Cool Farm Tool Online Guide: Crops

Contents

Introduction

The Cool Farm Tool is a farm-level greenhouse gas (GHG) calculator for estimating net GHG emissions from agriculture. While harmonized with other calculators, this tool is characterized by:

- Its farmer focus, being as management sensitive as possible while requiring only input data a farm manager would typically have
- Its use of site sensitive empirical models built from hundreds of peer-reviewed studies.

This calculator takes the estimates of technical potential to the farm and uncovers what is practical and pragmatic from a farmer and field perspective. The Cool Farm Tool sits between calculators using simple emission factor approaches (IPCC Tier 1) and Process-Based models that require a greater level of data input and training to interpret (IPCC Tier 3).

The calculator has seven input sections, each on a separate page, relating to:

- Farm Settings (location, climate etc.)
- General Information (product, year, co-products etc.)
- Growing Area (area, characteristics of soil etc.)
- Field Treatment (crop protection, fertilizer use, residue management etc.)
- Management (land use and management, above ground biomass etc.)
- Energy & Processing (energy use, farm machinery, etc.)
- Transport (road, rail, air, ship)

This Users' Guide goes through each of these sections and the results section to offer details and tips for accurately using the Cool Farm Tool to calculate your farm's greenhouse gas emissions.

General Tips

- Clearly define the boundaries of your analysis before you start collecting data. For example, if you are interested in on-farm impacts then only consider emission sources between 'field' and 'farm gate'. In this case processing and transport impacts that occur after the product leaves the farm would be excluded.
- Use the Comments boxes to add in useful additional information.
- Note that your total farm energy, processing and transport impacts may be attributable to several crops. You make sure that you correctly allocate impacts to each crop or product.

Data Entry and Editing

You may complete whichever sections you have data for, bearing in mind that some of the analyses are only available when the relevant input sections are completed.

Farm Settings

Who is this section for? Everyone

Everyone using the tool must fill in this section. It establishes certain factors that will affect emissions on your farm whether you produce crops, livestock, or both. Chief among these is your location – the Cool Farm Tool will calculate the emissions from electricity in your area based on your Country.

Tips and Explanations

- For the Climate question, there are only two options – Tropical and Temperate. These are tied to just two default options for annual average temperature. Temperate Climates are assumed to have an average annual temperature of 50°F or 10°C. Tropical Climates are assumed to have an average of 64.4°F or 18°C.
- If you know your own climate's average temperature, and it is different from either of these two averages – enter the correct average temperature. Otherwise enter 10°C or 18°C for temperate and Tropical climates respectively. This decision affects emissions from fertilizer and soil carbon management (e.g. organic amendments, tillage, cover cropping, etc.).

General Information

Who is this section for? Everyone

Everyone using the tool must fill in this section.

Your per-unit volume GHG figure is based on the production figures you enter here. Because data you enter in this section affects the results in other sections, it's important that you complete this section accurately.

Tips and explanations

- First pick a crop or product from the list available. If you do not see your exact crop listed in the drop down menu, choose the category at the end of the list that includes your crop. This choice effects N2O emissions and estimates of crop residues.
- If you produce rice, you will be asked the following:
  - Days under cultivation
  - Water management before cultivation. Choices:
    - Not flooded pre-season (for less than 180 days)
    - Not flooded pre-season (for more than 180 days)
    - Flooded pre-season
  - Water management during cultivation. Choices:
    - Upland
    - Continuously flooded
    - Intermittently flooded
    - Intermittently flooded - multiple aeration
    - Rainfed
    - Drought prone
    - Deep water
- Filling out the year does not affect other data – it is for your own record keeping. This will be especially useful if you manage land in multiple areas or if you wish to analyze data from multiple years.
- Be sure to give your crop a descriptive name, such as "Corn_2010_Webster City". A default value is provided but can be overwritten. You must give each footprint a unique name.
- The CFT assumes that your fresh and finished product volumes are exactly the same. If not, then overwrite the values.

Co-products

Who is this section for? Those who wish to allocate a proportion of their emissions to one or more co-products of the main product.

In many cases it is relevant to attribute some of the management emissions to several co-products – for example, those that have an economic value.

You need to enter a name for your co-product, for example 'straw'.

You can either choose to estimate its contribution to overall GHG emissions using economic value or finished product weight and value.

- For example, if the economic value of the co-product produced is 10% of the main product, enter 10% for percentage main value using the slider.
- Alternatively, if the per unit value is known relative to the main product then this may be entered using the finished product weight and value option.

Tips and Explanations
- You can add more than one co-product by clicking on '+ add another'

Growing Area

Who is this section for? Crop Producers

Here you enter the characteristics of the area used to grow the selected crop including the total growing area and soil characteristics.

Tips and explanations
- Note that you your growing area is given a default name which you can overwrite with a label of your choice, for example "My Big Field". This avoids you having to re-enter your growing area details a second time. When you next return to the CFT, any previous growing areas can be selected from the Template dropdown.

Here is a list of the data you will need ahead of time in order to complete the crop management section of the Cool Farm Tool.

- What is your soil texture? Fine, Medium, or Coarse? This information is usually available through routine soil tests or based on feel. The help provides translation from typical U.S soil categories (clay, loam, sandy-loam, silt etc.) to Fine, Medium or Coarse.
- What is your soil organic matter content? Options are given in the drop down list.
- Is your soil moist or dry? (Irrigated soils should be classed as moist.) Moist soils have slightly higher N2O emissions than dry ones.
- Is your soil drainage good or poor? Soils with poor drainage have significantly higher N2O emissions than those with good drainage.
- What is your soil pH? This information affects de-nitrification, and will have an impact on N2O emissions. Choose from these options:
    - pH<=5.5
    - 5.5 < pH <= 7.3

- 7.4 < pH <= 8.3
- pH >8.3

Field Treatment

Who is this section for? Crop Producers

If you produce crops for sale or for feeding to livestock, the information you provide on how you manage your crop production will compute the emissions that come from your fertilizer, pesticide, and crop residue.

Tips and Explanations

Which fertilizers do you use? Note that you can re-use previous fertilizer entries by selecting from the '+ add from template' dropdown and then clicking on '+add from template'.

The fertilizers to choose from are the following:

Ammonium Bicarbonate - 30% N

Ammonium nitrate - 35% N

Ammonium sulphate - 21% N

Ammonium sulphate nitrate - 21% N

Anhydrous ammonia - 82% N

Calcium ammonium nitrate -27% N

Calcium nitrate - 15% N

Compound NK - 19.5% N; 29.5% K

Compound NPK 15%N 15% K2O 15% P2O5

Diammonium phosphate - 14% N; 44% P2O5

Kainit / Magnesium Sulphate - 11% K2O; 5% MgO

Lime - 52% CaO

Limestone - 55% CaCO3 / 29%CaO

Lime, algal - 30% CaO

Monoammonium phosphate - 11% N; 52% P2O5

Muriate of potash/ Potassium Chloride - 60% K2O

Phosphate/Rock Phosphate - 25% P2O5

Potassium sulphate - 50% K2O; 45% SO3

Super phosphate - 21% P2O5

Triple super phosphate - 48% P2O5

Urea - 46.4% N

Urea ammonium nitrate solution - 32% N

Compost (zero emissions) - 1% N

Compost (fully aerated production) - 1% N

Compost (other non-zero emissions) - 1% N

Cattle Farmyard manure - 0.6% N

Pig Farmyard manure - 0.7% N

Sheep Farmyard manure - 0.7% N

Horse Farmyard Manure - 0.7% N

Poultry layer manure - 1.9% N

Broiler/Turkey litter - 3% N

Cattle Slurry - 0.26% N

Pig slurry - 0.36% N

Separated Pig slurry - liquid part - 0.36% N

Separated Pig slurry - solid part - 0.5% N

What is the application method for your fertilizer? Choose from the following options:

- Apply in solution
- Broadcast
- Broadcast or incorporate then flood

- Broadcast to floodwater at panicle initiation
- Incorporate
- Subsurface drip

Do you use an emissions inhibitor with your fertilizer? If so, do you use a nitrification inhibitor or is your fertilizer polymer coated?

How many pesticide applications do you do per year?

- Each dose of each pesticide counts as a separate application.
    - For split applications, two applications at half the rate count as one.
- If you do tank mixes, count each pesticide in the mix as a separate application.
- Entering this information will account for the energy required to produce pesticides. The values in the literature typically only account for the active ingredient, not the entire formulation. If you have better data, you can change the default in the "Default Factors" tab in cell F8 (the default factor reflects the average of a range of pesticides).
- The Cool Farm Tool uses a very simple model of emissions from pesticide use is employed. Because of the number of agro-chemicals available to farmers it is beyond the scope of this model to incorporate a detailed emissions sub-model for this aspect. Future versions of the CFT may allow the option of inputting specific crop protection products for those products that have robust data on their specific emissions factors.

How much crop residue remains post-harvest and how do you manage it?

- Residue is defined as the plant matter from crop production that is not used as a sellable product - e.g. straw, stalks, leaf litter, etc. If the quantity is unknown, a default is estimated based on crop type and fresh yield vs. finished yield.
- Note that for tree crops we currently have no estimate. If you grow tree crops, please enter your own data for the amount of residue per year. You can chose tonnes (metric tons)/acre, tonnes/hectare, kg/hectare, kg/acre, or tons (US tons – 2000 pounds)/acre.
- Choose from the following management options:
    - Removed; left untreated in heaps or pits
    - Removed; non-Forced Aeration Compost
    - Removed; Forced Aeration Compost
    - Left on field; Incorporated or mulch
    - Burned
    - Exported off farm

Compost

You will see that there are three options for compost used as a fertilizer. If you buy compost from off-site, you should use one of the two non-zero emissions compost options - either fully aerated if you know that the compost you purchased was fully aerated or the "other non-zero emissions compost". If you produce your own compost on-site, you will fill information about compost production within the crop residue management section of the crop management tab. If you fill in this information accurately, your emissions will be accounted for there - so you should choose "zero-emissions compost" in the fertilizer section.

You might have different amounts of compost added as fertilizer and residue managed as compost. This is fine – the emissions calculations will work as long as you enter the amounts of residue converted to compost and the amounts of compost used as fertilizer accurately.

If you don't see the kind of fertilizer that you use listed in the drop down menu, then you can request that the Cool Farm Institute adds additional products.

Important: Organic (carbon based) fertilizers

Note that in order to take account of the soil carbon effects of using organic (carbon based) fertilizers such as compost or composted manure you must complete the corresponding section of Management page.

The Tool will not calculate the soil carbon effects until you say how long ago you started.

Management

Who is this section for? Crop Producers

This section tracks how land use and management affect your overall GHG emissions. This section will also allow you to test what the impact of potential changes in land management could make in terms of greenhouse gas emissions.

Most of this section focuses on changes made within the last 20 years. If there have been no significant changes to tillage, land use or cover cropping then this section can be ignored.

Note that the land being referred to is that defined under Growing Area.

Tips and explanations

Has any part of your land been converted? Enter any recent changes you've made in how you manage your land. For example, where long-term grassland/pasture has been converted to arable production or forest has been cleared.

Have you changed your tillage practices? This section refers to long term changes in how you manage your land. It is not designed to account for annual fluctuations, e.g. conversion from conventional (always) to no-till (always) would be represented by "Conventional to No-till". If you do go back and forth between conventional and reduced or no-till cultivation, use you best judgment about which practices to indicate and over what time frame.

- Select the choice in tillage change that most closely matches your situation. (I.e. choose the description that best matches what your tillage practices were BEFORE you made a change, and what tillage practices you changed to. Then enter the numbers of years ago that you made this change and on what % of your productive land. Tillage changes are a switch from one of the following practices to a different practice.
    - No-till: Direct seeding without primary tillage, minimal soil disturbance in seeding zone. Weed control via herbicides.
    - Reduced-till: Primary and/or secondary tillage with reduced soil disturbance (shallow and without full inversion). Normally leaving >30% surface coverage at planting.

- Conventional till: Substantial soil disturbance, such as plowing, and/or frequent tillage operations. Little surface coverage with residues at planting time.

Have you started or stopped growing a cover crop? You should answer if you've changed your practice, how long ago and on what % of your productive land.

- If you started cover cropping but only put in a cover crop every 4-5 years you could say that you cover crop 20-25% of the affected area. If you've been cover cropping once every four years for over 20 years and recently started cover cropping every other year you could input that change as "started adding" on 50% of the productive area.

Annual Biomass for trees and bushes – this section refers to productive species such as coffee, as well as shade trees which grow on the land area for which you are using the Cool Farm Tool.

a) First select the species of tree/bush on your farm and the number of trees per unit (acre or hectare) on your land in the year previous to the one you are reporting for.
b) Enter the average diameter of the trees of this species (height, at 15 cm from ground or at breast height) for the current and previous years, ensuring that you select the appropriate unit (mm, cm, inch, meter).
c) Enter the change in the total number of trees planted or felled on your productive land for the current year.
d) Follow the same procedure for each species of tree on your farm.

Energy & Processing
Who is this section for? Everyone.

Every farm uses energy. The Energy Use section allows you to account for the emissions from your on-farm energy use. This includes both electricity and fuel use. Farms use electricity for heating, lighting, some machinery and many other things. Some farms generate their own electricity, and others purchase grid electricity from a utility. Utilities differ around the world and within United States about what fuel mix they use for electricity generation, and how much renewable energy they use. Farms use liquid fuel (petrol or diesel) for running the machinery required to work the soil and to harvest, among many other purposes.

Note that emissions from transport; from the fuel use in vehicles used to transport necessary inputs such as fertilizer, seeds, pesticides, etc. and finished products are accounted for in the Transport section.

This section also includes a question regarding Waste Water. You only need to answer this is you produce waste water containing organic matter.

Tips and explanations
- If you don't know your total annual use of diesel fuel, petrol then use the Field Operations calculator for tillage, spraying/spreading, and harvesting. Take care not to double count the fuel use – add it to the Energy Use OR Field Operations sections only.

- You can add as many different energy sources and field operations as you like by clicking on '+ add another'.
- If you also do processing of your products on-site, you can include those calculations in this section.
- The Cool Farm Tool does NOT assume a zero emissions factor for renewable energy. Emissions for electricity from renewable energy are quite a bit lower than for electricity from the grid – but not zero. This is because the CFT takes development energy costs for renewable energy technology into account. Practically what this means is that if you are producing your own electricity onsite from renewable sources, you should still enter the amount of renewably sourced electricity into the tool and not assume that it doesn't need to be accounted for.
- For liquid fuels, the Cool Farm Tool includes a default assumption that the emissions from biodiesel and bio-ethanol are half of those from the fossil fuel based counter-part. The actual emissions factors for bio-fuels can vary widely, however. If you use bio-diesel or bio-ethanol, we STRONGLY recommend that you determine your own emissions factor and ask that this is added to the CFT.
- Note that for tillage, spraying/spreading, and harvesting the "number of operations" refers to conducting the chosen operation (e.g. harvesting, tilling, etc.) over the entire production area.

Transport

Who is this section for? Everyone

This section is for all farmers who transport inputs to the farm, or finished products from the farm to a point of sale. Transport includes having materials delivered or removed, even if you do not use your own vehicles to transport products. This section will be relevant to all commercial farmers.

Tips and explanations

Depending on the boundaries of your analysis you may wish to exclude some transport impacts. For example, if you are only looking at field to farm gate impacts you would exclude the off-farm transport of your crops.

You can add as many transport emission sources as you want by clicking '+ add another'.

When you enter transport information, note that:

- Quantity is the amount of goods you cause to be transported. Be sure to choose the right units (kg, tonnes etc.).
- Distance calls for the distance that the goods travel to get to you from their origin, or the distance that your products travel to get to their point of sale. This is the one way distance, not the round trip distance even if your vehicle does make a round trip.
- For Road transport, you have three choices for the question 'add vehicle weight?'
    - Yes – returning empty
    - Yes – single journey
    - No

Yes – returning empty is what you would choose if you take product out in a vehicle, drop it off, and return in an empty vehicle. Alternatively, you would also choose this to calculate the emissions from importing farm inputs and you might order products that arrive, are dropped off, and return empty.

Yes – single journey is what you should choose if you wish to calculate the emissions for the product being transported plus the emissions from the weight of the vehicle itself. This would be the best choice for receiving a delivery from a vehicle that makes other stops as well, such as a package delivery from UPS.

No - will calculate just the emissions from the product transported in the type of vehicle you choose.

If you are transport a large amount of material that comes in many trips per year, such as feed for livestock from a mill, you can enter the total amount of material and choose the appropriate vehicle, you don't need to enter separate trips on separate lines.

Results and Graphs

The summary results panel displays various key performance indicators. You can also get more detailed results by clicking 'see all results'.

Tips and explanations

This section shows you in words, graphs, and numbers what the total emissions are for your farm. It will indicate clearly where the emissions come from (as in – how much of the total comes from land management, how much from transportation, etc.). This can give you a good idea of what aspects of your farm you could make changes to in order to reduce your total emissions.

Keep in mind that the section that ends up as the greatest source of emissions might not always be the best place to try to make changes first. Sometimes changes in other areas may be more feasible – technically or financially. Be sure to look at all possible changes that you could make on your farm to evaluate the effect on total emissions.

Also keep in mind that some changes might reduce your emissions just a little, but would also help you save money, or have a better marketing angle. These might be worth pursuing, especially if some other changes have a higher implementation cost. Making a combination of changes that can reduce GHG emissions can end up being less expensive than one massive change. Each farmer's situation will be different.

Boundary and Scope

This Users Guide is designed to help you use the Cool Farm Tool but does not dictate how to draw the boundaries around the system you are evaluating. You have options about how much transport to account for – whether you account for the inbound transport of all inputs, and whether you account for the outbound transport of your finished product. You can also decide to calculate that actual emissions factors for your feed components if you grow them yourself or have access to information from the growers you purchase from.

These are decisions that will be dictated by the reasons you are conducting the GHG estimation exercise.

It is important that you are aware that other farmers may use the tool differently and that the system boundaries – such as whether input transport is included or not – must be clear before any farm-to-farm comparisons can be made. As the field of agricultural carbon footprinting matures, protocols will be developed for common guidance.

Glossary

GHG - Greenhouse Gas. These include:

- CO_2 emissions – carbon dioxide, given a weight of 1 in the CO2-equivalent scheme
- CH_4 emissions – methane, given a weight of 25 in the CO2-equivalent scheme
- N_2O emissions – nitrous oxide, given a weight of 296 in the CO2-equivalent scheme

N - Nitrogen, an important nutrient in soils and fertilizers. Plants require nitrogen for proper leaf production. Too much nitrogen in fertilizers or in composting can lead to ammonia or increased methane production. Proteins are high in nitrogen.

C - Carbon, a key component of all life forms and found in concentrated form in carbohydrates including cellulose. When animals breathe they release carbon in the form of CO2. When plants and animals decompose, microbes digest the material and also release carbon in the form of CO2.