

Options for setting the methodology for the agriculture emissions pricing calculator.

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Options for setting the methodology for the agriculture emissions pricing calculator.

Purpose

1. The purpose of this aide memoire is to provide you with additional information requested in a conversation with officials on 28 February 2023. It specifically addresses the proposed methodology for agricultural emissions pricing, including detail on the data standards and formula supporting the calculation. We also cover potential options for how the calculator methodology could be legislated and the role of agencies in building and managing the calculator.

Key Messages

2. Final decisions on the legislative framework and technical details do not need to be made immediately and there is ongoing opportunity to provide input into this process.
3. However, officials' advice is that the framework set out in the s215 report is the most robust option for setting out the calculator methodology. There is scope to explore through the legislative process how the right balance of flexibility and certainty is provided through the level of detail included within and outside the regulations.
4. Enabling MPI to build the initial calculator provides the greatest certainty of meeting the 2025 delivery timeframe. There are additional options for how this process can evolve over time, and this will be outlined in the April/May Implementation Cabinet paper.
5. Officials do not recommend mirroring the XRB process given we consider that the methodology should largely sit in regulations. We don't consider it's possible to procure, fund or establish an appropriate agency other than MPI to carry out this role within the timeframes.
6. Decisions on the structure of any technical advisory panels do not need to be made now and can be pursued through legislative drafting.

Background

7. In the meeting with officials, you asked for further information about some of the underpinning detail of the agricultural emissions pricing system. This follows information provided in BRF-2502 and BRF-2770 on implementation arrangements for the agriculture emissions pricing system, but specifically related to details of the

calculations that will determine emissions, and what agencies or individuals will have a role in setting them.

8. Officials understand your key driver as being to ensure integrity, robustness and independence is maintained in the system.
9. You expressed an interest in understanding more of what sits within the calculator, including the determination of the data standard and formula that support the calculation. Officials have attached an excerpt on agricultural emissions calculations from the Interim Climate Change Committee (ICCC) which sets out background relevant to this issue (Appendix One).
10. Ministry for Primary Industries (MPI) have set up an Agriculture Emissions Pricing Implementation Unit (AEP-IU) with funding from Budget 22 to progress operational requirements to get the pricing system in place by 2025. Work is being progressed on the basis of decisions outlined in the s215 report. MfE is involved in related policy decisions and at a governance level providing oversight of this process.

Current position

11. The government consultation document last year set out that:
 - a) The methods used to estimate emissions will be in regulations, and-
 - b) that there would be a single centralised calculator managed by the implementation agency.

The requirement for data and methodologies to be in regulations was also set out in the s215 report Section A4. This would align with requirements for the NZ ETS.

12. Including the methodology in legislation was favoured by the Partnership and officials during the Partnership process due to alignment with NZ ETS requirements, and to provide certainty and quality assurance. It is also the recommended approach set out in the ICCC report which notes inclusion of the calculation methodology in regulation (like the NZ ETS) provides a level of transparency and governance that can support user confidence.
13. The report acknowledges that this approach comes with fixed timeframes for updates and recommends exploring alternative options such as setting emissions factors outside of regulation. The report also notes the robust process related to the GHG inventory that could be used to support the methodology.
14. MPI are moving forward with a plan to build a calculator for 2025 based on what was in the s215 report. This is still dependent on agreement as MPI as the lead implementation agency.
15. The current draft agriculture emissions pricing cabinet paper (CAB-224) under your consideration outlines some proposed recommendations that support these proposals as previously agreed for consultation and the s215 report. This includes agreeing that the methodology for emissions reporting, alongside categories and

emissions factors for mitigations and sequestration should be in regulations. It also proposes MPI taking a leadership role to build the emissions calculator.

16. The implementation cabinet paper being drafted by the AEP-IU (scheduled to go to Ministers in April/May) will lay out more detail on the options for delivery of the agriculture emissions calculator. This includes what is considered necessary to deliver the calculator in 2025, and what changes can be made over time to this system. The cabinet paper will explore and seek feedback regarding options for how the calculator should be managed in the medium to long term. This includes potential to decentralise the calculator to other providers beyond government. There will be further opportunity for you to provide feedback and input on this topic at this point.

Agriculture emissions calculator components

17. The calculator itself is the term used to describe the tool that will calculate the emissions and levy. Establishing it includes making decisions on:
 - a. The user interface – how will participants register and enter data;
 - b. The IT system – what software requirements are needed to run the calculator;
 - c. The standards and methodology underpinning the calculations in the calculator.
18. This brief focuses on the standards and methodology component of the calculator.
19. Some aspects of the standards and methodology are being set through the policy decisions that will be agreed at Cabinet, such as:
 - a. Legislative framework:** The extent to which the calculator methodology (e.g. data requirements, formulae, emissions factors) sits in legislation and who will be the lead agency to build it.
 - b. Scope:** the scope of farm level emissions included in the calculator (e.g., the types of gases included within the system), and any exemptions (e.g. type of animals/sectors), and inclusion of mitigations and sequestration.
 - c. High level reporting requirements:** the minimum level of information required to start in 2025 (e.g., stock reconciliation and fertiliser use).
20. Aspects still to be determined and finalised include:
 - d. Definitions** for data requirements. For example, definitions for various stock classes for the reconciliation.
 - e. Formulae** for calculating emissions at farm level including recognition of uptake of emissions mitigations technology or practices, and sequestration. For example, $E = A$

x 8.5 where A = tonnes of milk solids, E is total emissions and 8.5 is the emissions factor.

f. Emissions factors for stock and fertiliser use. For example, methane yield from adult dairy cattle of 21.6g CH₄ per kg dry matter intake.

Role of government agencies in emissions calculator

21. A process needs to be in place for how this scope of decisions are made initially and how they will be enhanced over time. Given tight timeframes to get the system in place by 2025, the proposal is to start with a 'simple' calculator that captures stock numbers, fertiliser use, and uptake of particular mitigation technologies. As recommended in the appended ICCC report, and by the Climate Change Commission in their "Progress towards agricultural emissions pricing"¹ report shifting to a 'detailed' farm emissions calculator that can capture emissions reductions achieved via a range of activities would give farmers more choice about what actions to take. It enables reductions to be achieved from emissions intensity of production, as well as through reduced production and land-use change. This needs to be balanced against the additional cost that a detailed methodology may bring.
22. Decisions to enhance the methodology to ensure a broad range of emissions reductions are achieved need to be made alongside updates based on science and data availability enhancements. There may be a role for further advice from the Climate Change Commission once the system is established regarding the "readiness" of farmers and the system, as well as the potential cost-benefit, of shifting to a more detailed reporting and calculator methodology.
23. The current proposal as outlined in the Implementation brief (BRF-2502) is that MfE and MPI would jointly govern the policy and regulatory process for the emissions calculator. This will include decisions related to the scope of activities included in the calculator, shifting towards more detailed reporting, what mitigations and sequestration categories are included, and updates to emissions factors.
24. This option mirrors the governance arrangements updates to the agriculture GHG inventory process and NZ ETS forestry regulations. This approach also builds on existing capability and experience within MPI related to agriculture emissions reporting, and MfE in relation to NZ ETS reporting requirements.
25. It is proposed that MPI would manage the operational aspects for the calculator, which includes managing the outsourcing of the build of the initial calculator to an external provider to meet the prescribed 1 January 2025 "go live" date. In the future, this could also include overseeing the certification of additional calculators from

¹ <https://www.climatecommission.govt.nz/public/Advice-on-Agricultural-Assistance/Progress-towards-agricultural-emissions-pricing-CCC-report.pdf>

other providers that would be required to use the calculation methodology prescribed in regulations.

26. As outlined in previous briefs, MfE officials support MPI leading the build of the initial emissions calculator. MPI currently lead the process related to the GHG Inventory for agriculture and have connections to the industry and science necessary for the process. We consider that the process can have sufficient checks and balances to ensure robustness, integrity and independence. These processes include MfE Tier 2 and Tier 3 leaders sitting on the relevant implementation steering and governance groups to oversee the build.

Technical components

27. The current cabinet paper sets out that the details required and methodologies to measure emissions, and the impact of mitigations and sequestration would be set in regulations. It is expected that these will be determined in line with what's already prescribed in the GHG Inventory, where available. Linking emissions factors to the GHG Inventory adds a level of rigor given the robustness of this process. Appendix Two sets this process out in more detail.
28. A technical panel or panels will be required to provide advice and peer review on the development of and changes to the emissions calculation. This may need to include a number of sub-groups for specific areas of the calculator such as gross emissions, mitigation technologies and sequestration. This would be supplemented by a related but separate panel that focuses on data standards and interoperability, to optimise data sharing and reduced administrative burden. MfE and MPI would be jointly responsible for convening the necessary technical panels.
29. You have expressed an interest in the extent to which the calculator could be designed and managed to align with future reporting requirements or interests of participants such as net zero claims. Additional work is required to understand the potential alignment and linkages with other systems. Officials can provide further advice on this through the legislative process.

Alternative options

30. You have asked for more information on alternative options for how standards and methodology for the calculator could be set, and who should do this.
31. You have raised the current framework for accounting standards as a potential model for the agriculture emissions pricing calculator.

Incorporation by reference

32. Incorporation by reference refers to creating or defining rights, powers, or obligations by a reference in primary or secondary legislation to another document (usually prepared by someone outside government), or part of a document, the

provisions of which are not set out in legislation². This occurs for aspects of the NZ ETS under regulations, where material has legal effect as part of regulations including (where referenced):

- decisions, computer programmes, rules, guidelines, principles, measures, methodologies, modalities, procedures, mechanisms, or other matters; and
- any standards, requirements, or recommended practices of a government agency, standard-setting organisation, or professional body.

33. The Field Measurement Approach Standards for NZ ETS Forestry is an example.

34. The Legislation Design and Advisory Committee (LDAC) advises that incorporation by reference must be tested against some principles of good law making, and should only be utilised in limited circumstances.

35. LDAC advise that risks associated with incorporation by reference include:

- **Quality**—material incorporated is not sufficiently certain or understandable to be appropriate for legislation, particularly where offences are associated.
- **Accessibility**—Legislation should be easy to find, use, and understand.
- **Legitimacy**—If it is possible to change the incorporated material and for those changes to automatically flow through into the legislation, Parliament or the other law maker does not have control over the content of the secondary legislation. This relates to some of the challenges that have been experienced with Regional Councils use of Overseer as a regulatory tool.
- **Good process**—An appropriate process should be followed in making the law and if incorporation by reference enables the usual process to be bypassed, this can be problematic.

36. LDAC advise that rational for incorporation by reference include removing unnecessary lengthy, technical detail that undermines the ease of finding and using the core requirements. It could simplify compliance by allowing users to rely on material they are already complying with in another context. Where appropriate, incorporation by reference can facilitate convergence and consistency of standards being used and enable rules to remain up to date with international and national standards.

Mirroring the accounting standards framework

37. Requirements for company financial reporting are set out in the Financial Reporting Act. The Act sets out the role and functions of the External Reporting Board (XRB) in

² 15.3. Does the legislation authorise “incorporation by reference”? | The Legislation Design and Advisory Committee (ldac.org.nz)

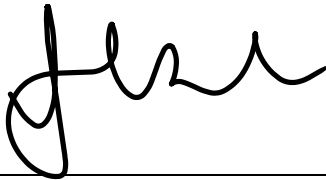
setting financial reporting standards. The XRB is a crown entity and has delegated authority to develop and issue New Zealand's accounting standards to the New Zealand Accounting Standards Board (NZASB). Standards and authoritative notes developed are considered secondary legislation.

38. With this option, the standards are not set out in the regulations directly (as for the NZ ETS) but is outsourced to a crown entity who can then provide updates as and when needed. As with incorporation by reference, this provides for greater flexibility but comes with some risk around quality assurance, certainty, and accessibility.
39. Most examples where details such as the methodology sit outside of legislation do not relate directly to a financial obligation such as will be the case for the emissions calculator. Generally, where financial obligations exist, detail is more prescriptive in legislation (e.g. The Income Tax Act).
40. If we were to adopt a similar method for agriculture emissions pricing, we would need to establish the equivalent of the XRB or determine which existing agency is appropriate to take on this role.
41. The implications of making this decision now would include the need to establish, procure or fund an arm's length agency to administer the framework. We don't consider that any existing non-government entities have the particular set of expertise or capacity needed to pick up this task within the 2025 timeframe.

Next Steps

42. If you wish to pursue an alternative legislative framework from what is proposed in the current Cabinet paper for the calculator methodology or the role of MPI in developing the calculator, this will need to be agreed with the Minister of Agriculture. Officials will then work to make these changes in the cabinet paper.
43. Officials will seek further decisions from Ministers during the legislative drafting process on areas such as how prescriptive the legislation is, the initial and ongoing role of various agencies in managing the calculator, and the role of technical advisory groups.
44. The Implementation cabinet paper will provide further opportunity for input into the development of the emissions calculator. This will include options for how this may will evolve from a government only tool in 2025 to incorporation of external providers.

Signature

Sara Clarke Director – Implementation	
Date:	14 March 2023

Appendix One: Interim Climate Change Committee, action on agriculture, technical appendix 2, section 2.

*Action on
agricultural emissions*

Technical
appendix

2

Calculating agricultural emissions



Calculating agricultural emissions

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1. Purpose

Any policy to reduce greenhouse gas (GHG) emissions will require participants to calculate emissions on a regular basis in order to track achievement towards the desired outcome/s. There are a range of possible methods and tools for calculating agricultural greenhouse gas emissions, which vary according to the point of obligation and the required level of complexity, accuracy and cost.

This paper outlines the options for calculating emissions at both processor and farm level. It also makes recommendations on further work needed to develop and select an approach that would be suitable for calculating emissions for a farm level emissions pricing policy.

2. Background – calculating agricultural GHG emissions

2.1. How are emissions calculated?

Calculating emissions is an essential foundation of policies to reduce emissions.

Directly measuring emissions at the farm scale is not currently possible. Emissions can only be calculated using proxies, underpinned by scientific research involving direct measurement. These estimation methods can be simple, for example, a fixed emission per animal per year¹ – or more complex, using models that require farm specific data on such things as diet quality, animal size and animal performance.

2.2. New Zealand's National GHG Inventory

At the national level, New Zealand's GHG Inventory provides transparency and accountability for our contribution to international climate change efforts. It is the official estimate of all human-generated greenhouse gas emissions and removals that have occurred in New Zealand since 1990. It is updated annually and prepared according to Intergovernmental Panel on Climate Change (IPCC) Guidelines. These Guidelines have been developed since the 1990s and serve as the basis for all international emissions estimates.

In relation to agriculture, New Zealand's Inventory includes estimates of annual emissions from:

- Enteric fermentation (methane)
- Dung and urine deposited onto soil (nitrous oxide)
- Manure management (methane and N₂O)
- Fertilisers and field burning (CO₂, nitrous oxide and methane)

These estimates are calculated using detailed industry and government information on animal numbers and animal performance. The average performance of animals (such as milk yield or weight gain) is used to estimate feed intake. An extensive set of measurements exists to predict methane

¹ An emissions factor is a value used to convert data on activities that cause greenhouse gas emissions (such as the number of animals on a farm) into estimates of actual emissions. For example multiplying a known number of animals by an 'emission factor' specific to those animals (i.e. the typical emissions for a mature ewe) provides an estimate of the actual greenhouse gas emissions that a herd of a given size would cause.

emissions based on total dry matter intake, and nitrous oxide emissions based on the total amount of nitrogen excreted by animals and applied as synthetic nitrogen fertiliser.²

The national inventory is supported by a dedicated research programme, managed by MPI, to constantly update and improve the calculations and emission factors used in the inventory, and is subjected to annual international expert review.

The national GHG Inventory is used to monitor progress towards New Zealand's emission reduction targets. It also represents the state-of-the-art in terms of recognised, science-based GHG estimation methods applicable to New Zealand.

For these reasons, the national inventory is the starting point for the development of any GHG calculation methods used in domestic policies to reduce emissions.

2.3. GHG calculation methods for use in regulation

The appropriateness of using emissions estimates, rather than direct measurements, for the purposes of a regulatory policy is sometimes questioned. Use of estimates calculated from activity data or models is, however, the most common approach used in emission reduction policies around the world, including in New Zealand's ETS.

Emissions estimates are acceptable for use in regulation as long as the calculation methods are underpinned by robust science and subject to sufficient oversight. Trust in emissions calculation methods can be safeguarded through their relationship to the national inventory, which is subject to rigorous domestic and international peer review and governance processes. In the NZ ETS, the regulations specifying calculation methods are also developed and updated through transparent processes involving consultation with participants and other interested parties.

From a practical perspective, there is a trade-off between the accuracy of any calculation method and its cost. In agriculture, as in other sectors, gathering the data required to reflect the full diversity of conditions that affect emissions can be costly. A balance needs to be struck between the data requirements of the calculation method and the cost of the obtaining the information needed.

While any estimation method will have uncertainties, some of those uncertainties are less relevant if the goal is to reduce emissions by a certain percentage - as is the case for New Zealand's emission reduction targets. For example, there is uncertainty about how much methane exactly an average dairy cow emits, but there is a high degree of confidence that if the number of dairy cows is reduced by 10%, their emissions will also reduce by 10%, provided that their production characteristics have not changed.

Key considerations for choosing emission calculation methods for use in any regulation of agricultural GHG emissions include:

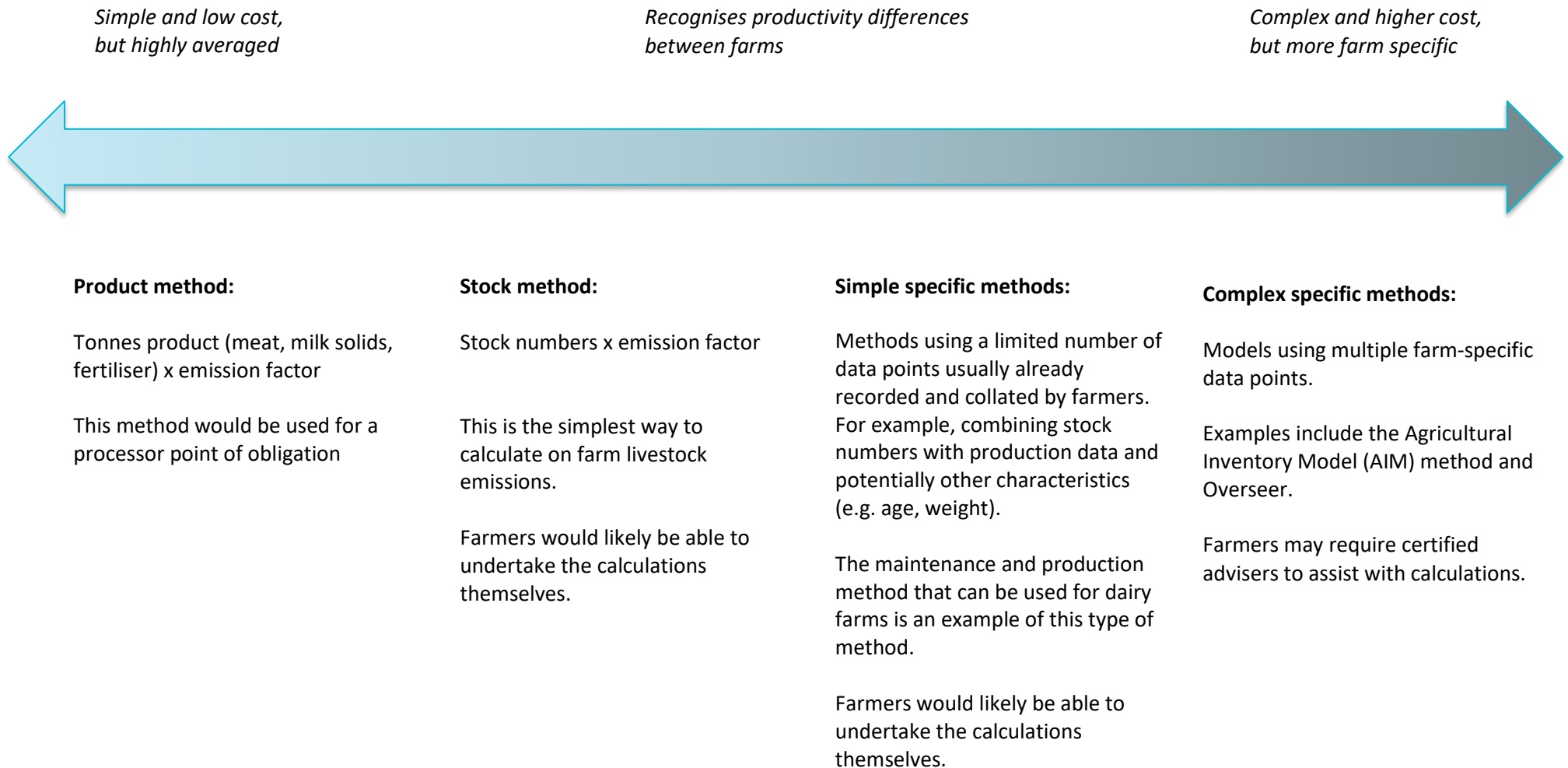
- **Alignment with New Zealand's GHG Inventory** – any methods should align as closely as possible to the national inventory. This is because the aim of policies to reduce emissions is to help New Zealand meet its emission reduction targets, and the inventory is how we track achievement towards these goals.

² For details, see pp211 of Pickering, A. and Gibbs, J. (2018).

- **Recognition of individual farm circumstances (including mitigation actions)** – the level of resolution of the calculation method affects the accuracy of emissions estimates, including which mitigations are captured and rewarded by any policy using the calculation method.
- **Administrative costs** - for both the private sector and the Government.
- **Transparency and governance** – so that those affected by the regulation can understand the basis for the results delivered by the calculation method, and to give confidence that the method will be managed and updated appropriately (in line with sound science and with adequate notice to those affected by any updates).

There is a spectrum of methods, from very simple to data-heavy complex models, which can be used to calculate agricultural greenhouse gas emissions. These methods are summarised in Figure 1 and described in the following sections with a discussion of their pros and cons.

Figure 1: There is a spectrum of methods for calculating agricultural greenhouse gas emissions at entity-level



3. Calculating emissions at processor level

Agricultural processors (fertiliser importers and manufacturers, abattoirs, dairy processors and live animal exporters) already calculate emissions for the purpose of mandatory NZ ETS reporting. The methods they use are specified in regulations - the Climate Change (Agriculture Sector) Regulations 2010, made under the Climate Change Response Act 2002 (CCRA).

The emissions calculation methods are based on the amount of product handled. This “product method” uses the following general formula:

$$\text{Emissions} = \text{tonnes of product} \times \text{emission factor}$$

The emissions factor is a national average of emissions per unit of output. It is derived from the total national emissions attributed to a particular product (from the national GHG inventory) divided by the total national amount of that product.

$$\text{Emission factor} = \text{total national emissions from the product} / \text{total national product}$$

The averaged emission factor does not reflect any differences in on-farm practices that change an individual farm’s emissions per unit of product. The only way individual farmers can reduce their emissions costs is by producing less product (i.e. meat or milk), or for fertiliser, using less of it.

If farmers as a group reduce emissions, the national average emissions per unit of product would decrease. Updating the emission factors regularly would allow farmers to collectively benefit from such improvements (see section 4.5). These industry-wide reductions have indeed occurred in New Zealand and are expected to continue, at least in the near term.

A way that on-farm emission reductions could be rewarded if there is a processor-level policy is if agricultural processors were permitted to apply for Unique Emission Factors (UEFs). This is a mechanism available for certain other sectors in the NZ ETS, where a participant can use a different emissions factor if they can provide evidence that their emissions are lower than the default value.

Applying for a UEF would require an agricultural processor to collect data from suppliers to demonstrate the emissions per unit of product caused by its suppliers or by a group of its suppliers are lower than the New Zealand average.

In the dairy sector, it may be relatively straightforward for processors to work with farmers to collect the information needed for the purposes of gaining UEFs and/or differentially rewarding individual farmers. Processors would only need access to information on the numbers of cows in milk on a farm in addition to the quantity of milk produced by a farm to undertake relatively simple farm-specific emissions calculations. Section 4.2.2 provides more information on this calculation method.

In the meat sector, an option to enable more accurate calculations and cost pass-through to farmers may be to incorporate a greater diversity of stock classes and/or deemed or actual age data into emissions calculations.³ Meat processors hold some of these data already and data collected on cattle via the National Animal Identification and Tracking scheme (NAIT) could potentially be used at some point in the future. This more sophisticated approach would differentially reward farmers based on both time to slaughter and weight at slaughter. Getting stock to slaughter at a younger age

³ Some data would be available as meat processors separate different classes of stock (lambs, ewes, cows, steers, heifers, dairy culls, hinds, stags, fawns, etc) and farmers are paid at differential rates per kg, depending on animal class and meat quality.

and at the same or higher weight results in lower greenhouse gas emissions per animal and per unit of product.

The benefits that could be delivered through these more sophisticated methods would need to be balanced against the added complexity and cost for processors and the government.

For some products (such as nitrogenous fertiliser, poultry, and pigs), deriving the emissions factor used for the product method is very straightforward. In the case of fertiliser, the emissions of nitrous oxide are a fixed fraction of the total nitrogen applied. The science currently is not robust enough to reliably differentiate nitrous oxide emissions from fertiliser based on the type of soil or soil moisture. This is a key difference as compared to estimating the impact of nitrogen fertiliser on water quality, where such factors play an important role in determining nitrate leaching.

For some ruminant livestock products deriving the emissions factor is somewhat more complex than appears from the formula above. This is because of inter-relationships between the dairy and beef industries, and between the meat sector and live animal exports. Some assumptions and judgement must be used in identifying the share of emissions from the national inventory that can be attributed to each product.

For example, attributing emissions per tonne of milk solids must also consider that dairy cattle will eventually, for the most part, be slaughtered and some emissions should also be attributed to the beef produced. Most beef cattle in New Zealand are sourced from the dairy industry, meaning there is also the question as to how to attribute the emissions associated with gestation of beef calves produced by dairy cows.

Technical working groups involving sector representatives, as well as wider consultation, have dealt with these issues in the past when determining the agricultural emission factors to be included in regulations.

The emission factors contained in the Climate Change (Agriculture Sector) Regulations 2010 were last updated in 2012. Since then, there have been methodological improvements to the inventory, changes in animal performance as well as a change to the Global Warming Potential values used for methane and nitrous oxide. This means that the emission factors currently in the regulations are out-of-date and need to be revised before they could be used as the basis for pricing or any other regulation of emissions.

Apart from this, the Committee has not encountered any fundamental issues with the way emissions are calculated at processor level. It considers the existing approach fit for purpose, especially if pricing at processor level is only intended as an interim measure.

4. Options for calculating emissions at farm level

Calculating emissions on farm offers the opportunity to use farm specific data rather than national average values and to recognise additional on-farm practices that reduce emissions.

4.1. Nitrogenous fertiliser emissions

The method for estimating nitrous oxide emissions from nitrogenous fertiliser at farm level is identical to the method used at processor level, which is also the method used to calculate national emissions in New Zealand's GHG Inventory i.e.:

$$\text{Emissions} = \text{N content of fertiliser} \times \text{tonnes of fertiliser} \times \text{emissions factor}^4$$

This relatively simple formula applies even at farm scale because it is the only scientifically robust method to calculate these emissions. A corollary of this is that the only mitigations for fertiliser nitrous oxide emissions are using less of it, and/or using fertiliser with inhibitors.⁵

This method would be relatively easily for farmers to undertake, as they could use records of fertiliser purchased to calculate annual emissions. However, it does not offer any advantage in terms of recognising mitigations as compared to a processor point of obligation. As noted in Chapter 8 of the Committee's report on agricultural emissions, the added cost of a large number of farmers calculating nitrous oxide emissions from fertiliser at farm level is therefore not considered justified.

Farmer understanding of fertiliser's contribution to emissions and how to improve fertiliser practices should still be supported through farm environment planning. This would promote efficient fertiliser use at farm level to complement pricing at processor level, while avoiding the costs of a farm-level point of obligation.

⁴ Lower emission factors would apply to fertiliser incorporating nitrification or urease inhibitors, which reduce the loss of nitrous oxide to the atmosphere.

⁵ Fertiliser coated with a urease inhibitor has a dual potential benefit. A urease inhibitor slows down the break-down of fertiliser. This reduces the amount of nitrous oxide released per kg of nitrogen applied but also in principle allows farmers to use less fertiliser for the same benefit to increased plant growth.

4.2. Livestock emissions

Methods for calculating emissions from ruminant livestock range from a very simple method using only stock numbers, to a complex models that utilise well established nutritional principles and experimentally derived methane conversion factors.⁶ Overseer is an example of a complex model.⁷

4.2.1. Stock method

The “stock method” would be the simplest method that ruminant livestock farmers could use to calculate emissions. This would involve stock numbers for a given class of stock (e.g. dairy cow) and a national average emissions factor for that class of stock derived from the national inventory:

$$\text{Emissions} = \text{stock numbers} \times \text{emission factor}$$

A different emission factor would apply to each class of stock.

For dairy farms opening or closing stock numbers for each class of stock may be adequate for a sufficiently accurate emissions calculation. In the case of drystock farms, however, it is likely that monthly or at least quarterly stock numbers by class would be required, as the number of animals on these farms can vary significantly throughout the year.

This simple method does not capture the differences in emissions that arise on farms due to diverse management practices. The emission factor is a national average, so the calculation for two dairy farms with the same number of cattle would result in equal emissions irrespective of the level of production, breed of cattle, milk and diet quality and diet composition.

If production of milk solids per cow on one farm is higher than that on the other, the emissions cost relative to the amount of product will be lower. This approach will also encourage farmers to look for potential reductions based on reducing stocking rates combined with improvements in animal performance.

4.2.2. Maintenance / production method (only applicable to dairy)

For dairy herds, there is also a slightly more sophisticated but still relatively simple alternative calculation method. This approach uses cow numbers and milk yields in the following equation:

$$\text{Emissions} = (\text{cow numbers} \times \text{emission factor 1}) + (\text{milk yield} \times \text{emission factor 2})$$

The emission factors 1 and 2 reflect ratios derived from the national inventory related to the emissions associated with cow “maintenance” (i.e. feed eaten for staying alive) and feed needed for milk production.⁸

This method would more strongly reward and encourage efficiency as compared to the stock method, as it can more accurately capture productivity differences. A more sophisticated version could also include breed type and milk quality.

⁶ The product method used at processor level could also in principle be used at farm level, at least for dairy farms (not all drystock – i.e. sheep, beef and deer - farms directly produce meat, e.g. trading farms). But it would not improve recognition of on-farm mitigation, which would be the aim of calculating emissions at farm rather than at processor level.

⁷ Overseer is used in this document as a generic term for the modelling tools owned by Overseer Limited, OVERSEER® Nutrient Budgets and OverseerFM. OVERSEER® Nutrient Budgets will be decommissioned in June 2019 in favour of OverseerFM, a new web-based version released in 2018 that retains the same underlying farm system modelling.

⁸ For an example calculation using this method, see p86 of Agriculture Technical Advisory Group (2009).

A similar approach for drystock (i.e. sheep, beef and deer farms) using maintenance and liveweight is possible in theory. But it would be difficult to apply because it is hard to quantify the maintenance and production components based on readily available farm records. This is particularly challenging for trading farms.

4.2.3. Complex models

The agricultural inventory model (AIM) used for New Zealand's national greenhouse gas inventory reporting is an example of a complex GHG accounting model. The AIM methodology can be applied at the farm-level using farm specific data although the software to allow farmers to undertake this would need to be developed.

The AIM approach is typical of that adopted by developed countries to estimate methane and nitrous oxide emissions from livestock. It has been developed by the Ministry for Primary Industries (MPI) for the purposes of national GHG reporting required by the UNFCCC. Methodologies, inputs and equations used by AIM are described in the annual National Inventory Report (NIR) and in a technical report by MPI.⁹

AIM calculates methane emissions by estimating feed intake and then using a relationship between feed intake and methane per unit of intake to calculate methane emissions. Nitrous oxide emissions are calculated from estimates of nitrogen excreted and relationships between excreta nitrogen and nitrous oxide emissions.

To calculate intake and nitrogen excreted AIM needs detailed animal performance information (e.g. size, milk yield, and liveweight gain) and detailed diet characteristics (e.g. metabolisable energy, nitrogen content and digestibility). These data are all required on a monthly basis.

It uses a series of well-validated equations, in this case the Australian Feeding Standards, to calculate intake from animal performance and diet information. The intake/nitrogen excreta and methane/nitrous oxide relationships have been obtained from New Zealand experiments conducted over the last 20 years.

Overseer is an example of a software-based, dedicated complex model for calculating emissions at farm rather than national level. Although it works at a different scale to AIM it uses exactly the same approach. It estimates intake and N excreta and converts this to methane/nitrous oxide emissions using data from New Zealand experiments. Overseer uses the Australian Feeding Standards equations to estimate intake/nitrogen excreta and data from New Zealand experiments convert intake/nitrogen excreta into methane/nitrous oxide emissions.

The difference between AIM and Overseer is that AIM uses national average data while Overseer uses farm specific data. If the same data are fed into AIM and Overseer they will give very similar estimates for methane and nitrous oxide emissions. Differences only arise because the two models are not updated on the same timescales but any differences arising from this are generally minor. A major exercise has recently been conducted to fully align the greenhouse gas emission routines in AIM and Overseer.¹⁰

⁹ Pickering, A. and Gibbs, J. (2018).

¹⁰ de Klein et al. (2017).

4.3. Assessing options for calculating livestock emissions

The pros and cons of the various options for calculating livestock emissions at farm level are discussed below, using the considerations highlighted earlier for choosing methods to be used in regulation of emissions:

- Alignment with New Zealand's GHG Inventory
- Recognition of specific farm circumstances (including mitigation actions)
- Administrative costs
- Transparency and governance

4.3.1. Alignment with New Zealand's national GHG inventory

The calculation methods based on stock, maintenance and production, and AIM (applied at farm scale) all have a direct relationship to the national inventory. The emission factors used in the first two are derived from the inventory, while the third uses the same model employed to calculate the national agricultural GHG emissions estimates.

Complex calculation methods work on the same basic principles as the AIM in that they use animal performance and diet data to estimate dry matter and/or energy intake and then use this to estimate emissions of methane and nitrous oxide.

For example, the GHG calculations within Overseer using the 'national inventory' default mode have the same underlying methodology as AIM and hence should also align well with the national inventory calculations.¹¹ A review commissioned as part of the Biological Emissions Reference Group (BERG) found that greenhouse gas emission estimates from Overseer were generally consistent with the National Greenhouse Gas Inventory, taking into account that small variations exist given that the models operate at different scales (farm versus national scale).¹²

This finding should apply generically to complex calculation methods tailored for the New Zealand situation. However, there is an important caveat to this. AIM uses annual population data and models monthly populations of sheep, beef and dairy cattle at a national level based on June 30th population numbers, with numbers each month being adjusted for births, deaths and average slaughter dates. It also uses national average growth rates, milk yields and reproductive performance. This approach aligns well with dairy farms where population changes are relatively predictable. But it cannot capture the diversity of situations that occur on drystock farms where monthly numbers can change abruptly due to sales between farms and slaughter dates, and reproductive performance and growth rates also vary considerably.

¹¹ There are user-selectable calculation modes in Overseer but the "annual average emission factors" mode is the recommended mode for GHG emissions estimations. de Klein et al. (2017) identified that the "farm specific" mode for estimating nitrous oxide emissions employs routines (calculation algorithms) for N cycling relationships that are not consistent with national inventory emission calculations and produced incorrect results for some farms and soil types. As a result, the "annual average EFs" mode has now been made the default and only recommended mode for calculating nitrous oxide emissions in Overseer

¹² de Klein et al. (2017).

4.3.2. Recognition of individual farm circumstances (including mitigation actions)

Recognition of individual farm circumstances

A key advantage of the more complex farm methods is that by their very nature they capture individual farm circumstances. However, along with this comes the need to have comprehensive farm data, data that may not be readily available or of sufficient quality to fully exploit the theoretical advantages of using a complex approach. In practice simpler methods may be preferable.

To investigate this further, the ICCC Secretariat benchmarked two simple methods (the stock and maintenance/production methods) against Overseer estimates obtained using farm datasets provided by the DairyNZ Economic Service and Beef+Lamb New Zealand Economic Service.¹³

The simple calculation methods were undertaken using data extracted from the Overseer reports of each farm. The results were plotted against the Overseer emissions estimates and are provided in figures 2, 3 and 5. Information from a similar exercise carried by Fonterra and AgResearch comparing the AIM method with OVERSEER (Version 6.3.0) for 104 dairy farms was made available to the ICCC.¹⁴ The outcome of this comparison is provided in figure 4.

The emission factors used for the simple methods were derived from the national GHG inventory 1990-2015 and are given in Table 1 below.

Table 1: Emission factors used in simple calculation methods.

Stock method	Emission Factor (t CO ₂ e)
Cattle SU	0.324
Deer SU	0.342
Sheep SU	0.370
Maintenance/Production method	
Maintenance (43%)	1.701 t CO ₂ e per milking cow
Production (57%)	6.1 t CO ₂ e per t MS

As illustrated by figures 2-3 for dairy there was a good general correlation between the two simple methods and the complex Overseer method ($R^2 = 0.83$ for the simple stock method and 0.86 for the maintenance and production method). However, the wide scatter around the regression line indicates reduced confidence that at an individual farm level the simple methods can accurately predict the values obtained from the more complex Overseer method.

The situation for drystock farms seen in Figure 5 is similar in that there is a good general relationship between the calculations obtained using the stock method and Overseer ($R^2 = 0.85$) but with considerably greater scatter of points around the regression line. With the Beef+Lamb NZ dataset, annual stock numbers were used for the stock method calculations, while monthly stock numbers

¹³ For information about these datasets, including the version of Overseer used for emissions estimates, see the methodology section in Technical Appendix 5 on free allocation for agriculture. Note that for the comparison of calculation methods, the nominal Overseer emissions estimates were used, as compared to the free allocation analysis, for which the Overseer results were scaled against the national GHG inventory.

¹⁴ Rollo et al. (2018)

would have been used for the Overseer calculations. Using monthly stock numbers for both methods could well have improved the relationship between the two methods.

For dairy both the stock method and maintenance/production method under predict emission values compared with Overseer - the majority of values sitting under the 1:1 line in Figure 2 and 3. This is far less evident for the drystock Overseer comparison (Figure 5). This systematic under prediction for dairy is because the ICCC did not have access to the full Overseer reports for the DairyNZ dataset, and was not able to remove fertiliser emissions from the Overseer emissions estimates. Fertiliser emissions depend on farm systems but are typically around 5-10% of emissions for dairy farms using N fertiliser.

The correlation between AIM and Overseer is high, as to be expected from two methods that utilise the same computational approach. Not only is there strong correlation between the two methods ($R^2 = 0.89$) but the points lie very close to the regression line indicating a lower variance and greater confidence that the simpler AIM method can accurately predict emissions obtained using the more complex Overseer method.

Overseer systematically predicts higher values compared with AIM with the difference getting larger as the absolute emission predictions per farm increase. There is no obvious explanation for this although Overseer, in the absence of farm specific data, and AIM use default values for things like diet quality and there does not appear to have been an attempt to align these default values.

A more detailed study with more recent and fuller access to Overseer farm files would be able to deliver a more precise and up-to-date understanding of how accurate simple methods are compared to a complex method like Overseer.

Recognising mitigation actions

A breakdown of which specific on-farm practices to reduce emissions are recognised by different farm-level calculation methods is presented in Table 2.

A strength of the detailed model-based methods is their ability to capture mitigation actions taken on farm. It also shows that even the simplest calculation methods are able to reflect some on farm mitigations. However, the accuracy or extent to which these simple methods do so is less than the detailed models.

Figure 2: Dairy – comparing Overseer and stock method

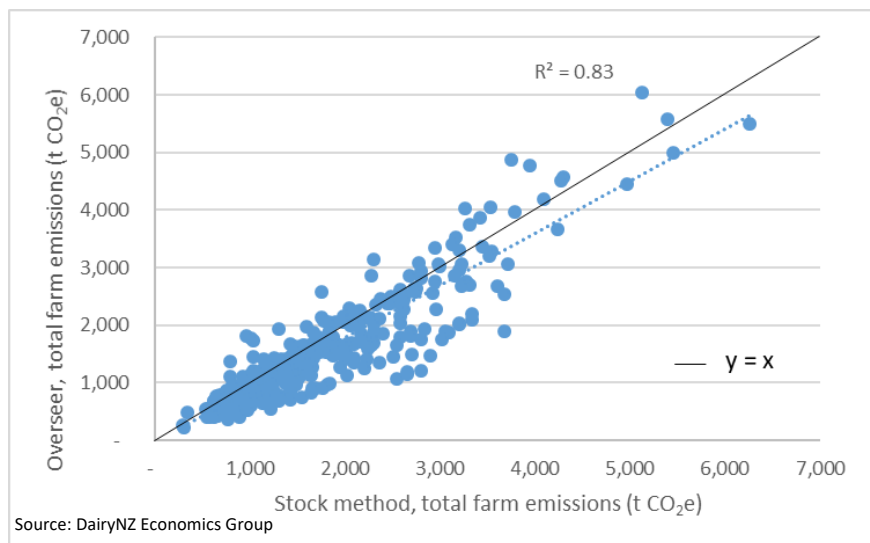


Figure 3: Dairy – comparing Overseer and the maintenance / production method

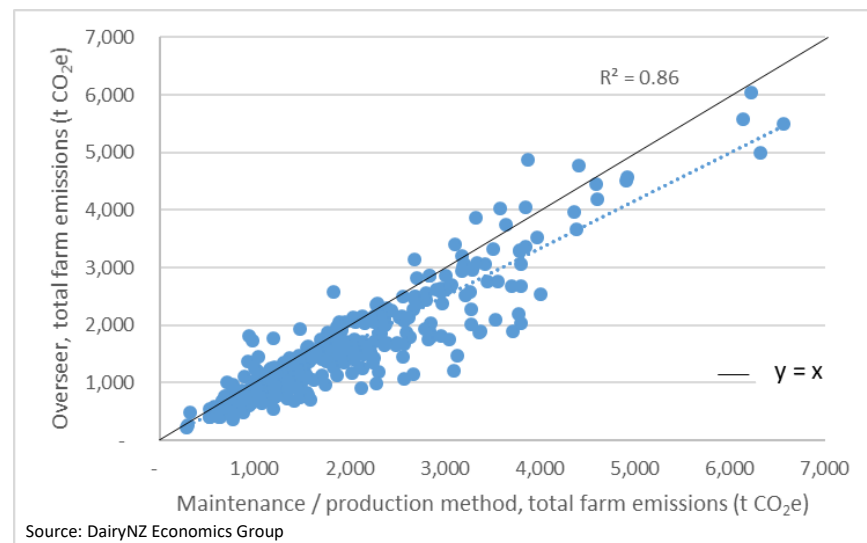


Figure 4: Dairy – comparing Overseer and AIM method. source: Rollo (2018)

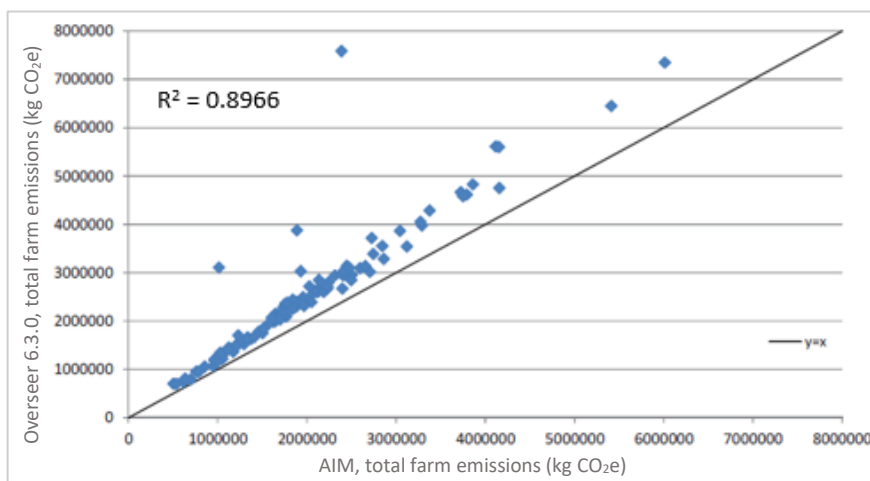


Figure 5: Drystock - comparing Overseer and stock method

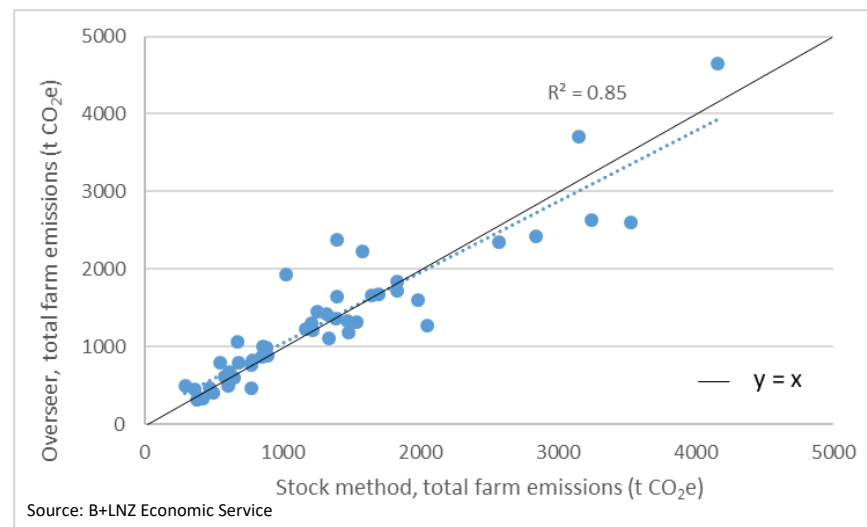


Table 2: Livestock emission mitigations recognised by emissions calculation methods

	Mitigations	Stock method	Maintenance / production method	AIM method	Complex farm-level methods e.g. Overseer
Existing or emerging practices	Increasing performance of individual animals while reducing stocking rate	✓ (partially)	✓	✓	✓
	De-intensification of dairy systems	✓ (partially)	✓	✓	✓
	Removal of breeding beef cows	✓	✓	✓	✓
	Nitrification and urease inhibitors	? ¹⁵	? ¹⁵	✓	✓
	Once-A-Day milking	✓ (partially)	✓	✓	✓
	Low emissions feeds	✗	✗	✓ (partially)	✓ (partially)
	Low emissions breeding	✗	✗	Potential to capture	Potential to capture
	Enhanced manure management	✗	✗	Potential to capture	Potential to capture
Future practices	Methane inhibitors	✗ ¹⁶	✗ ¹⁶	Potential to capture	Potential to capture
	Methane vaccine	✗ ¹⁶	✗ ¹⁶	Potential to capture	Potential to capture
	Low emissions feeds (GM ryegrass)	✗	✗	Potential to capture	Potential to capture

¹⁵ This mitigation would only be reflected in calculation results if use of these inhibitors improves productivity, and currently scientific evidence is inconclusive as to whether they do.

¹⁶ These simple methods could generate perverse results (increased emissions), as the direct mitigation effect of the vaccine / inhibitor would not be captured but production could increase as a result. It would be relatively easy to remedy this by incorporating another factor into the method, relating to number of animals vaccinated or fed with inhibitor.

4.3.3. Administrative costs

The benefits of estimating emissions more accurately at the farm scale and capturing a wider range of mitigation options need to be weighed up against the administrative costs of different calculation methods to both farmers and to the government.

As part of the BERG's work, the costs of calculating emissions on farm were assessed in a report commissioned from BECA.¹⁷ As an example of a complex method BECA used Overseer. A summary of the results is provided in Table 3, showing both the costs per farm as well as how those costs would aggregate up for the sector as a whole.

If a dedicated greenhouse gas estimation method was used the costs could be lower. Much of the cost of using Overseer is due to the set-up costs associated with its use as a nutrient budgeting tool, which requires assistance from certified advisers. To balance that, the ICC's discussions with stakeholders indicate that the costs estimated by BECA, particularly the cost of calculating emissions using Overseer, are likely to be an underestimate for some farm systems.

Nevertheless, the cost estimates give a useful indication of the scale of the cost difference between a simple method and a complex method.

Table 3: Cost of calculating emissions (BECA, 2018)

Annual cost	Simple farm-level methods	OVERSEER® Nutrient Budgets
Per farm	\$80	\$500 per dairy farm \$900 per sheep and beef farm (reducing to \$400 over time)
For the sector	\$1,900,000	\$11,000,000

The cost of undertaking emissions calculations increases with the amount of data required, but costs can come down if data are already collected or if calculation tools are already being used for other purposes.

In the case of Overseer, it is already used by a significant number of farmers in certain parts of New Zealand in nutrient budgeting and farm environmental planning.¹⁸ For example, BECA (2018) estimated that around 4000 dairy farms may already be using Overseer due to water regulation. These farms would be able to generate greenhouse gas emissions reports from Overseer with little additional cost or effort.

¹⁷ BECA (2018).

¹⁸ Some regional councils and unitary authorities require the use of Overseer for farm-scale nutrient reporting or to meet farm-scale nutrient loss limits, as part of effects-based approaches to managing freshwater driven by the National Policy Statement for Freshwater Management 2014 (Freshwater NPS) under the Resource Management Act. Overseer has also been widely used in the dairy industry and across sectors in farm planning approaches.

Costs could be reduced if the calculation methods do not require the assistance of certified adviser. There may also be the opportunity to improve the data sharing ability of systems or processes that farmers already use. Farmers may use farm systems tools or accounting packages in the course of their business which may hold relevant information such as stock reconciliations and feed data. It may be possible to leverage the data collected in these systems for emissions calculations. One way of doing this may be to make use of the New Zealand Farm Data Standards in the emissions calculation and reporting system.¹⁹ The Farm Data Standards is a tool that aims to make it easier to transfer data across systems in the primary sector in a secure and efficient way.

4.3.4. Transparency and governance

The transparency and governance arrangements applying to calculation methods are key for giving confidence around the results they deliver. This is particularly important for calculation methods used in regulation, given that results may have a bearing on financial costs imposed on businesses (in the case of a pricing policy) or on compliance action that may be taken (in the case of a command-and-control regulation such as GHG emissions limits). Trust in the results of calculations are essential for perceptions of fairness and for generating confidence in the policy.

The governance and transparency around New Zealand's agricultural GHG inventory lends a degree of confidence to the calculation methods directly linked to it. There is a robust process around any changes made to any methodologies or underlying data in the inventory – an independent technical advisory committee scrutinises any changes suggested by MPI and makes recommendations to the MPI Deputy Director General. It is also subject to formal international peer reviews on a regular basis as part of New Zealand's UNFCCC obligations.

Any calculation method adopted for use in agricultural greenhouse gas policy will face rigorous scrutiny. Simple methods based on the national inventory are underpinned by the robust domestic and international processes already in place. More complex methods will need to implement similar processes.

The processes used in the NZ ETS also serve as an example for how calculation methods for regulating agricultural emissions could be managed. The calculation methods, including emission factors or models and input parameters where applicable, that NZ ETS participants must follow are specified in regulations. There is a well-established process for any updates to these regulations, designed to give sufficient notice of any change. It includes expert advice as well as consultation to give affected parties an opportunity to provide input.

In respect of Overseer, questions have been raised about whether its current level of governance and transparency is adequate for use in regulation. In December 2018, the Parliamentary Commissioner for the Environment (PCE) released a report into Overseer's use in freshwater regulation.²⁰ While focused on Overseer's use as a tool in to help regulate water quality, the report made recommendations concerning transparency and governance that apply to any regulatory use of Overseer.

The PCE assessed Overseer using the United States Environmental Protection Agency's (US EPA) framework for the evaluation of environmental models. This exercise found that the transparency

¹⁹ The Farm Data Standards are one of three data integration initiative developed by the pastoral sector, with funding from DairyNZ, the Red Meat Profit Partnership and MPI through the Primary Growth. More information can be found on this website: <http://www.farmdatastandards.org.nz/>

²⁰ PCE (2018).

around some elements of Overseer was insufficient to assess its fitness for purpose.²¹ It also found that its peer review processes and documentation were less than ideal for a model used in a regulatory setting. The review also raised questions about the model's ownership arrangements, which involve the Ministry of Primary Industries, AgResearch (a Crown Research Institute) and the New Zealand Phosphate Company.²²

The report made several recommendations related to Overseer's governance, transparency, peer review, funding, and ownership arrangements, with the aim of improving confidence in its use in a regulatory context.

Although these comments are about Overseer the same transparency and governance issues would arise over any complex method.

4.4. Audit

Audit refers to the systematic examination of an organisation's information or records to determine if they are accurate and in accordance any applicable rules, regulations, and laws. It may be carried out by a regulator, or by an independent third party.

Audit is an important tool for discouraging non-compliance in any regulatory policy that involves reporting. The "auditability" of information used in emissions calculations is therefore an important practical consideration for any policy to regulate agricultural emissions. The more data that are required for the calculation, the more likely that it will be costly and challenging to audit.

If the information used in emissions calculations can be verified using independent data sources, audit is less costly. It becomes a paper-based process of cross-checking records through, for example, examining invoices or other financial records.

This approach is used in New Zealand's tax system, and in the NZ ETS (whose compliance approach is modelled on the tax system – self-assessment by participants, the regulator holding powers of audit, and high penalties for fraud). NZ ETS participants are required to calculate and report their emissions, and keep sufficient records to enable verification of their emission calculations.

The Environmental Protection Authority is responsible for reviewing emission returns for sectors other than forestry, and undertakes a range of desktop checks. It may also contract third parties to undertake more detailed audits of participants' compliance with obligations, which typically involve cross-checking data sources and financial records. This is a relatively low-cost system for NZ ETS participants, as the government bears most of the cost of the audit activities.

For a farm-level policy to regulate GHG emissions, the suitability of this approach will depend on the nature of the information used in emissions calculations. Some of the data used, such as milk production and stock numbers, are recorded and reported by farmers for other purposes already. This gives a source of data against which the calculations could be verified, although the quality of data may be limited for some farm systems. However there may be no independent sources of data

²¹ For example, its source code and some algorithms are proprietary and not publicly accessible.

²² The New Zealand Phosphate Company is a limited liability company trading as The Fertiliser Association of New Zealand Incorporated. The Fertiliser Association is a trade association representing and owned by New Zealand's two major fertiliser manufacturers, Balance Agri-Nutrients Ltd and Ravensdown Ltd, both of which are farmer-owned cooperatives.

in some other cases, for example, the amount of supplementary feeds grown on farm, which can influence nitrous oxide emissions.

In such cases, allowing farmers to use agents to certify information used in calculations could be an alternative. This approach has been taken in some freshwater regulations implemented by councils, where reporting via Overseer must be undertaken with the assistance of a certified nutrient advisor. This is more suitable for data that is permanent or less changeable (e.g. land area, soil type), but can be very costly for quantities that change annually. Note, this was a key driver for the cost of using Overseer, as assessed by BECA.²³

Certification undertaken for other purposes, e.g. for Farm Environment Plans or the various assurance activities undertaken within the sector, may increase the amount of auditable information available over time.

Another alternative would be to undertake audits by visiting farms to check or inspect farm infrastructure or stock. This is a much more interventionist approach and may be cost-prohibitive in a scheme involving 20,000+ participants. It is also unlikely to be welcomed by farmers.

Irrespective of the audit approach used, the high number of participants that would be involved in a policy regulating emissions at farm-level will require the government to devote a significant amount of resources to audit. For agencies involved in the implementation of the policy, a step change increase in funding and capability is likely to be required, as compared to the current resourcing for audit in the NZ ETS.

4.5. Updating calculation methods

The national inventory estimates of New Zealand's historical agricultural emissions have changed over time. This has been due to a combination of changing scientific knowledge and the development of improved estimation methods. In addition, activity data used to calculate emissions in the national inventory, such as liveweights of different animals, fat and protein content of milk, and dressing out percentages at slaughter, have been refined over time.

This means processes will need to be established to keep the emissions calculation methods used in regulation updated to reflect how emissions per animal or per product change over time based on data provided from the national inventory and national agricultural statistics. Issues to consider in this regard include:

- That updates could cause estimates to go both up or down, even if farm practices or output are unchanged
- The frequency of updates
- Managing updates in a predictable and transparent way so that changes are understood and are not a surprise for affected parties.

If an update is made to the national GHG inventory, then it is applied to the entire times series going back to 1990. This means that New Zealand's emission reduction targets, which are expressed as a percentage reduction against emissions in a specific year, are also scaled in line with any inventory updates.

²³ BECA (2018)

New Zealand has invested heavily in research to underpin the national inventory calculations and the basic methodology has been in place since 2004. Although changes to the methodology occur on an annual basis their impact on estimated emissions tends to be small. The risk that updates to calculation methods will cause large changes in estimated emissions when on farm practices have remained the same is low. The main exception to this would be if there are changes to the Global Warming Potentials (GWPs) used to make greenhouse gases comparable with CO₂, although any changes do apply to the historical time series.

Processes for updating calculation methods could draw on those already used in the NZ ETS. The calculation methods, including emission factors or models and input parameters where applicable, that NZ ETS participants must follow are specified in regulations. There is a well-established process for updates to regulations, with some updates pursued every year. From the point when the need for a regulatory update is identified, the process takes around 15 months in total. This is designed to give affected parties an opportunity to comment and to give sufficient notice of any changes

For example, for an update to an emission factor in regulations that is intended to take effect in January 2021 (meaning it would apply to 2021 emissions, for which unit surrenders are due in May 2021), the timeline would be:

- Q3 2019: expert technical advice sought on regulation to be updated
- Q1 2020: Cabinet approval to consult on options
- Q2 2020: approx. six weeks consultation with interested parties
- Q3 2020: Cabinet decision, taking into account consultation feedback, followed by drafting and approval of amendment regulations
- Q4 2020: 3 month stand-down period before amended regulations can enter into force in January 2021.

In the case of agricultural emissions, there could be a case to have a streamlined process whereby emissions factors are updated in a relatively automatic way each year when new inventory data becomes available. The full process outlined above could be reserved for when there are methodological or other changes such as new GWP values that could have more impact on calculated emissions values.

4.6. Providing choice of calculation method

The question arises as to whether to allow farmers choice over calculation methods, given the varying capability among farmers to calculate emissions – for example some are already using Overseer but for others starting with a simpler method could be more appropriate.

Providing farmers with choice would give them flexibility, but would create challenges for the stability of any regulatory system.

The two main scenarios which could involve farmers opting to use a particular calculation method for a pricing scheme are:

- A processor obligation, with farms able to opt-in as point of obligation (opted-in farms' emissions would need to be subtracted from processors' obligations, to avoid double counting).

- A farm obligation, with a simple method as the default but allowing any farm to opt-in voluntarily to using an agreed complex method.

A challenge with both these scenarios is that only the farmers with lower emissions would be likely to opt-in. This is because for these farmers, opting in would minimise their costs as compared to using national average emission factors at processor level or for a simple farm-level calculation, whereas for those with higher emissions opting in would increase their costs.

Lower emitting farmers opting in would mean that the processor-level or simple farm-level calculations underestimate the actual emissions for the farmers still using the default method.

There are two ways to manage this:

- Set default emission factors conservatively, and potentially update them regularly to account for any bias that might develop.
- Constrain the choices available to farmers in some way.

A potential drawback with the first approach is that adjusting emission factors to reflect the skew would also make opting-in even more attractive. It could perpetuate the problem as each increase to emission factors would mean another group of farmers would benefit from opting-in. Whether this is a problem in reality would depend on how costly the more complex calculation method is, compared to the cost of staying with the simple method.

Ways to constrain choice could include:

- Making the complex method compulsory for farms over a certain size, so there is a mix of farms using that method rather than only those who get an advantage from doing so.
- Limiting how often a farm could change calculation methods (e.g. only once every 5 years)
- Allowing choice for only a certain period of time, and migrate all participants into the complex method by a set date.

A further consideration would be added cost for the government from potentially having to run and maintain more than one system, particularly in the case of a processor-level obligation where a principle benefit is reduced administrative cost.

4.7. Opportunities for new or improved calculation tools

The discussion above has focused generically on the range of calculation options available. With respect to complex calculation approaches, Overseer has been used as an example as a readily available tool for farmers wanting to calculate their emissions. As noted, although Overseer generally aligns well with the national inventory approach, governance and transparency concerns raise issues about the use of Overseer as a complex calculation method for a pricing policy – although it could be made fit for purpose if these issues are addressed.

Alternatively, given that Overseer mimics the national inventory and does not use proprietary information when calculating emissions, a new more open and transparent calculation method could be developed that aligns with the AIM. In addition to being viewed as a duplication of an existing method a further disadvantage is that it creates another stand-alone tool when, from what we have heard, the sector wants to have a joined-up approach to managing environmental issues.

Comparisons of Overseer with simple methods indicate, however, that simple calculation methods using default national average emission factors can have strong general relationships with more

complex methods. The loss of accuracy at the individual farm level and the greater ability to incorporate on-farm mitigation actions have to be balanced against the cost savings that many farmers could make.

A potential way forward would be to develop a new, complex emissions calculation tool, based on the AIM, which can also be run as a simple method using very limited farm-specific data. The tool could be set up with a complex model within it, but with most of the inputs populated with default values. It initially could be run with only stock numbers or basic production data. It may be possible to modify Overseer to perform in this way also.

If choice is allowed, some farmers who wish to go to the expense and effort of using the tool with greater levels of farm specific data could be permitted to do so. Alternatively, over time the amount of farm specific data that can be used to replace defaults could be increased. The advantage of this approach would be that all farmers could use the same tool, and migrating farmers over time to more complex calculations may be easier.

Box: Overseer

Overseer was developed initially as a tool to help improve the efficiency of fertiliser use on farms. To do this Overseer models nutrient flows on farms. It takes into account nutrients present on the farm, those coming from external sources such as in feed and fertiliser, those leaving the farm in farm products and those leaving the farm via losses to water (e.g. leaching) and the atmosphere (e.g. greenhouse gases).

Overseer is now used widely by regional councils to assist in the management of nutrient discharges from farming operations. The detailed characteristics of Overseer and its suitability for use as a regulatory tool has been the subject of a detailed review by the PCE.²⁴

With regard to estimating agricultural greenhouse gas emissions on-farm Overseer takes an approach similar to that recommended by the IPCC for national inventory calculations.

For enteric methane, emissions are predicted directly from dry matter intake using an empirically derived New Zealand constant. Dry matter intake is estimated using well published peer-reviewed energy algorithms (The Australian Feeding Standards) and detailed animal and diet characteristics; these include such things as monthly animal numbers by stock class, animal size, liveweight change, milk yield and reproductive performance. Where farm specific data are not available, e.g. for diet quality, default average values are used. Methane from manure management is also estimated in a manner similar to that recommended by the IPCC – the quantity of manure entering a particular manure management system is estimated and the quantity of methane emitted is estimated using New Zealand derived constants.

Nitrous oxide emission estimation is more complex in Overseer as a choice of modes is available. However, it is recommended that the 'Annual average EFs' mode is used since it reproduces the national inventory approach and is the most well-validated. The other two approaches try to capture local circumstances (e.g. soil water status and temperature) but the relationships are less robust. The basic approach is that nitrogen inputs from urine, dung, effluent and fertiliser are used with nationally derived emission factors (EFs) to predict nitrous oxide emissions. Fertiliser inputs are obtained from farm records while the other inputs are estimated from dry matter intake, the nitrogen content of this dry matter, and the amount of nitrogen leaving the farm in product.

The routines (calculation algorithms) used by Overseer to estimate farm GHG emissions mirror the New Zealand national Agricultural Inventory Approach (AIM). They both use the Australian Feeding Standards algorithms for estimating feed intake and the same methane and nitrous oxide conversion factors. The principle difference is that Overseer uses monthly farm specific data while AIM uses national average data for feed and performance and models monthly populations based on annual June 30th population data. If the same input data are used Overseer and AIM should essentially predict the same quantity of GHG emissions.

The AIM is updated annually but this is not the case with Overseer and small differences have arisen over time in the approaches adopted by Overseer and AIM to estimate GHG emissions. Overseer, MPI and the NZAGRC are currently working together to fully align the routines in both models and to develop processes to ensure that they remain aligned in the future. Improving the description of the Overseer routines is an ongoing activity

²⁴ PCE (2018)

As the routines used in Overseer to predict methane and nitrous oxide emissions are essentially those used in AIM they have been subjected to extensive domestic and international peer review. As Overseer works at a monthly time step it is data hungry and not all farms will have the amount and quality of data needed to drive the GHG emission calculations. This is a generic problem but is especially an issue for trading drystock farms where numbers can change abruptly from month to month and key performance data (e.g. animal weights) are not always available.

As Overseer is already used on some New Zealand farms for nutrient management purposes, extending its use to estimating methane and nitrous oxide emissions in any GHG policy setting has clear advantages. It avoids duplication and allows for a more holistic approach to environmental management.

However, Overseer is complex to set up and generally rural professionals work with farmers to set up and run Overseer rather than farmers running it themselves. This increases the cost. Additionally, some of the data needed for setting up Overseer, for example soil and climatic data, are not used when estimating methane and nitrous oxide emissions. If being used for greenhouse gas estimation alone the Overseer calculation approach could be replicated in a simpler, more user friendly framework.

The PCE has raised the issue of transparency and governance arrangements with regard to using Overseer as a regulatory tool. The model is not open source and the level of documentation is not sufficient to allow easy identification of the methods and assumptions used within the model. His conclusion is that ‘..in some important respects Overseer does not meet the levels of documentation and transparency that are desirable in a regulatory setting.’ He further states that ‘..... If the model is to be opened up, there are implications for Overseer Ltd’s ownership, governance and resourcing’. These concerns urgently need to be addressed if Overseer becomes the tool of choice for calculating agricultural greenhouse gas emissions.

5. Conclusions

Determining appropriate and practical calculation methods for use in regulating agricultural emissions will require further work by the government, in collaboration with the agricultural sector. This applies to methods applicable at both the processor and farm level.

Approaches to calculating emissions at processor level are relatively limited, but there are some choices or options for incorporating additional farm-specific data to enable more specific emissions estimates.

For calculating emissions at farm level, it would be entirely acceptable to begin by using a simple method, with the aim of moving to a more complex method over time.

Use of relatively simple calculation methods result in sector-wide emissions estimates that generally correspond with those obtained from the most detailed on-farm method currently available, Overseer. Simple methods have disadvantages in terms of accuracy at the individual farm level and the ability to capture on-farm mitigation actions. These disadvantages need to be balanced against the cost of using a complex model approach.

It is worth noting, however, that the relative advantages and disadvantages of these methods will likely change over time as more mitigation options become available and if the cost associated with using complex methods such as Overseer decreases.

An alternative that should be explored further would be to start with a complex model, using a methodology based on that in AIM, but populate it mainly with default values in the first instance. More farm specific data could be progressively included, to provide more accurate emissions estimates. This may be easier to manage over time, as data required from a farmer could be expanded and updated, rather than changing to an entirely different calculation method or tool. Audit processes and requirements need to be considered in determining which farm data can be included.

It may be possible to allow farmers already using, or capable of using, a more complex calculation method the choice of opting in to use a complex method or providing more farm-specific data. This would need to be managed carefully, bearing in mind that only farmers with lower emissions are likely to take up such an option. One way to manage risks with this approach would be to allow choice of calculation method or use of more farm-specific data only for a set period of time, after which all farmers must use the more complex method or the additional farm-specific data points.

Any methods or tools used will need to be subject to appropriate transparency and governance processes. The approaches already used for oversight and management of New Zealand's national GHG inventory and for calculation methods in the NZ ETS provide useful examples to inform how methods to calculate agricultural emissions could be handled.

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Appendix Two: Other examples of methodologies

NZ GHG Inventory for agriculture methodology

The Agriculture Inventory Advisory Panel advises on changes to scientific data and methodologies for the agriculture greenhouse gas inventory. These changes are first approved by MPI and then by the Reporting Governance Group (RGG). The RGG is a cross-agency manager level group that provides oversight of UNFCCC reporting.

The methodology for the agriculture inventory is set outside of legislation through the “Methodology for calculation of New Zealand’s agricultural greenhouse gas emissions”.

The Inventory adheres to the UNFCCC reporting guidelines and the international methodology guidelines set out by the Intergovernmental Panel on Climate Change (IPCC). The guidelines permit the development of country specific emission methods and emission factors, as long as they are scientifically defensible and meet the requirements of the guidelines. Most of New Zealand’s agricultural emissions are calculated using country specific emissions factors and default IPCC methods.

The Agriculture Inventory Advisory Panel meets on an annual basis to agree any changes to the methodology as well as emissions factors. The Panel is made up of representatives from the Royal Society of New Zealand, New Zealand Agricultural Greenhouse Gas Research Centre, experts on methane emissions (New Zealand Methanet advisory group) and experts on nitrous oxide emissions ((New Zealand NZN2Onet advisory group) and government officials from MPI and MfE.

Nomination of Panel members comes from MPI/MfE representatives and is made to the Deputy Director Generals (DDG) for policy and trade at MPI. These government representatives will seek advice from NZMethanet, NZN2Onet, the Royal Society of New Zealand and the NZAGGRC about their respective nominees. The MPI DDGs have final approval for all members.

Domestically, New Zealand has an engaged network of scientific experts in the field of CH₄ and N₂O emissions. Research findings are presented annually at the Greenhouse Gas Inventory Research Workshop. New inventory research ideas raised by the research community inform decisions for future inventory research.

Final decisions on inventory research priorities are made by MPI, following discussions between the network leaders and MfE staff. Research is contracted to address specific questions relating to gaps in New Zealand’s knowledge and to review, test and improve current model parameters used.

Draft research reports are peer reviewed by at least one external independent expert with knowledge in the field and are assessed for their scientific robustness and suitability to be included in the inventory. A standard peer review report template is used. If the report is suitable for inclusion in the inventory, a briefing and the final report are sent to the

Agriculture Inventory Advisory Panel, which meets annually to review proposed changes to the inventory.

The panel provides independent advice on whether proposed changes to the agriculture inventory are scientifically robust, justifiable and internationally defensible. The Panel assesses if the proposed changes have been appropriately researched, using recognised scientific principles, and if there is sufficient scientific evidence to support the recommended changes.

Changes recommended by the Panel are sent to the Deputy Director-General (Policy and Trade) at MPI. The Deputy Director-General and the Reporting Governance Group (RGG) must approve the changes for implementation into the inventory.

The inventory methodology, including any changes made is then scrutinised during the annual inventory review by a team of international experts certified by the UNFCCC.

NZ ETS reporting requirements

The CCRA (s163) enables the making of regulations that detail the information collection and calculation methodology used by NZ ETS participants to calculate their emissions. These emissions calculations are submitted in emission returns that participants are required to submit.

Regulations made under the Act for each sector (e.g. Climate Change (Agriculture) Regulations 2010 or Climate Change (Liquid Fossil Fuels) Regulations 2008) set out clauses such as:

- Interpretations (definitions) of data requirements that need to be captured
- Information required to be collected for reporting annual emissions.
- The methodology for how the information will be used for calculating the total emissions.
- Emissions factors are set out in either the main body of the regulations, or in schedules of the regulations.
- The EPA can issue guidelines or standards related to information required to be collected by these regulations.
- For some other sectors, regulations provide thresholds and exemptions for inclusion.

For NZ ETS participants, including agricultural processors, the EPA has provided some guidance on how to report emissions. This is mostly focused on how to provide an emissions return, timing, and guidance on information that needs to be collected and kept and used in calculating emissions.

Agriculture has been required to report emissions since 2011, however there has not been a requirement to surrender units for those reported emissions. Because of this, less emphasis has been placed on reviewing these regulations than on those for other sectors, including the schedule of emissions factors.

For other sectors, elements of these regulations are updated as required to ensure they remain current. This includes occasional updates to emissions factors. Such updates require a public consultation process and occur as part of the annual suite of updates to NZ ETS regulations.