was achieved by splitting the farm types across three assessors, so that they could then view the same farm type across the different models. An assessment criterion scoring sheet was developed, relative to the minimum set of requirements for inputs and outputs (refer Appendix 1/2/3). This was used to help assess the different models for the purpose of classification, i.e. simple and detailed. The classification and scoring do not infer the

[7] The OverseerFM file was completed by removing the pastoral component from the data, resulting in a decreased farm area. Crops were mechanically harvested as opposed to grazed in situ by animals, and crops going into grass were harvested for grass silage. A single animal was added to a small paddock (0.5ha) to get the model to run.

[8] ProductionWise version 2 can calculate animal emissions.

[9] Toitū farm emanage relies on OverseerFM to calculate the on-farm emissions, hence why their emissions figures are identical.

suitability or effectiveness of each tool as it depends on the purpose of use. To assess mitigation options specific to a farm, for instance, more information is required.

During the assessments, the model providers were approached directly as to any issues that required clarification.

Once the individual assessments were complete, the three assessors met to discuss and compare the results. Tool providers' feedback was sought on the draft commentary for their model, and feedback incorporated.

A draft report was provided to He Waka Eke Noa, which was then finalised following their feedback.

5.0 SUMMARY OF MODELS

A summary of the various models assessed is outlined below.

5.1 Beef + Lamb New Zealand – B+LNZ GHG Calculator

The Beef + Lamb New Zealand tool "B+LNZ GHG Calculator" is an open source model, which is based on the New Zealand Inventory (NZI). The tool can model farms that have sheep, beef, and deer. The model also includes forestry sequestration.

5.1.1 Inputs

The main inputs into the model are:

- Livestock data: average stock numbers by type, sales, and purchases.
- Nitrogen fertiliser input as well as dolomite and lime.
- Forestry by area, type, and age with harvest option.

5.1.2 Outputs

The outputs from the model are presented in a report to the farmer, showing:

- A summary of the input data. In future this will be compared to the regional average along with other on-farm key performance indicators.
- The separate gases (CH_4, N_2O, and CO_2) are not reported as CO_2 equivalents in the results table, but rather as weight of the gas itself. This is then converted to total emissions using the appropriate AR4 values, consistent with He Waka Eke Noa requirements. The emissions are then subtracted from sequestration, which does not align with the current settings in the Climate Change Response Act.

The tool does not consider supplementary feed or cropping and works from annual stock numbers. The tool multiplies the emissions factors by Relative Stock Units (RSU) for each stock class to better illustrate the dry matter intake. The tool illustrates the gases by livestock class, which will be incorporated into the yardstick tool which allows farmers to benchmark their system against similar systems. It is free to use for sheep and beef farmers who fund the tool via their levy.

5.2 FAR – Production Wise

The FAR tool (Production Wise) is focused on arable crops, with simple inputs and outputs. The tool was provided in two versions: one without animals (version one) and one with (version two). The first version has more crop inputs but has a single emissions factor for nitrogen fertiliser while the second version has few crop inputs but has an additional animal component, similar to that of the MfE tool assessed in the first report, as well as more detailed emissions factors for nitrogen fertiliser. The primary tool uses relevant emissions factors and works off yearly averages.

5.2.1 Inputs

Key inputs are:

- Crop yield.
- Farm fuel and tractor hours.
- Fertiliser input.
- Crop type.
- Animal numbers.

5.2.2 Outputs

For greenhouse gas emissions, the key output is total CO_2 e, split between total and effective hectares. This includes CH_4, N_2O and CO_2. The CO_2 emissions include fertiliser production, electricity, and machinery emissions. A graph illustrates the percentage of each gas over the farm. The tool shows the equivalent amount of emission produced by kilometres driven in a medium car or airplane travel, as well as the hectares of exotic or indigenous forest that would be needed to offset.

The model is available within the arable industry.

5.3 Toitū farm emanage

The Toitū farm emanage tool uses the on-farm component of the GHG footprint and the carbon sequestration estimates calculated by OverseerFM tool. This was assessed in the previous report for the farm-specific information. Toitū farm emanage requests further information from users to cover "beyond farm gate" emissions and uses ISO forestry standards to offset the emissions. This certification programme includes auditing which is done on a three-yearly basis. Users create an OverseerFM analysis first and uploads the on-farm GHG footprint modelled results and the carbon sequestration estimates into emanage.

The Toitū policy for sequestration is to allow a cap of 80% of on-farm sequestration (which aligns with ISO standards) to be used as a removal from gross emissions. This policy is intended to provide a precautionary buffer against a loss of biomass (either intentional or unintentional e.g. fire). If the buffer is not sufficient then carbon credits will need to be purchased to offset the losses. The tool provider standardises carbon accounting by recognising any carbon which is already registered under the ETS, preventing double accounting for carbon sequestration.

Toitū has an additional component which relates to ISO standards. This involves sending farmers a survey to fill out regarding things such as waste and employee travel, capturing emissions from the wider farming business.

5.3.1 Inputs

On-farm GHG footprint and the carbon sequestration estimates used by Toitū are modelled by OverseerFM. OverseerFM inputs include:

- Soil type, climatic data, pasture type(s), drainage.
- Effluent management systems for dairy farms.
- Crop type, areas, yields.
- Stock numbers by type, age, liveweight, production parameters.

- Allocation of feed in relation to stock.
- Supplementary feed inputs by type, amount, and what animals they are fed to.
- Detailed information on fertiliser inputs: types, amounts, timing, blocks applied to.
- Irrigation management.

Additional inputs required for the certification process include:

- Distance to works
- Employee travel
- Farm waste
- ISO sequestration

5.3.2 Outputs

Key outputs are:

- Greenhouse gas emissions: CO_2 e/ha broken down by CH_4, N_2O, CO_2, and the source of each of the gases. This was provided as a screenshot of the OverseerFM analysis as the on-farm GHG footprint was modelled by OverseerFM.
- Carbon sequestration by forestry (cumulative over time and annual tonnes), based on ISO standards (ISO 14064:2018).

Toitū farm emanage is commercially available. Users need to create OverseerFM farm analysis first and upload the results into farm emanage before inputting additional data required for certification purposes. OverseerFM is commercially available on an annual subscription basis to advisors and farmers. Training is required to operate the model.

5.4 MyImprint Farm

The MyImprint tool, MyImprint Farm, is a proprietary model, which is based off the New Zealand Inventory (NZI). The tool can model farms that have sheep, beef, deer and dairy cattle. The model also includes forestry sequestration. Farmers provide the input data to the company and in return get a greenhouse gas report.

5.4.1 Inputs:

The main inputs into the model are:

- Livestock data: average stock numbers by type, sales, and purchases.
- Nitrogen fertiliser input by type as well as dolomite and lime.
- Forestry by area and type.
- Fuel consumption, electricity use and waste management.

5.4.2 Outputs

The outputs from the model are presented in a report to the farmer, showing:

- A summary of the input data with animal numbers, fertiliser, imported supplements and forestry.
- The separate gases (CH_4, N_2O, and CO_2) are reported as CO_2 equivalents on a total and per hectare basis. Each gas is broken down into its respective category, as presented in the agriculture sections of the New Zealand Greenhouse Gas Inventory.
- Sequestration is presented, based on the MfE guidelines for reporting emissions[10], and then subtracted off the gross emissions. These are categorised into exotic forest, indigenous forest and shrubland.

The tool uses more basic inputs such as annual stock numbers, fertiliser inputs and forestry data in conjunction with additional inputs, such as fuel and electricity, which are outside of He Waka Eke Noa's requirements. MyImprint have the intention of providing a certification to the farmer stating that their emissions have been calculated independently and will advise how emissions could be reduced as part of the report.

5.5 Summary of model output detail for methane and nitrous oxide

A summary of the detail of output around methane (CH_4) and nitrous oxide (N_2O) from the models is:

Table 5: Model breakdown of Methane and Nitrous Oxide

	Methane			Nitrous Oxide			
	Enteric	Dung	Effluent	Dung	Effluent	N fertiliser	Crops
ProductionWise	✗	✗	✗	✗	✗	✓	✗
Toitū farm emanage	✓	✓	✓	✓	✓	✓	✓
B+LNZ GHG Calculator	✗	✗	✗	✓	✗	✓	✗
MyImprint Farm	✓	✓	✓	✓	✓	✓	✗

5.6 Emission Factors

All the models use the emission factors from the National Inventory.

[10] https://environment.govt.nz/assets/Publications/Files/Measuring-Emissions-Detailed-Guide-2020.pdf. This uses average data from the Land Use and Carbon Analysis System (LUCAS) national sample, whereas the MPI lookup tables for the ETS differentiate by age, forest type and region.

6.0 RESULTS

The model information given by the providers was assessed as discussed in Section 4.0, with the results collated relative to farm type. This is summarised below across all the tools that have been assessed in both reports.

6.1 Dairy Farms

6.1.1 Waikato Dairy

Collation of the results showed:

Table 6: Collation of Waikato Dairy Modelling Results

	Detail Score	% methane	kg/ha CH_4 (kg CO_2 e)	kg/ha N_2O (kg CO_2 e)	Total GHG kg/ha (kg CO_2 e)
Toitū farm emanage	92%	78%	8,525	2,356	10,881
OverseerFM	92%	78%	8,525	2,356	10,881
Alltech	45%	77%	9,297	2,701	11,998
E2M	57%	83%	6,234	1,297	7,531
Farmax	73%	75%	8,420	2,749	11,169
Fonterra	43%	82%	7,962	1,780	9,742
MfE	32%	75%	6,838	2,325	9,163
MyImprint Farm	41%	78%	7,148	2,064	9,212

Note:

(i) Detail Score: this is as per the assessment sheet, which was largely designed to give an indication of the level of detail required relative to the minimum set of requirements for inputs and outputs and was used as the basis for classifying the models; a higher score indicates a detailed model, a lower score a more simplistic model (as outlined in Section 3.0). A higher score does not mean the model is 'better' than a model with a lower score, just that there is more detailed information required to input.

(ii) % Methane. The average methane to nitrous oxide emissions (as expressed as CO_2e) for New Zealand pastoral farms, is 78% CH_4, 22% N_2O. This is used as a 'rule of thumb', as a check to see if the model results were falling around this ratio.

(iii) GHG emissions. These are expressed as (a) kg CO_2 e, and (b) per **total** hectare. The models varied as to whether they reported effective or total area. For reporting purposes, emissions are shown across total area.

(iv) Milksolids production. This is not shown in the table above, but there was some variation in milksolids production between the models. Alltech and Farmax calculated an allowance of milk used to feed calves, whereas the other models simply input the amount of milksolids sold to the milk company. Fonterra uses daily milk production split by protein and fat content.

Canterbury Dairy

Collation of the results showed:

Table 7: Collation of Canterbury Dairy Modelling Results

	Detail Score	% methane	kg/ha CH_4 (kg CO_2 e)	kg/ha N_2O (kg CO_2 e)	Total GHG kg/ha (kg CO_2 e)
Toitū farm emanage	92%	78%	6,451	1,853	8,304
OverseerFM	92%	78%	6,451	1,853	8,304
Alltech	45%	78%	6,792	1,943	8,735
E2M	57%	83%	6,506	1,295	7,801
Farmax	73%	75%	6,066	2,067	8,133
Fonterra	43%	81%	6,768	1,625	8,393
MfE	32%	75%	5,259	1,713	6,972
MyImprint Farm	41%	77%	6,343	1,916	8,259

Sheep & Beef Farms

6.1.2 Sheep and Beef - Dairy Grazers

Collation of the results showed:

Table 8: Collation of the Sheep and Beef with Dairy Grazers Modelling Results

	Detail Score	% methane	kg/ha CH_4 (kg CO_2 e)	kg/ha N_2O (kg CO_2 e)	Total GHG kg/ha (kg CO_2 e)
B+LNZ GHG Calculator	39%	80%	4,581	1,156	5,738
Toitū farm emanage	97%	75%	3,488	1,180	4,668
OverseerFM	97%	75%	3,488	1,180	4,668
Farmax	68%	80%	4,334	1,103	5,437
MfE	32%	80%	7,619	1,873	9,492
MyImprint Farm	44%	82%	7,404	1,637	9,041

6.1.3 Sheep and Beef – South Island High Country

Collation of the results showed:

Table 9: Collation of the South Island High Country Modelling Results

	Detail Score	% methane	kg/ha CH_4 (kg CO_2 e)	kg/ha N_2O (kg CO_2 e)	Total GHG kg/ha (kg CO_2 e)
B+LNZ GHG Calculator	39%	81%	1,117	265	1,382
Toitū farm emanage	97%	78%	1,281	351	1,632
OverseerFM	97%	78%	1,281	351	1,632
Alltech	47%	60%	814	533	1,347
Farmax	68%	81%	1,029	242	1,271
MfE	32%	81%	1,497	349	1,846

MyImprint Farm	44%	82%	1,127	260	1,387

Sheep and Beef – South Island Intensive

Collation of the results showed:

Table 10: Collation of the Sheep and Beef South Island Intensive Modelling Results

	Detail Score	% methane	kg/ha CH_4 (kg CO_2 e)	kg/ha N_2O (kg CO_2 e)	Total GHG kg/ha (kg CO_2 e)
B+LNZ GHG Calculator	39%	81%	4,717	1,123	5,840
Toitū farm emanage	97%	78%	5,250	1,480	6,730
OverseerFM	97%	78%	5,250	1,480	6,730
E2M	59%	82%	4,766	1,046	5,812
Farmax	68%	81%	4,924	1,191	6,115
MfE	32%	80%	3,908	967	4,876
MyImprint Farm	44%	82%	4,061	978	5,039

6.2 Arable

Collation of the results showed:

Table 11: Collation of the Arable Modelling Results

	Detail Score	Cropping emissions kg/ha N_2O (kg CO_2 e)	Kg/ha CH_4 emissions (kg CO_2 e)	Total GHG/ha (kg CO_2 e)
ProductionWise without animals	73%	666	-	666
OverseerFM without animals	91%	1,159	-	1,159
ProductionWise with animals	32%	639	489	1,128
OverseerFM with animals	97%	946	1,278	2,224
Toitū farm emanage with animals	97%	946	1,278	2,224
MfE with animals	32%	820	1,031	1,851

Note:

(i) The 'cropping emission' is the N_2O emissions related to cropping on the farm (i.e. directly related to nitrogen fertiliser use). The total GHG/ha includes the biological greenhouse gas emissions from stock (both N_2O and CH_4) which graze the pasture within the crop rotation. The farm with animals has a larger area, which includes pasture for the animals, hence why the N_2O emissions per hectare are lower.

Deer

Collation of the results showed:

Table 12: Collation of the Deer Modelling Results

	Detail Score	% Methane	kg/ha CH_4 (kg CO_2 e)	kg/ha N_2O (kg CO_2 e)	Total GHG/ha (kg CO_2 e)
B+LNZ GHG Calculator	39%	82%	2,625	593	3,218
Toitū farm emanage	97%	81%	5,084	1,216	6,300
OverseerFM	97%	81%	5,084	1,216	6,300
Farmax	68%	79%	3,380	875	4,254
MfE	32%	79%	3,113	847	3,960
MyImprint Farm	44%	88%	3,411	459	3,870

7.0 DISCUSSION

7.1 Variation in GHG Output Figures between the models

As can be seen from the results Section (Section 6.0), there is some variation in total GHG emissions as calculated by the various models, and in some cases, this is quite significant. This variation is driven by differences within models and operator differences.

7.1.1 Within Model Factors

Farm level GHG emissions are driven by three key factors:

- Amount of drymatter (DM) eaten, or the DMI.
- Amount of protein in the diet (%N).
- Amount of nitrogen (N) fertiliser applied.

Of these, the main driver is the amount of drymatter eaten. This means drymatter intake is crucial, which in turn is driven by the percentage of feed utilisation and energy (ME) levels (and within this animal ME requirements and ME available from feed). Most of the models have in-built DMI/utilisation/ME values, and it would appear that they are not necessarily aligned between models.

Similarly, most have % N factors relating to forages, and again it would appear these are not necessarily aligned between models.

The end result is that the differences between results of different models will vary depending on the assumptions around DMI, ME, and % N levels.

7.1.2 Operator Error

AgFirst standardised the data prior to sending the information out to the tool providers for this second group of GHG tool evaluation. This was done to reduce the input error.

7.2 Farm Location

While this was recommended, some models currently do not allow for this. While necessary, the current lack of a farm location system (e.g. physical address/GPS coordinates) did not detract from the ability of the model to calculate GHG emissions, but is something that needs to be standardised across models.

7.3 Context around Emission Figures Calculated

None of the models provided a contextual aspect to the resultant emission figures calculated. Whether this is a component of the model itself, or a subsequent aspect of the report provided is unknown.

While the recommendations request a *Context for greenhouse gas emissions in terms of the He Waka Eke Noa Primary Sector Climate Change Partnership* as part of the presentation of the information to farmers, it is felt that this is something beyond the scope of the model itself. The purpose of the model is to calculate the relevant biological GHG emissions for the farm. Given the complexity of responding to this in terms of mitigations/farm system change/offsetting, it is felt that this is beyond the scope of the model per se and falls within the realm of the advisor to take the figures generated and then provide suitable advice as to the measures the farmer may need to take.

7.4 Carbon Sequestration via Forestry

Although not illustrated in the report, Toitū farm emanage, B+LNZ GHG Calculator and MyImprint Farm include sequestration from forestry. ProductionWise illustrates how much forestry would be needed to offset the farm emissions, based on the MPI carbon lookup tables. As noted in the February 2021 report, Alltech, MfE, and OverseerFM also incorporate sequestration components, and subsequent to the previous version of this report, Farmax have released an update which includes forestry sequestration.

Offsetting farm emissions via forestry sequestration is likely to be an important component of land managers' GHG management. The key "rules" around sequestration within New Zealand currently are established within the Emissions Trading Scheme (ETS). He Waka Eke Noa is working on a programme to measure and recognise on-farm carbon sequestration which could include indigenous forestry and other woody vegetation on-farm which isn't currently accounted for in the ETS.

The ETS rules include the IPCC definition of a forest, and only consider sequestration post-1989. Any forest stands under 100ha must use the sequestration rates indicated by the MPI lookup tables which are part of the tier 2 IPCC reporting, while any forest over 100ha must be measured. The lookup tables are currently being reassessed.

Differences between the various tools and the look-up tables are summarised below:

B+LNZ GHG Calculator

The B+LNZ GHG Calculator includes several categories of forestry for sequestration:

- Exotic forest (less than 29 years old)
- Indigenous forest - regenerating natural forest (less than 100 years old)
- Indigenous forest - established natural forest
- Shrubland < 30 years old
- Shrubland > 30 years old.

Of these, Exotic forest, Indigenous forest - regenerating natural forest (less than 100 years old), and Shrubland < 30 years old are included in the calculation and accrue carbon sequestration units, which are then offset against the farm emissions to give a net emission figure.

(i) All exotic forests are combined in B+LNZ GHG Calculator, whereas the different species have differing sequestration rates. The average sequestration rate used is 34 tonne CO_2e/ha/year, as against the MPI look-up tables for pines (generally the fastest growing) of 25-28 tonnes CO_2e/ha/year. The rate used in B+LNZ GHG Calculator is also used in the MfE tool on which B+LNZ GHG Calculator is partly based.

(ii) While regenerating indigenous forest is eligible under the ETS, this only applies for forests regenerating post 1989. The B+LNZ GHG Calculator assumes a sequestration rate of 5.1 tonne CO_2e/ha/year, as compared to the look-up tables of 6.5 tonne CO_2e/ha/year. The rate used in B+LNZ GHG Calculator is also used in the MfE tool on which B+LNZ GHG Calculator is partly based.

(iii) Inclusion of shrubland in B+LNZ GHG Calculator. No definition is given of "shrubland". While the calculator indicates the ETS definition of a "forest", the term "shrubland" could be misleading, and the average sequestration level assumed of 1.7 tonne CO_2e/ha/year would tend to indicate something less than a "forest".

Toitū

Toitū farm emanage uses ISO standards for carbon accounting which do not completely align with the ETS, such as allowing for additional forestry including anything less than a hectare, less than 30 metres in width and pre-1990 plantings. While the tool uses the MPI look-up tables as the base for sequestration rates, the inclusion of areas of forest outside of the ETS definition would overestimate the amount of carbon offset a landowner could claim against farm emissions under current ETS rules.

MyImprint Farm

MyImprint use a similar sequestration approach to the MfE tool, as mentioned in footnote 10 and below. This incorporates average sequestration rates from the Land Use and Carbon Analysis (LUCAS) plots. These average rates differ from the more detailed MPI carbon lookup tables.

Other Tools

As discussed in the February report, the Alltech model includes sequestration in woodland, wetland, grassland, trees, hedgerow. Of these, only woodland is likely to be compatible with the NZ ETS requirements.

The MfE calculator has two classes of forestry: "Planted forest" with an average sequestration rate of 34 tonnes/CO_2e/ha/year, and "regenerating natural forest", with an average sequestration rate of 5.1 tonnes CO_2e/ha/year – both sequestration rates being different to the MPI look-up tables.

Currently only OverseerFM and the newly released update of Farmax are directly compatible with the ETS, offering a range of tree species by region by age, and then directly linking this to the MPI look-up tables.

The varied approaches to accounting for sequestration used by emissions tools in the two assessments will generate some confusion amongst farmers. Tools that use a non-ETS aligned approach cannot be relied on to give an accurate estimate of sequestration that would be "counted" should the farmer enter the ETS. In addition, having different approaches to calculating sequestration between the ETS and emissions calculation tools may cause some confusion and/or expectations amongst farmers about the worth of farm vegetation under the future pricing scheme being developed by He Waka Eke Noa.

Other Issues

Using forestry as an offset to farm emissions is a complex area, with several other factors needing to be understood:

(i) Under the Zero-Carbon Act, methane cannot be directly offset by forestry sequestration, although all the models infer this is the case. An offset is possible, via a transactional process; the carbon credits from the forestry sequestration could be sold and the funds raised then used to pay any methane tax. It is understood that He Waka Eke Noa is considering other approaches.

(ii) In the ETS, there are different forestry regimes, with the new averaging scheme scheduled to become available in 2023, and mandatory thereafter, along with a permanent forestry sink initiative which sequesters out to 50+ years. The sequestration component of the tools would need to allow for the ability to have both systems within the tool if it were to account for carbon sequestered.

(iii) If the carbon credits from forestry sequestration are sold, they then cannot be directly used for offsetting, or vice versa. In other words, there is potential for "double dipping", and currently only the Toitū process takes this into consideration.

These aspects may well be beyond the scope of the current models/calculators to handle, in which case the emphasis to understand these remains with the landowner and their advisors.

7.5 Classification of the Models

The review would classify the models, as to their parameters (discussed in Section 3.0), as:

Table 13: Model Classification

	Simple	Detailed
ProductionWise	✓	
Toitū farm emanage		✓
B+LNZ GHG Calculator	✓	
MyImprint Farm	✓	

The coverage of the models by farm type are:

Table 14: Model Coverage by Farm Type

	Dairy	Sheep & Beef	Deer	Arable
ProductionWise				✓
Toitū farm emanage	✓	✓	✓	✓
B+LNZ GHG Calculator		✓	✓	
MyImprint Farm	✓	✓	✓	

All the tools are niche to their industries, apart from Toitū farm emanage which works from OverseerFM and MyImprint Farm. The underlying FAR tool which was provided did not include an animal assessment model, but another version of the tool was used which combined the emissions from the arable component and a simplified animal component via a spreadsheet. This was compared against an OverseerFM file to assess the difference in emissions.

7.6 Minimum Standards

A summary of the models' performance relative to the draft minimum specifications is:

Table 15: Model Output Summary

Emissions source	Enteric Methane (CH_4)	Effluent Storage and dung deposited onto land (CH_4)	Total Methane from livestock	Effluent Storage (not effluent applied to land) (N_2O)	Agriculture Soils (N_2O): Simple Tools (single value encompassing direct & indirect)	Agriculture Soils (N_2O): Intermediate & Detailed tools: separates direct from Indirect (leaching)	Agriculture Soils (N_2O): Intermediate and Detailed tools: separates direct from Indirect (volatilisation)	Total Nitrous Oxide Emissions from livestock and fertilizers	CO_2 from application of Urea fertiliser to soil (if included in tool)
ProductionWise	NA	NA	NA	NA	NA	✓	NA	✓	✓
Toitū farm emanage	✓	✓	✓	✓	NA	NA	✓	✓	✓
B+LNZ GHG Calculator	✗	✗	✓	NA	NA	✓	NA	✓	✓
MyImprint Farm	✓	✓	✓	✓	✓	NA	NA	✓	✓

Table 16: Model performance relative to He Waka Eke Noa minimum standards

	Draft Minimum Specs for Methods				Presentation (area, address, system, context)					
	Valid emission factors (referenced)	Minimum inputs (livestock/fertiliser)	Model Structure/ equations	NZ Peer reviewed research for mitigation or sequestration	Reporting of GHG -metrics used	Area	Address or unique identification number	Farm system	HWEN context & sequestration statement	Tag if mitigations used are not in the NZI
ProductionWise	✓	✓	NIS	NIP	✓	✓	✓	✓	✗	NA
Toitū farm emanage	✓	✓	NIS	NIP	✓	✓	✓	✓	✗	NA
B+LNZ GHG Calculator	✓	✓	NIS	NIP	✗	✓	✓	✓	✗	NA
MyImprint Farm	✓	✓	NIS	NIP	✓	✓	✓	✓	*	NA

Key: ✓ = meets specification or recommendation ✗ = does not meet specification or recommendation NIP = No information provided NIS = Not in scope NA = not applicable

* = Mention of context but not sequestration

Based on the data supplied, all models appear to adequately calculate farm-level GHG emissions.

In noting this, not all models met the recommendations on presentation of results:

(i) ProductionWise did not include a farm address or unique farm identifier.

(ii) None of the tools provided any context around He Waka Eke Noa, apart from MyImprint Farm (which had a further year compared to other tools).

Some further comments at an individual model level are provided in Appendix 3.

8.0 APPENDICES

8.1 Appendix 1: Pastoral Model Assessment Criteria for Model Detail

He Waka Eke Noa GHG Model Evaluation

Pastoral farms

Model:

Farm/Farm Type:

	Yes	No		Score	
Physical Address of Farm			Include any specific comments alongside	Yes =	1
	Total	**Effective**		No =	0
Does the model work on total or effective area of the farm					
Livestock Details	Yes	No			
Does the model identify stock type				Score 0 through to 3	

	No	Some break-down	Annual stock reconciliation	Monthly stock reconciliation
Does the model identify stock classes and numbers				

Production Parameters	Yes	No	Alternative: Uses average livestock liveweights	
Initial liveweight of animals				
	Yes	No		
Final/mature liveweights				
	Yes	No		
Liveweight gain or final carcass weights				
	Yes	No		
Milksolids production				
	Yes	No		
Lambing/Calving/Fawning %'s				

Diet

	Yes	No			Yes	No
Does the model indicate type of pasture grown			Does it provide an estimate of amount grown/consumed			
Does the model indicate ME values of forage within it						
Does the model indicate protein/N values of forage within it						
Type and amount of bought-in supplement identified			Does it show to which stock classes the supplement is fed			
Type/area/yield of crops grown identified			Does it show to which stock classes the crop is fed			

	No	Partial	Full description	
Types of nitrogen fertiliser applied to pasture identified (all N fertiliser, not just synthetic)				Score 0 through to 2

	Yes	No
Timing and rate of application to pasture identified		

	No	Partial	Full description	
Types of nitrogen fertiliser applied to crops identified				Score 0 through to 2

	Yes	No
Timing and rate of application to crops identified		

Model Output

	Yes	No		Amount of CH_4
Does the model provide an estimate of biogenic methane			[in either Tonnes or kg/ha CO_2e]	

Breakdown of methane:

	Yes	No
Enteric		
Dung		
Effluent		

	Yes	No		Amount of N_2O
Does the model provide an estimate of nitrous oxide			[in either Tonnes or kg/ha CO_2e]	

Breakdown of nitrous oxide

	Yes	No	
Excreta paddock			
Excreta effluent			[excluded for the S&B + dairy grazers scenario]
N fertiliser			
Crops			

	Yes	No
Is the methane:nitrous oxide ratio in the order of 78:22		

Other

	Yes	No	Comment on the context:
Does the model calculate forestry sequestration			
Does the model provide context around the GHG emissions			
Does the model include carbon dioxide in the outputs?			

	Simple	Intermediate	Detailed
Model classification			

Comments

Check List:

Soil data

Climate data

Manure management

Does the model include mitigation options/are these recognised

Is the model suitable for modelling GHG mitigations/system change

Ease of use

Other

Total Score	0	Out of 37

8.2 Appendix 2: Horticultural Model Assessment Criteria for Model Detail

Horticultural farms

Model:	
Farm/Farm Type:	

	Yes	No
Physical Address of Farm		

Include any specific comments alongside

	Total	Effective
Does the model work on total or effective area of the farm		

	Yes	No
Does the model specify the type of nitrogen fertiliser used		

	Yes	No
Does the model specify application rates (kg/ha, tonnes)		

	Yes	No	EF
Does the model use the average N emission factor			5.72

or EF's by fertiliser type:	Yes	No	
Non-urea nitrogen fertiliser			5.40
Urea nitrogen fertiliser not coated with urease inhibitor			5.07
Urea nitrogen fertiliser coated with urease inhibitor			4.86

Model output

	Yes	No	Amount of N_2O	
Does the model provide an estimate of nitrous oxide				[in either Tonnes or kg/ha CO_2e]

Other

Does the model give a breakdown of:	Yes	No	
Crop type(s) by area			Not included in total score below
Crop yields			
Cultivation methods			

	Simple	Intermediate	Detailed
Model classification			

Comments

Check List:
Is the model suitable for modelling GHG mitigations/system change

Ease of use

Other

Total Score	0	Out of 8

8.3 Appendix 3: Arable Model Assessment Criteria for Model Detail

Arable farms

Model:			**Score**	
Farm/Farm Type:	Arable		Yes =	1
	Yes	No	No =	0
Physical Address of Farm				

Include any specific comments alongside

	Total	Effective
Does the model work on total or effective area of the farm		

Livestock Details

	Yes	No
Does the model identify stock type		

	No	Some break-down	Annual stock reconciliation	Monthly stock reconciliation	
Does the model identify stock classes and numbers					Score 0 through to 3

Production Parameters

	Yes	No	Alternative: Uses average livestock liveweights
Initial liveweight of animals			

	Yes	No
Final/mature liveweights		

	Yes	No
Liveweight gain or final carcass weights		

Milksolids production

Yes	No

Lambing/Calving/Fawning %'s

Yes	No

Diet

Does the model indicate type of pasture grown

Yes	No

Does it provide an estimate of amount grown/consumed

Yes	No

Does the model indicate ME values of forage within it

Yes	No

Does the model indicate protein/N values of forage within it

Yes	No

Type and amount of bought-in supplement identified

Yes	No

Does it show to which stock classes the supplement is fed

Yes	No

Type/area/yield of crops grown identified

Yes	No

Does it show to which stock classes the crop is fed

Yes	No

Nitrogen fertiliser

Types of nitrogen fertiliser applied to pasture identified No Partial Full description

(all N fertiliser, not just synthetic)				Score 0 through to 2

Timing and rate of application to pasture identified	Yes	No

Types of nitrogen fertiliser applied to crops identified	No	Partial	Full description	
				Score 0 through to 2

Timing and rate of application to crops identified	Yes	No

	Yes	No	EF
Does the model use the average N emission factor			5.72

or EF's by fertiliser type:	Yes	No	
Non-urea nitrogen fertiliser			5.40
Urea nitrogen fertiliser not coated with urease inhibitor			5.07
Urea nitrogen fertiliser coated with urease inhibitor			4.86

Model Output

	Yes	No		Amount of CH_4
Does the model provide an estimate of biogenic methane			[in either Tonnes or kg/ha CO_2e]	

Breakdown of methane:	Yes	No
Enteric		
Dung		

Effluent		

Does the model provide an estimate of nitrous oxide

	Yes	No

[in either Tonnes or kg/ha CO_2e]

Amount of N_2O

Breakdown of nitrous oxide	Yes	No
Excreta paddock		
Excreta effluent		
N fertiliser		
Crops		

total

Other

Does the model calculate forestry sequestration	Yes	No

Does the model provide context around the GHG emissions	Yes	No

Comment on the context:

Does the model include carbon dioxide in the outputs?	Yes	No

Does the model give a breakdown of:	Yes	No
Crop type(s) by area		
Crop yields		
Cultivation methods		

Model classification	Simple	Intermediate	Detailed

Comments

Check List:

Soil data

Climate data

Manure management

Does the model include mitigation options/are these recognised

Is the model suitable for modelling GHG mitigations/system change

Ease of use

Other

Total Score		out of 39

8.4 Appendix 4: Individual Model Comments

The following are some comments relating to the individual models.

ProductionWise

- Tool uses basic data to calculate arable emissions. There appears to be a considerable amount of emissions associated with fertiliser manufacturing, which should be covered under the ETS and should not be the responsibility of the farmer. Possibly useful in life cycle analysis.
- Animal emissions are not included in the model currently, but for this assessment, animal emissions were estimated using a separate tool. The arable tool would score reasonably highly for detail, but the tool would score low when including animals currently.
- Output sheet is good with farm emissions on a total hectare basis and graph illustrating the farm emission profile. Also, some information on what the emissions mean.

Toitū

- Toitū extrapolates data from OverseerFM and adds additional emissions. In essence, without the OverseerFM tool, Toitū would not be able to calculate on-farm emissions with the farm data provided.
- Uses ISO standards for sequestration as opposed to ETS, which does not align with the IPCC and the ETS rules.
- Can offer certainty that sequestration is not double accounted.

B+LNZ GHG Calculator

- Basic tool which has a good estimate of on-farm GHG emissions.
- The separate gases are not reported as CO2 equivalents in the results table, but rather as weight of the gas itself. This is then converted to total emissions using the appropriate AR4 values. This is consistent with the He Waka Eke Noa requirements. The emissions are then subtracted from sequestration, which does not align with the current settings in the Climate Change Response Act.

MyImprint Farm

- The Tool uses basic data to calculate emissions, like the MfE tool but with some additional categories.
- The total emissions are within the range compared with other tools.
- Sequestration rates are aligned with MfE guideline rates. MyImprint have stated that they intend to align their sequestration rates with whatever is recommended by He Waka Eke Noa.
- Output sheet illustrates emissions on a per hectare and total basis, as well as total emissions illustrated through graphs.

Contact

Phil Journeaux

Agricultural Economist
Phone 027 511 8161
Email phil.journeaux@agfirst.co.nz

AgFirst Waikato (2016) Ltd
26D Liverpool Street
PO Box 9078, Hamilton 3240, New Zealand
07 839 2683
waikato@agfirst.co.nz
www.agfirst.co.nz