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Report

Assessment of the administration costs and barriers of scenarios to mitigate biological emissions from agriculture

Prepared for Ministry for Primary Industries

Prepared by Beca Limited

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Revision History

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B	Paul Melville	Final draft for Peer Review	28/11/2017
C	Paul Melville	Second draft for Peer Review (a second draft was prepared following a revised briefing from BERG)	11/05/2018
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Document Acceptance

Action	Name	Signed	Date
Prepared by	Paul Melville		11/05/2018
Reviewed by	Sean Newland		14/05/2018
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on behalf of	Beca Limited		

Executive Summary

This assessment provides an estimate of the administration costs and potential capability and capacity barriers to a number of scenarios to mitigate biological emissions from agriculture. This assessment has been undertaken primarily through engagement with government and agricultural sector stakeholders, supported by desktop research.

Analysis of the overall merits of various scenarios and detailed development of policy is beyond the scope of this assessment. Policy scenarios have been developed only to the extent necessary to undertake an assessment of administration costs. Sensitivity analysis has been undertaken to understand how the assumptions made within scenarios impact the overall assessment of administration costs.

A workshop was undertaken to identify scenarios for assessment. Three scenarios were identified that related to different methods of pricing biological emissions from agriculture. A further three scenarios were identified that captured regulatory and voluntary options. These scenarios can be summarised as:

- Price based scenarios:
  - Emissions trading obligations for biological emissions with a **Processor point of obligation**;
  - Emissions trading obligations for biological emissions with an **On-farm point of obligation**; and,
  - Price based incentive for users of biological emissions mitigation technologies (**Payment for low emissions technologies**).
- Non-price based scenarios:
  - **Regulated biological emissions limits** (eg biological emissions per hectare limit);
  - **Regulated use of emissions mitigation technologies** (eg compulsory use of methanogen vaccine); and,
  - An agreement between the government and agricultural sector in which agricultural sector organisations support farmers to undertake biological emissions reduction activities (**Government-industry agreement)**.

Further detail and explanation on the construction and assumptions within each scenario is contained in the body of this report.

Estimate of administration costs

Table E1 displays Beca's estimate of administration costs for each of the scenarios assessed. This estimate includes costs organisations need to undertake to implement or comply with each scenario, but does not include costs related to undertaking mitigation activities. For example, the cost of brokerage (or procurement) of New Zealand Emissions units (NZUs) is included, but not the purchase cost of NZUs themselves.

Table E1: Estimate of total annual administration costs for each scenario (rounded to two significant figures)

	Processor point of obligation	On-farm point of obligation	Payment for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Total cost estimate (per year)	**$2,700,000**	**$39,000,000**	**$3,600,000**	**$15,000,000**	**$1,300,000**	**$6,900,000**
Government Costs	$660,000	$9,300,000	$1,600,000	$4,100,000	$1,200,000	$570,000
Sector Costs	$2,100,000	$30,000,000	$2,000,000	$11,000,000	$82,000	$6,300,000

A key finding from this assessment are that there were four key drivers of cost across the group of scenarios. A number of other cost drivers were assessed, but even if assumptions were adjusted, did not have a material impact on the overall cost estimate. The key drivers of cost were:

- The cost of engaging a certified nutrient management advisor to support modelling of farm biological emissions;
- The brokerage costs farmers may face in procuring NZUs within the On-farm point of obligation scenario;
- The government administration costs of an On-farm point of obligation scenario; and,
- The cost of developing a Farm Environmental Plan, where a farmer is required to develop this as a result of having high levels of biological emissions.

Sensitivity analysis focussed on adjusting assumptions relating to these four key cost drivers. This analysis focussed on considering areas of disagreement or uncertainty within the initial assumptions applied for these four key cost drivers. For example, there were views expressed that a greater allowance of time taken to estimate farm greenhouse gas emissions could have been applied.

Adjusting assumptions in relation to the time taken to estimate farm greenhouse gas emissions, government administration and the number of farmers who are required to undertake Farm Environmental Plans can increase the cost further for each of the three most expensive scenarios.

The costs of an On-farm point of obligation scenario can be significantly reduced if a method can be established to allow farmers to estimate biological emissions without engaging a certified nutrient management advisor and if a method can be found to reduce the brokerage fees farmers' face in procuring emissions trading units.

Beca has not undertaken an assessment of the feasibility of these measures as potential cost mitigation measures, simply identified these factors as key drivers of cost. Table E2 displays a summary of the results of sensitivity analysis. The On-farm point of obligation scenario in particular has a high degree of sensitivity to changing assumptions relating to these key drivers of cost. Despite this sensitivity, a low-cost On-farm point of obligation scenario maintains a higher cost than any other scenario, with like-for-like assumptions. The lower cost scenario for On-farm point of obligation may be relevant when both costs and benefits of different scenarios are considered (an On-farm point of obligation may also have the highest benefits).

Table E2: Sensitivity analysis of annual administration cost estimate (adjustments made to four key drivers of cost)

	Processor point of obligation	On-farm point of obligation	Payments for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Low cost scenario	*No change*	$16,000,000	*No change*	$11,000,000	*No change*	*No change*
Central scenario	**$2,700,000**	**$39,000,000**	**$3,600,000**	**$15,000,000**	**$1,300,000**	**$6,900,000**
High cost scenario	*No change*	$61,000,000	*No change*	$32,000,000	*No change*	$16,000,000

Key barriers to implementation of scenarios

A number of potential barriers and limitations are able to be identified for each scenario assessed. Individually, each of these barriers can likely be overcome through government or sector programmes or investment. No critical barriers have been identified that would prevent any particular option from being implemented.

An On-farm point of obligation scenario is however likely to face the highest number of barriers to implementation.

Estimation of biological emissions would significantly increase the demand for certified nutrient management advisors. This scenario is likely to require an additional 50-100 such advisors over a base of circa 50 certified nutrient management advisors currently employed by rural consultancies. There may be barriers to training and supervising such a large proportion of new advisors over a short period of time.

Both rural consultancies and brokerage firms would need to expand operations significantly to service the increase in demand for services that an On-farm point of obligation scenario would drive. Policy uncertainty may present a barrier to large-scale expansion by such firms.

Discussion

Table E3 compares the total administration cost to the total level of biological emissions in New Zealand and the administration costs agricultural sector participants face under each scenario (central cost estimates).

Table E3: Annual administration cost key metrics

Key metric	Processor point of obligation	On-farm point of obligation	Payment for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Total administration cost, per tonne biological emissions in New Zealand	$0.07	$1.02	$0.09	$0.40	$0.03	$0.18
Sector cost as a % of net emissions trading obligation (95% allocation)	5.1%	78%	5.2%	30%	0.2%	16%
Sector costs, per farm	$87	$1,300	$83	$470	$3	$260

On-farm point of obligation

The On-farm point of obligation scenario stands out as having a significantly higher level of administration costs and a greater number of barriers compared to other scenarios within our assessment.

Two individual drivers of cost are responsible for the majority of the estimate of administration cost within this scenario.

Estimation of biological emissions using a certified nutrient management advisor is expected to initially cost $700 for the average farm. This cost will vary between farms and may reduce slightly as farmers become more familiar with this process.

Secondly, brokerage fees are currently $500 per transaction.

Together, these two drivers of cost alone result in a cost to farmers of approximately $1,200 per annum.

In the event that biological emissions entered the Emissions Trading Scheme (ETS), either at a Processor point of obligation or On-farm point of obligation, a typical farm is likely to face an emissions trading cost of approximately $1,600.[1] When viewed in comparison to this expected emissions trading cost, a compliance cost of over $1,200 can be viewed as highly significant.

While this assessment has noted higher costs and barriers for this scenario, we have not undertaken any investigation into comparative benefits between scenarios (this is beyond the scope of our work). Further, key drivers of cost, such as the cost of estimating farm biological emissions and farm brokerage costs, may also be able to be reduced through alternative policy measures within this scenario. Consideration of such elements is required to understand a complete picture of the merits of each scenario.

[1] On present assumptions, including an emissions price of $20 and an allocation equivalent to 95% of baseline emissions.

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Appendices

1 Background

The Biological Emissions Reference Group (BERG) has commissioned Beca to undertake an 'Assessment of the costs and barriers of implementing various scenarios to mitigate biological emissions from agriculture'.

This project is for the purpose of answering the questions:

> *What are the comparative and approximate administration costs of different scenarios to mitigate biological greenhouse gas emissions?*

And,

> *What are the various barriers to implementation and administration of different scenarios to mitigate biological greenhouse gas emissions?*

Consideration of all benefits and the broader economic cost of various scenarios to mitigate biological emissions is out of the scope of this project, as are any indications of policy preference.

The project considers dairy, sheep, beef and deer sectors only. Other animal sectors, horticulture and arable farming were all excluded from the scope of the report.

Beca has conducted a 'second order estimate' of the administrative costs of five regulatory and one non-regulatory option for facilitating biological emissions mitigation in New Zealand.

A second-order estimate seeks to provide a quality approximation of costs while using simplifying assumptions. This is an appropriate approach when estimating the costs of a number of different scenarios and can be used within options analysis. This provides for the ability to undertake a relative comparison between options using similar assumptions. In the event a preferred option is identified, further, higher-order, cost estimation would be required to undertake a detailed cost-benefit assessment and / or project plan.

1.1 Biological Emissions Reference Group

BERG is a partnership between New Zealand's agricultural sector and government agencies. BERG has been tasked with collaboratively establishing a robust and agreed evidence base on the opportunities available now, and in future, to reduce biological greenhouse gas emissions (methane and nitrous oxide) on-farm. In doing so, it will consider the costs, benefits, and barriers to mitigating biological emissions from agriculture.

This report is one of several commissioned by BERG to build an evidence base to inform future actions or policies.

2 Scenarios

A Beca facilitated workshop with a sub-committee of BERG was held on the 20th July 2017. This workshop developed both a long-list and short-list of scenarios considered representative of options to mitigate biological emissions.

The workshop short-listed three price based scenarios and three non-price based scenarios to be assessed. These scenarios can be summarised as:

- Price based scenarios:
  - Emissions trading obligations for biological emissions with a processor point of obligation;
  - Emissions trading obligations for biological emissions with an on-farm point of obligation; and,
  - Price based incentive for users of biological emissions mitigation technologies.
- Non-price based scenarios:
  - Regulating farm biological emissions limits (eg biological emissions / hectare);
  - Regulating the use of specific biological emissions mitigation technologies; and,
  - An agreement between the government and agricultural sector in which agricultural sector organisations support farmers to undertake biological emissions reduction activities.

An outline of the scenarios long-listed and the process for developing the short-list of scenarios is contained in Appendix 2.

Beca, in consultation with BERG, has developed a set of detailed assumptions to sit within each of these policy scenarios. These assumptions have been developed for the purpose of allowing Beca to quantify administration costs associated with each scenario.

Where assumptions applied by Beca have had a key bearing on costs, Beca has undertaken sensitivity analysis to test alternative assumptions in Section 3.4 of this assessment. Beca has not made any judgement on the merits or appropriateness of various policy assumptions, alternative assumptions have simply been mapped to provide a broader understanding of the potential cost implications of each scenario. Where alternative assumptions result in lower administration costs, more detailed analysis would be required to confirm the feasibility of the various options before concluding a preferred way forward.

2.1 Price based scenarios

New Zealand has operated an emissions trading scheme since 2008. Under the New Zealand ETS, activities that emit greenhouse gases as a result of deforestation, fossil fuel use, industrial processes and waste disposal (landfill emissions) face obligations to surrender New Zealand emissions units (NZUs) to a Crown agency.

Activities that result in biological emissions from agriculture do not currently face an obligation to surrender NZUs.

The price based scenarios each describe different scenarios for how biological emissions could be introduced into the ETS.

2.1.1 Processor point of obligation scenario

Biological emissions do not currently face surrender obligations under the ETS. The Climate Change Response Act (CCRA), which establishes the New Zealand ETS, contains provisions setting out a framework by which biological emissions could enter the ETS.

The framework, if enacted, confirms meat and dairy processors, fertiliser manufacturers and importers, and live animal exporters as the point of obligation for biological emissions.

Emissions factors have been regulated for cattle, sheep, deer and goats (both if sent for slaughter or exported alive), milk or colostrum processed, and nitrogen fertiliser imported or manufactured. Agricultural processors currently have obligations to report emissions levels based on these emissions factors, but have no emissions liabilities or obligations to surrender NZUs.

Present legislation provides for an allocation of NZUs to agriculture equivalent to 90% of baseline emissions levels, if obligations are introduced. The present Government has indicated that if agricultural emissions enter the ETS this level of allocation will shift to 95%. On the request of BERG, Beca has assumed a 95% level of allocation in producing this report.

We have based our assumptions for a 'Processor point of obligation' scenario on this current legislation and regulation, with the simple addition of surrender obligations for agricultural processors and an increase to 95% allocation.

Under this Processor point of obligation scenario, agricultural processors and fertiliser suppliers would face a uniform biological emissions cost for each animal received, unit of milk processed or unit of nitrogen fertiliser supplied. Noting export and import prices for meat, milk or fertiliser would not change, economically rational firms would be expected to pass this cost of emissions trading onto farmers through reduced prices for animals sold and milk supplied, and increased prices for nitrogen fertiliser.[2]

We have assumed a third party audit of processor participants will be undertaken.

2.1.2 On-farm point of obligation scenario

The CCRA contains a provision that allows the Minister responsible to shift the point of obligation for biological emissions to the farmer (Section 2B).[3]

Under an 'On-farm point of obligation', we assume farmers would each individually estimate their farm specific biological emissions each year and face individual obligations to procure and surrender NZUs.

We have assumed within this scenario that farmers would estimate farm biological emissions using the OVERSEER Nutrient Budgets software. This software is presently used to model farm nitrogen loss and assess fertiliser needs, and, with modifications, it is believed that OVERSEER could be capable of providing a robust estimate of biological emissions. Appendix 1 provides additional information on the OVERSEER software.

A 'Nutrient Management Adviser Certification Programme' has been established to provide a transparent set of industry standards for nutrient management advisers, supporting nationally consistent farm nutrient budgets and advice using the OVERSEER software. A requirement to estimate nitrogen loss using a certified

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[2] This assumption is further strengthened by the presence of a number of co-operatives in the agriculture sector (Fonterra, Silverfern Farms, Ballance Agri-nutrients, Ravensdown). If firms choose to absorb some of the emissions trading cost via reduced profit margins, this reduced margin is also passed onto farmer shareholders. It is also our understanding that the Dairy Industry Restructuring Act would require Fonterra to reflect an emissions trading cost in the milk price (and therefore pass this cost on to farmers).

[3] In taking this decision, under current legislation, the Minister must consider the ability of the EPA to verify information submitted by farmers, the likelihood this shift to a farm level point of obligation will cause farmers to reduce their emissions and the administration costs this will cause for the Crown.

nutrient management advisor is a feature of water quality regulation developed by a number of regional councils.

In this On-farm point of obligation scenario Beca is assuming that a farmer would likewise be required to engage a nutrient management advisor certified under this 'Nutrient Management Adviser Certification Programme' to assess and report biological emissions using OVERSEER. This could be either a private consultant or supplied by an industry organisation. This assumption was an outcome of the Beca facilitated workshop held with a sub-group of BERG.

2.1.3 Payment for low-emissions technologies scenario

The government and the agricultural sector have undertaken a programme of investment in biological emissions mitigation technologies (through the Pastoral Greenhouse Gas Research Consortium, the New Zealand Agricultural Greenhouse Research Centre and the Global Research Alliance on Agricultural Greenhouse Gases). Further investment has also occurred outside this programme in New Zealand and abroad.

A number of mitigation solutions are in various phases of development. The following list summarises a selection of these technologies, a short description for how the technology may hypothetically work, and an assumption as to how farmers may hypothetically apply these technologies. We have then used these assumptions to test verification challenges.

- A methanogen vaccine: A vaccine that is applied once a year to stock that supresses the activity of the microbes responsible for methane production in the rumen.
- A methanogen inhibitor: A slow release capsule ('bolus') is swallowed by stock once a year. This capsule contains a substance which inhibits the microbes responsible for methane production in the rumen.
- Low-emissions breeding: Animals are selected specifically for low greenhouse gas emissions traits.
- Low-emissions feed: Farmers adopt feed options which result in less methane production per unit of feed intake. This could include forage crops such as brassicas or specially developed genetically modified pastures.
- Nitrification inhibitor: Farmers apply substances to pasture which slow down the nitrification process in soils. This results in a lower level of farm nitrous oxide emissions.

This scenario assumes that providers of these technologies receive some form of payment from government where their technology is used by qualifying farmers (cash or emissions unit). This government payment offsets a portion of the cost of mitigation and these cost savings will then be passed onto farmers that use these technologies.[4] This payment would be approximately equal to the value of the expected emissions reduction (potentially linked to prevailing NZU prices).

In some instances it may be possible that the payment made would have a greater value than the cost of supplying the technology. In such cases farmers may be paid by suppliers to receive low-emissions technologies. This enhances the need to ensure the government can verify that farmers are applying the technologies appropriately, as there can be no assumption that because farmers have purchased the technology they will necessarily apply it (because they may have been provided the technology free of charge).

[4] A barrier to this policy is that, where only a small number of providers are available for a technology, providers may pass less than 100% of this payment onto farmers. This barrier is noted in Section 4.

Note that this scenario would not be able to instigate emissions reductions through non-discrete practices. For example, improved nutrient management. Payment for such mitigation options is likely to require some form of on-farm GHG measurement, which is not included in the cost estimate of this scenario.

2.2 Non-price based scenarios

Three non-price based scenarios were also considered. Each of these scenarios considers policy approaches and strategies that have been adopted in relation to water quality and considers how they could apply to biological greenhouse gas emissions.

2.2.1 Regulated biological emissions limits scenario

A number of regional councils are limiting the level of nitrogen farmers are permitted to leach as a means of achieving water quality objectives. Nitrogen leaching is modelled using the OVERSEER Nutrient Budget software.

This ‘Regulated biological emissions limits’ scenario assumes farmers face a similar limit for biological emissions. This could be on a greenhouse gas emissions per hectare, per unit of product basis or an alternative measure (this would be a separate policy decision not relevant to our cost assessment, as only the number of farmers who exceed this threshold will impact our assessment of administration costs).

We have assumed that farmers use a certified nutrient management advisor to measure and report biological emissions using OVERSEER. A risk based approach to reporting frequency is utilised reducing the frequency of reporting required by many farms (eg with low stock units per hectare). On average, farmers would measure biological emissions once every three years.

Beca has assumed that where biological emissions exceed a threshold level farmers are required to implement a “Farm environment plan” with an emissions reduction element. A rural consultant is engaged to support the farmer to produce this plan (either a private consultant or an industry good body). A farmer is given three years to reduce emissions levels to the regulated level.

We have made an assumption that initially 15% of farmers exceed the regulated emissions limit. The number of farmers that exceed the regulated level will be function of the policy settings. For example, if the policy sets the regulated maximum level of emissions based on the 75th percentile of farmers, 25% of farmers will exceed the regulated maximum and need to undertake a Farm environment plan.

Following an initial biological emissions assessment, farmers will be required to reduce biological emissions levels. Therefore the level of farmers who exceed second and subsequent biological emissions assessment is likely to reduce as farmers have already taken actions. We assume that from the second and subsequent assessment the number of farmers who exceed an emissions limit is 5%. The level is not zero as some farmers may shift production patterns in response to changing markets and / or the threshold level may be set to reduce over time. Farmers are assessed on average once every three years, therefore, in any given year, 1.67% of farmers are assumed to be required to undertake a Farm environment plan (5% divided by three).

These assumptions are made simply for the purposes of assessing an annual administration cost and do not reflect any preference of BERG for how such a policy should be designed. Any alternative set of assumptions could be argued to be equally valid. We have tested our assumptions with sensitivity analysis in Section 3.4.

There is no obligation to surrender emissions units at any time within this scenario, and no payment is made to participants for undertaking actions required by regulation. This scenario simply assumes a requirement is placed on farmers to take action, similar to requirements to manage farm effluent and stock exclusion from waterways.

2.2.2 Regulated use of mitigation technologies scenario

In this scenario farmers are required by regulation to undertake mitigation practices that are considered to be a minimum requirement of farming in New Zealand. For example, the government may regulate the use of a methanogen vaccine (if commercialised). This could be considered as a similar approach to government regulation requiring farmers to exclude stock from waterways (based on specific criteria).

A selection of the technologies listed within the description of the 'Payment for low-emissions technologies' scenario will also apply to this scenario. Regulators may choose to adopt specific criteria regarding which farm types or systems are required to utilise such technologies.

As with the Regulated biological emissions limits scenario, there is no payment made to farmers under this scenario.

Also, as with the scenario Payment for low-emissions technologies, this scenario would be limited in the mitigation practices it could incentives (only those related to a unique technology).

2.2.3 Government-industry agreement scenario

The government and the dairy industry have established two accords for the purposes of promoting more sustainable dairy farming practices. These were the Dairying and Clean Streams Accord 2003 and the Sustainable Dairying: Water Accord 2013.

The dairy industry has recently launched the Dairy Action for Climate Change plan, an agreement between the dairy sector and the government on dairy sector climate change actions.

This scenario assumes further agreements build on this plan and implement mitigation measures across dairy, sheep, beef and deer sectors to voluntarily achieve emission reduction targets.

This agreement is assumed to include a commitment by all sectors to estimate farm biological emissions and support farmers to undertake measures to improve emissions efficiency. This agreement would also include a commitment by sector organisations to support the uptake of mitigation technologies once they become available.

2.3 Key scenario assumptions within cost estimate

Table 1 outlines the key assumptions for each scenario that drive the costs estimated. Appendix 2 contains a full list of assumptions within each scenario and explains underlying rationale for some assumptions (for example, farm numbers).

Table 1: Key scenario assumptions within cost estimate

Scenario	Key assumptions within cost estimate
Processor point of obligation	■ 70 agricultural processors participants (2016 ETS Annual Report). ■ Minimal administration time. ■ Brokerage $0.05 per NZU. ■ 10% of processors are audited by a third party each year.
On-farm point of obligation	■ 24,000 farmer participants (all economically significant farming enterprises). ■ Initial certified nutrient management advisor OVERSEER report costs $500 per dairy farm and $900 for other farm types. As farmers are conducting this

Scenario	Key assumptions within cost estimate
	assessment every year, after 5 years this reduces to an average of $440 per farm assessment.[5] ■ 4,000 dairy farmers already face this cost on average once every second year (this is subtracted from the cost of policy). ■ Farmers face a brokerage cost of $500 per annum. ■ 1% of farmers are audited by a third party each year, 10% of nutrient management organisations are audited by a third party each year.
Payment for low-emissions technologies	■ 20 mitigation suppliers receive payments each per year. ■ Record of the use of farm technologies is undertaken by provider (for example, vet technician for methanogen vaccine, fertiliser supplier for nitrification inhibitor). ■ 10% of these providers are subject to third party audited each year.
Regulated biological emissions limits	■ 24,000 farmer participants (all economically significant farming enterprises). ■ Risk based approach to requirement of OVERSEER report. On average, farmers undertake an OVERSEER report every 3 years. ■ Initial certified nutrient management advisor OVERSEER report costs $500 per dairy farm and $900 for other farm types. As farmers are conducting this assessment every three years, after 5 years this reduces to an average of $530 per farm assessment. ■ From initial assessment, 15% of farmers need to reduce emissions to meet limit. Farmers are required to reduce emissions in order to be compliant with this policy. ■ After 5 years, 5% of assessments lead to a farmer needing to reduce emissions (sensitivity analysis tests this assumption). ■ Farmers who are required to reduce emissions engage a rural consultant to undertake a Farm environment plan at a cost of $7,000. ■ 1% of farmers are third party audited each year, 10% of rural consultancies are third party audited each year.
Regulated use of mitigation technologies	■ 20 mitigation suppliers regulated. ■ Recording of the use of farm technologies is undertaken by provider. ■ 10% of providers are third party audited each year. ■ Dairy sector farm records monitored by existing farm inspections. Sheep, beef and deer farmers subject to random audit of farm records (1% per year).
Government-industry agreement	■ 24,000 farmer participants. ■ Farmers requested to supply farm information to processors (no requirement to engage certified nutrient management advisor to estimate biological emissions). ■ As the dairy industry is already undertaking reporting of nitrogen loss, we assume no additional cost to also report biological emissions. ■ From initial assessment, 15% of farmers receive farm emissions reduction plan. This reduces to 5% of farmers over long-term (sensitivity analysis tests this assumption).

[5] We assume costs fall as farmers become more familiar with the OVERSEER process and the information they need to retain. The assumed reduction is less for the Regulated biological emissions limits scenario as farmers are only undertaking an assessment on average every three years.

2.3.1 Assumed number of farms

We have assumed obligations are limited to economically significant enterprises. This is explained further in Appendix 2 (Section 1.3.5).

We have needed to develop an assumption in relation to the number of farmer participants, but this is illustrative only. Alternative methods / assumptions will result in differing number of farmer participants, and we have not made any judgement about the most suitable approach.

2.4 Stakeholder views on scenarios assessed

A number of stakeholder expressed views expressing disagreement with the scenarios identified for analysis.

This was either due to a view that the scenarios assessed were not realistic or that scenarios described focused too specifically on greenhouse gas emissions.

Stakeholders noted that greenhouse gas emissions were one of many environmental challenges New Zealand's pastoral sector was facing. If policies were only focussed on greenhouse gas emissions they may deliver an optimal outcome from a greenhouse gas emissions point of view, but sub-optimal outcomes in other areas or when multiple issues were considered together.

For example, if a dairy farmer reduced the biological emissions intensity of milk production through increased use of supplementary feed, this may increase nitrogen losses.

Stakeholders noted that for the sheep, beef and deer sectors there was not an existing voluntary agreement on water quality. In the event that a Government-industry agreement scenario was favoured for biological emissions, it may take the form of a broader sustainability agreement, capturing aspects related to water quality, biological emissions and biodiversity. It would therefore be difficult to disentangle specific greenhouse gas emissions costs from broader sustainability costs.

3 Estimate of administration costs

We have undertaken a second order estimate of the administration costs to both central government and the agricultural sector of each scenario. Beca identified the key drivers of cost within each scenario. We undertook engagement with government and industry participants to develop estimates for the time and resource required for each process. We estimated costs of this time and resource based on further participant engagement and publically available information.

This estimate includes costs organisations need to undertake to implement or comply with each scenario, but does not include costs related to undertaking mitigation activities. For example, if a participant is required to procure emissions trading units, the cost of procuring the units (brokerage and time) is included, but not the cost of the units, i.e. we are not assessing farm mitigation costs, but scenario administration costs.

Where a number of farmers are already undertaken an activity for alternative purposes this has been noted as a sunk cost and subtracted from our cost estimate (for example, any existing requirements to engage a certified nutrient management advisor).

Only those costs which participants (government, sector organisations or farmers) are required to bear are included. For example, where sector organisations are likely to undertake farmer extension but not required to do this by the scenario in question, this cost is not included. The impact of including such costs is discussed in Section 3.1.1 below.

We have not included revenue received or payments made by government (or processors) within administration costs (such as potential revenues from non-compliance penalties, payments to farmers for use of technologies). These costs would be viewed as separate policy costs and dependent on policy decisions. For example, if a government policy provided a $1000 subsidy for a certain behaviour, the administration costs of such a policy would be all the costs associated with managing this policy, but the actual cost of providing the $1000 payment would not be considered an administration cost.

Appendix 2 lists in more detail the assumptions applied to estimate administration costs.

We have used aspects of the APMG-International Better Business Case Framework to guide our analysis to the degree appropriate, our second order cost estimate does not represent a full Better Business Case approach. All costs exclude GST.

3.1 Total cost of mitigation scenarios

Table 2 displays this second order cost estimate. Noting the high margin of error associated with our estimate, we conclude that the Processor point of obligation, Payments for low-emissions technologies and Regulated use of mitigation technologies and practices all have comparatively similar costs.

Costs escalate for other scenarios as more frequent and more accurate estimates of farm biological emissions are required. Costs escalate further for the On-farm point of obligation scenario due to the cost of government administration and brokerage fees for farmer purchases of NZUs.

Table 2: Estimate of total annual administration costs for each scenario (rounded to two significant figures)

	Processor point of obligation	On-farm point of obligation	Payments for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Total cost estimate (per year)	**$2,700,000**	**$39,000,000**	**$3,600,000**	**$15,000,000**	**$1,300,000**	**$6,900,000**
Government Costs	$660,000	$9,300,000	$1,600,000	$4,100,000	$1,200,000	$570,000
Sector Costs	$2,100,000	$30,000,000	$2,000,000	$11,000,000	$82,000[6]	$6,300,000

3.1.1 Further costs that are likely to occur

In the cost estimate we have not included administration costs that are not required under the policy scenario, but nevertheless likely to occur. In some cases, these costs may be significant, and so are discussed here qualitatively.

The key additional driver of cost identified is sector extension programmes. Each scenario may require either agricultural processors or sector organisations to develop farm extension programmes to support farmer compliance. An example of an intensive version of a sector engagement programme is the “Every Farm Every Year” programme that Fonterra implemented in 2010 to support compliance with regional council effluent management rules.

At the time, Fonterra stated this programme required an annual investment of $5 million.[7] This cost was partly associated with the hiring of sustainability advisors. It is unclear if this cost has escalated or reduced since 2010.

A similar investment may be undertaken by sector organisations in all six scenarios to support both compliance and greenhouse gas mitigation. Extension programmes on climate change are also possible, and even probable, under a ‘do nothing’ scenario (a scenario where no scenario is implemented).

In understanding how these costs are likely to play out, it is important to consider the marginal additional cost the scenario is placing on the sector. For instance, while sector organisations have existing farm extension investments, and will likely continue to increase this investment under a do-nothing scenario, to what degree will these need to even further increase under various policy scenarios?

Understanding this additional cost impost is challenging. Compared to the Every Farm Every Year programme, there are likely to be efficiencies associated with building a climate change programme on top of existing sustainability extension. There may be cases where an advisor who is currently providing effluent and nutrient management advice can be upskilled to also provide climate change policy advice in conjunction with existing services.

[6] The agricultural sector does not face any direct administration costs under this scenario. The only costs assessed is the farmer and supplier time spent during audit and verification processes. For each hour of audit time we have included both a direct cost charged by an audit firm and an indirect cost of the time that the organisation being audited must take to provide auditors with relevant information.

[7] Fonterra. (2010). *Media release: Fonterra launches programme to tackle effluent issues.* Retrieved from: https://www.infonews.co.nz/news.cfm?id=55778 September 2017.

For all of these reasons a true cost of farm extension programmes is hard to pin down.

A 'probability' approach can be used to assess both the likelihood of a further additional cost and the scale of the cost. Note, where a cost is 50% likely to occur and is $2 million per annum, the expected cost per annum can be viewed as $1 million. Table 3 provides a broad approximation of potential costs and probabilities for farm extension.

Broadly speaking, the cost of extension programmes could be significant for a number of scenarios, but won't have a significant impact on the comparisons between scenarios. They will also alter the balance of costs between the government and sector organisations. Costs may reduce over time as farmers gain an understanding of policy and therefore less intensive extension is required.

Table 3: Potential cost of sector extension programme

Scenarios	**Processor point of obligation** **Payment for low-emissions technologies**	**On-farm point of obligation** **Regulated biological emissions limits** **Regulated use of mitigation technologies or practices** **Government-industry agreement (already included in administration cost estimate)**
Likelihood of additional investment beyond 'do-nothing' scenario	Medium to high	Almost certain
Broad estimate of cost over and above 'do-nothing scenario'	Medium ($0-2 million per annum) (likely to be enhancement of existing programmes)	High ($2-5+ million per annum) (may require new programmes and specialists)

Processor point of obligation

Processors or sector organisations may invest in farm extension programmes under a processor point of obligation, with the probability increasing as NZU prices increase. These may reduce sector-wide emissions trading costs.

Processors will face a barrier in making this investment, as while the cost of any programme will fall on individual processors, the benefit of reduced emissions trading obligations will be shared across all processors.

Processors may cooperate to invest in common programmes, or sector organisations such as DairyNZ and Beef+LambNZ may make this investment.

Payment for low-emissions technologies

Sector organisations may establish programmes to support farmers to leverage low-emissions technologies. The providers of these technologies may also invest in marketing for these technologies that may take the form of providing farm advice.

Other scenarios

Other scenarios either require farmers to undertake an activity or require the sector to undertake activities (Government industry agreement).

Farmer non-compliance with effluent management regulatory requirements has resulted in a reduced public image of agriculture in general. Sector organisations have responded to this by implementing extension programmes such as the 'Every-farm every-year' programme. It is highly likely sector organisations will learn from this experience and seek to avoid non-compliance issues before they arise. Such programmes are also likely to be more comprehensive (than the two scenarios above) and therefore more costly.

3.1.2 Costs by agricultural sub-sector

Costs were not disaggregated in the model between different agricultural sub-sectors (dairy, sheep, beef and deer).

Some costs were higher for sheep and beef and lower for dairy farming. Stakeholders noted that dairy farms tended to require less time to develop an OVERSEER report than sheep and beef farms, however this would not be the case for every dairy farm or sheep and beef farm.

If, in the long-term, an OVERSEER report produced by a certified nutrient management advisor would cost approximately $440 per farm, this could be expected to be on average 25% lower for a dairy farm and 25% higher for a sheep and / or beef farm. There is also likely to be a large amount of variation in the cost of assessment amongst sheep and beef farms.

Dairy farms are also be more likely to be undertaking activities already, meaning there is less marginal cost in implementing scenarios (for example, we assumed 4000 dairy farmers were already undertaking an OVERSEER assessment by a certified nutrient management advisor).

3.2 Transition costs of mitigation scenarios

Table 4 displays an estimate of the transition costs estimated by Beca.
A number of cost drivers occur only during the transition to the policy. For example, costs have been estimated for enhancing software capability and change management programmes. These factors add costs to the transition period for all scenarios aside from the Processor point of obligation scenario.

Some costs also are assumed to reduce slightly with time. We assumed that farmers will become more familiar with the information requirements for estimating biological emissions with time, and this will reduce the total time taken by an accredited nutrient advisor to complete an estimate of farm biological emissions.

We have also assumed that some policies are introduced gradually. For the scenarios On-farm point of obligation and Regulated biological emissions limits, we have assumed reporting is introduced over a three year period, with one third of farmers being required to enter emissions reporting each year. This has the effect of smoothing the administration cost of the first year of reporting, which we have assumed is higher than subsequent years.

Surrender obligations are introduced in Year 3 of the On-farm point of obligation scenario, to all farmers at once.

Table 4: Estimate of annual transition cost of mitigation scenarios

	Processor point of obligation	On-farm point of obligation	Payments for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Total cost over first five years	**$14,000,000**	**$170,000,000**	**$19,000,000**	**$110,000,000**	**$7,500,000**	**$58,000,000**
Year 0	$430,000	$4,100,000	$640,000	$4,700,000	$640,000	$910,000
Year 1	$2,700,000	$16,000,000	$3,800,000	$20,000,000	$1,500,000	$5,700,000
Year 2	$2,700,000	$21,000,000	$3,800,000	$21,000,000	$1,500,000	$9,800,000
Year 3	$2,700,000	$45,000,000	$3,800,000	$24,000,000	$1,300,000	$12,000,000
Year 4	$2,700,000	$41,000,000	$3,800,000	$19,000,000	$1,300,000	$14,000,000
Year 5	$2,700,000	$40,000,000	$3,600,000	$19,000,000	$1,300,000	$16,000,000
Out years	$2,700,000	$39,000,000	$3,600,000	$15,000,000	$1,300,000	$6,900,000

3.3 Key drivers of cost estimate

The majority of the administration costs for each scenario are driven by a small number of key cost drivers. In particular, the cost of engaging a certified nutrient management advisor to perform an OVERSEER nutrient management report, the cost of NZU brokerage for farmer participants and the cost of government administering emissions returns under the On-farm point of obligation scenario.

We have also included a further 20% contingency in all of our estimates to adjust for optimism bias. This represents a meaningful additional cost in the more expensive scenarios.

3.3.1 Impact of large number of farmer participants

We have assumed 24000 farmer participants for each of the scenarios that require individual farmer actions (On-farm point of obligation, Regulated biological emissions limits, Government-industry agreement).

This figure is derived from the Statistics New Zealand 2012 Agricultural Census. A 2017 Agricultural Census is underway, but was not completed at the time of our calculation.

The 2012 agricultural census reported 36000 dairy, sheep, beef and deer farms in New Zealand. We removed all sheep, beef and deer farms below 80 hectares in size, and all dairy farms below 10 hectares in size. This is based on an assumption that only 'economically significant' farmers participate in scenarios and resulted in a population of 12000 dairy farms and 12000 sheep, beef and deer farms.[8,9]

[8] This threshold was a recommendation of MPI Technical Paper 'Reporting agricultural emissions at farm level', prepared for MPI in 2013 by KPMG.

[9] Under the Statistics New Zealand definition of economically significant enterprise, an enterprise must either have: annual expenses or sales subject to GST of more than $30,000; 12-month rolling mean employee count of greater than three; be part of a group of enterprises; registered for GST and involved in agriculture or forestry; or, over $40,000 of income recorded in the IR10 annual tax return (this includes some units in residential property leasing and rental). It is estimated that this definition approximately corresponds to a 10 hectare dairy farm or an 80 hectare sheep and beef farm.

Due to this high number of participants, any cost that is faced by every farmer in every year is significant. For example, if a single task requires 2 hours each year of a farmer's time, with an estimated cost for farm manager time of $36 per hour, this cost of $72 per farm per annum results in an annual cost of $1.7 million across the population of farms. A number of such tasks are included in each of the three scenarios that include on-farm biological emissions reporting.

3.3.2 Cost of estimating biological emissions using OVERSEER

We have assumed that estimating biological emissions using OVERSEER for regulatory purpose will require farmers to engage a certified nutrient management advisor to perform a farm assessment using the OVERSEER Nutrient Budget software. In the Regulated biological emissions limits scenario and Government-industry agreement scenario, farmers are also required to undertake a farm environmental plan to support emissions reduction efforts.

Stakeholders Beca engaged with noted that a farm environmental plan generally costs $4,000 - $5,000 per dairy farm and $8,000 - $10,000 per sheep and beef farm. Stakeholders showed strong consistency in estimating this figures.

Stakeholders suggested an OVERSEER report would cost approximately $700 per farm (across a range of farm types). AgFirst was able to share a recent study undertaken which confirms this.[10]

This cost is incurred regardless of if the assessment is undertaken by a private consultant or provided by sector organisation. All sector costs ultimately flow back to farmers: organisations such as DairyNZ, Beef+Lamb NZ and Deer Industry New Zealand are funded through farmer levies, while agricultural processors and fertiliser providers will need to pass any increase in costs back to farmer suppliers / customers.

Undertaking such an assessment for 24000 farms would cost $17 million. In our assessment we have discounted this figure slightly to allow for approximately 4000 dairy farms that may already be required to conduct such an OVERSEER assessment for water quality regulatory requirements. This reduces the initial cost to $15 million.

Much of this cost is associated with setting up the farm in OVERSEER. Nutrient advisors are required to sight farm records used to develop the OVERSEER report and further cost is associated with time taken for this. We discussed with stakeholders the possibility that, in the longer term, these costs would reduce as farm blocks could be copied from previous OVERSEER files and farmers would become more familiar with the information required and the need to maintain this information in an easily accessible form.

Within our cost estimate we therefore assumed that the average time taken per OVERSEER report would reduce the more frequently such an assessment was undertaken. For the On-farm point of obligation scenario, where an assessment is required annually, we assumed a reduction from 4 hours per farm presently to 2.5 hours per farm in the long-term, resulting in an annual cost of $440 per year per farm. This results in a total annual cost of $10 million (discounting for dairy farms already undertaking this exercise).

Note there is a degree of uncertainty with the assumption that annual costs for farmers will decrease to this degree.

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[10] AgFirst. (2016). *Farm Environmental Plan Project.* Report to Waikato Federated Farmers. *Can be retrieved from: https://www.far.org.nz/assets/files/blog/files//eb1879f6-9c20-4d50-a809-87d6deaea782.pdf*

3.3.3 Brokerage under an On-farm point of obligation scenario

Under an On-farm point of obligation scenario, 24000 farmers will require on average 80 NZUs per annum. This is based on New Zealand's agricultural emissions in the 2015 calendar year and an assumption farmers receive a 95% allocation. In the event that farmers received no allocation, the average demand would be 1600 NZUs per year.

We discussed with stakeholders both current brokerage fees and the ability to deliver NZUs to farmers.

Stakeholders noted either a minimum transaction volume of 10000 NZUs or a minimum transaction fee of $500. Where transactions exceeded 10000 NZUs, brokerage fees were approximately 5c per NZU. These fees would apply regardless of whether a customer was buying or selling NZUs.

We expect extremely few farmers to have an annual demand of greater than 10000 NZUs. Even under a scenario where farmers received zero allocation, under current emissions factors for cows and milk solids, a dairy farm would need to run at least 3000 dairy cows to have an annual obligation greater than 10000 NZUs.[11]

Brokerage costs are driven by the need for brokers to charge a minimum transaction fee to cover the fixed administration costs associated with the sale and purchase of NZUs. We were informed this is likely to be at least 2-3 hours per client.

Our model assumes a transaction fee of $500 per farm. Across 24000 farms this leads to an annual cost of $12,000,000 per annum.

3.3.4 Administration

The administration costs of the On-farm point of obligation scenario are difficult to estimate.

Beca consulted with Ministry for Primary Industries (MPI) and Environmental Protection Authority (EPA) regulatory teams in regard to the administrative requirements that biological emissions entering the ETS would create.

At present EPA receives circa 350 emissions returns per annum while MPI receives circa 600 forestry returns per annum.[12]

An On-farm point of obligation scenario would result in an additional 24000 emissions returns per annum (given our assumptions). This would represent a 40 and 70 fold increase in emissions returns for MPI and EPA subsequently.

Simply pro-rating current staff requirements across this increase in volume would result in an FTE count in the many hundreds being required for receiving biological emissions returns. If this approach was taken we would calculate approximately $50 million per annum in government administration for an On-farm point of obligation scenario.

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[11] DairyNZ report herd size parameters annually. In the 2015/16 New Zealand Dairy Statistics herd sizes are reported in brackets of 50 cows, with the most frequent herd size being between 200-249 cows. The highest bracket is greater than 1500 cows, with 1% of herds being greater than 1500 cows.

[12] MPI experiences a peak in emissions returns every fifth year (due to forestry reporting requirements). Additional staff are required to support administration of these peak.

However, it is not appropriate to assume operation of an emissions trading scheme with 24000 participants would adopt the same administration approaches as an ETS with far fewer participants.

In practice, before $50 million per annum is spent in such a way, other investments opportunities will almost certainly present themselves. Stakeholders noted the potential to increase investment in automated information systems, for example.

We have already assumed that farmers are required to use a certified nutrient management advisor to complete a farm biological emissions estimate. It is possible that use of such experts can support upfront administration and harmonisation of emissions returns by farmers. This may reduce the staff requirements for the EPA.

In addition, software solutions may be able to support a reduced administrative burden on government. For example, software could be developed to automatically produce an emissions return from an OVERSEER report and deliver this to government.

Government authorities could also develop software to undertake an initial assessment of emissions returns and reject uncompleted returns without requiring labour time. We understand that MPI has developed such an assessment to filter forestry returns.

Finally, stakeholders noted that assessing a 'net liability' for farmers, which represented the difference between allocations and obligations, would avoid the need for government to also undertake transactions associated with providing farmers with emissions allocations, reducing demand for staff.

We have therefore assumed a team of 18 FTEs required for administering an On-farm point of obligation scenario. This is higher than any other sector in the ETS, but still requires huge efficiency improvements in order to operate the On-farm point of obligation scenario with this staff count. We have also assumed additional costs in our estimate associated with information technology upgrades and annual maintenance.

Under these assumptions, government administration is the third most significant driver of total costs for an On-farm point of obligation scenario.

It is important to note that we are undertaking a high-level estimate for administration costs where there is no comparable real world scenario to base our estimate on (forestry and industrial participants being significantly lower in number). The closest comparison is regional council administration of nitrogen loss regulations. However, these programmes have considerably less participants and may not require a nitrogen report every year.

Due to the need to make such broad assumptions, and the lack of real world examples of high participant emissions trading schemes, our cost estimate for government administration of On-farm point of obligation has an extremely high degree of uncertainty, with a particular risk that costs may be higher than our estimate. Adjustment of this assumption is undertaken within sensitivity analysis in Section 3.4.

3.3.5 Optimism bias adjustment to cost estimate

Within both the public and private sectors, there is a demonstrated and systematic tendency for project appraisers to be optimistic. This is a worldwide phenomenon, whereby appraisers tend to overstate benefits, and understate timings and costs, both capital and operational.

To redress this tendency, within the APMG-International Better Business Case Framework, appraisers are now required to make adjustments for this bias. This takes the form of increasing the estimate of costs and decreasing and delaying the receipt of benefits.

Adjusting for optimism bias provides a better estimate earlier on of key project parameters. Enforcing these adjustments for optimism bias is designed to complement, rather than replace, existing good practice in terms of calculating project specific risk. It is also designed to encourage more accurate costing. Adjustments for optimism bias may be reduced as more reliable estimates of relevant costs are built up and project specific risk work is undertaken.

We have applied a 20% contingency cost to each scenario. This is included as a final line item rather than applied individually to each individual cost item.

3.4 Sensitivity analysis of cost estimate

Sensitivity analysis has been undertaken to test the impact of a number of key assumptions. The following section details the results of this sensitivity analysis.

3.4.1 Estimation of biological emissions

The OVERSEER nutrient budget software was originally developed as the Computer Fertiliser Advisory Scheme in 1982.

This model has evolved over time to what is today OVERSEER. An estimate of nitrogen loss was included in the year 2000, and greenhouse gas reporting was added in 2003. Today the model is a whole farm system nutrient budget model that can be used to inform farm management decisions and estimate farm environmental losses.

Where farmers are already undertaking a high quality OVERSEER report, OVERSEER also provides an easily accessible estimate of farm biological emissions.

However, if a farmer is looking only to estimate farm greenhouse gas emissions, it would be possible to do this using a simpler tool.

OVERSEER contains a high number of parameters that are not presently used[13] to estimate farm biological emissions (soil tests, soil type, climate data). OVERSEER also contains flexibility to adjust emissions factors and adjust other key internal settings, which are not useful within a regulatory tool (where consistent assumptions are needed).

The government may explore the potential to develop a simplified tool, established only for the purposes of estimating greenhouse gas emissions. This may take the form of a simplified version of OVERSEER that only includes parameters required to accurately estimate biological emissions, or be an altogether new tool.

If this enabled farmers to submit emissions returns using this tool without engaging a certified nutrient management advisor, this would reduce compliance costs.

It may be problematic to ask farmers to submit two farm environmental assessments where farmers are already using OVERSEER for nitrogen reporting to a regional council. If this tool was based on the same base calculations as OVERSEER, but simply contained a simplified user interface and only required

[13] Some of these factors could be used to calculate farm nitrous oxide emissions in the future. Present practice is to use national average soil conditions to calculate nitrous oxide emissions. Calculations that use farm specific soil conditions presently have unacceptably high levels of uncertainty (see de Klein et al (2017), *Initial review of the suitability of OVERSEER Nutrient Budgets Model for farm scale greenhouse gas reporting*).

parameters relevant to biological emissions reporting, each tool may be able to be used interchangeably (further work would be required to understand interchangeability issues).

This would allow farmers to choose to use an existing OVERSEER assessment where this was available, or a simplified tool where this can reduce compliance costs.Table 5 displays alternative cost estimates for the On-farm point of obligation and Regulated biological emissions limits scenarios, in which the cost of engaging a certified nutrient management advisor has been subtracted.

Table 5: Alternative annual cost estimate when a simplified tool is utilised

Cost Category	On-farm point of obligation (base assumptions)	On-farm point of obligation (simplified tool)	Regulated biological emissions limits (base assumptions)	Regulated biological emissions limits (simplified tool)
Government administration	$5,400,000	$5,400,000	$1,100,000	$1,100,000
Measuring emissions	$11,000,000	$1,900,000	$4,400,000	$800,000
Emissions reduction plans	$0	$0	$4,800,000	$4,800,000
Audit	$2,500,000	$2,500,000	$2,500,000	$2,500,000
NZU Brokerage	$14,000,000	$14,000,000	$0	$0
20% contingency adjustment	$6,600,000	$4,800,000	$2,600,000	$1,800,000
Total	$39,000,000	$29,000,000	$15,000,000	$11,000,000

3.4.2 Procurement of NZU units

Brokers noted that, in the event that 24000 farmers became participants in the ETS, they may be able to invest in mechanisms to reduce the cost of supplying NZUs to farmer participants.

Policy uncertainty presents a barrier to this. The risk that either the ETS itself is replaced or that the policy for biological emissions is changed, would make investment in significantly increasing staff numbers and investment in new software risky.

An online trading portal may be possible and may reduce costs for farmers. Brokers presently treat NZUs like a financial instrument and therefore required purchasers or sellers to confirm identity through two forms of identification. Providers may be able to invest in platforms that supplied NZUs to farmers annually by requiring an initial ‘sign-up fee’ (confirming identity) and then charging a lower annual fee after this.

Table 6 displays adjusted costs for an On-farm point of obligation scenario. These adjusted costs are based on adjusted assumptions in which farmers do not need to engage a rural consultant to estimate biological emissions and where brokers could charge as little as $50 per transaction for NZUs (equivalent to 30c per NZU). These adjusted assumptions reduce the administration costs of this scenario by 59%.

Table 6: Alternative annual cost estimate when a simplified tool is utilised and lower brokerage fees are assumed

Cost Category	On-farm point of obligation (base assumptions)	On-farm point of obligation ($50 NZU transaction cost)	On-farm point of obligation (simplified tool & $50 NZU transaction cost)
Government administration	$5,400,000	$5,400,000	$5,400,000
Measuring emissions	$11,000,000	$11,000,000	$1,886,806
Emissions reduction plans	$0	$0	$0
Audit	$2,500,000	$2,500,000	$2,500,000
NZU Procurement	$14,000,000	$3,600,000	$3,600,000
20% contingency adjustment	$6,600,000	$4,500,000	$2,700,000
Total	$39,000,000	$27,000,000	$16,000,000

3.4.3 Government administration

We have noted an uncertain estimate for Government administration costs in the On-farm point of obligation scenario. If we were to double the size of the regulatory team assumed it results in an increase in annual cost of $3.5 million. These costs are displayed in Table 7.

Table 7: Alternative annual cost estimate when a greater number of regulatory analysts are assumed

Cost Category	On-farm point of obligation (base assumptions)	On-farm point of obligation (36 regulatory analysts (double base assumptions))
Government administration	$5,400,000	$8,300,000
Measuring emissions	$11,000,000	$11,000,000
Emissions reduction plans	$0	$0
Audit	$2,500,000	$2,500,000
NZU Procurement	$14,000,000	$14,000,000
20% contingency adjustment	$6,600,000	$7,200,000
Total	$39,000,000	$43,000,000

3.4.4 Farm environmental plans

The Regulated biological emissions limits and the Government industry agreement scenarios both include a cost for full farm environment plans where farmers are identified as having high biological emissions.

The number of farmers who need to undertake these assessments will be a function of the policy. For example, the Waikato Regional Council Healthy Rivers Plan Change One proposes to require all farmers with nitrogen losses levels above the 75th percentile to reduce nitrogen loss.

Our scenarios are based on an assumption that, upon the initial introduction of the policy, 15% of farmers are asked to reduce emissions.[14] In the longer term, for every assessment of farm biological emissions level we

[14] 15% is a simple assumption. The number of farmers that are required to reduce emissions will be the function of the policy settings. Waikato Regional Council Plan Change One proposes to set a nitrogen limit equal to the 75th percentile

assume 5% of farm estimates result in a requirement to undertake a follow-up emissions reduction plan. This is over and above the number of farmers that are already undertaking farm environmental plans for other purposes.

Shifting this assumption to a higher level will increase our cost estimate. Table 8 displays adjusted costs that result from shifting the long-term assumption for emissions reduction plans from 5% to 15% of farm assessments.

Table 8: Alternative annual cost estimate with a greater number of farm environmental plans required

Cost Category	Regulated biological emissions limits (5% farm environmental plans)	Regulated biological emissions limits (15% farm environmental plans)	Government-industry agreement (5% farm environmental plans)	Government-industry agreement (15% farm environmental plans)
Government administration	$1,100,000	$1,100,000	$480,000	$480,000
Measuring emissions	$4,400,000	$4,400,000	$1,300,000	$1,300,000
Emissions reduction plans	$4,800,000	$14,400,000	$4,000,000	$12,000,000
Audit	$2,500,000	$2,500,000	$0	$0
NZU Procurement	$0	$0	$0	$0
20% contingency adjustment	$2,600,000	$4,500,000	$1,200,000	$2,800,000
Total	$15,000,000	$27,000,000	$6,900,000	$17,000,000

3.4.5 Extended time to undertake estimate of farm greenhouse gas emissions

Beca has consulted extensively with stakeholders to understand the time that is likely to be required per farm for a certified nutrient advisor to produce a farm OVERSEER report, in order to estimate farm biological emissions. Through consultation we arrived at the central values contained in Table 9.

Table 9: Certified nutrient management advisor time per farm biological emissions estimate

	Average	Dairy	Other
Hours per OVERSEER assessment year 1	4.0	3.0	5.0
Hours per OVERSEER assessment year 2	3.0	2.5	3.5
Hours per OVERSEER assessment (ongoing)	2.5	2.0	3.0

Consultation also highlighted some disagreement amongst stakeholders in regards to this number. Further, Beca is making some assumptions in relation to the level at which time per assessment can be reduced in subsequent years.

Table 10 displays an adjusted estimate of administration costs for the On-farm point of obligation scenario and the Regulated biological emissions limits scenario, where assumptions are adjusted to firstly remove the decrease in time taken per assessment and secondly to also increase the time taken per assessment by 50%. Under these assumptions, the cost estimate of these scenarios increases by circa 40-50%, suggesting

of nitrogen loss per hectare. This policy setting results in 25% of farmers needing to reduce nitrogen loss. The number of farmers required to reduce biological emissions will also be a function of where the biological emissions threshold is set.

high sensitivity within the cost model to the assumptions related to time taken to estimate farm biological emissions.

Table 10: Alternative annual cost estimate with an increased assumption for time taken to estimate biological emissions

Cost Category	On-farm point of obligation (base assumptions)	On-farm point of obligation (no decrease in time per farm)	On-farm point of obligation (50% extra time per assessment)	Regulated biological emissions limits (base assumptions)	Regulated biological emissions limits (no decrease in time per farm)	Regulated biological emissions limits (50% greater time per assessment)
Government administration	$5,400,000	$5,400,000	$5,400,000	$1,100,000	$1,100,000	$1,100,000
Measuring emissions	$11,000,000	$18,000,000	$26,000,000	$4,400,000	$5,900,000	$8,800,000
Emissions reduction plans	$0	$0	$0	$4,800,000	$4,800,000	$4,800,000
Audit	$2,500,000	$2,500,000	$2,500,000	$2,500,000	$2,500,000	$2,500,000
NZU Procurement	$14,000,000	$14,000,000	$14,000,000	$0	$0	$0
20% contingency adjustment	$6,600,000	$7,900,000	$9,700,000	$2,600,000	$2,900,000	$3,400,000
Total	$39,000,000	$47,000,000	$58,000,000	$15,000,000	$17,000,000	$21,000,000

3.4.6 Summary of sensitivity analysis

Table 11 displays a summary of the impact of all sensitivity analysis when factors that shift cost in the same direction are combined, ie all factors that increase cost are viewed together, and all factors that reduce cost are viewed together. The On-farm point of obligation scenario is particularly sensitive to the values of key assumptions, with a cost estimate that can shift plus 56% or minus 59% by changing only 4 key variables. Regardless, even if a low cost scenario is chosen, the On-farm point of obligation scenario will continue to have higher administration costs than all other scenarios.

Table 11: Summary of the impact of sensitivity analysis on the estimate of administration costs

	Processor point of obligation	On-farm point of obligation	Payments for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Low cost scenario	*No change*	$16,000,000	*No change*	$11,000,000	*No change*	*No change*
Central scenario	**$2,700,000**	**$39,000,000**	**$3,600,000**	**$15,000,000**	**$1,300,000**	**$6,900,000**
High cost scenario	*No change*	$61,000,000	*No change*	$32,000,000	*No change*	$16,000,000

3.5 Potential hybrid scenarios

A broad range of simplistic scenarios were identified for assessment. This allows scenarios to be combined to understand the administration costs of alternative, more complex, scenario possibilities. We have not undertaken cost estimates for alternative scenarios, but, broadly speaking:

Hybrid Scenario	*Approximate costs*
The **Processor point of obligation** scenario could be combined with **Payments for low-emissions technologies** (creating incentives for farmers to reduce emissions without requiring an estimate of farm emissions levels).	This would have a broadly similar cost to combining the costs of a Processor Point of Obligation Scenario and the Payment for low-emissions technologies scenario.
A **Government industry agreement** could be supported by regulated approaches at a later date.	This would have lower costs than the combination of these scenarios. Costs associated with farm emissions reduction plans would not need to occur twice.
The **Processor point of obligation** scenario could be complemented by allowing farmers to voluntary opt-in to farm level reporting.	Costs would depend on the number of farms that adopted voluntary reporting, on an approximate pro-rata basis. There are some barriers to this option discussed in Section 4.
Measurement of biological emissions could occur **On-farm**, while the point of obligation could be the **Processor**. Processors would pool farm emissions reports and each submit a single emissions return to government.	On one hand, costs could be similar to the On-farm point of obligation, with reduced brokerage fees. On the other hand, administration cost is likely to be increased as processors would now also need to undertake differentiated payment to farmer suppliers. It is difficult to understand this trade-off without detailed analysis. Processors were sceptical they would have an easy ability to pass emissions trading costs onto farmers on an individual basis. There are barriers to this scenario discussed in Section 4.

4 Barriers and limitations to scenario implementation

Beca have identified a small number of key barriers to implementation and a longer list of minor barriers and limitations to scenario implementation.

4.1 Key barriers to implementation

The following key barriers to implementation have been identified.

4.1.1 Number of certified nutrient management advisors in New Zealand

The On-farm point of obligation scenario and the Regulated biological emissions scenario each require every farm in New Zealand to undertake an OVERSEER assessment using a certified nutrient management advisor. As noted, we assume that there are presently 4000 dairy farms which are already required to undertake this exercise.

Nutrient Management Advisor Certification Programme Limited presently list 162 currently practicing certified nutrient management advisors.[15] Of these, 117 are listed as working for Ballance Agri-Nutrients (fertiliser provider, 40), Ravensdown (fertiliser provider, 58), DairyNZ (3), Fonterra (14) or a regional council (2), leaving 45 certified nutrient management providers remaining who may be working as consultants.

A further 57 people are listed as currently in the training course.

Stakeholders noted that a shortage of certified nutrient management advisors has been observed in regions where regional councils have required an OVERSEER report for water quality regulation.

While we note approximately 4000 dairy farms are required to engage a certified nutrient management advisor to undertake an OVERSEER report for water quality regulation purposes, this does not mean these 4000 farmers have already undertaken this exercise. This process is presently on-going.

It is reasonable to assume that the nutrient management advisors who are either already certified or currently undergoing certification will be at full capacity simply supporting farmers who are already facing water quality regulation and undertaking other activities such as developing farm environmental plans.

We estimate that a further 12000 OVERSEER assessments for sheep, beef and deer farmers and a further 8000 OVERSEER assessments for dairy farmers would require an additional 54 certified nutrient management advisors, if each new certified nutrient management advisor worked **full time on OVERSEER reports only**.

Such a policy may increase demand for other advisory services (such as farm environmental plans) and some certified nutrient management advisors may move into supervisor roles. This increase in demand for associated services means that an assumption of 54 – 108 additional certified nutrient management advisors is reasonable (allowing for 50% of time spent on complementary advice).

A Regulated biological emissions scenario requires a similar number of additional certified nutrient management advisors. This scenario includes a lower number of OVERSEER reports, but also includes an increased demand for farm environmental plans.

[15] See http://www.nmacertification.org.nz/Site/Nutrient_Management/Certified_Advisers/default.aspx , retrieved September 2017.

There may be barriers to training such a large number of additional nutrient management advisors in a short period of time. Training to become a certified nutrient management advisor can take several years and requires a level of existing experience. Additionally, If all the additional advisors required went to rural consultancies, this would create a situation where over half of consulting nutrient management advisors have a low level of experience. This would increase the risk of inconsistencies in the development of OVERSEER reports and place pressure on senior nutrient management advisors who may be required to verify junior staff work.

4.1.2 Capacity of brokerage in New Zealand

Brokerage services in New Zealand are currently catering for trades associated with a market of approximately 2300 participants. Approximately 200 of these are mandatory participants, with the remainder mostly made up of voluntary post-1989 forestry participants.

An On-farm point of obligation scenario would add a further 24000 participants, resulting in a 10-fold increase in the number of ETS participants.

The private sector may have the capacity to invest in employees and systems required to fulfil this demand. There would however be policy risk for brokers / financial institutions in undertaking this investment. Brokers may need assurance that future Governments will not change this policy. Such assurance would be hard to give unless there was a cross-party commitment to an On-farm point of obligation scenario.

Further, this demand would essentially come on-line all at the same time (unless there was a phased transition from a Processor point of obligation to an On-farm point of obligation). It may be difficult for brokers to shift from providing services to 2300 participants to 26000 participants, essentially overnight.

4.1.3 Farmer non-compliance

The On-farm point of obligation, Regulated biological emissions limits and Regulated use of mitigation technologies or practices will face challenges in building an understanding of policy requirements across 24000 farmer participants. In initial years, regulators are likely to spend significant time following up non-compliance. This could simply be due to a lack of farmer awareness in relation to the policy. It has been noted to Beca through stakeholder engagement that compliance with ETS forestry rules has faced some similar challenges.

In 2010 the dairy industry faced difficulties due to farmer non-compliance with effluent management regulations. Fonterra implemented the "Every Farm Every Year" programme in which dairy inspectors were asked to undertake a preliminary assessment of farmer effluent management compliance. Where an inspector was concerned that non-compliance may be an issue, a Fonterra Sustainable Dairying Specialist undertook a follow-up assessment and, if needed, provided farm advice that supported the farmer to become compliant with regional council effluent rules. At the time Fonterra stated this programme required an annual investment of $5 million.[16]

Such an investment may also be required to support farmer compliance with the scenarios listed above.

It could be viewed that farmers may resist entry into the emissions trading or similar policies through mass non-compliance. Beca and stakeholders do not believe this is **likely** to be a factor. In the past, once regulations are passed, farm compliance rates have always been high. An example of this is the Taupo

[16] Fonterra. (2010). *Media release: Fonterra launches programme to tackle effluent issues.* Retrieved from: https://www.infonews.co.nz/news.cfm?id=55778 September 2017.

nutrient trading scheme, where there has been no instance of farmer refusal to participate. Beca's judgement is that non-compliance issues are likely to be due to poor awareness rather than farmer resistance.

4.1.4 Southern hemisphere agriculture season not a calendar year

The OVERSEER Nutrient Management software assess livestock farms on a year ending 31st May, reflecting the Southern Hemisphere agricultural production season. The emissions trading scheme operates on a calendar year, with participants calculating emissions annually for the year ending 31st December.

It may be possible to adjust OVERSEER to calculate biological emissions on a calendar year, however doing so would nullify any efficiency advantage of using OVERSEER for biological emissions reporting, as even where farmers are using OVERSEER for water quality regulation they would now need to complete an additional OVERSEER report, which would also come with an additional cost. Assessing biological emissions on a calendar year would also increase complexity in deriving input information for OVERSEER reports as farm inputs and production associated with a production season would have to be apportioned to a calendar year. This may increase the cost of estimating emissions to the higher range estimated in the sensitivity analysis undertaken in Section 3.4.

A legislative change to the CCRA that shifted the date of compliance for biological emissions to a year ending 31st May could be pursued, however this would also raise further issues as EPA systems would need to be revised. Further consultation with the EPA would be required to understand the magnitude of such issues.

A simple fix may be to require farmers to submit a biological emissions estimate for the most recent production season, while retaining the 31st December submission date within the CCRA. For example, for the year ending 31st December 2017, a farmer would submit an OVERSEER file relevant for the season ending 31st May 2017.

4.1.5 Allocations under an on-farm point of obligation

Two possible approaches have been identified for allocation under an on-farm point of obligation. Both may present barriers to the successful implementation of the policy.

A simple approach would be to provide all farmers who have obligations with a free allocation of NZUs equivalent to 95% of their emissions obligation. For example, if a farmer has an OVERSEER estimate of 1000 tonnes of CO_2e, their allocation would be 950 tonnes, and their net liability would be 50 tonnes, costing $1000 at an emissions price of $20 per NZU.

Such an approach has an immediate short-fall. The chief rationale for shifting the point of obligation to the farm level is the inability for a processor point of obligation to drive an emissions signal at the farm-gate, but an allocation regime that provided all farmers with a 95% allocation in such a way severely dilutes any emissions price signal. In the event a farmer faced an emissions price of $20 per tonne, a mitigation option would have to have a marginal cost of abatement of between $0 and $1 per tonne to be encouraged by the policy (mitigation options of less than $0 are encouraged without the policy).

This is likely to severely reduce the number of actions encouraged by the policy, and reduce the likelihood that the increased administration cost of an on-farm point of obligation has a favourable benefit-cost ratio vis-à-vis a simple Processor point of obligation scenario.

The second option is to apply allocation on a per unit of production basis. This is the option used for industrial allocations in the ETS.

Under such a situation, if the benchmark level of GHG per tonne of milk solids was 8.5, a 95% allocation would provide a farmer with 8.1 free NZUs for every tonne of milk solids produced (and similar for meat, live cow exports, etc).

If an efficient farmer produced milk at lower than 8.1 tonnes of CO_2e per tonne of milk solids, they may be in a position to profit from emissions trading, as allocations would exceed emissions. If an inefficient farmer produced milk at substantially higher 8.5 tonnes of CO_2e per tonne of milk solids, their emissions trading costs may quickly be double or triple the national average (i.e. an efficiency level of 9.5 tonnes of CO_2e per tonne of milk solids would receive an effective allocation of 85%).

This situation in itself is not a barrier. It is simply the allocation regime and emissions price creating marginal price incentive for farmers.

Barriers may eventuate in the following four instances:

- Not all farm greenhouse gas emissions occur in New Zealand. Use of imported supplementary feed such as Palm Kernel Expeller (PKE) can decrease farm methane emissions per unit of production, but **increase** total farm lifecycle GHG per unit production. Ledgard et al (2016) considered the impact of the supplementary feed use on farm climate efficiency in a recent paper.[17] This paper showed that a farm that fed a high level of supplementary feed may have **lower** biological emissions per unit of production, but, where that supplementary feed was PKE, **higher** total lifecycle emissions per unit of production. A perverse situation could arise under this allocation regime where a farmer was receiving an incentive from emissions trading (if emissions were less than 95% of the benchmark) who had higher than typical GHG intensity, on a life-cycle basis (if they fed high levels of PKE).
- Farmer emissions intensity may be driven by physical farm attributes. For example, dairy farmers in Northland may have higher emissions intensity due to a less favourable dairying climate, high country sheep and beef farmers may have higher emissions intensity due to less favourable soils and topography. Such a policy may result in a transfer of wealth between farmers (some farmers receiving benefit, other farmers receiving higher debits) based on starting conditions rather than actual behaviour.
- Not all farming activities are centred on meat and milk production for a farmer. A farmer may rear calves or receive animals for winter grazing. This will reduce the emissions intensity of the farm that does not undertake this activity and increase the emissions intensity of the farm that does. In an efficient market, farmers should push this emissions trading cost down the supply chain in the form of higher prices for winter grazing and calf rearing. There may be barriers to this however. This may also send confusing information to farmers, as a potentially emissions inefficient farmer who has a high utilisation of winter grazing or external calf rearing, may receive a net-credit for emissions trading within their own farming platform. Providing allocations for activities such as calf-rearing and winter grazing may add significant complexity to the policy.
- GHG intensity may vary year-to-year based on climatic and economic factors. Where New Zealand experiences a wet summer, meat and milk production per animal may increase, reducing that season's GHG intensity. This may erode the overall level of NZUs surrendered and received by the Crown. Likewise, a drought may have the opposite effect. This would be a 'counter-cyclical' impact, pushing higher costs on farmers at times of difficulty. Farmers may also increase use of supplementary feed and fertiliser when agricultural prices are high, again causing seasonal variations in the average emissions intensity. As the benchmark emissions level is likely to be set in advance, this may lead to unpredictability in the level of NZUs surrendered to the Crown each year.

[17] Ledgard, S. F., Chobtang, J., Falconer, S., McLaren, S. (2016) *Life Cycle Assessment of Dairy Production Systems in Waikato, New Zealand.* Integrated nutrient and water management for sustainable farming**.**

4.2 Minor barriers and limitations to scenario implementation

Table 12 outlines minor barriers and limitations to implementation of each scenario. In each case there is likely measures that can be adopted to overcome barriers.

Table 12: Summary of the key barriers associated with each scenario

Scenario	Barriers and limitations
Processor point of obligation	▪ **Potential for misalignment with inventory:** Emissions factors that agricultural processors use to estimate biological emissions will be set based on forecasts of emissions and agricultural production rather than actual results (ex-ante). Actual emissions and production will vary based on seasonal conditions or market prices. In each individual year there will be a variation between the level of biological emissions recorded in the New Zealand greenhouse gas inventory and that for which agricultural processors face an emissions obligation. An on-farm point of obligation partially avoids this by using actual farm data to estimate emissions each year, there will however still be some variation as the OVERSEER tool has slight differences to the greenhouse gas inventory methodology.
Emissions trading scheme – on-farm point of obligation	▪ **Farm information:** Significant variation in farmer information management may mean that some farmers face difficulties in providing and maintaining farm information. This reduces the ability to verify and audit farm biological emissions estimates. In general, farmers need to maintain these records for tax purposes. There is a minority of farmers however (we are told) with extremely poor farm record keeping. Such farmers may need to access a 'default maximum level'. This would be an estimate of emissions that would apply (per hectare or per stock unit) where farmers are unable to produce any verifiable farm information. This level would need to be set at a level high enough to avoid high emitting farmers having an incentive to report this default level. ▪ **Farmer expectations:** Farmers currently have a low level of understanding of their farm emissions efficiency. Time may be needed to build farmer understanding of how allocations are provided and how shifts in the emissions efficiency of production will impact emissions liabilities. If farmers were to enter the ETS quickly, many farmers may be surprised by how their farm presently performs on an emissions efficiency basis. For example, organic farmers and low-input farmers are likely to have high emissions obligations (under intensity based allocations) but may be expecting the opposite. ▪ **Audit:** Present practice is for all industrial ETS participants to be audited over a period of time (circa 10 years). Forestry consultants are audited rather than forestry participants. It will not be possible to audit all farmers, even over a ten year period. Auditing 1% of farms per year would require 240 audits per year. For the purposes of estimating administration costs, we have assumed certified nutrient management advisors are subject to audit as well as 1% of farmers per year. Policy makers will need to establish their own audit principles, but there will be limited ability to audit a large number of farmers.
Payments for low-emissions technologies	▪ **Payment rate will represent national average:** Technologies will reduce emissions to a varying degree based on background emissions levels. For example, a methanogen vaccine will reduce emissions more where a farm has higher production (and emissions) per animal. Providing payments to the suppliers of technologies will require that payments are based on national average emissions reduction from the use of that technology, rather than the specific farm emissions reduction. ▪ **Payment may not be passed on:** Where only a small number of providers are available for a given technology, the provider may not pass through all of the payment. The portion of the payment not passed on will result in increased profit for the provider.

Scenario	Barriers and limitations
Regulated biological emissions levels	*If emissions limits are on an emissions per unit of production basis* ■ **Regulation of intensity limits:** It may be difficult to force some farmers to reduce emissions intensity. In some cases improving emissions intensity may require improved management ability. Low emissions efficiency may also be a product of farm physical characteristics (topography, climate) or a result of production methods (eg organic production). In such circumstances farmers may face barriers to responding to a regulation placing a limit on biological emissions intensity levels.
Regulated use of mitigation technologies	■ **Organic and other market claims:** Some mitigation tools and technologies may not be consistent with all farm strategies, in particular where farmers seek to market themselves as pasture based, organic or 'GMO free'. Introducing exemptions to a regulation would complicate this approach. ■ **Variation in farm systems**: Biological emissions per animal vary based on the different volumes of feed consumed by different animal species in different farming systems. Mitigation technologies are unlikely to be cost-effective for all farming systems, for example, technologies such as a methanogen vaccine, that face a 'per animal' cost, will be less cost-effective where production per animal is very low. A regulatory approach to mitigation technologies may therefore lead to some instances of highly inefficient use of mitigation interventions.
Government-industry agreement	■ **Limited enforcement ability:** This model is unlikely to result in full participation in voluntary programmes. Agricultural sector representative bodies, such as Beef+LambNZ or DairyNZ, are not able to place obligations of farmers. The model would rely on agricultural processors and sector bodies to work with farmers to change behaviours and aggregate farm information. It is difficult to attract 100% of processors to such programmes, and for processors to in turn support 100% compliance amongst farmer suppliers. ■ **Sheep, beef and deer sectors:** Stakeholders noted the difficulty of achieving industry agreement in the meat sectors. This was due to both the fragmented nature of the industry and the reduced level of loyalty of farmers to a single supplier. While in the dairy sector farmers supplied a single processor for a dairy season, meat farmers may supply multiple processors in a single year. There was not always a strong link between a farmer and a processor. Beef+LambNZ and DeerNZ could develop a voluntary standard and work with processors to adopt this standard, but it was difficult to achieve a majority of processor support quickly for new industry requirements. This was partly due to no single processor individually representing a clear majority of supply (as is the case for dairy).
Hybrid scenarios	
The Processor point of obligation scenario with Payment for low-emissions technologies (hybrid scenario)	■ **Accounting issues:** If farmers utilised low-emissions technologies, and these were recognised in the New Zealand agricultural greenhouse gas inventory, it could be expected that these would be captured in the emissions factors agricultural processors face for biological emissions. Providing a payment for use of these technologies would then result in rewarding the agricultural sector twice for utilisation of this technology. Emissions factors could be calculated to represent agricultural emissions without the use of these technologies to avoid this issue, adding some complexity to this scenario.

Scenario	Barriers and limitations
Processor point of obligation allowing farmers to voluntarily opt-in to farm level reporting (hybrid scenario)	▪ **Reduced obligation:** Would result in an overall lower obligation for the agricultural sector, as it can be expected that only farmers with below average biological emissions levels would opt-in to farm level reporting. This impact could be reduced over time if emissions factors for processors were adjusted up to reflect increased level of emissions for those farmers who haven't opted-in only (i.e. represent the average of the remainder of farms). ▪ **Rebates**: Splitting obligations between processors and farmers would require agricultural processors to track suppliers who have opted-in to on-farm reporting and remove the cost of emissions obligations from prices paid to these specific farmers. This would be a complex process for agricultural processors. Those that Beca consulted with viewed the feasibility of such a situation with scepticism. If farmers who opted-in to farm level reporting submitted information directly to government, the government could provide low-emissions farmers with a direct cash rebate rather than operate two tiers of emissions trading, and therefore avoid processors needing to differentiate farmers reporting choice in payments for meat and milk. ▪ **Combining two different approaches to estimating biological emissions:** Emissions factors within a Processor point of obligation are based on the lifecycle emissions required to produce each product. This will occur over a number of years. For example, the emissions factor for beef supplied to a meat processor will estimate biological emissions levels from three years of cattle weight gain. OVERSEER estimates annual farm biological emissions, regardless of if animals were sent to slaughter or not.
Measurement of biological emissions could occur **On-farm**, while the point of obligation could remain at the **Processor**.	▪ **Existing ability:** Dairy processors already undertake differentiated payments based on environmental and milk quality standards. Miraka provides farmers with a bonus payment for achieving set environmental and social outcomes under the 'Te Ara Miraka' programme. Meat payments are adjusted based on meat quality grade. ▪ **Farmers shift processor:** In the meat sector farmers may shift meat processor mid-season. This would add significant complication to this system. ▪ **Lost efficiencies of scale**: Under an On-farm point of obligation government agencies may invest in software solutions to support information management. There are presently 43 meat processors, 15 dairy processors and 12 animal exporter participants in the ETS (reporting obligations only). Each processor investing in information management activities may significantly increase information management costs. Allowing processors to 'opt-out' and report a default value may result in any processors for whom farmer emissions levels are above average simply opting out (reducing the overall liability the agricultural sector faces).

5 Monitoring, reporting and verification

Verification frameworks are related to information provided by processors, farm information, and ability to verify specific technologies.

5.1 Verification of processor information

The EPA has existing procedures relating to the verification and audit of participant information. The EPA is also able to undertake desktop verification, for example, noting where total agricultural production does not match national statistics. The EPA also verifies participant information through an external audit of ETS participants.

A scenario where payments are provided to providers of low-emissions technologies would likely utilise a similar verification framework (desktop audit followed by random audit).

5.2 Verification of farm management information

Under the Waikato Regional Council's Lake Taupo nitrogen discharge limits (Waikato Regional Council Plan Variation 5) farmers were required to submit farm OVERSEER files compiled by a certified nutrient management advisor.

Nutrient management advisors are required to sight farm records when completing an OVERSEER report.

Farmers were also required to maintain records, such as receipts for stock sale and fertiliser purchased, to support an in-farm audit, should it occur. Note that farmers also have a tax incentive to declare purchases of feed and fertiliser.

The government conducts audits of forestry consultants who supply emissions trading services to forestry participants. Our assumptions for scenarios that require the use of certified nutrient management advisors also includes allowance for audits of rural consultancies. Such audits will verify good practice by certified nutrient management advisors.

5.2.1 Standing stock off pasture

Standing stock off pasture (eg on feed pads or stand-off pads) can have the impact of reducing nitrous oxide emissions associated with excretion of nitrogen to pasture and with nitrogen leaching.

On the other hand, effluent captured from these pads must be managed and stored effluent can produce nitrous and methane emissions.

Overall, standing stock off pasture could either increase or decrease biological emissions, depending on the farm effluent management system and the assumptions applied to the calculation of emissions.

Time that stock spend off pasture is an input into OVERSEER and will impact biological emissions. It will however be difficult to verify values that farmers claim for time stock spend off pasture.

A certified nutrient management advisor will only be able to observe if there is infrastructure available for standing stock off pasture. They would not be able to verify how that infrastructure has been used throughout the year.

5.3 Verification of the use of specific technologies

5.3.1 Methanogen vaccine or inhibitor

5.3.1.1 Potential for farmers to receive payment for use of methanogen vaccine

We discussed the cost of vaccinations with The New Zealand Veterinary Association and other stakeholders. Vet technicians generally charge 70c to $2 per dairy cow for the service of providing and administering various vaccines. We have no information on the specific pharmaceutical cost farmers would pay for a methanogen vaccine.

The On-farm point of obligation scenario and the Payments for low-emissions technologies scenario would both create a price incentive for farmers to use mitigation technologies. Table 13 displays the value of a 20% reduction in enteric methane emissions, at an emissions price of $20 per NZU, in per animal terms. In the event that a methanogen vaccine resulted in a 20% reduction in enteric methane emissions this may exceed the cost of administering the vaccine for some animal types (ie it would be a cost effective mitigation option).

Table 13: Per animal value of a 20% enteric methane reduction

	Population (millions)	Kg CH_4 / head / year	Tonne CO_2e / head / year ($CO_2e:CH_4$ conversion of 25)	20% emissions reduction	Value of per animal emissions reduction (@ $20 / NZU)
Dairy cattle	6.5	84	2.1	0.42	$8.43
Beef cattle	3.5	59	1.5	0.29	$5.86
Deer	0.9	22	0.54	0.11	$2.17
Sheep	29	12	0.30	0.060	$1.19

Under a Payment for low-emitting technologies scenario, providers of a methane vaccine may receive an allocation of greater value than the cost of providing the methanogen vaccine. Equally, under an On-farm point of obligation scenario, farmers will receive an emissions trading saving greater than the cost of applying the vaccine.

This is a positive situation from the point of view of promoting use of the vaccination. However, this increases the need to verify the use of such a technology by farmers and avoid the risk that farmers receive payment for use of the technology without actually administering the technology.

5.3.1.2 Verification of Methanogen Vaccine or Inhibitor

The ability to verify the use of a methanogen vaccine or inhibitor was discussed with a number of stakeholders. On face value, if a regulator visited a farm it would be difficult to confirm whether stock had received a methanogen vaccine.

This scenario assumes there is no ‘natural incentive’ for farmers to apply the vaccine or inhibitor – that the vaccine or inhibitor will not improve farm milk or meat production. It remains unclear if farmers will observe an improvement in farm production through the use of a methanogen vaccine or inhibitor.

Regardless of this natural incentive, there is a need to be able to verify actual on-farm use of a methanogen vaccine or inhibitor.

Stakeholders noted that it will likely be important both a vaccine and an inhibitor are applied by an expert.

Stakeholders drew a parallel to the Leptosure vaccination (leptospirosis vaccine). It was estimated by stakeholders that well over 90% of dairy farmers used this vaccination. It was preferable that it was applied by a vet technician as there is a need to treat the vaccine vials appropriately (eg prevent exposure to sunlight).

Vet technicians recorded the use of the vaccine in the farm medical records.

In order to allow verification of use, farmers could be required to record use of a methanogen vaccination in farm medical records. This would require the vaccination to be administered by a vet technician, and this vet technician to record application to stock, and thus provide verification of use.

In regards to a methanogen inhibitor, stakeholders discussed potential application using a bolus (slow release capsule).

Again, this would likely need to be administered by an expert (vet or vet technician). This would provide the same opportunity for this expert to also record that stock had received the inhibitor, and thus provide verification of use.

5.3.1.3 Administration cost of methanogen vaccine or inhibitor verification

We have not included the cost of a vet technician as an administration cost as we have assumed that engaging a vet technician to apply these mitigation technologies will be a necessary part of the costs of these technologies (just as hiring contractors will be part of the cost of applying nitrification inhibitor to pastures).

In the event that a vet technician is only required for verification purposes, this will add significant administration costs to all scenarios that require verification (On-farm point of obligation, Payments for low-emissions technologies, Regulated biological emissions limits, Regulated use of mitigation technologies).

If verification required on average 3 hours of a vet technician time (to both apply the mitigation technology and record its use), this would have an annual cost of $7,000,000 across 24000 farms.

This cost would reduce in each scenario based on the percentage of farms which use the vaccine (even a regulatory approach may only apply to farms that meet specific criteria) and if application of the vaccine can be undertaken in conjunction with existing farm engagement of a vet technician (on dairy farms, application of the Leptosure vaccine for instance).

5.3.2 Low-emissions breeding

5.3.2.1 Low emissions breeding in the Dairy Sector

Artificial insemination is prevalent in the dairy sector (70-75% of herds). All artificial inseminations are recorded on the Livestock Improvement Corporation (LIC) Herd Improvement Database. Dairy stock which have been bred from artificial insemination will have a quantified 'Breeding Worth' estimated.

Breeding Worth ranks dairy bulls and cows on the expected ability of their progeny to meet the National Breeding Objective to "Breed dairy cows that are able to efficiently convert feed into profit".[18]

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[18] DairyNZ. (2017). *All About BW.* https://www.dairynz.co.nz/animal/animal-evaluation/interpreting-the-info/all-about-bw/ (retrieved 12-9-2017)

Presently, there are eight traits evaluated within breeding worth: milkfat (kg), protein (kg), milk volume, live weight, fertility, somatic cell count, residual survival and body condition score. Milk volume, live weight and somatic cell count are represented by negative economic values, meaning cows that have lower quantities will have a higher BW (lower milk volume rather than low milk solids).

Within this system, it would be possible to include information on the low-emissions value of a cow's genetic background, and by extension that of a total herd.

Artificial insemination providers may be able to supply farmers with a record of the prevalence of low-emissions traits within their dairy herds. This could then be used to verify low-emissions traits under scenarios that adopt farm-level reporting.

5.3.2.2 Low emissions breeding in the sheep, beef and deer sectors

Artificial breeding is less common in sheep, beef and deer sectors.

Artificial breeding is used by farmers specialising in producing breeding bulls. Natural breeding then occurs from these bulls to produce beef animals.

Sheep Improvement Limited (SIL) supplies sheep farmers with genetically indexed rams. Progressive farmers may then undertake flock genetic testing to understand flock genetic improvement.

Low-emissions traits could be pushed through New Zealand's sheep flock and beef herd through these existing breeding programmes.

Where farmers have purchased low-emissions rams or bulls, this could be verified, however it will be unclear to what extent low-emissions traits are spread to farm breeding ewes and cows and, by extension, lambs and calves, without genetic testing.

Therefore, while there are mechanisms to push low-emissions traits through the sheep, beef and deer sectors, it is unclear if there are strong mechanisms to **verify** the prevalence of low emissions traits at a herd and flock level. Genetic testing of sample farms may support verification at the national level, but genetic testing to support farm-level verification is likely to be prohibitively expensive.

5.3.3 Low-emissions pastures or feeds

5.3.3.1 Brassicas

Research has shown reduced methane emissions in stock fed brassicas.

Use of fodder crops and supplementary feed will be an important factor in the completion of an OVERSEER nutrient budget for both biological emissions and nutrient loss purposes.

Auditors may seek evidence that OVERSEER reports are accurate through receipts for the purchase of seed or planting services.

5.3.3.2 Genetically Modified Rye-grass

Research is currently on-going into genetically modified (GMO) rye-grass that may reduce biological emissions from pastoral farming.

If such a technology was commercialised it would be less apparent to a farm inspector if pastures were GMO variety rye-grass or standard rye-grass.

As with the verification of a methanogen vaccine, it is likely an approach can be developed where at the point of purchase the supplier of the rye-grass seed provides a record that the seed has been purchased and sowed, and that this is used for verification.

Issues may arise in regards to how the pasture is maintained over a longer period of time and if and when renewal is required to continually claim an emissions benefit. These will detailed policy decisions to be made at the time of any policy implementation.

6 Stakeholder engagement

Beca talked to staff from a number of organisations to gain an understanding of the implications, costs and barriers associated with each scenario. Organisations are listed in Table 14.

Table 14: List of stakeholders Beca engaged with to inform our analysis

Stakeholder	Particular points of interest
New Zealand Agricultural Greenhouse Gas Research Centre	■ List of technologies to include in assessment
Ministry for Primary Industries (MPI) (ETS Operations)	■ Experience administering forestry in the ETS ■ Barriers to on-farm reporting / 24,000 participants ■ Likely resource required to administer both processor point of obligation and on-farm point of obligation ■ Method of audit and verification
Environmental Protection Authority (EPA)	■ Experience administering ETS and biological emissions reporting (at processor level) ■ Barriers to on-farm reporting / 24,000 participants ■ Likely resource required to administer both processor point of obligation and on-farm point of obligation ■ Method of audit and verification
DairyNZ	■ Cost of offering extension services for all dairy farmers ■ Cost of undertaking Sustainable Dairying Water Accord
Fonterra (Farm Source, Corporate Sustainability)	■ Costs (number of FTEs) and barriers of nutrient reporting programme (translating this to GHG reporting for sheep and beef) ■ Cost of compliance for ETS (purchasing of units, reporting emissions)
Beef + Lamb & DeerNZ	■ Costs and barriers of industry accord on GHG emissions. ■ Cost of extension services
Meat Industry Association	■ Cost of compliance for ETS (purchasing of units, reporting emissions)
AgFirst	■ Time and cost for completing OVERSEER report on-farm. ■ Farmer time involved in this.
OMF	■ Cost of purchasing NZUs for farmers
CarbonMatch	■ Cost of purchasing NZUs for farmers
Waikato Regional Council	■ Use of OVERSEER in regulation ■ Use of OVERSEER for nutrient trading
The New Zealand Veterinary Association	■ Verification framework for methanogen vaccine or inhibitor ■ Cost of verification of methanogen vaccine or inhibitor

Engagement with stakeholders provided valuable information across a number of parameters.

In some instances stakeholders were unable to provide a robust estimate of the cost of servicing a scenario due to commercial sensitivity or because scenarios shifted too far beyond their present experience and it became difficult to calculate what a scenario would mean.

7 Discussion

7.1 Price based options to mitigate biological emissions

Legislation was passed in New Zealand in 2008 that included provision to introduce biological emissions into an emissions trading scheme (Climate Change Response (Emissions Trading) Amendment Act 2008).

Since this time, there has been discussion regarding, in the event that biological emissions entered the emissions trading, whether the point of obligation should be at the processor or farm level.

A farm level point of obligation has generally been viewed as a way to create an incentive for individual farmers to reduce emissions due to the ability to link farm management to emissions, however it is recognised also as having higher administration costs compared to a processor point of obligation.

Our findings confirm that an On-farm point of obligation is likely to have high low administration costs when compared to a Processor point of obligation.

Our findings suggest that the administration costs from an on-farm point of obligation result chiefly from the mechanism used to measure biological emissions on-farm and potential fees charged by NZU brokers. In a scenario where farmers engage a certified nutrient management advisor to estimate biological emissions per farm and pay present day brokerage fees, we estimate the administration costs of an On-farm point obligation scenario would cost $39 million per annum. $30 million of this cost would fall on sector and farm organisations, with the remainder falling on the government.

At an emissions price of $20 per NZU, and receiving an allocations equivalent to 95% of emissions liabilities, the ETS would cost a typical farm $1600 per annum based on NZU obligations alone. A sector cost of $30 million per annum is equivalent to an additional $1300 per farm – increasing the total cost of the ETS on farmers by 78% (see Table 15).

Table 15: Key metrics for discussion of scenario annual administration costs

Key metric	Processor point of obligation	On-farm point of obligation	Payments for low-emissions technologies	Regulated biological emissions limits	Regulated use of mitigation technologies or practices	Government-industry agreement
Per tonne emissions	$0.07	$1.02	$0.09	$0.40	$0.03	$0.18
Sector cost as a % of total ETS obligations	2.7%	78%	2.6%	15%	0.1%	8%
Sector costs, per farm	$87	$1,300	$83	$470	$3	$260

Sensitivity analysis suggests that alternative assumptions could significantly reduce the costs associated with an on-farm point of obligation.

Beca confirmed the list of scenarios assessed and key assumptions with a sub-group of BERG. A preference was expressed to use the OVERSEER software as many farmers are already using this software for water quality regulatory purposes (and this trend is expected to continue).

Where farmers are not using OVERSEER for water quality regulatory purposes, and many are likely to not have to ever do this every year, using OVERSEER as the sole means to estimate farm biological emissions may be inefficient. BERG may wish to investigate a two-tier system, where a simplified tool, using the same base calculations but focused solely on emissions, is available to farmers.

Investing methods to reduce the brokerage costs farmer face is a second potential avenue to reduce costs associated with an On-farm point of obligation scenario.

Payment for low-emissions technologies

An alternative method of providing an incentive to farmers to reduce emissions is to provide a payment to providers of low-emissions technologies (such as a methanogen vaccine or low-emissions breeding). This payment would be passed onto farmers in the form of lower prices for these technology options vis-à-vis alternatives, or potentially create a situation where suppliers pay farmers to use technologies.

If this scenario was combined with a Processor Point of Obligation scenario, it may allow for the cost of payment to be recovered by the Crown. This is similar to the policy being discussed by the present Government, in which there is a desire for “All revenues from [emissions trading to be] recycled back into agriculture in order to encourage agricultural innovation, mitigation and additional planting of forestry.”[19]

Our assessment suggests this option would have much lower administration costs than an On-farm point of obligation (although we have not considered broader policy aspects).

Broader strategy on the use of OVERSEER in New Zealand

Our analysis has focussed on the use of OVERSEER for regulation of biological emissions. We estimate that an OVERSEER assessment for 24000 farms would cost farmers at least $17 million per annum.

Regional councils, to varying degrees, are utilising OVERSEER to regulate nitrogen loss to waterways.

The agricultural sector and regional government could consider a broader strategy on the use of OVERSEER for both regulation and farm improvement. A strategy on the use of OVERSEER could consider both opportunities to reduce the cost associated with using OVERSEER and greater benefits realisation where farmers are required to use OVERSEER. If there was a clearer view on how widely certified nutrient management advisor OVERSEER reports are expected to be used by farmers across New Zealand in the future, this would support a stronger understanding of if using the OVERSEER software to also estimate greenhouse gas emissions can be achieved at low marginal cost (in the event that farmers are likely to already be using the software).

7.2 Non-price based scenarios

Our assessment suggests that the administration costs associated with non-price options also depend on the degree to which an individual estimate of farm biological emissions is required.

Regulatory options also face some barriers related to the diversity of farms in New Zealand. Regulation of an emissions limit may face challenges in determining an appropriate biological emissions level for different types of land and land use. Regulating mitigation interventions would also face difficulties when applied to the diversity of farm enterprises in New Zealand.

[19] New Zealand House of Representatives (52nd Parliament). (2017). *Coalition Agreement: New Zealand Labour Party & New Zealand First.*

7.3 Next steps

We understand that the BERG group has commissioned parallel work assessing the most effective mechanisms for driving farmer behaviour change and also looking at the wider economic costs and benefits of biological emissions mitigation options.

This work can support an understanding of which of the mitigation scenarios assessed in this report (or scenarios not assessed) warrant further analysis (considering administration costs, the ability of scenarios to drive behaviour change, and have strong benefit-cost ratios).

Further analysis of policy options can investigate the barriers we have identified further and undertake detailed design of mitigations to these barriers.

Appendix 1

OVERSEER Nutrient Budget software

Appendix 2

Cost estimate methodology report