FARM ENVIRONMENT PLAN

FOUNDATION FOR ARABLE RESEARCH

Greenhouse Gas Module

The Planning Process

Before you begin to fill in the template, save it to your computer hard drive. Remember to keep saving as you work your way through it - at the end of each page or management section would be a good idea. Once it is completed you will need to file your plan and supporting documents in one place. An easy practical solution is to keep all the information in a single, indexed ring-binder.

This template will enable you to create a **Greenhouse Gas (GHG) farm plan module** as part of your wider Farm Environment Plan. This could integrate with other farm plan modules being developed by FAR including those on Freshwater, Biodiversity and Biosecurity.

The planning process will enable you to develop a schedule of actions to manage identified features on your farm and address identified risks.

Refer to the Greenhouse Gas module template guide for more information.

The template has three main sections:

- Property details and farm maps (this may already be covered in your Freshwater farm plan module).
- Farm management for reduction in on-farm greenhouse gas emissions.
- Farm management carbon capture.

Fill in all the sections that are relevant to your farm business.

The planning process is;

1. Risk assessment - considering the management practices that contribute to or reduce GHG emissions from the farm.

2. Developing the action plan – ranking priorities, identifying cost and developing a time frame.

3. Collation of documents to support your plan and provide evidence that you are delivering on your planned objectives.

The template guides you through the process.

This Greenhouse Gas module template was developed in August 2021, based on current available knowledge. It will be updated as new information comes to hand.

Property details and farm maps for the Greenhouse Gas farm plan module

Property name:

Address:

Business Owner(s):
Contact Details:

Land Owner(s):
Contact Details:

Property size:

Legal Description of the land.

http://www.linz.govt.nz/survey-titles/find-out/info-property-owners

Farm identifier
(GPS co-ordinates)

Brief description of the farm enterprise (crops and stock)

	Greenhouse Gas (GHG) emission numbers
Calculator used (e.g. E-Check)	
Version (e.g. v1.4)	
Time period (e.g. 1/4/2020-31/3/2021)	

	GHG emissions (kg CO_2-e)	**GHG emissions per hectare*** (kg CO_2-e/ha)
Nitrous oxide (N_2O)		
Carbon dioxide (CO_2)		
Methane (CH_4)		
Total		

* GHG emissions per hectare calculated from total farm area.

Responsibility for developing and implementing the Greenhouse Gas farm plan module

The greenhouse gas farm plan module has been prepared by;

Note if you have prepared your own plan please indicate whether you have attended a workshop.

I have attended a greenhouse gas farm plan workshop. YES ☐ NO ☐

As the person responsible for implementing this plan, I confirm that the information provided is correct:

Name (Plan implementer):

Signature:

Position (e.g. owner/manager):

Date:

Insert your farm map here

Summary of Farm Risks and Actions

Location (Where the risk area is - Map reference)	**Identified Risk** (e.g. nitrous oxide emissions linked to application of excess N fertiliser to crop X.)	**Planned Action (Mitigation)** (What do you plan to do and by whom?)	**Timeframe** (When will the work be done?)

Farm Plan Module
Greenhouse gas

Management Objective	Reduce on-farm greenhouse gas emissions.
Targets	Identify the opportunities to reduce on-farm greenhouse gas emissions.
Identified Risks	Risks associated with on-farm greenhouse gas emissions:

Key Actions Management changes to reduce on-farm greenhouse gas emissions:	**When by**	**Evidence of completion**

Management practices currently employed to reduce on-farm greenhouse gas emissions.		
Use this list of management practices to identify what is already being done on your farm and what you might consider changing in the future. Your answers will assist with the development of a plan to reduce and manage the environmental risks on your farm. Note: many of these management practices will overlap with other farm environment plan modules (e.g. freshwater) and their adoption may deliver multiple benefits. A range of management practices for reducing on-farm GHG emissions are outlined below. Not all of these management practices will be reflected in GHG emission calculators. GHG emissions calculators (e.g. E-CHECK) typically focus on two major sources of emissions, that being: 1) animals contributing methane from digestion of feed and nitrous oxide from urine and dung, and 2) nitrous oxide emissions from the application of synthetic N fertilisers (and Carbon dioxide from Urea).		
Improve the efficiency of crop (and pasture) production	**Greenhouse gases***	**Comment (Indicate answer)**
The right amount of nitrogen fertiliser. *Apply only as much N as the crop can utilise because excess N (nitrogen surplus) is susceptible to various direct and indirect losses. There are a number of tools to predict optimal fertiliser application rates.*	N_2O (and CO_2)**	
The right timing for nitrogen fertiliser application. *Apply N when the crop needs it. Loading the soil at the start of the season increases the risk of leaching and denitrification, whereas split applications (e.g. at planting and during the season) can minimise the risk that mineral N levels in the soil will exceed crop demand and uptake. To optimise applied N, ensure plant growth will not be limited by soil moisture.*	N_2O (and CO_2)**	
The right placement of nitrogen fertiliser. *Strategic application of N fertiliser to match crop demand can be enhanced by variable rate fertiliser technologies.*	N_2O (and CO_2)**	
Minimise the period that N fertilisers sit on the soil surface to limit volatilisation losses. *Broadcasting is typically less efficient than banding fertiliser into the soil. When broadcasting N fertiliser, ensure application is followed with sufficient rainfall or irrigation to assist with the migration of urea into the soil profile. As a general rule of thumb, 10mm of rainfall/irrigation is required within eight hours of urea application to significantly reduce volatilisation risk.*	N_2O (and CO_2)**	
Apply the right form of nitrogen to match the expected conditions. *If rainfall is not expected, fertilisers like calcium ammonium nitrate (CAN), which are more stable under low moisture conditions, may be a more cost-effective option than urea (https://www.far.org.nz/assets/files/uploads/Volatilisation.pdf).*	N_2O (and CO_2)**	
Use urease inhibitors to reduce N emissions from arable soils under certain conditions. *These benefits can similarly be achieved by applying the correct amount of N, at the right time and away from the soil surface.*	N_2O (and CO_2)**	
Minimise soil compaction and any associated reduction in soil porosity and aeration. Consider activities such as cultivation, livestock treading and vehicle movements. *Large N_2O emissions can occur under anaerobic conditions that are commonly associated with soil compaction. Remedial deep ripping may be appropriate in areas that are heavily compacted. Consider the impact of activities such as compaction and aim to mitigate that in the future. Controlled traffic approaches can restrict compaction damage, helping to reduce emissions and the need for further cultivation.*	N_2O	
Reduce intensive cultivation that stimulates mineralisation and the release of inorganic N into the soil. *If inorganic forms of N are produced in excess of crop demand, there is that a risk that they will be lost through processes of nitrification and/or denitrification.*	N_2O	
Improve drainage in paddocks where it is impeded. *This will reduce the extent of water saturation and denitrification in the soil, and may also have a strong positive effect on crop yields.*	N_2O	

* N_2O= Nitrous oxide, CH_4= Methane, CO_2= Carbon dioxide ** All N fertilisers applications produce N_2O emissions. Application of urea also produces CO_2.

Keep fallow periods to a minimum. *When there is no active sink for uptake of inorganic soil N, this is prone to nitrification or denitrification losses (increasing the risk of losses via leaching and gaseous emissions). Short and long-term cover crops can help reduce N losses and improve soil physical characteristics.*	N_2O	
Keep track of soil moisture for efficient irrigation. *When irrigating, use a direct measurement of soil moisture or a soil water budget to help determine the correct amount of water to apply. Aim to maintain a soil moisture deficit so the soil is never full with water (i.e. soil moisture does not exceed field capacity). This directly reduces the potential for nitrous oxide emissions because the bacteria that drive this process are most active in water logged (anaerobic) conditions. Deficit irrigation has been shown to have no negative impact on yield (in some cases it increases yield) and saves irrigation water.*	N_2O	
Apply water at a rate that matches the soil's capacity to absorb it. *Runoff can create localised areas of saturation, potentially accelerating denitrification losses.*	N_2O	
Utilise variable rate irrigation technologies to reduce over and under application of irrigation.	N_2O	
Calibrate and maintain all irrigation equipment regularly to ensure it is performing to specification. *Measured irrigation application depths should be within +/- 10% of the target depth (not including end gun).* *Distribution uniformity (DU) describes how evenly irrigation is applied to the crop. Distribution uniformity should be at least 0.8.* *Application depth and DU can be checked using a bucket test with industry approved guidance. Bucket tests should be undertaken on each irrigator at least once every three years.*	N_2O	
Optimise the use of lime through targeted applications. *Whilst the application of lime does produce CO_2 emissions, optimal soil pH results in more production per unit of nitrogen applied and therefore less N fertiliser applied.*	N_2O (and CO_2)	
Management practices other than those listed above.		

* N_2O= Nitrous oxide, CH_4= Methane, CO_2= Carbon dioxide

Reduce total feed eaten on the farm	**Greenhouse gases***	**Comment** (Indicate answer)
Identify and cull less productive stock early. *Less productive or dry stock culled early rather than carried through.*	CH_4 N_2O	
Reduce wastage rates (unplanned losses) so replacement rates can be optimised, and total feed eaten reduced. *Reduced total feed demand from fewer replacements results in a reduction in the use of N fertiliser and/or supplementary feed.*	CH_4 N_2O	
Adjust livestock class or ratios within the farm system to reduce the total feed eaten. *Increase breeding beef cow longevity or replace cows with dairy beef animals.* *Consider hogget mating to increase the lifetime efficiency.* *Increase lambing percentage and sell lambs earlier or finish lambs faster.*	CH_4 N_2O	
Use genetic selection over time to increase animal performance and decrease livestock maintenance requirements. *Over time this will result in higher profit and yield as less cows or sheep are required to convert the feed to profit.*	CH_4 N_2O	
Manage animal health. *Improved animal health leads to gains in efficiency and productivity.*	CH_4 N_2O	
Retire less productive land from grazing. *Match land use with land class. Highly erodible, very steep, or very wet areas, retired from production or converted to forestry.* *Livestock numbers reduced to match feed supply.*	CH_4 N_2O	
Consider options for high value land use change. *Highly productive land converted to high-value crop production. Livestock numbers reduced to match feed supply.*	CH_4 N_2O	
Management practices other than those listed above.		

* N_2O= Nitrous oxide, CH_4= Methane, CO_2= Carbon dioxide

Match feed demand with pasture growth and utilisation	Greenhouse gases*	Comment (Indicate answer)
Optimise pasture quality and production to better meet feed demand. *Pasture-based farming systems with good grazing management that maintain year-round quality pasture production reduce total feed demand.*	CH_4 N_2O	
Optimise supplementary feed inputs to better meet feed demand. *Adjust stocking rate (feed demand) to increase home grown feed and reduce bought-in feed.* *Use low N content supplementary feeds (e.g. maize silage).*	CH_4 N_2O	
Use of alternative forages to reduce protein in the diet. *See "Greenhouse Gases: Farm Planning Guidance" for more information on potential feed types and associated benefits.*	CH_4 N_2O	
Management practices other than those listed above.		

* N_2O= Nitrous oxide, CH_4= Methane, CO_2= Carbon dioxide

Improve the management of livestock effluent	**Greenhouse gases***	**Comment** (Indicate answer)
Avoid storing effluent in anaerobic conditions.	CH_4 N_2O	
Methane (CH_4) capture.	CH_4	
Use all captured effluent as a fertiliser enabling reduced N fertiliser use.	N_2O	
Management practices other than those listed above.		

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Reduce fossil fuel related emissions On-farm greenhouse gas emissions from fossil fuels are already accounted for through the New Zealand Emissions Trading Scheme and are not part of the on-farm emissions reporting and verification requirements. However, they are a key consideration in improving your farm's carbon footprint. It is also important to understand current and future non-renewable energy farm inputs when exploring on-farm greenhouse gas reduction opportunities.	**Greenhouse gases***	**Comment (Indicate answer)**
Reduce fossil fuel use by minimising machinery usage.	CO_2 N_2O	
Reduce fossil fuel use through selection of more efficient or electric machinery.	CO_2	
Reduce electricity use from the grid through more efficient energy use, and/ or on-farm solar/ wind and water generation.	CO_2	
Management practices other than those listed above.		

* N_2O= Nitrous oxide, CH_4= Methane, CO_2= Carbon dioxide

Management Objective	Enhance on-farm carbon sequestration (capture and storage).
Targets	Identify the opportunities for carbon sequestration.
Identified Risks	Risks associated with on-farm carbon sequestration.

Key Actions Management changes to enhance carbon sequestration:	**When by**	**Evidence of completion**

Management practices currently employed to capture carbon.
Use this list of management practices to identify what is already being done on your farm and what you might consider changing in the future.
Your answers will assist with the development of a plan to reduce and manage the environmental risks on your farm.
Note: many of these management practices will overlap with other farm environment plan modules (e.g. freshwater) and their adoption may deliver multiple benefits.

Capture and store carbon in vegetation	**Greenhouse gases***	**Comment** (Indicate answer)
Consider converting less productive land or diversifying land use by establishing perennial tree crops, indigenous vegetation, exotic forest and/or wetlands.	CO_2 CH_4	
Consider planting riparian setbacks.	CO_2	
Consider planting erosion control trees where erosion is active or could occur.	CO_2	
Plant trees for animal welfare and for wind breaks to protect crops and pastures.	CO_2	
Provide fencing and weed and pest control to protect existing and newly planted indigenous vegetation.	CO_2	
Management practices other than those listed above.		

* N_2O= Nitrous oxide, CH_4= Methane, CO_2= Carbon dioxide

Capture and store carbon in soils	Greenhouse gases*	Comment (Indicate answer)
Minimise time soils are left fallow, i.e., with no growing vegetation. *When soils are bare, there is no carbon input from photosynthesis, but losses of CO_2 from microbial respiration continues, so there is a net loss of soil carbon*	CO_2	
Increase the use of restorative crops in rotations or increase the duration of pasture. *Restorative phases can build the amount of carbon that is stored in soil. The net greenhouse gas impact should be considered across a cropping rotation.*	CO_2	
Retain and incorporate crop residues where possible. *Retaining material 'on-farm' provides the opportunity for it to be incorporated into soil organic matter.* *Avoid stubble burning unless necessary for pest and disease management.*	CO_2	
Add external organic amendments such as manure, compost, or biochar. *This approach is only likely to lead to measurable increases in soil carbon if large quantities are added. If amendments stop being added, soil carbon will likely decrease back towards the original equilibrium over time.* *Consider the net greenhouse gas benefit (e.g. emissions associated with production, transport and spreading).*	CO_2	
Optimise water table depth for peat soils. *Drainage of peat soils exposes large amounts of carbon to oxygen which accelerates microbial decomposition and CO2 release.*	CO_2	
Protect and manage erosion prone land. *Plant spaced poplars and willows, or other species with known root stabilising impact, on slopes to control and reduce erosion.*	CO_2	
Increase a range of plant species in pasture swards. *This is an area of active research in New Zealand. Diversity of functional groups (e.g. grass, legumes, and forbs/herbs) is generally considered more important than the number of species present.*	CO_2	
Management practices other than those listed above.		

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