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FACT SHEET | DECEMBER 2023

ESTIMATING EMISSIONS

Why measuring emissions is important and how to do it

Lower emissions and higher profits

A leaky production system is an inefficient production system.

Farm productivity and greenhouse gas emissions are closely linked, higher emissions are generally associated with lower productivity. Greenhouse gas emissions essentially represent lost or 'leaking' energy. Efficient use of energy on farm – creating a system without leaks – usually equates to better productivity and improved profitability. In a farm system, 'leaks' of greenhouse gas emissions often represent areas where farms can save money and improve efficiency.

Growers around the country are looking at their farm efficiency from many angles – the cost of inputs, changing commodity prices, resilience to climate extremes, and evolving attitudes towards climate and carbon. Growers are often at the forefront of both feeling the impacts and leading the change. Finding ways to tackle several important issues at once could have multiple benefits, such as easing the pressure on growers and opening new market opportunities.

KEY MESSAGES

- Farm productivity and greenhouse gas emissions are closely linked, with higher emissions generally associated with lower productivity.
- Calculating your emissions profile can help to identify where inputs can be used more efficiently, helping to save money.
- Calculating your emissions profile is an important first step in considering how carbon accounting or carbon credits could be used on your farm.
- Growers who reduce their emissions may get better market access opportunities for selling their products, both domestically and overseas.
- Growers can use free online tools to calculate their emissions profile such as Hort Carbon Info and H-GAF. This fact sheet provides step-by-step help in completing your emissions profile using these tools.
- Keep in mind that the quality of the data you put into the tools is important for producing a useful emissions profile.

Hort Innovation

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RMCG

ahr applied horticultural research

Emissions in vegetable and melon production

All farming systems produce greenhouse gas emissions, with the main forms being:

- **Carbon dioxide (CO_2)** – released when burning fossil fuels for energy (e.g., machinery and transport) and during decomposition of organic matter in soils (e.g., crop residue stockpiles).
- **Nitrous oxide (N_2O)** – released when nitrogen fertilisers are applied and during soil disturbances. Nitrous oxide emissions are often higher than expected. This is important because nitrous oxide has almost 300 times the warming potential of carbon dioxide in the atmosphere. See the SWICP fact sheet on nitrous oxide emissions for more information.
- **Methane (CH_4)** – released by ruminants (cows and sheep) during their digestion process, as well as from manure stockpiles and organic waste stockpiled or buried. Methane is more relevant in mixed farming and grazing enterprises.

For vegetable and melon farms, emissions primarily come from pumping irrigation water, fertiliser, cool stores and agri-chemicals as shown in the figure below.

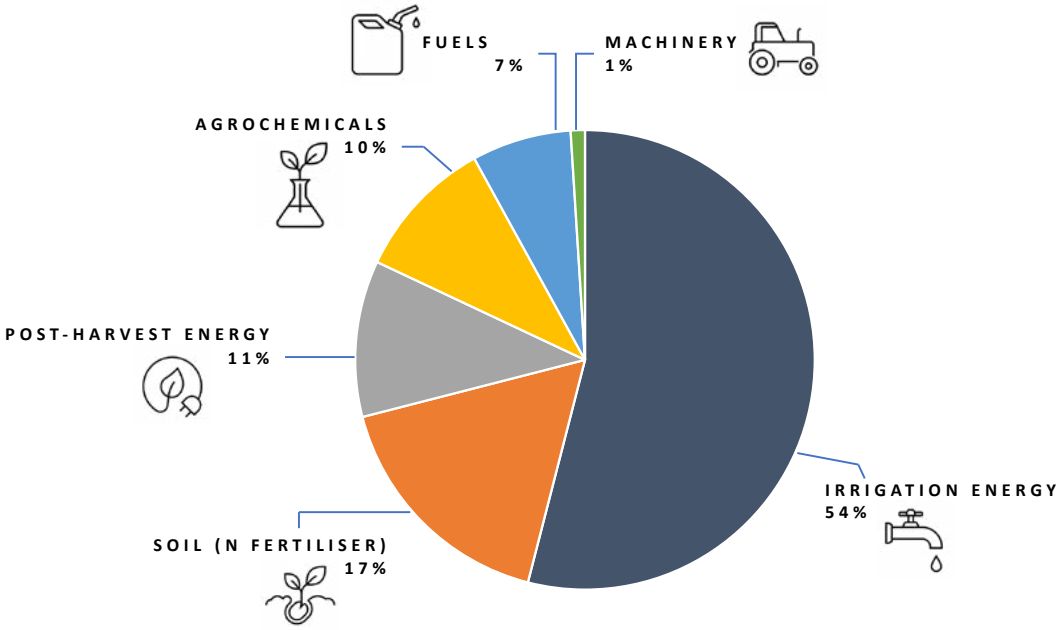

Figure 1: Greenhouse gas emissions from farm inputs and activities in the Australian vegetable industry. (source: An assessment of greenhouse gas emissions from the Australian vegetables industry)

Farms are both sources and sinks of carbon dioxide, as plants, grasses, trees and soils absorb and store carbon dioxide as they grow. In general, the balance on most farms leans towards more carbon dioxide out than carbon dioxide in. This means that agriculture overall contributes to the increasing concentrations of greenhouse gases in the atmosphere[1]. Many growers are aware of this, and finding ways to both boost productivity and profitability while reducing the amount of emissions leaking from farms is both good for growers and good for the planet.

[1] Agriculture Victoria, 2020, accessed via <https://agriculture.vic.gov.au/__data/assets/pdf_file/0010/578719/Cents-of-Carbon.pdf

There's another benefit of reducing emissions for growers that may boost profitability. Governments and industry bodies are widely introducing strategies and targets for improving the sustainability of agriculture. From the consumer side, demand is growing for food produced with lower emissions. This means that growers who reduce their emissions can expect growing market opportunities for selling their products, both domestically and overseas.

Carbon accounting

Working out your emissions profile is the first step towards making a carbon account for your farm – if you can't measure, you can't manage. A carbon account is essentially an emissions balance sheet – what emissions are going out from your farm against what emissions are being stored (sequestered).

An emissions profile works by estimating the **carbon dioxide equivalent (CO_2-eq)** a vegetable or melon growing business emits annually. CO_2-eq is a unit used to describe the global warming potential of different greenhouse gases compared to carbon dioxide, so that the overall emissions of a business can be expressed in one clear, consistent unit. CO_2-eq is calculated by multiplying the tonnes of a gas produced by its global warming potential.

Table 1: Global warming potential of common greenhouse gases emitted in agricultural systems.

Gas	Global warming potential
Carbon dioxide	1
Nitrous oxide	298
Methane	25

In Australia, the Emissions Reduction Fund gives businesses the opportunity to earn Australian Carbon Credit Units (ACCUs) for every tonne of carbon dioxide equivalent they either store or avoid emitting due to changed practices. ACCUs have two fundamental uses:

- ACCUs can be kept by a farm and used to offset their own farm emissions, thereby helping a farm move towards carbon neutrality (net zero emissions). This could be the wise choice for growers that are aware of market opportunities for lower emissions enterprises.
- ACCUs can be sold to private carbon markets or to the Australian Government to generate additional income streams – provided the project goes through an approval process.

Currently, there is a high degree of uncertainty around emissions reduction obligations for agricultural industries in Australia and what part agriculture will play in Australia's national target of net-zero emissions by 2050. Selling carbon credits now before this becomes clearer may have future implications for growers who need to reduce their own emissions or sell their products.

Soil Wealth ICP has put together a comprehensive series on carbon for vegetable growers looking for more information on soil carbon and carbon farming.

What is the link between emissions and my profitability?

Going back to the idea of a leaky production system, we can now look at emissions as those leaks that represent lost efficiency or profits. Examples of leaks that cost money and ways to address them that both save money in the long term and reduce emissions are provided in the figure below.

Essentially, inefficient machinery, equipment and vehicle use increases fuel costs and generates higher emissions. Applying nitrogen-based fertilisers in excess of plant needs or in ways that cause leaching means that this expensive input is not utilised by your vegetable or melon crop in the best way possible.

Note that changing practices or equipment is unlikely to show results overnight, and some ways of addressing inefficiencies may incur a high cost initially which is then earned back over time through saved inputs. For example, the purchase of a solar system will eventually pay for itself through saved electricity bills.

CARBON ACCOUNTING FACTS

- **Carbon neutral** refers to when businesses are able to balance all outgoing emissions with emissions captured, achieving net zero emissions.
- **Businesses that find it difficult to reach net zero** may choose to purchase offsets through a carbon market.
- **Carbon neutral certification** requires businesses to consider both direct (on-farm) and indirect (e.g., pre- and post-farm) emissions.
- In many cases, **growers investing in carbon storage practices** will see the best return for their investment by addressing their poorest soils or if they have not previously addressed soil carbon (e.g. maintaining groundcover, reducing tillage).

LEAKS IN THE PRODUCTION SYSTEM

CO_2 Carbon Dioxide
Fossil fuels

Example 'leaks'	How to address them
Performing activities inefficiently	▪ Improve efficiency by changing practices
Using energy during peak periods	▪ Understand your energy bills and usage ▪ Use energy during off-peak periods where possible
Using old, poorly maintained or inefficient machinery and equipment	▪ Regularly maintain machinery and equipment and replace where needed ▪ Switch to renewable power for pumps and heating/cooling devices ▪ Take energy use into account when purchasing new machinery and equipment
Irrigating in excess of plant needs	▪ Use soil moisture monitoring devices to schedule irrigation
Practicing conventional tillage	▪ Practice minimum tillage to reduce fuel use by up to 10%
Poorly insulated buildings, stores and heating/cooling devices	▪ Insulate buildings, stores and devices properly
Inefficient use of lighting and heating	▪ Install energy-efficient lighting and heating systems

Example 'leaks'	How to address them
▪ Applying fertiliser in excess of plant needs ▪ Applying fertiliser when soil moisture is too high ▪ Applying excess fertiliser outside the time of peak plant growth ▪ Applying fertiliser outside the active root zone ▪ Applying too much organic matter at the same time as fertilizing with nitrogen	▪ Follow the four Rs principle: Right product, right rate, right time, right place. Talk to your agronomist for more guidance. ▪ Avoid applying high rates of fertiliser in single applications ▪ Use plant or soil testing to assess plant nitrogen needs and supply, and determine the right rate ▪ Monitor climate forecasts and avoid fertilising and tilling during wet conditions ▪ Align fertiliser application with peak plant growth periods where possible ▪ Improve soil health to maximise plant access to nutrients

N_2O Nitrous Oxide
Fertiliser

Figure 2: Potential 'leaks' in the system and how to address them[1].

How do I measure my emissions profile?

There are several horticulture-specific tools available to help you measure your emissions profile. This fact sheet provides guidance on two of these tools:

- **HortCarbon Info**, developed by the Queensland Department of Agriculture and Fisheries
- **Horticulture Greenhouse Gas Accounting Framework (H-GAF)**, developed by the University of Melbourne.

Key points to note before you start work on your emissions profile are:

- **The quality of the data you enter into the tools dictates the quality of the data you receive** in your emissions profile. Your emissions profile will be more useful when you have sufficient time and information to complete it.
- **There are limits to the sensitivity of the tools available**. Keep in mind that at best, you will be producing an accurate estimate of your emissions, but exact figures will depend on elements that are difficult to measure.
- **Some tools exclude certain emissions or stores of carbon that you may want to consider.** For example, neither of the tools described here measure carbon sequestered in soils.

What data do I need?

The following list shows all the data you can choose to input into the HortCarbon Info tool. However, not all vegetable or melon growing enterprises will use all these inputs, so identify which data sources are relevant for your business.

Table 3: Data sources used in HortCarbon Info tool[2]

Data	Unit	Explanation
Electricity	Kilowatt hours (kWh)	All the electricity used on your farm. You can find this via your electricity bills and accounts.
Fuel	Litres (L)	Fuel used in both stationary appliances (e.g., pumps, generators) and vehicles (e.g., tractors, bikes, utes). Should be split into petrol, diesel and LPG.
Fertiliser	Tonnes (t)	Only include fertiliser containing nitrogen. Urea must be listed separately.
Animal manure or compost	Tonnes (t)	The % of nitrogen contained in these is required. This can often be obtained from the supplier.
On-farm waste	Tonnes (t)	Including green waste (used on farm and disposed of), paper, cardboard, commercial and industrial waste.
Refrigeration gas leakage	Kilograms (kg)	The quantity and type of refrigerant used to charge the system. This data may be found on the compressor.
List of crops	Area - hectare (ha)	This is used to calculate crop residue returned to the soil as well as emissions per tonne of product sold.
	Yield - tonnes per hectare (t/ha)	
Lime or dolomite	Tonnes (t)	Lime or dolomite applied to your soil.
Staff employed*	Number on payroll	In full-time equivalents. Used to calculate emissions per employee.
Turnover*	Million $	Used to calculate emissions per $million turnover.
Boundary	Proportion of farm	Your whole farm, or a portion of it if relevant (e.g., one of multiple distinct properties).
Time period	Year	One year is generally the time period selected, to express emissions per year.
Location	State/territory	Location is important for determining the main sources of electricity for your farm (e.g. coal, hydro, solar).

* These inputs are optional.

[2] HortCarbon Info, accessed via <http://grf-smartfarm.daf.qld.gov.au:3838/apps/hortcarboninfo/>

The H-GAF tool uses similar inputs but requires more detailed information in some cases. For example, fertiliser use is broken down into non-urea nitrogen, phosphorus, potassium, urea, and users can also enter how much urease or nitrification inhibitor they use, if any. It also allows users to enter areas of vegetation used to calculate carbon sequestered in plantation trees. To calculate carbon sequestered, users need the data listed in Table 4 below.

Table 4: Data sources used in carbon sequestration calculations for H-GAF tool[3]

Data	Unit or explanation
State and region	The regional location of your farm.
Species of tree	Allows users to select from common plantation species.
Soil type	Users will need to have knowledge of their soil type and select from a drop-down list in the tool.
Area of trees	Area of trees in hectares.
Age of trees	Estimated age of the stand of trees in years.

Step-by-step – HortCarbon Info

1. **Collect the required data**, most of which will be found in your farm records. Ensure you have the correct units for the data (e.g., kilowatt hours for electricity use, not the dollar amount used).
2. **Enter the data** into the tool on the HortCarbon Info webpage. Depending on your farm, not all data will be relevant, so leave cells blank where applicable.
3. **Check the data** to make sure the units are correct and look for any mistakes.
4. **Calculate and view the results**. The results are shown as emissions per hectare, per tonne of produce and per category of data that a user enters. The tool also generates a pie chart which shows where most of your emissions are generated, e.g., in fertiliser use, electricity, waste or transport.
5. **Use the information** to assess what the main sources of emissions are on your farm and investigate strategies for reducing them.

Step-by-step – H-GAF

1. **Download the Excel spreadsheet** from the Primary Industries Climate Challenges Centre website. There are different tools designed for specific agricultural industries. The Horticulture Greenhouse Accounting Framework (H-GAF) is the most specific tool for vegetable and melon growers.
2. **Review the 'Data input – crops' and 'Data input – vegetation' tabs** to see exactly what data is required. The other tabs provide information and help run the calculations, but do not require any user input.
3. **Enter the data.** Depending on your farm, not all data will be relevant, so leave cells blank where applicable. Make sure to enter data in the 'Data input – vegetation' tab if you are also looking to calculate carbon sequestered in permanent vegetation on your farm. Clear any data in this tab if it isn't relevant for your farm.
4. **Check the data** to make sure the units are correct and look for any mistakes.

5. **View the results** in the 'Data summary' tab. This tab shows your direct (scope one) and indirect (scope two and three) emissions, carbon sequestered in trees, net farm emissions and emissions per crop. The tool also generates a number of graphs explaining your emissions.
6. **Use the information** to assess what the main sources of emissions are on your farm and investigate strategies for reducing them.

Note that both tools are confidential and the information you enter won't be shared.

Why is it important to understand my emissions profile?

If done correctly, your emissions profile will help you identify where you could save money and improve your production system. Calculating your emissions profile will identify the biggest sources of emissions on your farm and help develop ways to reduce any 'leaks' as much as possible. This will also increase the efficiency of input use.

For example, if fuel and electricity emissions are very high, you may look to assess how efficient your current machinery and equipment is and make a plan to invest in more efficient technology. If fertiliser use contributes a significant amount of emissions on your farm, you may want to learn more about effective use of nitrogen-based fertilisers to get the most out of this expensive input or alternative sources of nitrogen (see resources listed in the final section).

Completing your emissions profile yearly can become an important part of your farm business plan, allowing you to assess the profitability impacts of any changed practices over time and track progress towards any emissions reduction goals, as well as prepare your farm well for any future requirements to report on emissions.

Trends from overseas suggest that it is going to become more important to have a robust emissions profile to access markets and comply with regulations. For example, farmers and growers in New Zealand will need to have a written plan in place to measure and manage their emissions by 2025.

Key considerations and questions

- Why do I want to know and better manage my emissions? What is my objective? e.g. improved productivity, market access, generate carbon credits
- Am I ready to calculate my emissions profile? Do I have all the data required or do I need to generate it first?
- Will changes to my practices, infrastructure or equipment on-farm incur a large initial cost? How long do I expect it to take to earn this back in savings on inputs, and is it a viable option for me right now?
- Which emissions profiling tool is right for me and my goals? How much time do I have to calculate it, and how accurate do I want the results to be? Do I need to include emissions sequestered?

Further resources

Table 5: Further resources on farm emissions calculation and management

Topic	Resource
Further information on the link between profitability and emissions	Agriculture Victoria's booklet Making cent$ of carbon and emissions on-farm
Soil carbon management and carbon farming	Soil Wealth ICP's Carbon Series global scan, webinar and podcast
Nitrous oxide emissions	Soil Wealth ICP fact sheet
Nitrogen management	Soil Wealth ICP article
Soil testing	Soil Wealth ICP Soil Testing and Interpretation for Vegetable Crops: A guide
A regularly updated directory of the range of carbon accounting tools in Australia	Agriculture Victoria's greenhouse gas accounting tools
A wide range of resources on carbon and emissions especially relevant for Victorian growers	Agriculture Victoria's Understanding Carbon and Emissions webpage
Australia's recent National Statement on Climate Change and Agriculture	Department of Agriculture, Fisheries and Forestry – National statement on Climate Change