CARBON CALCULATORS COMPARED

FOR AUSTRALIAN GRAIN GROWERS 2024

A GrainGrowers independent report

GrainGrowers

This report was commissioned by GrainGrowers and prepared by Ben White.

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A specialist in the areas of broadacre machinery, grain storage, communications and technology, Ben has authored numerous research reports and publications, including the GrainGrowers publication *Carbon for Cropping*.

Based in Western Australia, Ben comes from a family farm in northern NSW and has worked with the *Kondinin Group* for over 20-years, managing their research program.

Ben has extensive experience in the delivery of research information to farmers and is a member of the Grains Research & Development Corporation grain storage extension team.

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DESIGNED
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IN AUSTRALIA

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FOREWORD

Twenty years ago, the measurement of greenhouse gases (GHGs) linked to grain production was hardly a topic of conversation. Fast forward to today, and it has taken centre stage, emphasising the importance of carbon literacy in contemporary grain production.

Understanding your GHG emissions makes good business sense. It can equip you with the means to effectively benchmark your operation and uncover opportunities for improved efficiencies and cost savings over time. As demand increases for GHG emission reporting, knowing your farm's carbon footprint will help address sustainability criteria required by supply chain partners such as bulk handlers, customers, and banks. Your 'carbon footprint' is the total GHG emissions associated with your farm operations, expressed as carbon dioxide equivalent. See the Jargon Buster on page 12 for more detailed break downs of key concepts and terminology.

This report comes at a critical time in the Australian grains industry and GrainGrowers is well placed to release this independent report.

In recent years, GrainGrowers has developed the Grain Sustainability Framework (GSF). The GSF aims to monitor, measure, and report Australian grain industry performance against key sustainability priorities. The GSF intends to meet the growing requirement for transparent, standardised reporting driven chiefly by regulatory compliance and capital risk minimisation.

It is expected that mandatory reporting on GHG emissions by Australian businesses will continue to rise in prominence. To support Australia's transition to a net zero future, the Australian Government has signalled its intent to mandate climate-related disclosure. This will have implications for farming businesses in the near future. Appropriate and accessible tools are required for growers to measure and manage GHG emissions for their enterprise.

This report includes a Jargon Buster (see page 12), which breaks down some of the key concepts and terminology around carbon.

In 2020, GrainGrowers identified a need for an independent and trustworthy evaluation of carbon calculators available to growers and released the first carbon calculator report. Since then, the landscape has changed, with modifications to existing calculators and discontinued support for others.

This report stands as an independent assessment of two carbon calculators currently available to Australian grain growers. It is important to note that other calculators and tools are currently under development. GrainGrowers aims to assess these as they become available.

Growers are encouraged to familiarise themselves with the contents of this report and consider how the information can be practically applied to their individual operation. The ability to measure, understand, report and manage GHG emissions is rapidly becoming a standard operational feature of Australian grain production.

This easy-to-read comparison of carbon calculators is a great place to demystify the process and make an informed decision on your next steps.

EXECUTIVE SUMMARY

Agricultural industries face growing demands for transparent greenhouse gas (GHG) emissions reporting from regulatory bodies, export markets, and lenders. Reliable and standardised calculation methods are needed.

The purpose of this report is to compare the GHG emissions calculations and outputs of two commonly used carbon calculators for Australian grain growers:

- The Grains Greenhouse Gas Accounting Framework (G-GAF) V10.9; and
- The Cool Farm Tool (CFT) V2.10.0.

This report evaluates the commonalities and key differences between the G-GAF and CFT calculators, informed by real farming data. By comparing carbon calculator outputs, GrainGrowers aims to assist growers in understanding the metrics involved in calculating the GHGs generated in the production of grain; and to help growers select the most appropriate carbon calculator for their operation.

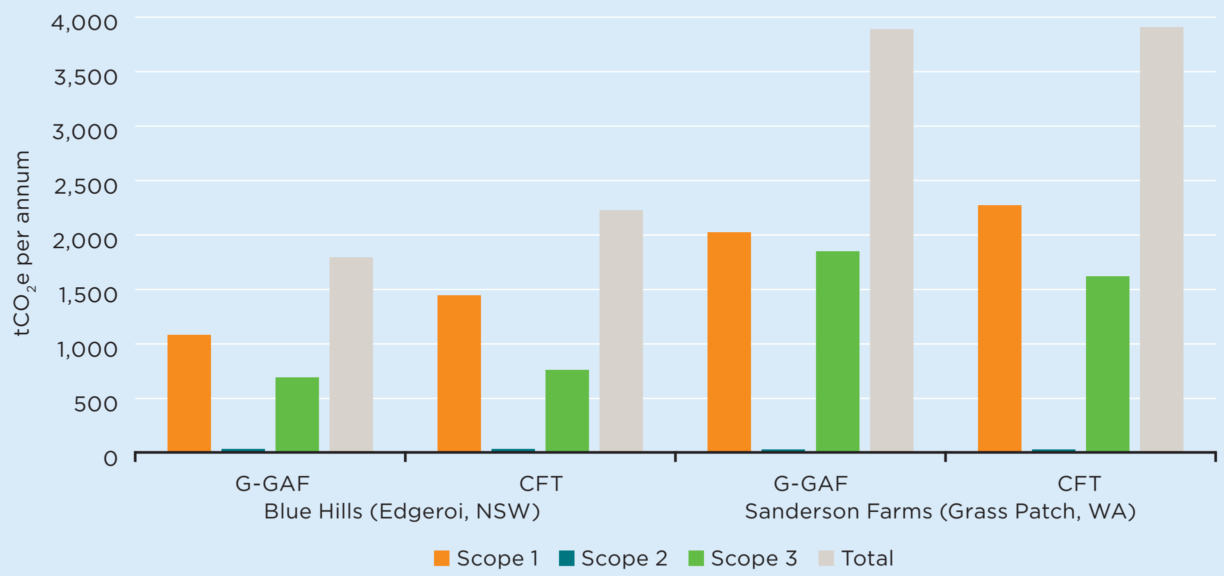
Winter 2022 crop data from two grain farms, Blue Hills in New South Wales (NSW) and Sanderson Farms in Western Australia (WA), was entered into both calculators. Emissions outputs were compared across Scopes 1, 2 and 3 and disaggregated by crop type.

At the whole-farm level, absolute emissions for Blue Hills in NSW calculated using the G-GAF model were 20 percent lower than those calculated using the CFT model. For Sanderson Farms in WA, absolute emissions were 0.5 percent lower with the G-GAF model compared to the CFT model (**Figure 1**).

Emissions results for individual crops varied by up to 35 per cent between calculators for Blue Hills in NSW and up to 14 per cent for Sanderson Farms in WA.

These variations were primarily attributed to differing emission factors employed for critical inputs, such as glyphosate, paraquat, and diquat. These factors substantially increased the calculated GHG emissions in the G-GAF model for both farms at a field level. Anhydrous ammonia inputs resulted in higher CFT calculated emissions for Blue Hills in NSW.

Figure 1: Comparison of 2022 whole of farm GHG emissions calculated for Blue Hills and Sanderson Farms using G-GAF and CFT



While both the G-GAF and CFT carbon calculators provide a means for Australian grain growers to estimate their farm's GHG emissions, differences in methodology and underlying assumptions between the tools gave rise to different results, particularly at a crop level. Some key differences were observed:

- **Scope 1:** CFT applied a higher emissions factor for anhydrous ammonia compared with G-GAF.
- **Scope 3**: G-GAF applied higher emission factors to glyphosate, paraquat and diquat compared with CFT.
- **User experience:** Both tools appeared straightforward to use with simple data entry processes. However, disaggregating chemical inputs into the individual ingredients required by G-GAF took more time than CFT.
- **Output sensitivity:** The timing of fertiliser applications in CFT had a notable impact on results, making those emission figures more sensitive to input assumptions.

For growers looking to estimate, understand and/or reduce their emissions, selecting the most suitable calculator requires the consideration of factors such as the intended use of results, the intended audience, geographic location, cropping system and data input requirements.

GrainGrowers is advocating for the development of a common national framework for GHG accounting in agriculture. This would help improve consistency and reliability, while ensuring reporting requirements do not place an undue burden on growers. As new tools become available, GrainGrowers will continue evaluating carbon calculators to identify options that are relevant, recognised and provide value for growers.

WHY USE A CARBON CALCULATOR? REALISE, REPORT, REDUCE

There are three main reasons why growers may choose to use a carbon calculator for their business. This can be summarised as the 3 Rs: Realise, Report and Reduce.

Realise

The first reason you may want to use a carbon calculator is to realise your carbon footprint. Realising your carbon footprint can help you to:

- Pinpoint on-farm sources of emissions;
- Model 'what if' scenarios around inputs, practices, and processes to support decision-making around reducing emissions and unlocking new opportunities;
- Optimise operations;
- Achieve on-farm efficiencies *and* also reduce GHG emissions.

To realise your carbon footprint, a carbon calculator will ascertain the emissions sources on your farm business. This is captured through Scope 1, 2 and 3 categories of GHGs (**Figure 2**). You can find out more information about the three scopes in the Jargon Buster section in this report.

So, how are these typically divided in a cropping operation? According to a 2022 report commissioned by the Grains Research and Development Corporation (GRDC) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO), for GHG emissions from Australian cropping, roughly 61 per cent of emissions are Scope 1, just under 40 per cent are Scope 3 and only 0.1 per cent are Scope 2 (**Figure 3**).

Once you understand where your emissions occur, you can then move on to reporting and reducing.

Figure 2: Delineation between Scopes 1, 2 and 3 to classify emissions sources and account for greenhouse gas emissions along the entire supply chain

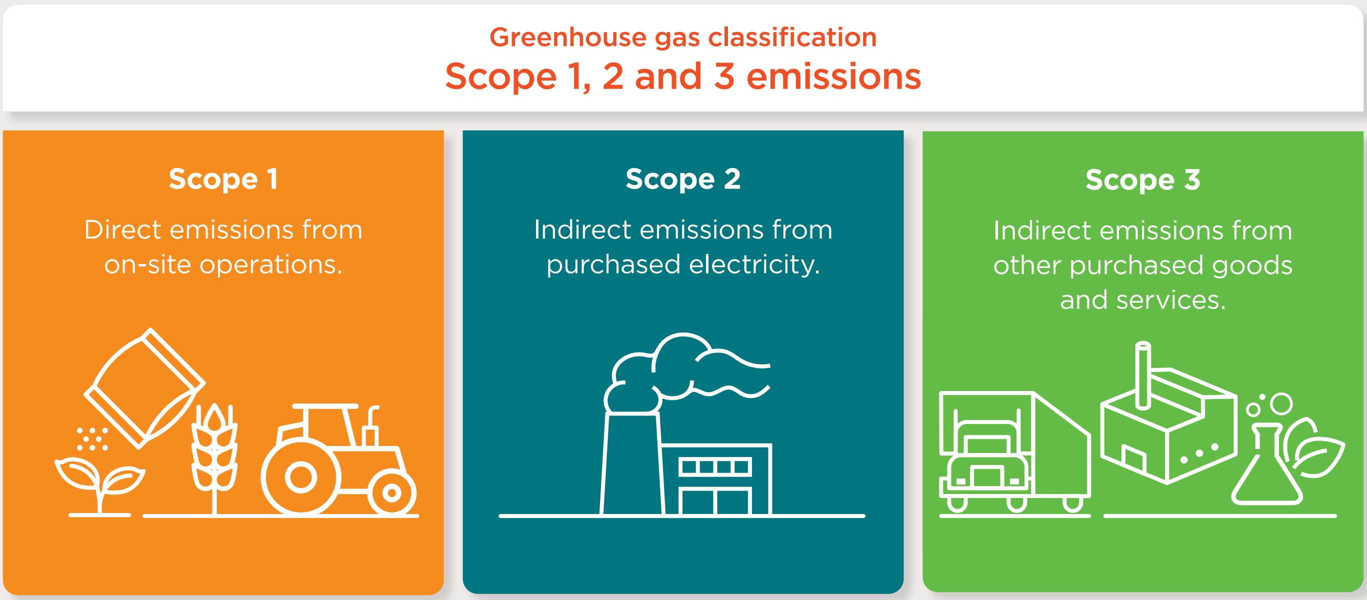
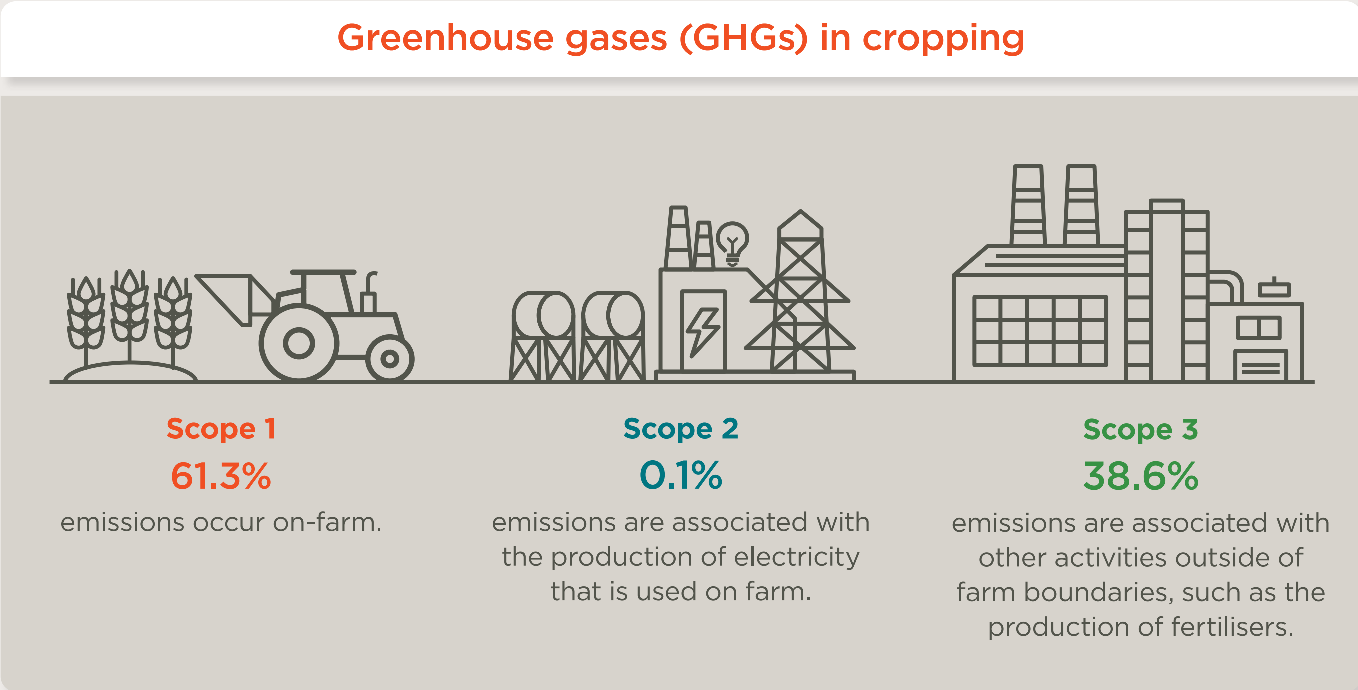


Figure 3: Breakdown of grain-related greenhouse gas emissions across Scopes 1, 2 and 3



Source: GRDC – Australian Grains Baseline and Mitigation Assessment Factsheet (2022)

Grower profile:

Julia Hausler

CROPPING | WIMMERA, VIC

Q: Do you know your GHG number for your farm?

A: Yes, we've recently participated in the Victorian Government's On-Farm Emissions Action Plan Pilot. They wanted grain, livestock, and horticulture businesses to go through the process, so we thought, what a great way for us as a farming unit to understand our GHG emissions.

Q: Why did you think it would be a good idea to know your number?

A: In probably two years' time we'll be caught up in the climate-related mandatory reporting. So, I thought if we had a bit of lead time to understand where we're at, what we might do and what our baseline is, then that would help us start the conversation.

Q: Do you think it would be useful to run a calculation annually and track the numbers over time?

A: Yes, definitely. It would also be handy to run the calculations retrospectively based on farm data we have for the past 20 years to show the progress we've already made, as long as the calculators become more simple to use. We participated in the On Farm Emissions Action Plan to see where our farm sits against other similar operations in the region – the benchmarking piece. If others are lower emitters than me, what are they doing that we're not?

Report

The changing business environment indicates that growers will likely be required to report their GHG emissions on farm in the near to medium future. We already know some growers are moving on this to capture first mover advantage. But who is asking for these numbers? Stakeholders along the value chain are beginning to seek GHG emissions including bulk handlers, customers, banks, investors, and shareholders.

Carbon calculators can help you to:

- Report your on-farm carbon footprint to customers and other stakeholders in the commercial landscape (e.g. banks);
- Further enhance your reputation to differentiate and gain potential marketplace advantages.

Grower profile:

Ash Brooks

CROPPING | WIMMERA, VIC

Q: Do you know your GHG emissions?

A: We've been looking at our emissions numbers for a couple of years now. We work with our farm consultant who completes our assessment as part of our annual review. We've started calculating our numbers as we feel there's value in building a long-term data set. As our data set grows, we're keen to explore what opportunities it may provide for our business.

Q: Does having this information improve the quality and resilience of your farming operation?

A: Farming is a long game! We see building our carbon capacity as an investment and hope the information we're generating will deliver benefits in the future. As our knowledge grows, and we learn more about our key sources of emissions, and as the models become more reliable, we believe we'll become more confident with the data. It is likely that carbon calculators will be another useful tool in supporting rotation and input decisions.

Q: Are you expecting that you will need to report your numbers in the near to medium future?

A: My assumption would be yes. As growers we're certainly not getting any firm advice that reporting is needed in the short term, but if you look at the government's mandatory reporting announcements and the associated timelines for different businesses, I would assume we're going to have to at some point. So, by building your carbon knowledge earlier, you'll at least be prepared and it may also provide some market opportunities along the way.

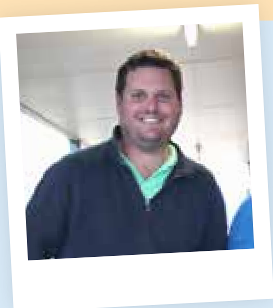
Reduce

If you've got 'your number' and have decided to implement a change of practice, you can measure the impact of this practice on your carbon footprint by using a calculator.

Why reduce?

- Supply chain partners (e.g. banks, customers, bulk handlers) are increasingly having to reduce their GHG emissions and will seek grower input;
- Grains are often an export commodity, and international customers are starting to ask for GHG emissions and evidence of reduction over time;
- To make Australian grains more competitive in an international context – demonstrating improvements in performance over time is a powerful tool in trade negotiations;
- In many cases, emission reduction activities have multiple benefits for farm businesses, such as increasing efficiency and profitability.

Grower profile:



Nigel Corish

CROPPING AND GRAZING | CONDAMINE, QLD

Q: How long have you been looking at your numbers?

A: I've known for 3 years now and redo them annually through the G-GAF tool to baseline and see where improvements can be made across the farm.

Q: Why did you think it would be a good idea to start looking at your carbon footprint?

A: My carbon journey started because I was interested in soil health and carbon levels in the soil, but also because of the general direction of agriculture and society in terms of looking at GHG emissions. Banks are starting to talk about it and are wanting to know what sort of emissions we are producing. We also want to be prepared for future requirements, especially talking to bulk handlers and buyers of our grain.

Q: Have you made any changes based on the results of your GHG emissions?

A: No, but it has put me down the path of a soil carbon project. Implementing the soil carbon project will hopefully balance out those emissions with the ACCUs I will develop.

Q: Would you still register for a soil carbon project if you had no grazing?

A: Even with the balance of grazing on the area that we've got, the soil carbon project wouldn't stand on its own. I think from a cropping point of view, it is really difficult to increase the soil carbon year on year. In the grazing situation, there's a bigger scope for improving the soil carbon.

Q: Has knowing your GHG emissions helped improve the quality and resilience of your farm?

A: Absolutely, it's given me a much better understanding of the overarching efficiency and productivity of the farm. Just the simple fact of knowing your numbers around your inputs, and then calculating what emissions are coming off your farm. It is a great way to understand your farm and business better and hopefully the business and the environment will be much better for it.

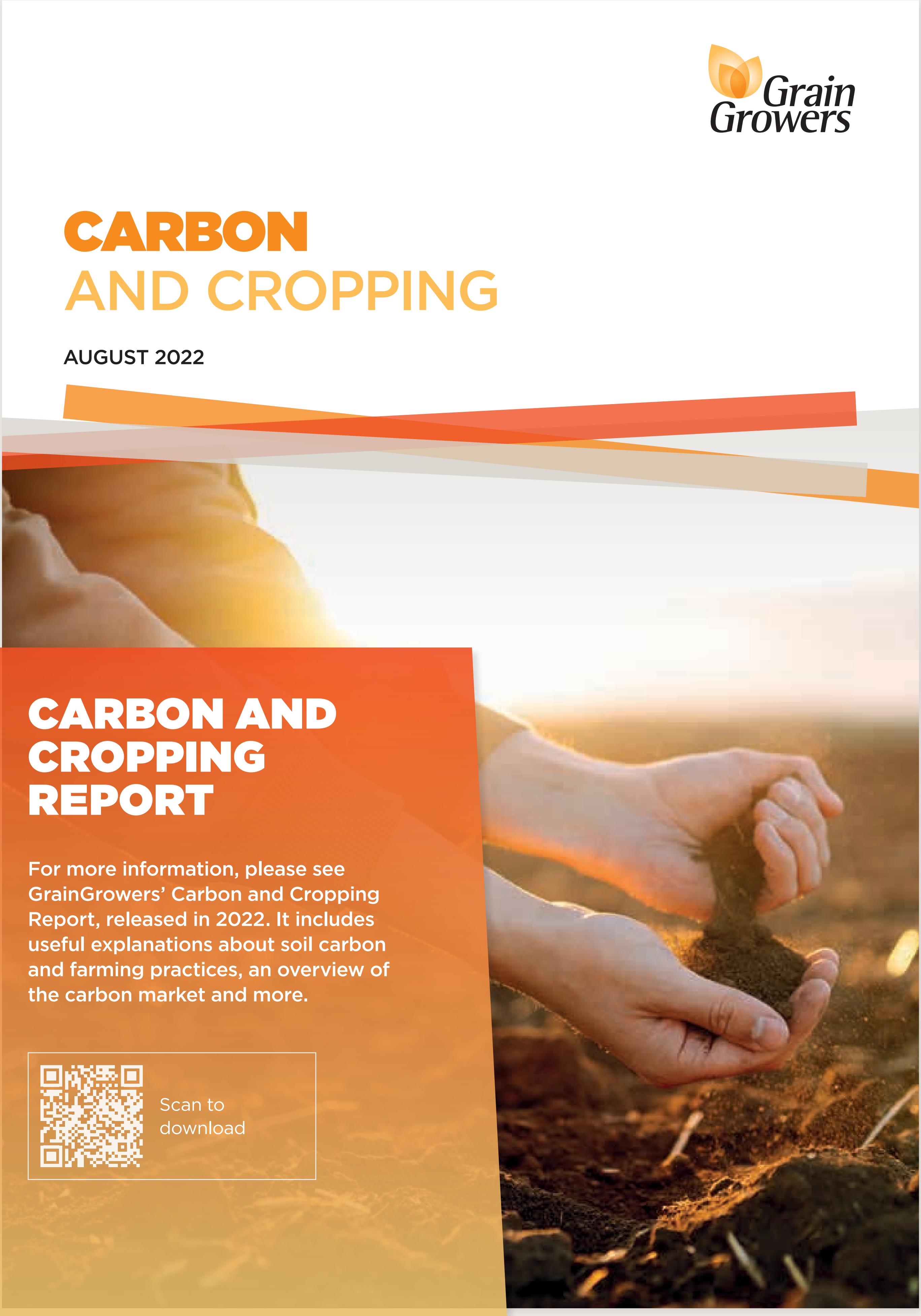
WHAT GRAINGROWERS IS ADVOCATING

GrainGrowers is advocating for the development of a common national framework for GHG accounting in agriculture. This unified approach should include standardised methodologies and simplified measurement tools that are easy for growers to implement on-farm. A consistent framework is vital to enable growers to accurately track and report emissions over time.

GrainGrowers is actively working to ensure growers are well-positioned to meet any mandatory or market-driven reporting requirements that may emerge. By establishing an easy-to-use system now, growers will have the confidence and capability to demonstrate their environmental stewardship into the future. Our advocacy aims to minimise any regulatory burden through proportionate policy solutions.

GrainGrowers is also calling on the Regional Investment Corporation to amend its lending rules to better assist grain growers to adopt low-emission practices. Specifically, we request that loans to support on-farm emission reductions and new technologies are not contingent only on triggers like drought or financial hardship. Making capital available will empower growers looking to proactively improve the sustainability and climate resilience of their operations.

Overall, our policy priorities seek to streamline carbon accounting while enabling growers' investment in practical solutions – positioning Australian grain growers as leaders in response to climate change.



CARBON AND CROPPING REPORT

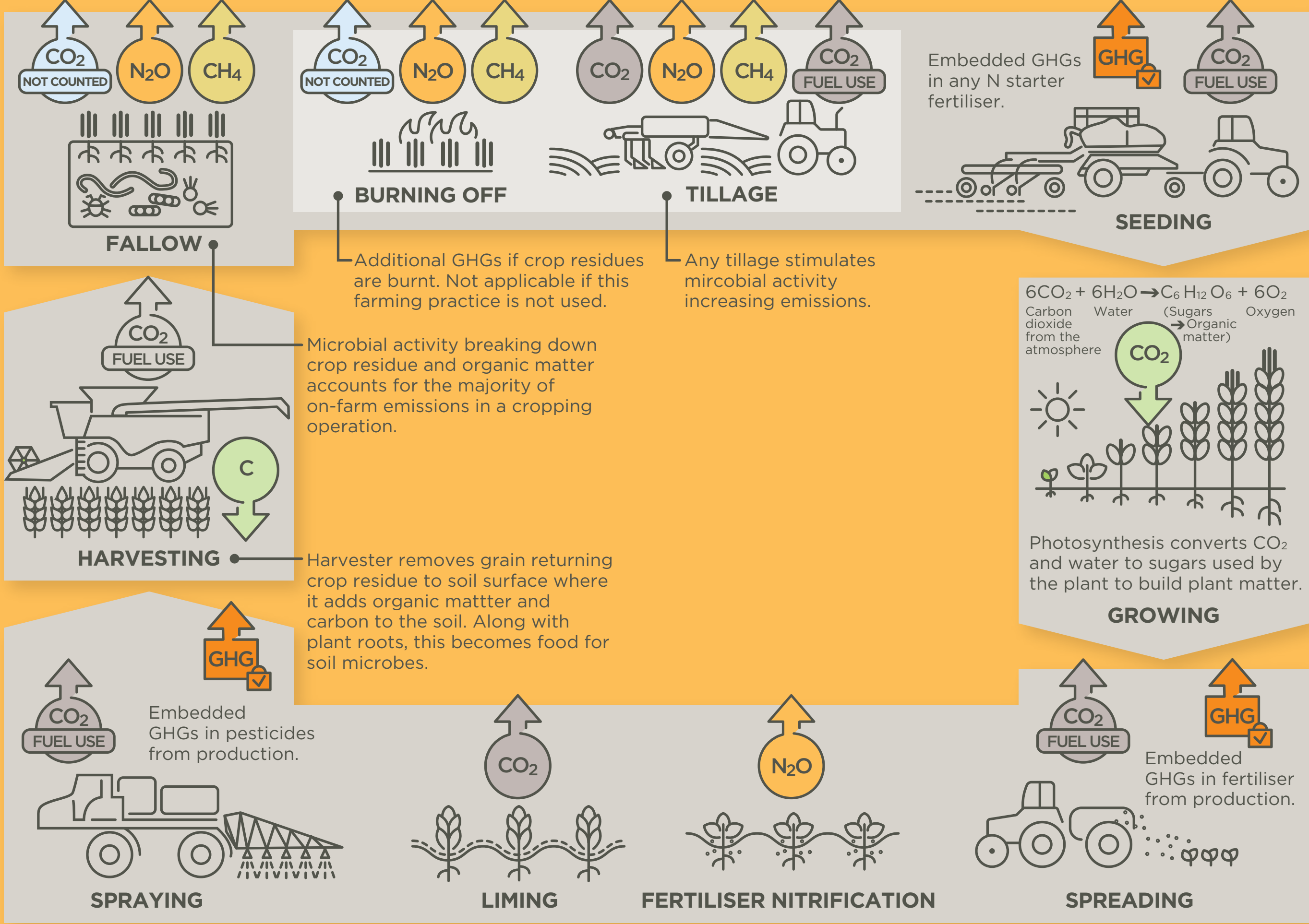
For more information, please see GrainGrowers' Carbon and Cropping Report, released in 2022. It includes useful explanations about soil carbon and farming practices, an overview of the carbon market and more.

Scan to download

JARGON BUSTER

Before calculating the greenhouse gas (GHG) emissions from growing grain, it is essential to understand the commonly used terminology related to GHGs. A more complete set of terms can be found in GrainGrowers' Carbon and Cropping Report, but you will need to be familiar with the following key terms when using GHG calculators.

GHG emission sources and sinks in a cropping operation



API

An acronym for Application Programming Interface. For consistency and ease of use, many software-based applications are integrating API functionality. This should improve workflow and make the formatting and entry of data easier. It also allows third-party businesses to put a skin over the calculator and brand it as their own. Outputs should become easier to understand and data should be simply formatted for export into other platforms if desired.

Classification of emissions

Emissions are classified into scopes to identify their source. Scope 1, 2 and 3 emissions are terms used by the Clean Energy Regulator to describe the source of emissions. Businesses also use these to calculate and report their emissions.

Carbon

Carbon is a chemical element, but the term carbon is sometimes loosely used as a collective term when referring to carbon dioxide, other carbon-based emissions (such as methane), soil organic carbon or more broadly around carbon farming.

The Carbon Cycle

Carbon is an essential element to life and living things. Elemental carbon cycles through living organisms, the atmosphere and the oceans in a continuous process called the carbon cycle. Through photosynthesis, plants convert carbon from atmospheric carbon dioxide into plant material. This organic carbon then cycles through living things where animals and microbes consume the plant material and then animals and microbes consume them and so on through the food web. It may ultimately be expended back into the atmosphere or tightly bound in fossilised substances. Carbon cycles, and the carbon within them, are described as short or long.

Carbon footprint

A carbon footprint is a measurement of the total greenhouse gas emissions associated with an individual, event, organisation, service, or product, typically expressed as tonnes of carbon dioxide equivalent (tCO_2e). It considers all relevant sources, sinks and storage within the spatial and temporal boundary of the activity of interest (e.g. on farm emissions from 2022 calendar year).

A 'carbon footprint' is often referred to as 'absolute emissions' to differentiate from emissions intensity (see below). 'Total emissions' or 'cumulative emissions' are also frequently used interchangeably with carbon footprint or absolute emissions.

Embedded emissions

Embedded emissions are emissions created in the manufacturing or processing of a product, which will be purchased for use or consumption. For example, the energy used to manufacture, package and transport a herbicide contributes to the embedded emissions for that product.

Emission intensity

Emission intensity is the amount of emissions per unit of activity or production. High emitting industries include electricity and transportation while low emitting industries include forestry. In the context of cropping, it usually relates to how much GHG is emitted to produce a tonne of grain. Both calculators provide the total or absolute emissions as well as the emission intensity.

Global warming potential (GWP) and CO_2 equivalence (CO_2e)

Different GHGs have different warming potential – that is, they cause a different amount of heating of the Earth's atmosphere. GWP is measured in units of CO_2e (carbon dioxide equivalents). The global warming potential (GWP) indexes any greenhouse gas potency to one tonne of carbon dioxide (CO_2). Some emissions are more potent than others and have higher CO_2e ratings. For example, one kilogram of methane (CH_4) has the GWP (over 100-years) 28 times that of CO_2 while nitrous oxide has a GWP 265 times that of over the 100-year standard. See **Figure 4**.

The Intergovernmental Panel on Climate Change (IPCC) updates GWP values based on new scientific knowledge of gases. The Parties to the Paris Agreement, which includes Australia, currently use the GWP values provided in the Fifth Assessment Report (AR5) for international greenhouse gas reporting. **Figure 4** contains GWP values from AR5. AR5 values are also used in this report.

Greenhouse gas (GHG)

Greenhouse gases (GHGs) are atmospheric gases that trap heat. They include carbon dioxide (CO_2), methane (CH_4), water vapour (H_2O), nitrous oxide (N_2O), ozone (O_3) and some artificial chemicals (**Figure 5**). Not all gases have the same impact or long-term effect, and each survives in the atmosphere for different amounts of time. Some are much more potent than others (see GWP explanation). The most significant of these for grain growers is N_2O, which is more than 265 times more potent than CO_2 and is associated with fertiliser production and use.

Offsets

Carbon offsets is the basis by which GHG emitters can neutralise their carbon footprint without directly reducing their emissions. Carbon offsets cancel out GHG emissions. GHGs emitted by a process (or industry or city or country) may be offset by carbon sequestration. It does not necessarily mean that there has been any change in the actual process that emitted the carbon. For example, any business may buy carbon offsets in the form of tree plantations that absorb the amount of carbon the business releases.

Scope 1

Scope 1 emissions (also called direct emissions) are those that are released to the atmosphere as a direct result of an activity, or series of activities at a facility. Grain growing examples include burning diesel in farm machinery releasing CO_2, the release of N_2O from bacteria breaking down crop residues or N_2O from the inefficient use of fertilisers.

Scope 2

Scope 2 emissions (also called indirect emissions), refers to emissions released into the atmosphere from the indirect consumption of an energy commodity. For farms, this is predominantly grid-sourced electricity use. In a grain production context, this could be for running grain aeration fans.

Scope 3

Scope 3 encompasses indirect emissions other than Scope 2 emissions that occur as a consequence of the activities of a facility but not from sources owned or controlled by that facility's business. For example, embedded emissions from the manufacture of urea, herbicides or insecticides. Scope 3 emissions are not reported under the National Greenhouse and Energy Reporting Scheme but can be reported under Australia's National Greenhouse Accounts. Grain buyers, processors and consumers are increasingly asking for full carbon footprints inclusive of Scope 3 emissions.

Sequestration

Carbon sequestration is the long-term storage of carbon in plants, soil, oceans and geological formations. Carbon can be sequestered naturally and artificially. Carbon sequestration is often discussed as a way of reducing the amount of atmospheric carbon dioxide, in turn reducing the concentration of greenhouse gases and limiting the impact of climate change.

Figure 4: Common cropping GHG emissions, their potency and atmospheric lifetime

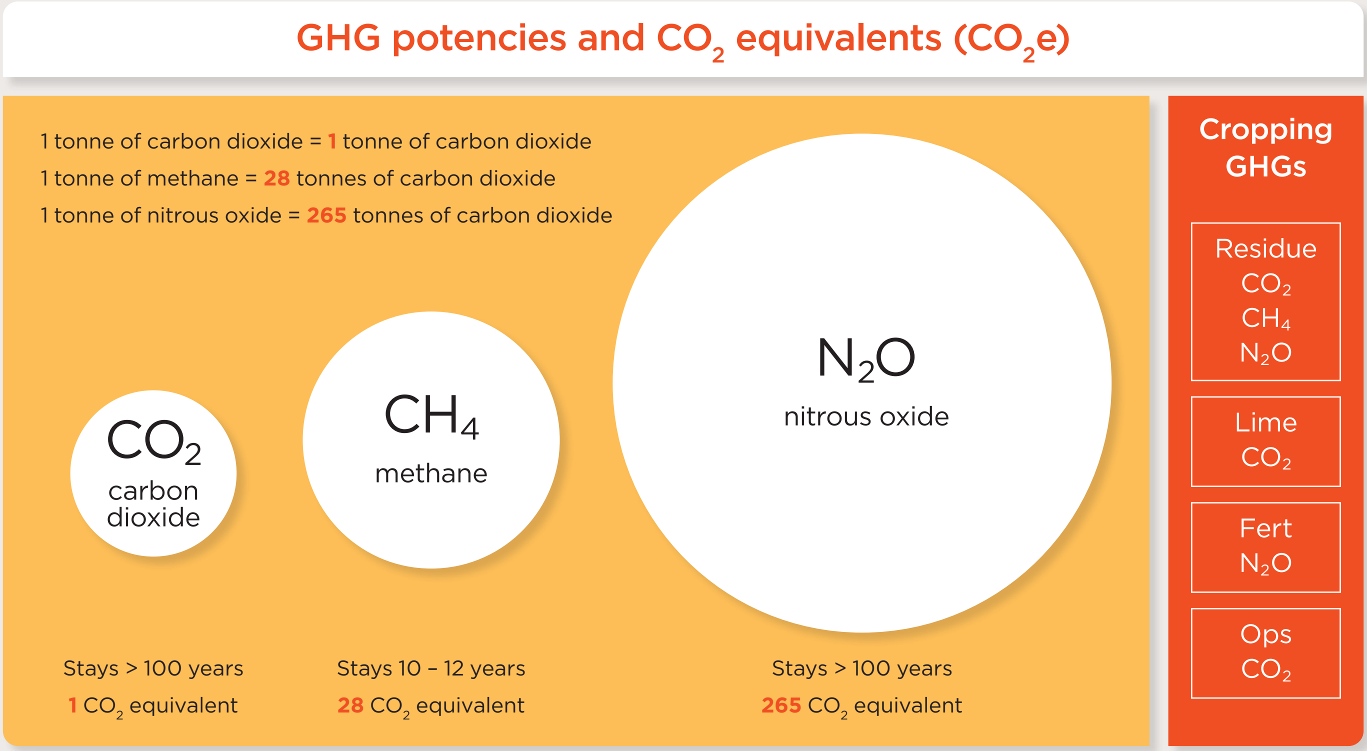


Figure 5: Common GHG emissions and their global and cropping sources

GHG emissions and sources

GHG	Main global source	Cropping sources
CO_2 carbon dioxide		• Tillage • Liming • Residue decomposition • Burning crop residue • Burning fuel
CH_4 methane		• Residue decomposition • Burning crop residue
N_2O nitrous oxide		• Fertiliser inefficiency • Residue decomposition

Source: Sevenster M., Bell L., Anderson B., Jamali H., Horan H., Simmons A., Cowie A., Hochman Z. (2022) Australian Grains Baseline and Mitigation Assessment. Main Report. CSIRO, Australia

OVERVIEW

THINGS TO NOTE

Market consolidation has seen the selection of available and relevant carbon calculators for grain growers reduce over the past four years.

Two calculators, the Grains Greenhouse Gas Accounting Framework (G-GAF) and the Cool Farm Tool (CFT) have been evaluated in this report using identical winter 2022 cropping cycle data from two Australian grain growers.

The production data entered for each farm, including tonnage, was identical for each calculator. Therefore, any observed differences in absolute emissions and emission intensity values between the calculators can be solely attributed to variations in their methodologies and assumptions.

The G-GAF tool requires chemicals to be entered as individual active ingredients rather than total products. This level of granularity makes the data entry process more complex and time-consuming compared with CFT. Simplifying the chemical data requirements, such as through crop-location based presets, could expedite use of the G-GAF tool for growers.

Software packages, including Agworld, do not currently integrate into either of the calculators evaluated, meaning data already entered into an agronomic platform must be re-entered into any carbon calculator. Integration would see the data entry process simplified but relies on accurate data entry in a compatible format.

Poor quality or incomplete data will impact the accuracy of any GHG calculator integration attempts.

Australian National Greenhouse Gas Inventory (NGGI) alignment and regular reviews remain essential ingredients in keeping any carbon calculators relevant and up-to-date.

ABOUT THE COMPARISON

Objective

The objective of the evaluation is to compare the computed greenhouse gas emissions results for two Australian grain farming operations using two calculators that are freely available to growers at this time.

This project investigates variations in reported emissions, (both intensity and absolute given the same tonnage basis is entered into both calculators), data segregation and presentation between the available carbon calculators.

Data requirements, availability and ease of entry are also evaluated.

Output is reported in absolute emissions (whole of farm) and emission intensity. A breakdown of Scope 1, 2 and 3 emissions is also reported.

Emissions categories:

Scope 1 –
Direct emissions
(e.g. burning diesel in farm machinery)

Scope 2 –
Indirect emissions
(e.g. grid-sourced electricity use)

Scope 3 –
Indirect emissions other than Scope 2
(e.g. embedded emissions from the manufacture of urea, herbicides, fungicides and insecticides)

For more information, see the Jargon Buster at the front of this report.

Methodology

This report analyses two calculators:

- **The Grains-Greenhouse Gas Accounting Framework (G-GAF) V10.9**
- **The Cool Farm Tool (CFT) V2.10.0**

Why are there only two calculators?

In 2020, GrainGrowers commissioned and released *Carbon Calculators Compared*, marking the first independent evaluation of carbon calculators for Australian grain growers.

The 2020 report compared four different calculators that were publicly available at the time. A fifth "carbon calculator" was included, although this solely investigated land-use change opportunities.

Using identical datasets provided by two growers, the GHG emissions computed by each calculator was analysed and compared.

The 2020 comparison looked for both consistency and variation amongst four carbon calculators:

- **The Grains Greenhouse Gas Accounting Framework (G-GAF) V9.1**
- **The Cool Farm Tool (CFT)**
- **The FarmGAS calculator from the Australian Farm Institute (AFI)**
- **FarmPrint model via CSIRO.**

Since then, due to (now) restricted access and project delivery delays, the number of relevant carbon calculators publicly available to Australian grain growers has reduced to two:

- **The Grains-Greenhouse Gas Accounting Framework (G-GAF) V10.9**
- **The Cool Farm Tool (CFT) V2.10.0**

GrainGrowers plans to assess the recently released Agricultural Innovation Australia Environmental Accounting Platform (AIA EAP), which is an Application Programming Interface for the GAF suite, in future reports. At this time, GrainGrowers will also evaluate the expanded launch of the Cool Soil Initiative's Australian version of CFT as they become available.

Sources of farm input data

For this analysis, GrainGrowers approached the two growers who contributed data for the 2020 carbon calculators report. Data from the 2022 winter crop production year from each grower was run through the calculators.

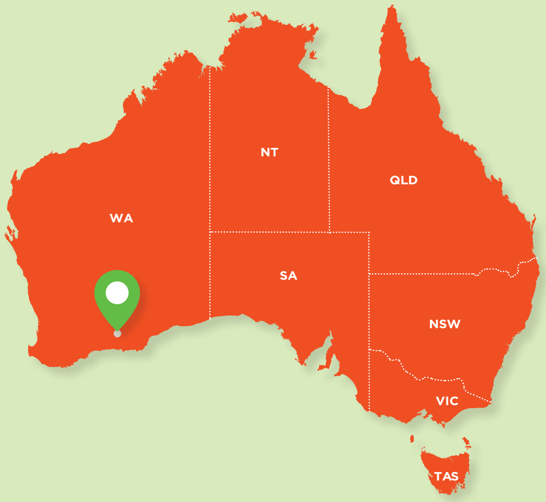
Farm 1: Blue Hills

Cropped area for evaluation: 2,900ha
Location: Edgeroi, NSW
Crops grown and included in calculations: Wheat (bread wheats and durum), chickpeas, canola, faba beans.
Data collection period: Winter 2022 crops including fallows prior.
Annual average rainfall: 658mm
Soil type: Grey clays to black earth

Blue Hills Crop	Number of paddocks/fields
Bread wheat	3
Durum wheat	4
Chickpeas	2
Canola	3
Faba beans	1

Farm 2: Sanderson Farms

Cropped area for evaluation: 5,900ha
Location: Grass Patch, WA
Crops grown and included in calculations: Wheat, barley, canola, and beans. (All crop data aggregated)
Data collection period: Winter 2022 crops including fallows prior.
Annual average rainfall: 338mm
Soil type: Heavy loams and duplex sand over clay



Note: data from Sanderson Farms has been aggregated by crop, not broken down by number of paddocks/fields per crop type.

Assumptions and standards adopted

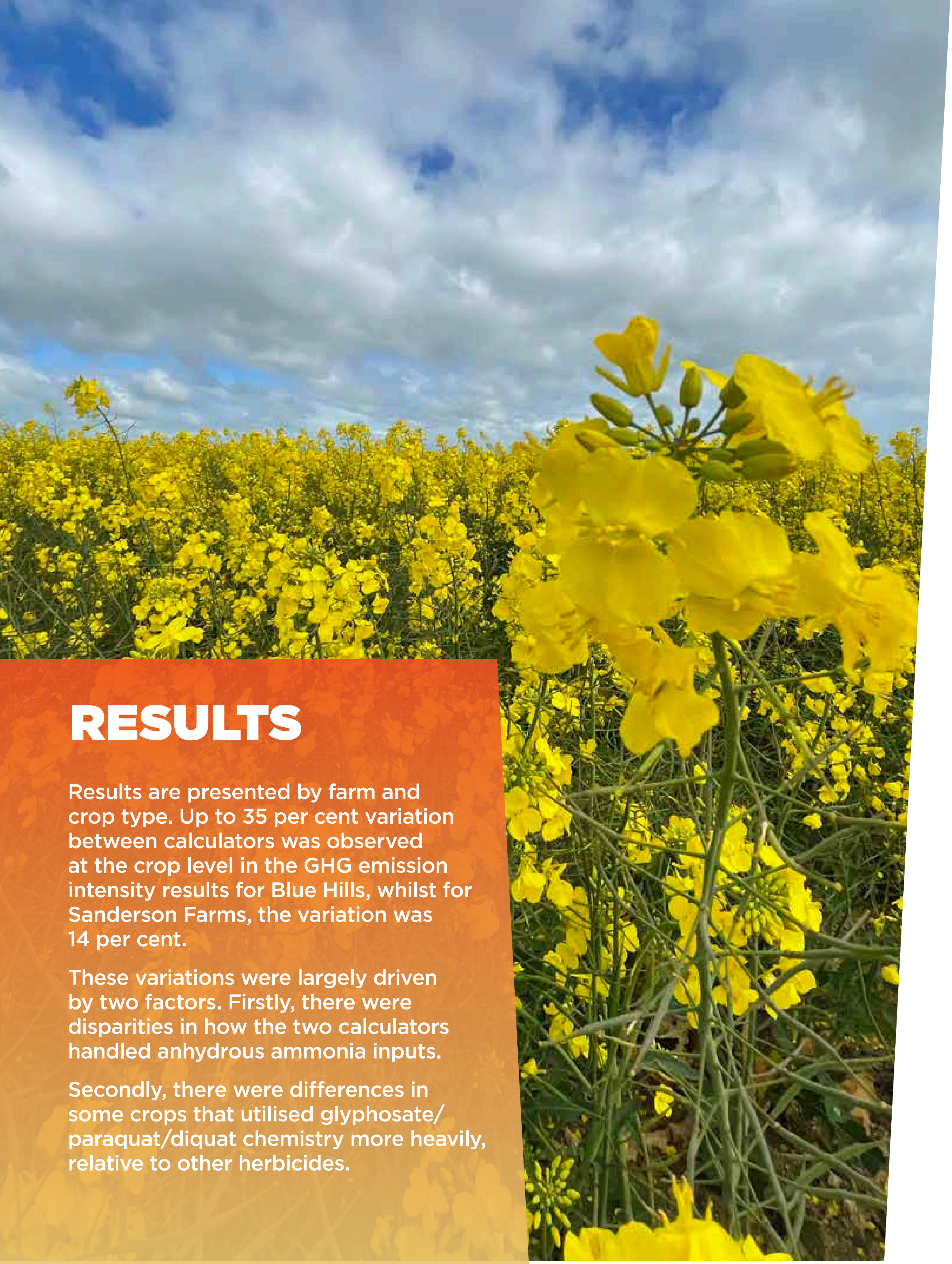
It is important to note that carbon calculators are continually improving. When using any GHG calculation tool, growers should check that they are using the most recent version.

For this analysis, the following versions were used:

- The Grains Greenhouse Gas Accounting Framework V10.9; (downloaded 1/12/23) (Referred to as G-GAF); and
- The Cool Farm Tool V2.10.0 (data entered 12/12/22-12/1/24) (Referred to as CFT).

Other assumptions included:

- Annual fuel use was apportioned by individual cropped paddock area as a fraction of the total cropped area.
- Annual grid power consumption was apportioned by individual cropped paddock area as a fraction of the total cropped area.
- Where power consumption was not known, but financials were available, grid power was nominally priced at 30c/kWh to derive energy consumption.
- In CFT, when fertilisers are applied at the time of seeding, they are considered to be “incorporated” into the soil.
- Fertilisers were all selected to be aligned with “Oceania 2014” emissions profiles in CFT. A sensitivity analysis indicated a variance of less than one per cent when selecting other origins.
- The “Pulses” dropdown was selected for chickpeas and faba beans in G-GAF.
- The “Other legume” selector was used for faba beans in CFT.
- (UAN) urea ammonium nitrate had a bulk density of 1.32 applied.
- Anhydrous ammonia (NH_3) was calculated as 82% nitrogen content.
- (DAP) diammonium phosphate $(NH_4)_2(HPO_4)$ was calculated at 18% nitrogen content.
- (MAP) monoammonium phosphate $(NH_4)(H_2PO_4)$ was calculated at 11% nitrogen content.
- (SOA) sulphate of ammonia $(NH_4)_2(SO_4)$ was calculated at 21% nitrogen content.
- Urea (H_2NCONH_2) was calculated at 46% nitrogen content.
- Mid-range label rate recommendations were applied for the designated crop where information was not available.
- Default soil selections from CFT were:
  - Sanderson Farms: sandy (coarse), SOM≤1.72, good drainage, pH 5.5-7.3.
  - Blue Hills: clay (fine), SOM≤1.72, good drainage, pH 5.5-7.3.
- Emissions from adjuvants were not included in spray applications.
- Fuel was nominated as mineral diesel in CFT.
- Sanderson Farms fuel use figures included fuel for the road freight of 1/3 of their grain transported off farm to Esperance as these could not be accurately broken down but were included in both calculators.



RESULTS

Results are presented by farm and crop type. Up to 35 per cent variation between calculators was observed at the crop level in the GHG emission intensity results for Blue Hills, whilst for Sanderson Farms, the variation was 14 per cent.

These variations were largely driven by two factors. Firstly, there were disparities in how the two calculators handled anhydrous ammonia inputs.

Secondly, there were differences in some crops that utilised glyphosate/paraquat/diquat chemistry more heavily, relative to other herbicides.

FARM 1: BLUE HILLS, NSW CALCULATOR OUTPUT COMPARISON

Blue Hills is located at Edgeroi, NSW. The crops grown at Blue Hills and examined in this study comprise wheat, chickpeas, canola, and faba beans.

GHG emission intensity per crop

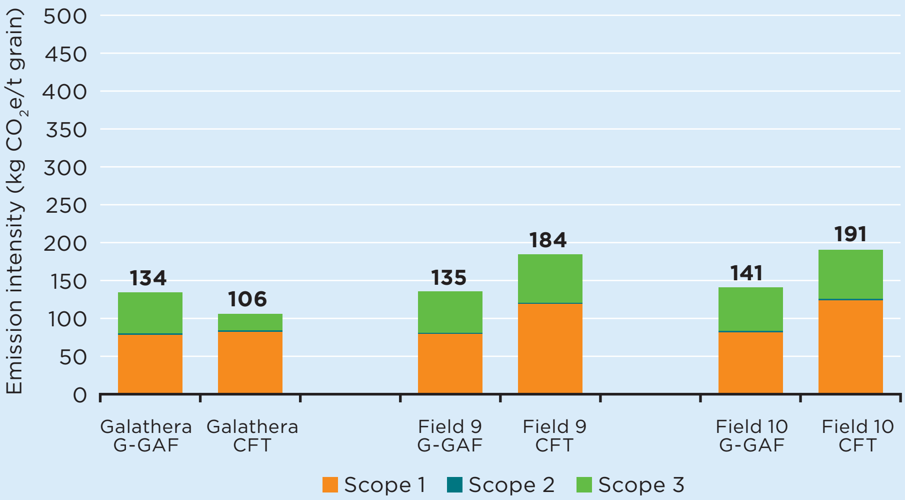
Bread wheat results

The Galathera field at Blue Hills saw a higher Scope 3 emissions footprint calculated by G-GAF due to higher relative proportions of glyphosate and paraquat used in this field in the fallow season when compared to Field 9 and 10.

Glyphosate, paraquat and diquats draws a significant GHG emissions factor loading in G-GAF calculations over CFT. This variation between the calculators is shown below (**Figure 6**).

Differences in the Scope 1 calculations in Field 9 and 10 are due to these crops having anhydrous ammonia applications prior to seeding. G-GAF and CFT treat anhydrous ammonia differently. G-GAF calculated Scope 1 emissions was 65% of the value of CFT Scope 1 emissions for Field 9 and Field 10. Each had an input of 120kg/ha of anhydrous ammonia.

Figure 6: Blue Hills 2022 bread wheat GHG emission intensity G-GAF vs CFT



Durum wheat results

Scope 1 emission intensity for durum wheat production was consistently calculated higher with the CFT calculator when compared to G-GAF.

On average for durum wheat, Scope 1 emissions calculated using CFT were 31 per cent higher than those calculated by G-GAF. Scope 3 emission intensity varied between 10 and 32 per cent higher with CFT.

All durum wheat fields had anhydrous ammonia applied between 121kg/ha and 140kg/ha.

Anhydrous ammonia is handled differently by G-GAF and CFT and may explain the variation in Scope 1 results between the two calculators (**Figure 7**).

Chickpea results

For chickpea crops, relatively higher rates of glyphosate and paraquat used for pre-seeding knockdown and desiccation saw G-GAF reporting 60 and 52 per cent higher Scope 3 emissions than CFT for Paddocks 3 and 4/5W respectively. As observed in the bread wheat crops, glyphosate and paraquat draw a significantly higher GHG loading in G-GAF compared with CFT. (**Figure 8**).

Figure 7: Blue Hills 2022 durum wheat GHG emission intensity G-GAF vs CFT

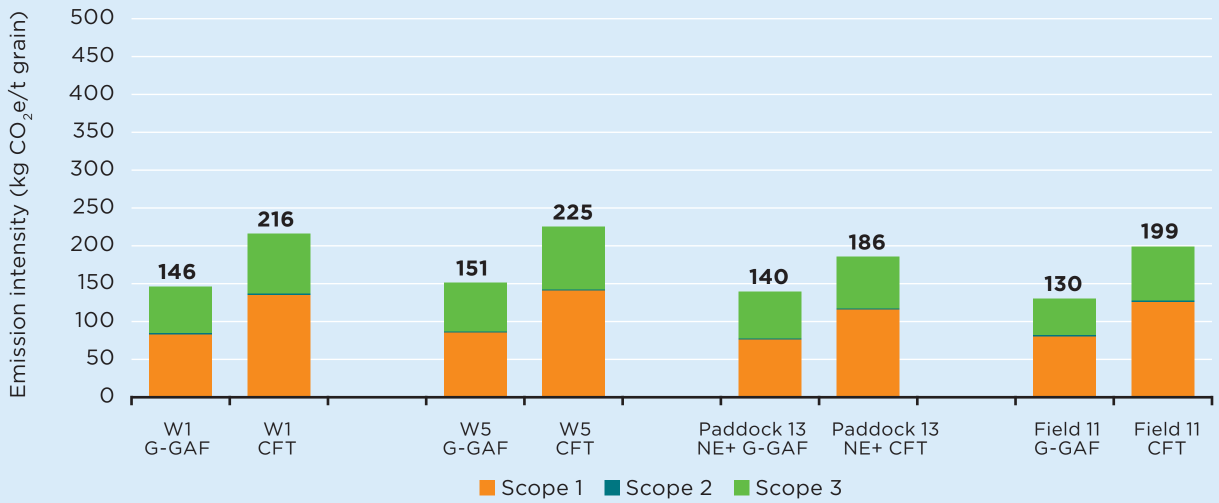
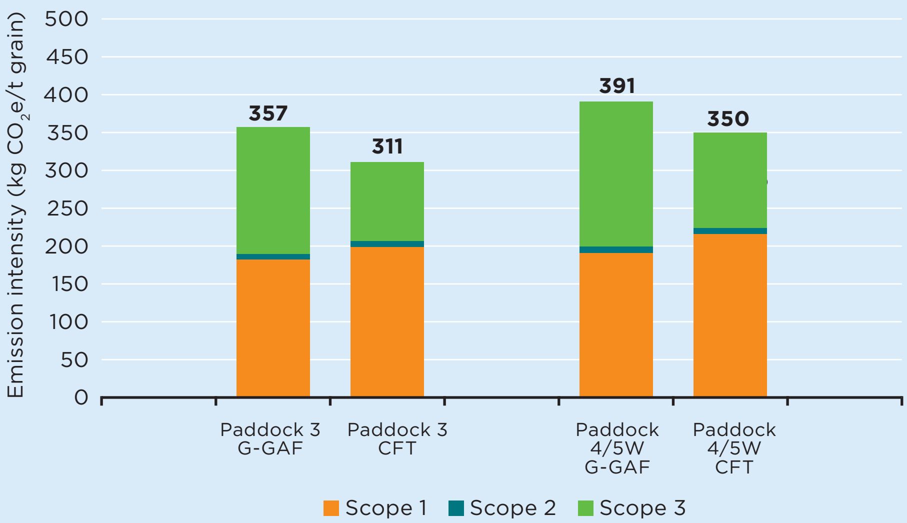


Figure 8: Blue Hills 2022 chickpea GHG emission intensity G-GAF vs CFT



Canola results

Variations in the canola results are largely driven by herbicide inputs. Paddock 4/5E saw the largest variation in Scope 3 emissions, with G-GAF reporting Scope 3 emissions more than double that of CFT. Of note, Paddock 4/5E had 50 per cent more glyphosate applied (on a per tonne of grain produced basis) than Field 7 or the 700ac paddock. The emission factor in G-GAF for glyphosate contributed to the large difference in Scope 3 GHGs for Paddock 4/5E. Paddock 4/5E was the only field that did not have anhydrous ammonia applied, instead receiving a top up with 100kg of urea (**Figure 9**).

Faba bean results

With low input requirements due to a double crop and no fallow cost, faba beans have a low emission intensity relative to other grains. Variations noted between results are largely due to pre-planting fallow and knockdown herbicide applications. Although the applications were entered into the calculators identically, these applications include glyphosate which, as observed in other crops, draws a significant GHG emissions factor loading in G-GAF calculations compared with CFT (**Figure 10**).

Figure 9: Blue Hills 2022 canola GHG emission intensity G-GAF vs CFT

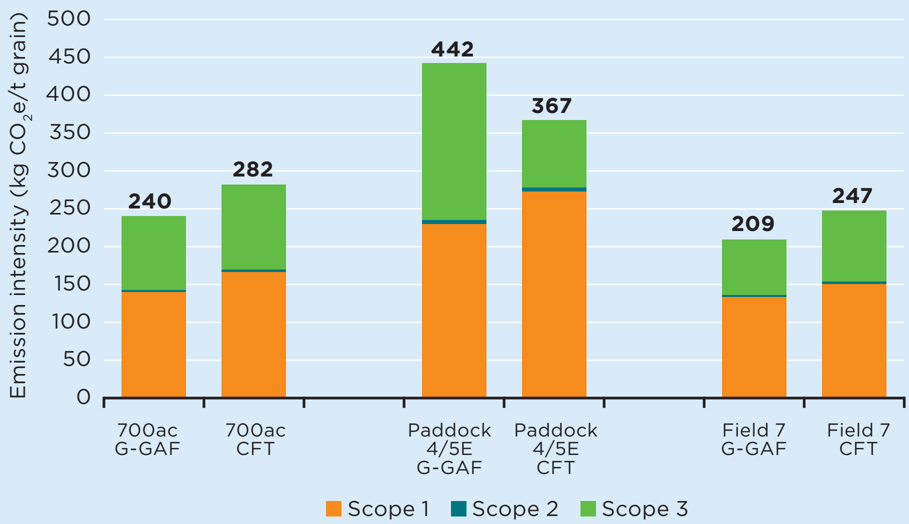
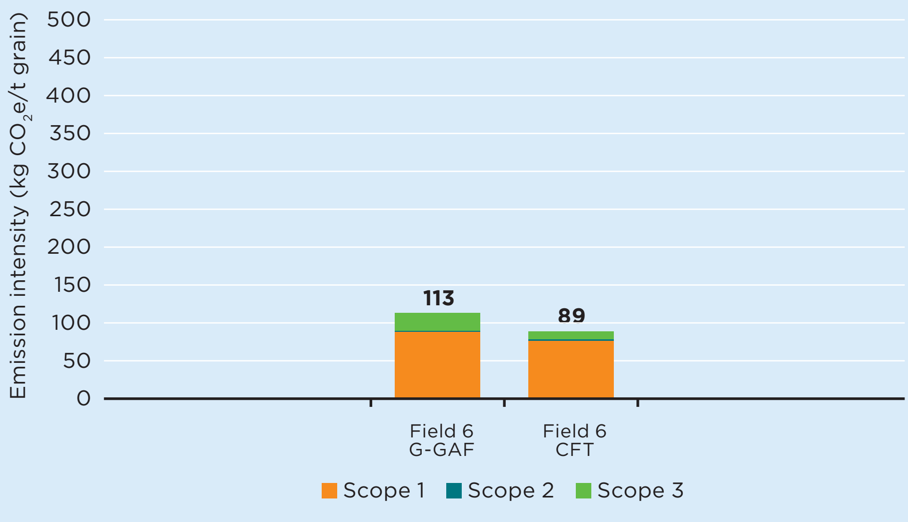


Figure 10: Blue Hills 2022 faba beans GHG emission intensity G-GAF vs CFT



Average emission intensity

Figures 11 and 12 illustrate the average emission intensity for all winter crops grown at Blue Hills in 2022 as determined by G-GAF and CFT.

Scope 3 emissions have been further broken down in each chart to identify the fraction of Scope 3 emissions attributable to active ingredients (AI) in glyphosate, paraquat and diquat due to the high emission factors given to these in G-GAF.

These average emission intensity pie charts are not to be confused with the data in **Table 1**, which states the total cumulative tonnes of Scope 1, 2 and 3 emissions calculated by G-GAF and CFT.

Figure 11: Blue Hills average GHG emission intensity breakdown for G-GAF (*active ingredients)

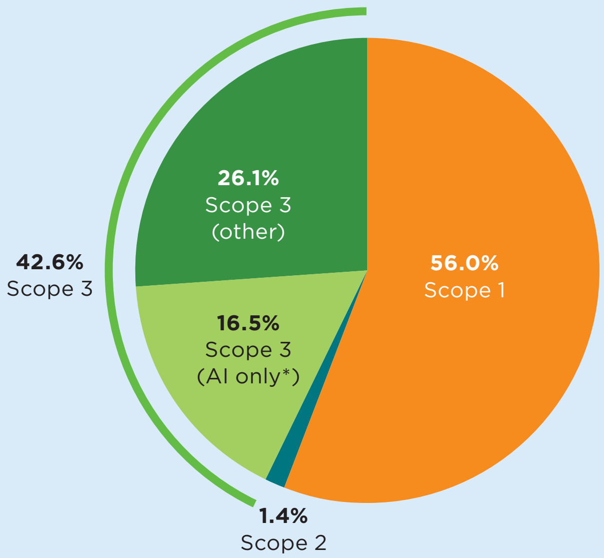
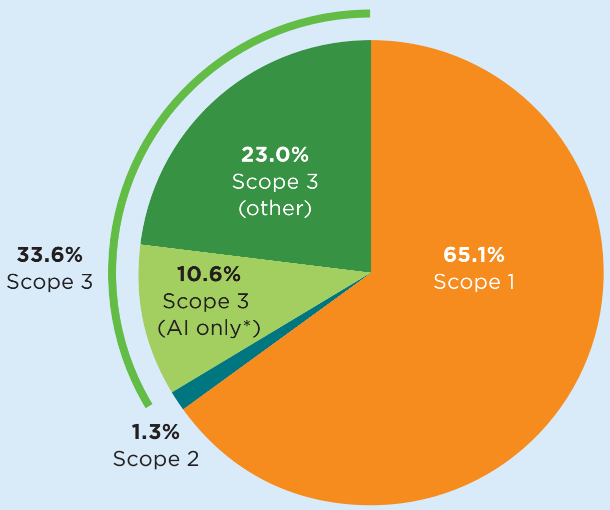


Figure 12: Blue Hills average GHG emission intensity breakdown for CFT (*active ingredients)



Absolute emissions

Whole-of-farm (absolute) emission results varied between calculators for Blue Hills, with CFT producing results that were 20 per cent greater than G-GAF (**Table 1**). Most of this variation was due to how each calculator accounts for anhydrous ammonia in Scope 1 emissions.

The CFT emission intensity results for individual Blue Hills fields varied widely – up to 35 per cent higher and 27 per cent lower than the G-GAF result.

The main reasons for the differences in field-level emission estimates between CFT and G-GAF is related to Scope 3 emissions from certain herbicides; and Scope 1 emissions from anhydrous ammonia application.

Glyphosate, paraquat and diquat produced higher Scope 3 emissions in G-GAF than in CFT. G-GAF treated these chemicals differently from other herbicides by assigning them greater emission factors and requiring chemicals to be entered as individual active ingredients rather than total products. This resulted in G-GAF calculating higher overall GHG emissions for fields where these herbicides were used.

Emissions from anhydrous ammonia inputs were also calculated differently, thereby impacting Scope 1 results. In this case, however, CFT calculated emissions to be higher than G-GAF as it uses a higher emissions factor.

The higher emission factors used in G-GAF for glyphosate, paraquat and diquat 'offset' some of the lower emission factors applied to anhydrous ammonia in G-GAF. When looking at the absolute emissions, the G-GAF and CFT results are closer to parity.

Table 1: Absolute emissions for Blue Hills: G-GAF vs CFT

Carbon calculator	Unit	Scope 1	Scope 2	Scope 3	Total
G-GAF	tCO_2e	1,080	22	692	**1,794**
	% of total	60.2	1.2	38.6	**100**
CFT	tCO_2e	1,446	20	759	**2,225**
	% of total	65.0	0.9	34.1	**100**

FARM 2: SANDERSON FARMS CALCULATOR OUTPUT COMPARISON

Sanderson Farms is located at Grass Patch, WA. The crops grown at Sanderson Farms and examined in this study comprise wheat, barley, canola, and beans.

Looking at all crops grown at Sanderson Farms, CFT reported a higher Scope 1 GHG emission intensity compared with G-GAF. The differences were more pronounced for higher nitrogen input crops (for example, canola), which can be explained due to the higher emissions factor applied by CFT for anhydrous ammonia (**Figure 13**).

CFT-calculated Scope 3 emission intensity was consistently lower than G-GAF-calculated figures which was reflected in the average emission intensity for all crops in the set (**Figures 14 and 15**). This can be explained due to the higher emission factors applied by G-GAF to glyphosate, paraquat and diquat compared with CFT.

These average emission intensity pie charts are not to be confused with the data in **Table 2**, which states the total cumulative tonnes of Scope 1, 2 and 3 emissions calculated by G-GAF and CFT.

The average emission intensity pie charts illustrate the average emissions per tonne of production across all crops shown in **Figure 13**. See Jargon Buster on page 12 for more detailed descriptions of emission intensity and absolute emissions.

Figure 13: Sanderson Farms 2022 GHG emission intensity field comparison G-GAF vs CFT

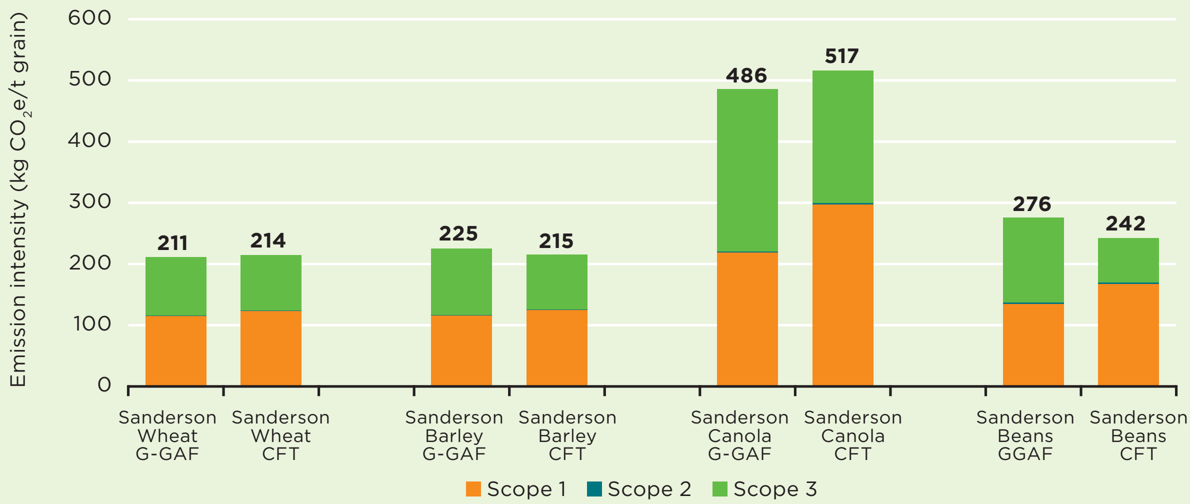


Figure 14: Sanderson Farms average GHG emission intensity breakdown (G-GAF) (*active ingredients)

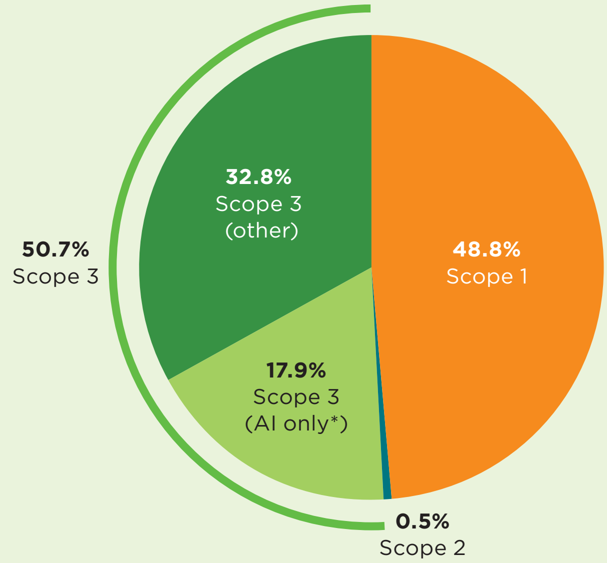
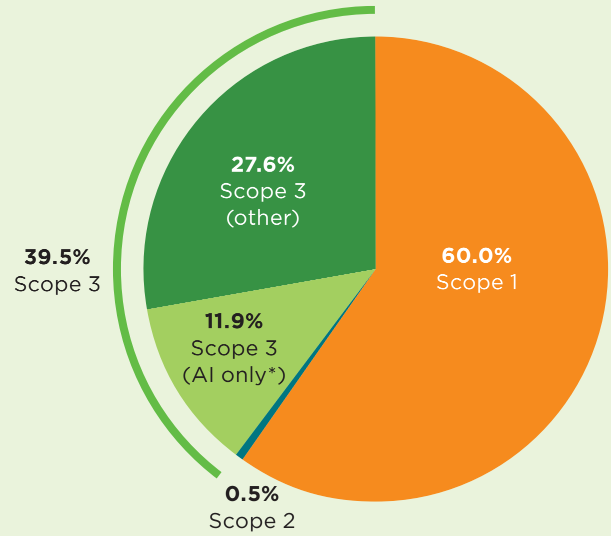


Figure 15: Sanderson Farms average GHG emission intensity breakdown (CFT) (*active ingredients)



Due to the differences in Scope 3 emission calculations, the Sanderson Farms CFT results indicate 41.5 per cent of GHGs from the aggregated enterprise were from Scope 3 sources, while G-GAF indicated 47.6 per cent of GHGs were from Scope 3 sources (**Table 2**).

Table 2: Absolute emissions for Sanderson Farms: G-GAF vs CFT

Carbon calculator	Unit	Scope 1	Scope 2	Scope 3	Total
G-GAF		2,025	15	1,850	**3,890**
	% of total	52	0.4	47.6	**100**
CFT	tCO_2e	2,273	14	1,621	**3,908**
	% of total	58.1	0.4	41.5	**100**

COMMENTARY: GRAINS GREENHOUSE GAS ACCOUNTING FRAMEWORK V10.9

Overview

The Grains Greenhouse Gas Accounting Framework (G-GAF) V10.9 is free to download and is one of a suite of calculators Primary Industries Climate Change Centre (PICCC) has developed for Australian agricultural enterprises. Other calculators include those for sheep and beef (SB-GAF) and cotton (C-GAF).

Developed through the University of Melbourne via the PICCC, the model breaks down emissions by type in an easy-to-understand Microsoft Excel layout which can be downloaded directly from the PICCC website.

As an Australian-built and maintained calculator, inputs are tailored to Australian grain production systems.

An important aspect of the G-GAF calculator is that it utilises the Australian National Greenhouse Gas Inventory (NGGI) methods to determine GHG emissions from farms.

The open nature of the G-GAF tool allows the user to explore the back end of the system to better understand the methodology and mechanics behind the reported data. Importantly, the back-end calculation tabs contain references to the data sources, calculations, assumptions as well as scientific papers and links to information used for calculations.

The launch of the Agriculture Innovation Australia Environmental Accounting Platform integrates the G-GAF tool along with other GAF tools behind a new data-entry API skin, allowing for multiple commodities to be entered at once.

Ease of use

Cropping data is entered via one spreadsheet tab while there is a second tab for vegetation (trees).

Information gathered on the vegetation tab is used to calculate offsets, which can be apportioned to reduce the overall carbon footprint for a specified crop. The data is very simple to enter although some units of measure are slightly ambiguous. For example, entries of active ingredient are denoted as “kg AI per farm” but in these cells, it is the total mass of active ingredients for the specific crop or paddock field that is required.

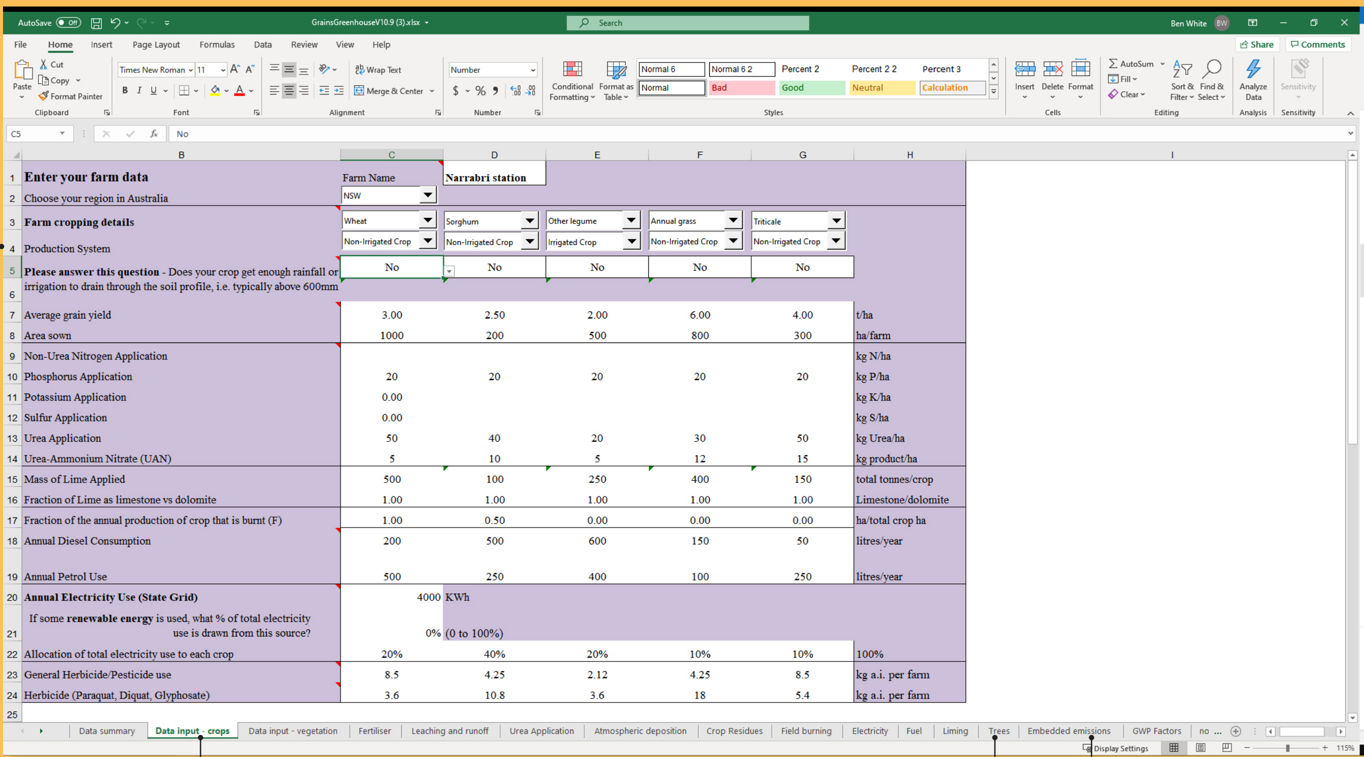
Other information required by G-GAF is relatively basic including yield, cropped area, nitrogen fertiliser used per hectare and energy use in the form of diesel and grid power use. G-GAF does not specifically evaluate or include off-farm transport of goods.

From the perspective of Australian broadacre grain production, crop categories remain relatively broad. For example, chickpeas and canola are designated into broad categorisations for “pulses” and “oilseeds” respectively.

Only five crop types can be entered, meaning that for one of the dataset evaluations, multiple sheets had to be used with cross-Excel-workbook references for whole of farm inputs including fuel and grid-power use.

A notes tab in the Excel sheet details changes with each release iteration and updates made to specific cells are noted since 8 April, 2022.

G-GAF V10.9 features



	B	C	D	E	F	G	H
1	**Enter your farm data**	Farm Name	**Narrabri station**				
2	Choose your region in Australia	NSW					
3	**Farm cropping details**	Wheat	Sorghum	Other legume	Annual grass	Triticale	
4	Production System	Non-Irrigated Crop	Non-Irrigated Crop	Irrigated Crop	Non-Irrigated Crop	Non-Irrigated Crop	
5	**Please answer this question** - Does your crop get enough rainfall or irrigation to drain through the soil profile, i.e. typically above 600mm	No	No	No	No	No	
6							
7	Average grain yield	3.00	2.50	2.00	6.00	4.00	t/ha
8	Area sown	1000	200	500	800	300	ha/farm
9	Non-Urea Nitrogen Application						kg N/ha
10	Phosphorus Application	20	20	20	20	20	kg P/ha
11	Potassium Application	0.00					kg K/ha
12	Sulfur Application	0.00					kg S/ha
13	Urea Application	50	40	20	30	50	kg Urea/ha
14	Urea-Ammonium Nitrate (UAN)	5	10	5	12	15	kg product/ha
15	Mass of Lime Applied	500	100	250	400	150	total tonnes/crop
16	Fraction of Lime as limestone vs dolomite	1.00	1.00	1.00	1.00	1.00	Limestone/dolomite
17	Fraction of the annual production of crop that is burnt (F)	1.00	0.50	0.00	0.00	0.00	ha/total crop ha
18	Annual Diesel Consumption	200	500	600	150	50	litres/year
19	Annual Petrol Use	500	250	400	100	250	litres/year
20	**Annual Electricity Use (State Grid)**	4000	KWh				
21	If some **renewable energy** is used, what % of total electricity use is drawn from this source?	0%	(0 to 100%)				
22	Allocation of total electricity use to each crop	20%	40%	20%	10%	10%	100%
23	General Herbicide/Pesticide use	8.5	4.25	2.12	4.25	8.5	kg a.i. per farm
24	Herbicide (Paraquat, Diquat, Glyphosate)	3.6	10.8	3.6	18	5.4	kg a.i. per farm
25							

As an Australian-built and maintained calculator, inputs are tailored to Australian grain production systems.

Cropping data is entered via one spreadsheet tab while there is a second tab for vegetation (trees).

Tabs expose the workings of the calculator so emission factors and information sources can be seen.

Leaching potential

Users are asked to determine the ratio of evapotranspiration (Et) over precipitation (P). Both of these figures are easily obtained from the Bureau of Meteorology (BOM) website for a given location or can be calculated if the figures are known.

Active ingredients

Herbicide inputs are broken down into active ingredients (AI). Users need to separate glyphosate, paraquat and diquat active ingredients as these carry a higher GHG loading than other herbicides. The loading for glyphosate, paraquat and diquat is calculated at around 1.8 times that of other herbicides with references to research indicating higher energy intensity in production.

It is important to allocate the active ingredients accurately as the Scope 3 emissions tied up in herbicides can be a significant source of GHGs.

To illustrate this point, Scope 3 emissions from active ingredients were not included in the version of G-GAF as evaluated in 2020. However, with their inclusion in the latest version, active ingredients alone are responsible for 16.5 per cent and 17.9 per cent of aggregated field emissions for Blue Hills and Sanderson Farms, respectively (**Figures 11** and **14**).

Lower-yielding and susceptible crops grown in wet seasons require higher inputs of herbicides and fungicides. This can lead to GHG emission intensities from active ingredients being as high as 37% for some crops across the two farms analysed in this report. Accurately recording which chemicals were used is especially important for the G-GAF tool to correctly estimate emissions, given how certain crops and weather conditions influence chemical input needs.

Fertiliser inputs

Fertiliser application inputs for the G-GAF calculator are simplified with easily available nitrogen, phosphorus, potassium and sulphur fractions entered in kg/ha.

Nitrogen inputs need to be identified as urea-based or non-urea nitrogen applications. This may require some background research and maths to obtain specific fractions for complex compound formulations. The label and the material safety data sheet are both useful information resources when doing these calculations.

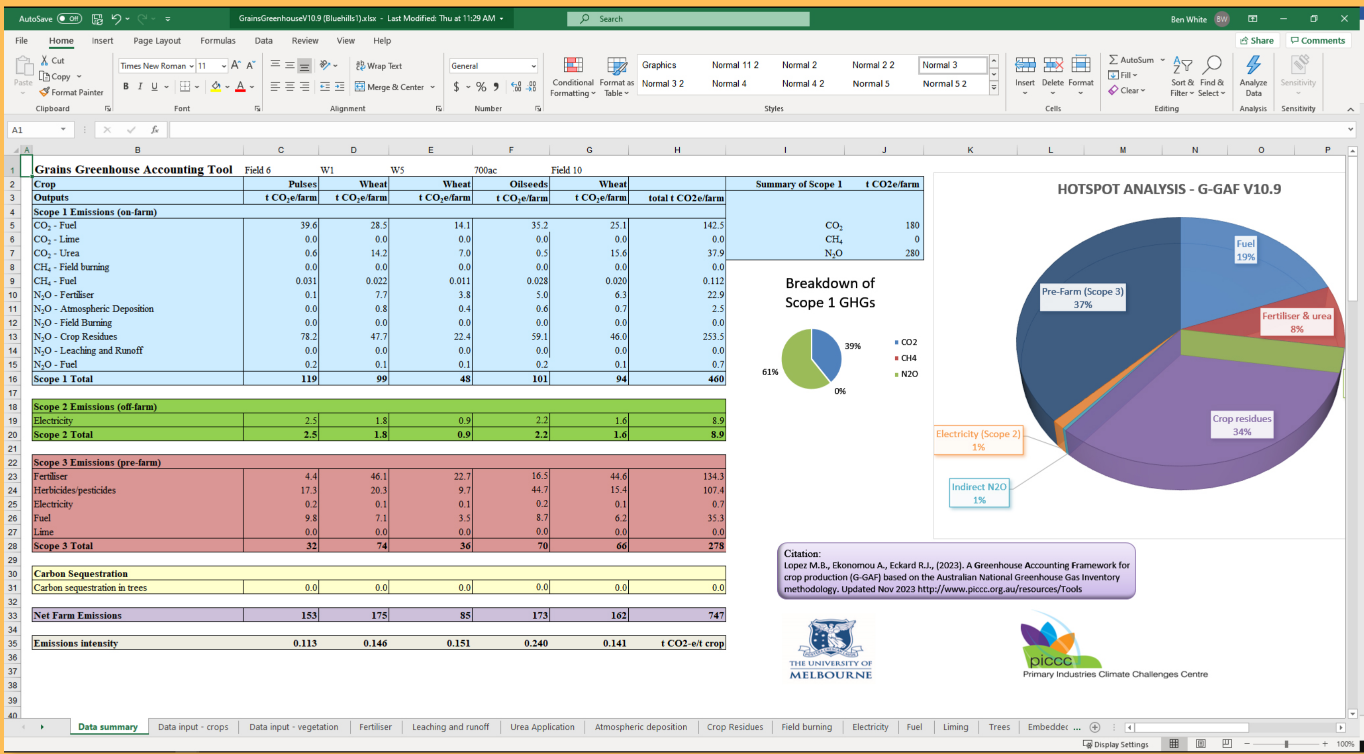
For reference, a useful fertiliser breakdown sheet serves as an appendix to the calculator and is also downloadable from Primary Industries Climate Change Centre (PICCC). FertCalc is also Excel-based and has numerous compounds and blends listed by trade in addition to staples like anhydrous ammonia, urea and urea-ammonium nitrate. Some conversion factors are also listed.

For liquid fertiliser inputs like urea-ammonium nitrate, growers need to convert the volumetric application rate (normally expressed as litres per hectare) to a kilogram per hectare rate before entering it into the calculator.

Outputs

The results tab displays the numerical breakdown of emissions for each of the crops entered. It also displays an aggregated graphic breaking the carbon footprint into field-generated (Scope 1) emissions, emissions specifically from fertiliser and urea, crop residue emissions, grid electricity (Scope 2) and pre-farm (Scope 3) emissions.

G-GAF results tab example



Grains Greenhouse Accounting Tool	Field 6	W1	W5	700ac	Field 10	
Crop	**Pulses**	**Wheat**	**Wheat**	**Oilseeds**	**Wheat**	
Outputs	**t CO_2e/farm**	**t CO_2e/farm**	**t CO_2e/farm**	**t CO_2e/farm**	**t CO_2e/farm**	**total t CO2e/farm**
Scope 1 Emissions (on-farm)						
CO_2 - Fuel	39.6	28.5	14.1	35.2	25.1	142.5
CO_2 - Lime	0.0	0.0	0.0	0.0	0.0	0.0
CO_2 - Urea	0.6	14.2	7.0	0.5	15.6	37.9
CH_4 - Field burning	0.0	0.0	0.0	0.0	0.0	0.0
CH_4 - Fuel	0.031	0.022	0.011	0.028	0.020	0.112
N_2O - Fertiliser	0.1	7.7	3.8	5.0	6.3	22.9
N_2O - Atmospheric Deposition	0.0	0.8	0.4	0.6	0.7	2.5
N_2O - Field Burning	0.0	0.0	0.0	0.0	0.0	0.0
N_2O - Crop Residues	78.2	47.7	22.4	59.1	46.0	253.5
N_2O - Leaching and Runoff	0.0	0.0	0.0	0.0	0.0	0.0
N_2O - Fuel	0.2	0.1	0.1	0.2	0.1	0.7
Scope 1 Total	**119**	**99**	**48**	**101**	**94**	**460**
Scope 2 Emissions (off-farm)						
Electricity	2.5	1.8	0.9	2.2	1.6	8.9
Scope 2 Total	**2.5**	**1.8**	**0.9**	**2.2**	**1.6**	**8.9**
Scope 3 Emissions (pre-farm)						
Fertiliser	4.4	46.1	22.7	16.5	44.6	134.3
Herbicides/pesticides	17.3	20.3	9.7	44.7	15.4	107.4
Electricity	0.2	0.1	0.1	0.2	0.1	0.7
Fuel	9.8	7.1	3.5	8.7	6.2	35.3
Lime	0.0	0.0	0.0	0.0	0.0	0.0
Scope 3 Total	**32**	**74**	**36**	**70**	**66**	**278**
Carbon Sequestration						
Carbon sequestration in trees	0.0	0.0	0.0	0.0	0.0	0.0
Net Farm Emissions	**153**	**175**	**85**	**173**	**162**	**747**
Emissions intensity	**0.113**	**0.146**	**0.151**	**0.240**	**0.141**	**t CO2-e/t crop**

Summary of Scope 1	t CO2e/farm
CO_2	180
CH_4	0
N_2O	280

Citation:
Lopez M.B., Ekonomou A., Eckard R.J., (2023). A Greenhouse Accounting Framework for crop production (G-GAF) based on the Australian National Greenhouse Gas Inventory methodology. Updated Nov 2023 http://www.piccc.org.au/resources/Tools

COMMENTARY: COOL FARM TOOL V2.10.0

Overview

The Cool Farm Institute was founded in 2012 by Unilever, the University of Aberdeen, and the Sustainable Food Lab. It was established to estimate GHG emissions from agriculture at the farm level. To accomplish this goal, the Cool Farm Institute developed the Cool Farm Tool (CFT). CFT enables calculation of GHG emissions from individual farms.

The tool aims to be a collaborative development via members including farmer organisations, agribusinesses, food & beverage companies, retailers, consultancies, and NGOs from around the world.

The online and freely available CFT can be used for up to five field entries for an account. This report evaluates CFT version V2.10.0, which is freely available to growers across Australia and the world. There is a version being developed by the Cool Soil Initiative (CSI) specifically for Australian farms, however this is not yet publicly available. See page 38 for more information about this, and the CSI.

CFT also has a release notes page on their website explaining the changes implemented between versions of the calculator.

Ease of use

Entering data into the CFT is relatively simple once production and input information is assembled in the required units of measure.

Data is entered for a specific crop across a series of tabs with pre-filled data in some fields pending initial data entry or drop-down selection. Examples of pre-filled data include residue amounts, soil carbon and inputs including common compounds, anhydrous ammonia, urea, urea-ammonium nitrate and limestone, each with a range of selectable manufacturing locations. Nitrogen fractions of inputs need to be entered as ammonium-N, nitrate-N and urea-N for custom blend fertilisers. The need to fill all boxes of the nitrogen fraction, even when it is zero, could be a minor frustration.

Users of CFT should be aware that entering the application date for fertiliser can have a large bearing on the calculated carbon footprint and while optional, this field should not be left blank.

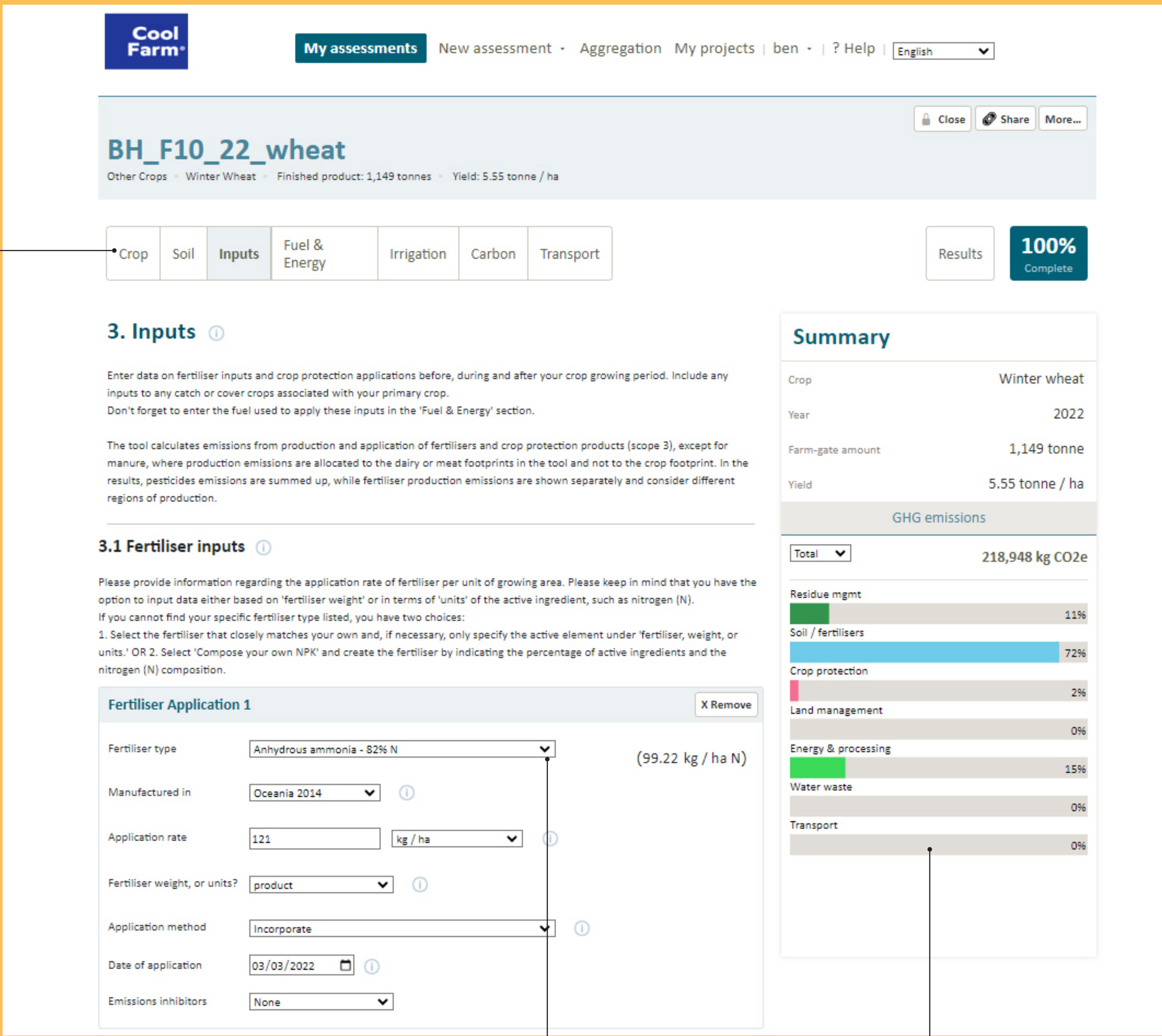
Many of the options have a drop-down list selection, which can make selection simple and guide the user as to the information being sought.

Lime inputs

A peculiar issue around limestone inputs persists with the latest version of CFT, which provides a significantly higher carbon footprint for lime entered in kg/ha versus the identical weight being entered in t/ha. GrainGrowers opted to enter limestone inputs in t/ha. According to the CSI team, the Australian API version of CFT has corrected this as part of the locally specific tuning of CFT.

The inputs tab asks users to specify if chemical applications were post-emergent, seed treatments, or soil treatments. This information is mainly used to account for emissions from chemical production. Typically, these production emissions make only a small contribution to the overall GHG emissions calculated for the farm.

Cool Farm Tool V2.10.0 features



Tabs allow easy entry of data for the crop.

Dropdowns for some inputs are pre-calculated making data entry easier.

Emissions tally updates as data is entered in absolute or intensity terms.

Fuel and energy inputs

Fuel and energy inputs including grid power can be entered and apportioned as a fraction by the user as required, based on total usage by area cropped. Alternatively, a field operations energy use estimator will approximate emissions for a wide range of field operations and tally the diesel used for each, although this is likely to be a more time-consuming process.

An optional transport tab can also be used to capture emissions generated when transporting inputs to the farm and/or grain from the farm. This can be applied where farm diesel receipts do not cover transport of goods in and out of the farm, which may for example, be conducted by a contractor. As a guide, selection of a Heavy Goods Vehicle via CFT which is carrying 100t (of an input such as fertiliser), 100km will result in 1175kg of emissions.

Carbon changes and vegetation inputs

The carbon changes and sequestration tabs track additions of non-crop biomass like tree plantings. Specific Australian tree species are not listed. Instead, any land converted from cultivation to native forest is broadly categorised as “temperate oceanic forest”.

On-farm practice inputs

In the crop carbon changes input tab, the user is asked: “Has any part of the field management practice changed between tillage, land use or inputs in the last 20 years?” Responses can involve land-use changes, tillage changes and carbon inputs, however the definition of terms including “reduced till” are not clearly defined.

Users should note that data entered in this input tab can have a significant impact on the calculated GHG outcome. As an example, a change from “reduced till” to “zero tillage” delivers a benefit of around 160kg/ha of sequestered carbon every year up until the 20th year since the practice was changed, but in the 21st year, there is no benefit. GrainGrowers opted to leave this tab blank for the purposes of calculator comparison.

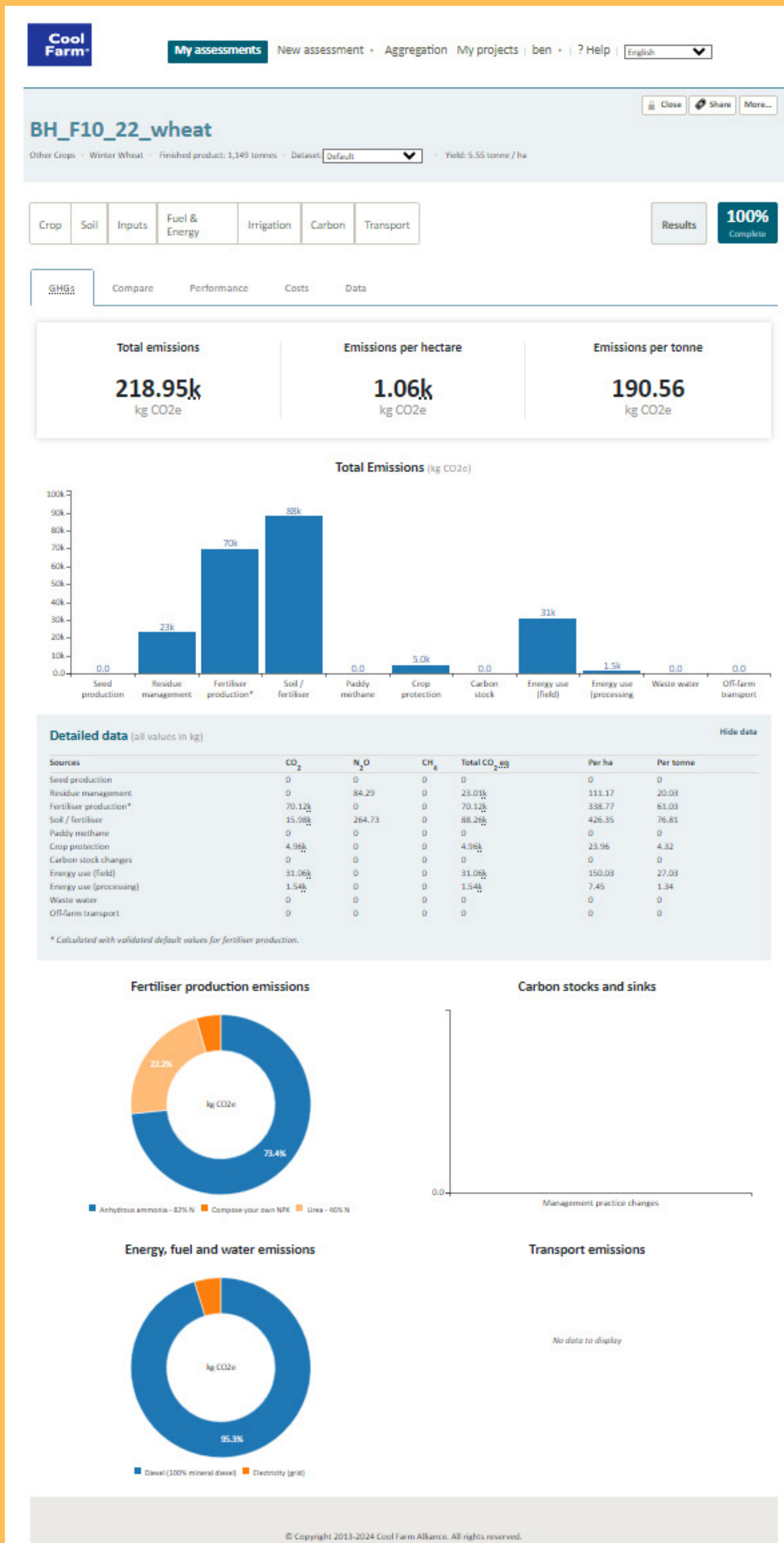
Output

A live GHG tally floats to the right-hand side of the data entry panels, updating the carbon footprint in real time while data is entered and will display both whole-of-farm absolute emissions and emission intensity.

A results tab displays a graphical breakdown of the GHG contributed through data in each of the input tabs as entered.

A table of data provides a numerical breakdown of each GHG source but is difficult to extract as not all figures are expressed in pure numbers.

CFT results tab example



COOL SOIL INITIATIVE

The Cool Soil Initiative (CSI), hosted by Charles Sturt University, is a not-for-profit, precompetitive collaboration program aiming to provide value to both farmers and industry through standardised GHG quantification, reporting and reduction strategies.

CSI delivers streamlined reporting aligned with both domestic and international requirements. It also considers regional growing conditions unique to Australian agriculture.

In 2023, an Application Programming Interface (API) version of the Cool Farm Tool (CFT) specifically for Australian farms was commissioned by the CSI, tailored to model emissions based on Australian climatic conditions and with alignment to Australia's National Greenhouse Gas Inventory (NGGI).

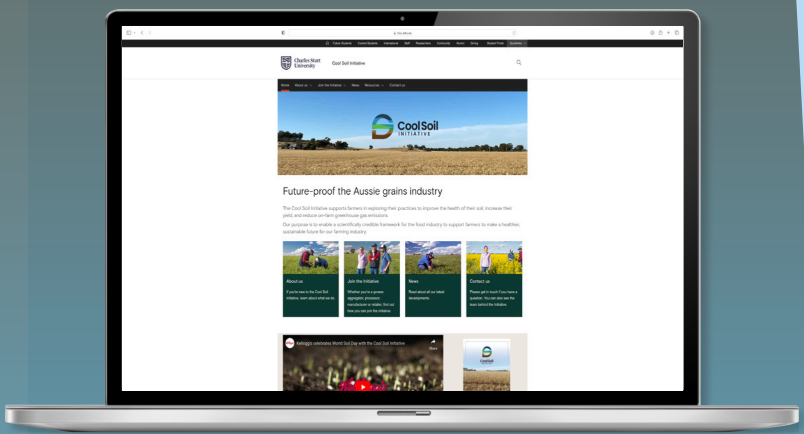
The Australian API version is, at the time of writing, only available to participants in the CSI, which currently includes members of four grower groups in New South Wales and Victoria (Central West Farming Systems, FarmLink, Irrigation Research Extension Committee and Riverine Plains), and a small group of farmers in northern New South Wales/Southern Queensland. There are plans for expansion into Western Australian oat growing regions in 2024 and then eventually into other growing regions and other sectors.

Participating farmers are provided with a detailed report of their emissions in the context of anonymised benchmarked peer data, and participation is free. Data integrity is essential and data entry is vetted to ensure quality and veracity. Farmers are also supported in innovation trials to further explore opportunities to improve soil health and sustainable production.

According to the CSI team, the Australian version utilises the CFT engine, albeit with differing emission factors for critical components of the calculator. These variations are built into the backend to accommodate Australian cropping conditions. Comparing the Australian version with CFT reportedly shows a smaller carbon footprint calculated due to better understanding of leaching potentials, better accounting for crop residue and nitrogen input emissions sources.

The service is funded by large corporate businesses including Mars, Kellanova, PepsiCo, Manildra Group, Allied Pinnacle and Corson, who need to adhere to their environmental commitments with knowledge of carbon footprints and farming practices of grain they buy. Data reported to corporate partners is aggregated at a regional supply-shed level to maintain the integrity and anonymity of an individual farmer's data.

As the Australian version of CFT progresses and is made publicly available, GrainGrowers will conduct an assessment of its suitability for Australian grain growers.



Growers wanting to participate can scan the QR code.

FINAL OBSERVATIONS

CARBON CALCULATORS COMPARED

For carbon footprint assessments, Australian grain growers have two accessible calculators at present, which have been analysed in this report: the Grains Greenhouse Gas Accounting Framework (G-GAF) and the Cool Farm Tool (CFT).

Other current published options include skins or APIs that utilise these two calculators as the calculator engine such as the Agriculture Innovation Australia Environmental Accounting Platform.

At the time of printing, both tools evaluated in this report can be used through online portals (CFT) or downloaded as an Excel spreadsheet and populated offline (G-GAF).

Key differences

Data entry requirements for the two calculators showed many similarities, with some variations specific to capturing Australian soil and climatic conditions. For example, the G-GAF tool required annual rainfall and evapotranspiration inputs while CFT requested soil carbon, pH and type, though defaults were provided.

Important to note is that CFT V2.10.0 does not utilise Australian National Greenhouse Gas Inventory emission factors in its calculations, where G-GAF does. As mentioned, a variation of the CFT tuned for Australian conditions is available for participants of the Cool Soils Initiative, however this version was not evaluated in this report as it is not yet publicly available (see page 38 for more information).

Additionally, CFT incorporated transportation of goods to and from the farm, an aspect not included in G-GAF. In terms of vegetation offsets, G-GAF allowed for specific Australian tree species while CFT utilised a broader 'temperate oceanic forest' category.

Although the calculators demonstrated some alignment on a total carbon footprint basis, analysis of the Scope 1 and Scope 3 figures revealed variation between the calculators, particularly at a field or crop level. This can be attributed to two factors:

1. **Scope 1:** CFT applied a higher emissions factor for anhydrous ammonia compared with G-GAF.
2. **Scope 3:** G-GAF applied higher emission factors to glyphosate, paraquat and diquat compared with CFT.

Scope 1 differences

The calculators produced differing results for crops where anhydrous ammonia was used to apply non-urea nitrogen before planting. Specifically, the emission factor used in G-GAF is lower than that used in CFT. The resulting variation is therefore more prominent for higher nitrogen input crops such as canola, making this effect much greater in the case of Blue Hills in NSW where there was a greater difference in whole-of-farm absolute emissions as a result (**Figure 1**).

Scope 3 differences

GHG emission intensities from active ingredients were as high as 37 per cent of total emissions for some crops. This highlights the importance of accurately recording which chemicals are used, especially given the higher emission factors given to glyphosate, paraquat and diquat in G-GAF. The emission factors are calculated at around 1.8 times that of other herbicides with references to research indicating higher energy intensity in production.

Reward for effort

One of the more arduous aspects to data collation is the entry of applied chemicals, which contribute Scope 3 GHGs to a profile. Numerous hours can be spent searching for active ingredient fractions for chemicals and, where required, categorising these into specific groups.

Integration with AgWorld or similar farm management and agronomy software would be ideal but would still require the grower to have entered data completely and cleanly.

Ultimately, the contribution from these chemicals to the total carbon footprint is typically between 10 and 15 per cent but typically take over half of the time required to enter the data. In many cases, the chemical inputs for a given crop are similar. An option for a default selection based on the geography and season could potentially be included by calculator providers while maintaining the precision of a custom entry for those that require it. This would significantly reduce the time requirement for data collation, analysis and entry.

Unintended messaging

Growers calculating GHG emissions from grain production will note that good practices including retaining stubble or adding lime, increases the GHG emissions of a crop. Both represent sound farming practices and should not be discouraged.

Single year snapshot

Both calculators look at data in a single year snapshot, in effect ignoring the long-term implications or benefits of some practices, previous crop failures, rotations or prior fallows. These are factors that can have a significant impact on the yield in a paddock and therefore impact the GHG emission intensity of a parcel of grain.

Calculating emissions on an annual basis allows grain growers to assess changes they have made year to year and to monitor the impact of different practices or conditions over time. Looking at emission trends annually also provides a more complete picture of a farming operation's sustainability performance than considering one isolated production year.

Using calculated results

At the point of sale, both the G-GAF calculator and CFT calculated figures have been referenced by various buyers who want to know the carbon footprint of a parcel of grain.

As an example, Boortmalt have utilised the CFT calculator and have had anonymised supplier data entered for comparative analysis both within Australia and internationally.

Additionally, Western Australian bulk handler, CBH, have utilised the G-GAF calculator data to market low-GHG barley within Australia and internationally.

RUNNING YOUR OWN NUMBERS

Growers will already have most of the figures required to measure the carbon footprint of a crop, particularly if they use software packages such as Agworld. To get started, you will need the following information about a crop, regardless of the carbon calculator selected:

☐ Crop type

☐ Area grown

☐ Harvested yield

☐ Annual rainfall and evapotranspiration

In an attempt to determine leaching potential, G-GAF asks if EvapoTranspiration/Precipitation (Et/P) is less than 0.8 or, if Et/P is greater than 1. Regions outside these areas are considered 'dryland' and not subject to leaching.

☐ Inputs

Fertilisers

- Fertiliser inputs should be broken down to their nitrogen, phosphorus, potassium and sulphur contents and the sources of these elements. For example: nitrogen sources broken down into urea-N, ammonia-N or nitrate-N.
- The bulk density of the product should also be known. For example, urea-ammonium nitrate has a bulk density of 1.32kg per litre and most data will need to be entered by weight (kg/ha).

Chemicals

- Chemical inputs should include any prior fallow applications.
- These need to be broken down to application rate and active ingredient.
- This can be the most laborious part of the process with both calculators then requiring categorisation of the chemistry. For example, G-GAF requires glyphosate, paraquat and diquat actives to be entered separately as the calculator applies a higher energy input requirement for the production of these chemicals.

Lime and gypsum

Application rates and neutralising values (NV) should be known for lime and/or gypsum inputs.

Fuel

- Farmers rarely keep individual field fuel-use figures, but one option is to tally annual fuel use and allocate usage based on the apportionment of the crop relative to the total cropped area.
- If the fuel tally includes usage for the transport of goods, be sure to deduct this from any transport figures in the case of CFT.

Power

Grid power use generally constitutes a very small fraction of GHGs in a grain operation unless irrigation or grain drying is employed. As with fuel usage, where specific allocation of power cannot be made to a given crop, apportionment by the crop relative to the total cropped area may be required.

Transport

CFT has a data input tab for transport of goods to and from the farm, requesting the mode of transport, distance travelled and weight of goods.

☐ Burning

If any, what fraction of the crop residue is burnt?

☐ Land use changes

Land use changes include converting poor production areas, for example, to trees.

☐ Vegetation (offsets)

Vegetation or biomass changes including trees can provide an offset variation in GHGs for an enterprise and is captured by the calculators. G-GAF has a data input tab for vegetation, which includes Australian tree species and the ability to allocate a sequestered carbon offset benefit to each crop.

☐ Soil information

CFT requests details about the soil texture, organic matter, drainage and pH.

☐ Irrigation

Is the crop irrigated? For G-GAF, “irrigated crop” can be selected from the data input tab drop-down. For CFT, additional details of irrigation events are required.

WHAT'S NEXT?

Quantifying on-farm GHG emissions is a significant undertaking, but an important one for advancing sustainable practices. This report provides a useful starting point, but hands-on experience and learning from industry peers can help accelerate understanding and application of carbon accounting on individual farms. Three actions that you can take now include:

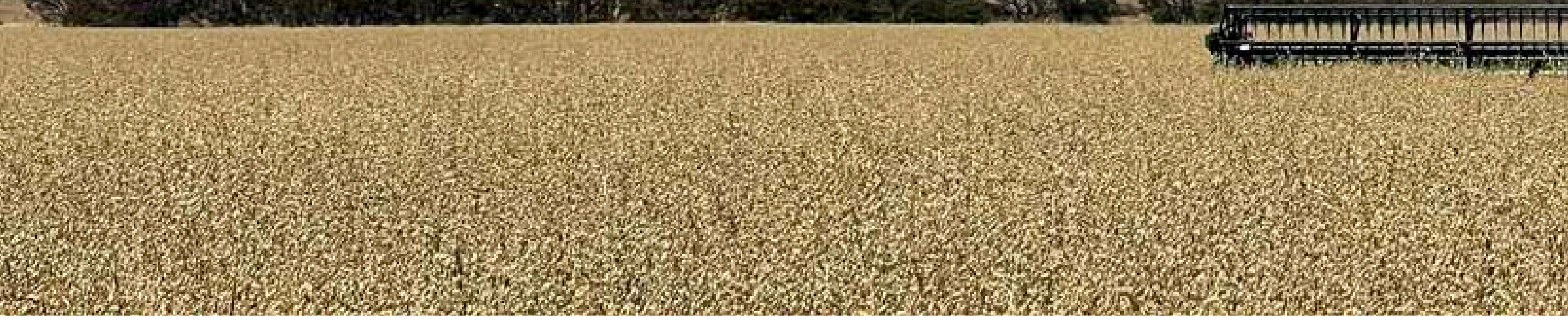
1. **Review available guidance materials:** Consider reviewing resources from GrainGrowers such as the Carbon and Cropping Guide discussed in this study, which covers introductory concepts and terms, how the carbon markets work, right through to the more detailed scientific aspects of carbon.
2. **Get hands on experience with carbon calculators:** Try using one of the calculators assessed in this report to gain first-hand experience with the processes involved. This will help inform which approach may be most suitable.
3. **Learn from peers actively measuring emissions:** Connecting with other growers further along in carbon accounting and measurement activities could offer helpful advice and guidance. The experiences shared by growers described here, who have undertaken on-farm GHG quantification, serve to highlight first steps and important considerations for those just starting out.

Q: What advice would you give to growers who are considering finding out what their carbon footprint is?

A – Julia Hausler: Well, you don't know what you don't know. So, the first thing to do is get in the know! You don't need to get hung up on the actual number. It's the makeup of the number, and where each part is coming from. Then it's about knowing what steps you might take. Once you know, you can talk to other people and see what they're doing and go from there.

A – Ash Brooks: Take a look at some carbon guides to help you understand carbon jargon, emissions sources and the types of data you'll need to collect to calculate your numbers. Good quality data is important, so understanding where your data exists in your business and working through a carbon calculation checklist is really worthwhile. Once you've completed your first year of carbon calculations, you'll find each year becomes easier as you'll work out the easiest ways to capture your data, and your knowledge around your numbers will grow. The process is definitely a valuable business investment.

A – Nigel Corish: Don't be afraid to get involved and give it a crack. Whether it's through reading information, going to sessions, or through the GRDC with different grower groups, just get yourself involved. A lot of people shy away from it – but the better educated and informed you are, the more confident you'll feel about calculating your emissions and knowing your numbers.



ABOUT GRAINGROWERS

Visit GrainGrowers free Carbon Curious Grower Resources Online Hub.

GrainGrowers is a national organisation working to enhance the profitability and sustainability of Australian grain. We achieve this through our focus areas of policy and advocacy, grower engagement, thought leadership and active investment in future focused activities for all growers. Australian growers are at the heart of all that we do and the focus of our work.

Stay in touch with GrainGrowers

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