# Grow Asia Counter
# User Manual

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# 1. Introduction

The Grow Asia Counter allows users to estimate their greenhouse gas emissions of different agricultural management scenarios for cocoa, coffee, tea, corn, rice, potatoes, and vegetables/horticulture.

The following factors of agricultural systems are evaluated in terms of their greenhouse gas emissions:

- Tillage and other soil management practices,
- Nutrient management practices,
- Liming,
- Crop residue burning and decomposition,
- Agrochemical use,
- Agroforestry practices,
- Fossil fuel use,
- Rice irrigation (for paddy rice).

Greenhouse gas emissions are presented in terms of total annual emissions of carbon dioxide equivalents (tonnes of $CO_2e$) and annual emissions per unit of yield (tonnes of $CO_2$ per tonne of product).

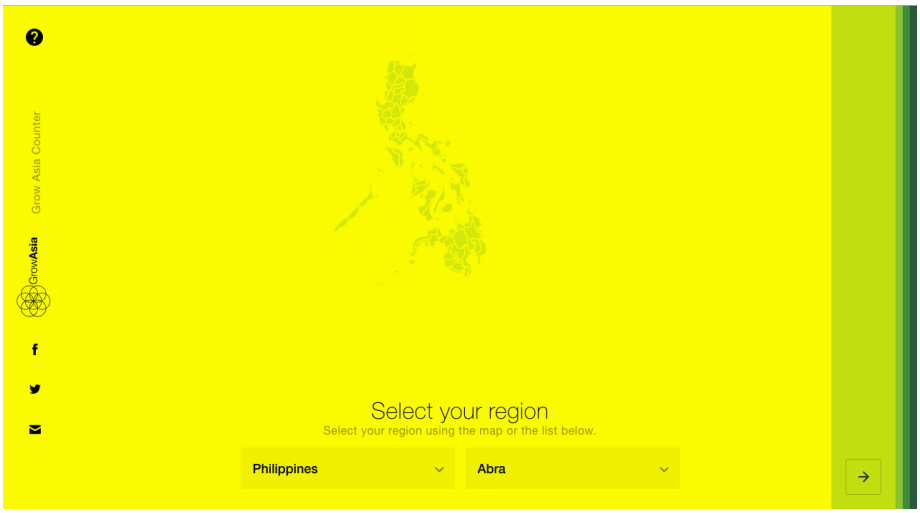
The tool allows users to view their greenhouse gas emissions based on their current practices (scenario 1) and what their greenhouse gas emissions would be if they changed their management practices (scenario 2).

Through a series of questions, the Counter will help you view these emissions. It will be helpful if you have accurate information in hand before starting to fill in data.

# 2. Area Selection

In this tool, geography plays - primarily through its influence on soil carbon content - a role in greenhouse gas emissions from agricultural activities. Soils in different areas of the region have different soil organic carbon contents. Furthermore, the relative impact that different

soil management activities (such as tillage) have on the soil carbon content varies by an area's particular climate (temperature and precipitation level).




The first screen you will see allows you to select the country, then region, where your agricultural area is located. You can use the map or the dropdown list to select your country and region. Once you have chosen both of these, you can proceed to the next page.

## 3. Describe your agricultural activity

On this page you will be asked to provide information on what you grow, how large your land is and your expected yield per hectare. The land area and expected yield options are both mandatory: you cannot proceed without providing a value.

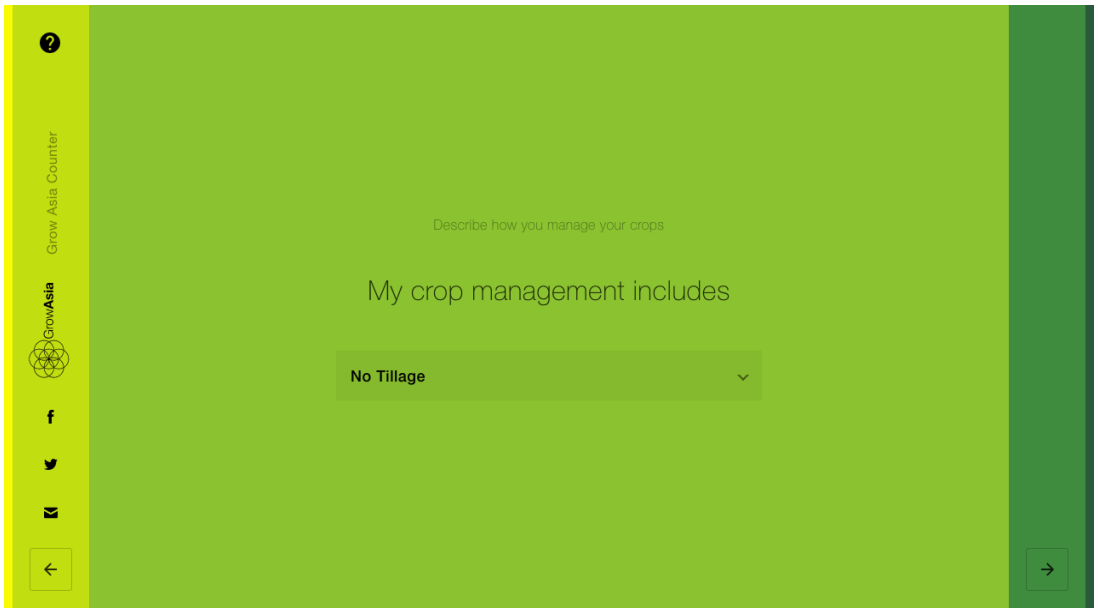

The type of crop is an essential input which will influence the rest of the agricultural management questions in this tool. For instance, the practices for growing paddy rice will be very different from those for growing corn. These different practices, in turn, have different greenhouse gas emission impacts.

The area of land cultivated influences the total volume of greenhouse gas emissions. As an example 100 hectares of potatoes cultivated will likely have substantially smaller emissions than 1000 hectares of potatoes cultivated assuming all the same management practices are applied.

Finally, the expected yield will be used to inform the emissions per unit of yield results.

# 4. Tillage practices

On this page you will be asked to provide your tillage practices. The type of tillage practice has an impact on soil carbon content. Intensive tillage practices lead to lower carbon contents in the soil than low intensive or no tillage systems. If tillage practice changes from scenario 1 to scenario 2, it could lead to either emissions or removals of atmospheric carbon dioxide depending on the change adopted.



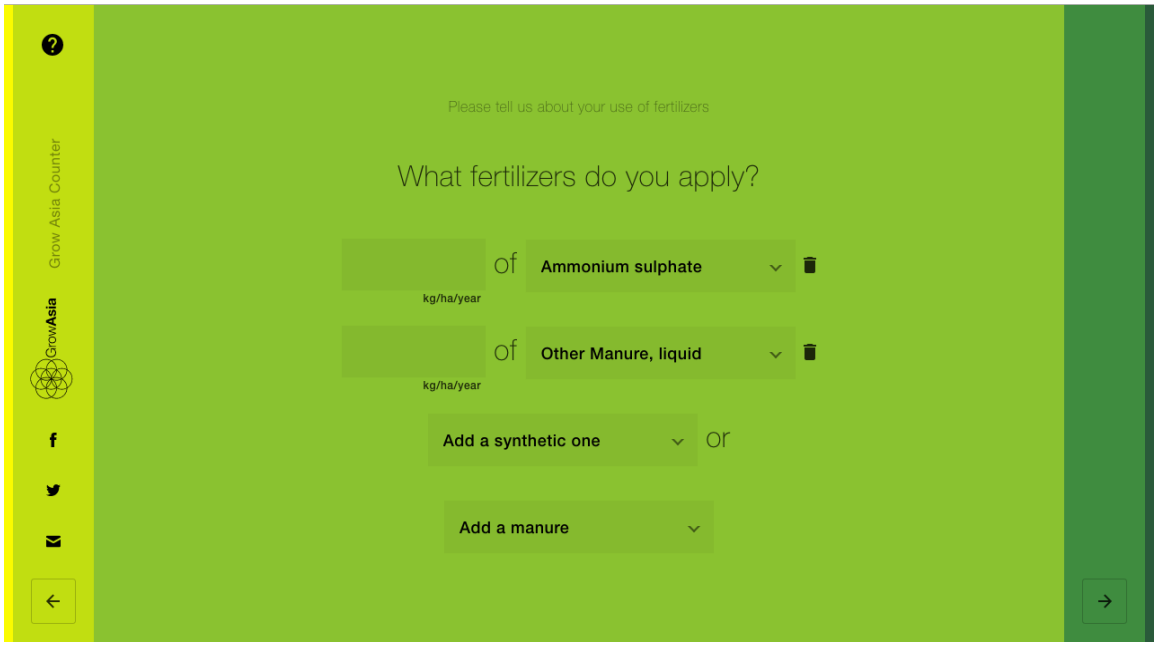

The tillage options are defined by the 2006 IPCC Guidelines[1] as the following:

- **No tillage** – Direct seeding without primary tillage, with only minimal soil disturbance in the seeding zone. Herbicides typically used for weed control.
- **Minimal/shallow till** - Primary and/or secondary tillage but with reduced soil disturbance (usually shallow and without full soil inversion). Normally leaves surface with >30% coverage by residues at planting.
- **Full tillage** - Substantial soil disturbance with full inversion and/or frequent (within year) tillage operations. At planting time, little (e.g., <30%) of the surface is covered by residues.

[1] 2006 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories, Volume 4 Agriculture, Forestry and Other Land Use, Chapter 5.

# 5. Fertilizers

On this page we will ask you what types of fertilizer you use. You can select multiple animal manure (i.e., organic) and synthetic (i.e., inorganic) fertilizers. After selecting each one, you will then be asked how much of that fertilizer you use.




Synthetic nitrogen fertilizer options include the following: urea, ammonia, ammonium sulphate, mono-ammonium phosphate (MAP), di-ammonium phosphate (DAP), ammonium nitrate, and calcium ammonium nitrate.

Animal manure fertilizer includes the following categories: poultry litter, liquid; poultry litter, dry; other manure, liquid; and other manure, dry. Other manure includes manure from other animals, including cattle, sheep, horse, swine, and goat.

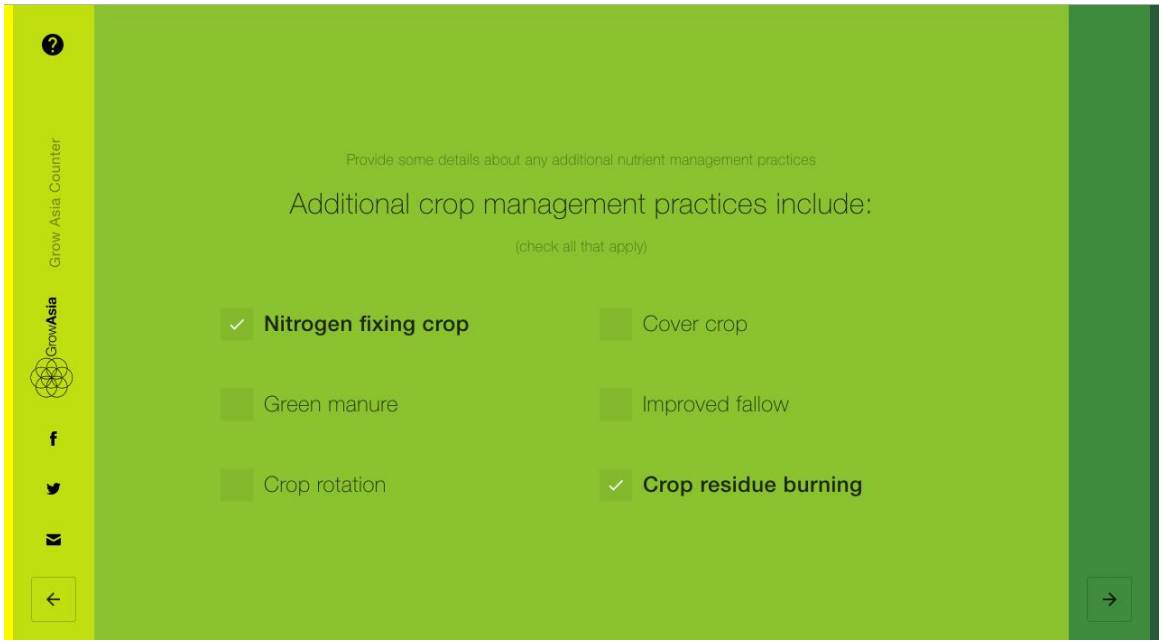
Fertilizer use can lead to emissions of the greenhouse gases - nitrous oxide ($N_2O$) and carbon dioxide ($CO_2$). When nitrogen-based fertilizers are applied to soils, it enhances the naturally occurring nitrification and denitrification chemical processes, which produce $N_2O$ as a by-product. Furthermore, emissions occur through the volatilization (in other words, conversion to a gas) of nitrogen, in the form of ammonia ($NH_3$) and nitrogen oxides ($NO_x$). Finally, the production of different synthetic fertilizers leads to emissions as well.

The use of fertilizers also impacts soil carbon content and, therefore, emissions from soil when management practices change. Applying synthetic and animal manure fertilizers lead to greater carbon, in the form of biomass in crops. A portion of this biomass will most likely be returned to the soil after harvest, thereby enhancing soil carbon content. In addition, application of manure directly adds carbon to the soils.

When the fertilizer applied is urea, additional emissions are released through hydrolysis. Hydrolysis is defined as the chemical reaction which breaks down a compound, in this case urea, in the presence of water. One of the products of the urea hydrolysis is bicarbonate ($HCO_3^-$), which in turn becomes $CO_2$.

# 6. Additional Crop Management

You will only see this question if you work on potatoes, vegetables, horticulture or upland rice. Simply tick all the options that apply to you




In addition to tillage and fertilizer use, various crop management practices have an impact on the carbon content in agricultural soils in terms of their contribution of carbon, in the form of biomass, to the soil or removal of carbon from the soil.

Additional crop management practices impacting soil carbon content include:

- Use of **nitrogen-fixing crops,** which convert atmospheric nitrogen into organic compounds. The nitrogen-fixing crops raise the nitrogen content of the soil benefiting all crops and increasing growth, and with growth, carbon in the soil.
- Use of **green manure,** which involves growing plants specifically for the purpose of then incorporating them into the soil to function as fertilizer once they die.
- **Crop rotation** is the practice of varying the cultivation of different crops to maintain soil fertility, among other reasons.
- **Cover crops** are planted for the specific purpose of protecting soil, in particular its structure and fertility.
- **Improved fallow** is land resting from cultivation, which is planted with vegetation designed to protect and enhance soil fertility.
- **Crop residue/rice straw burning** is the practice of burning the remaining organic material, such as stalks and leaves, in the field after harvest.

*It is important to note that these crop management practices are not mutually exclusive*. For example, nitrogen-fixing crops can be a form of green manure.

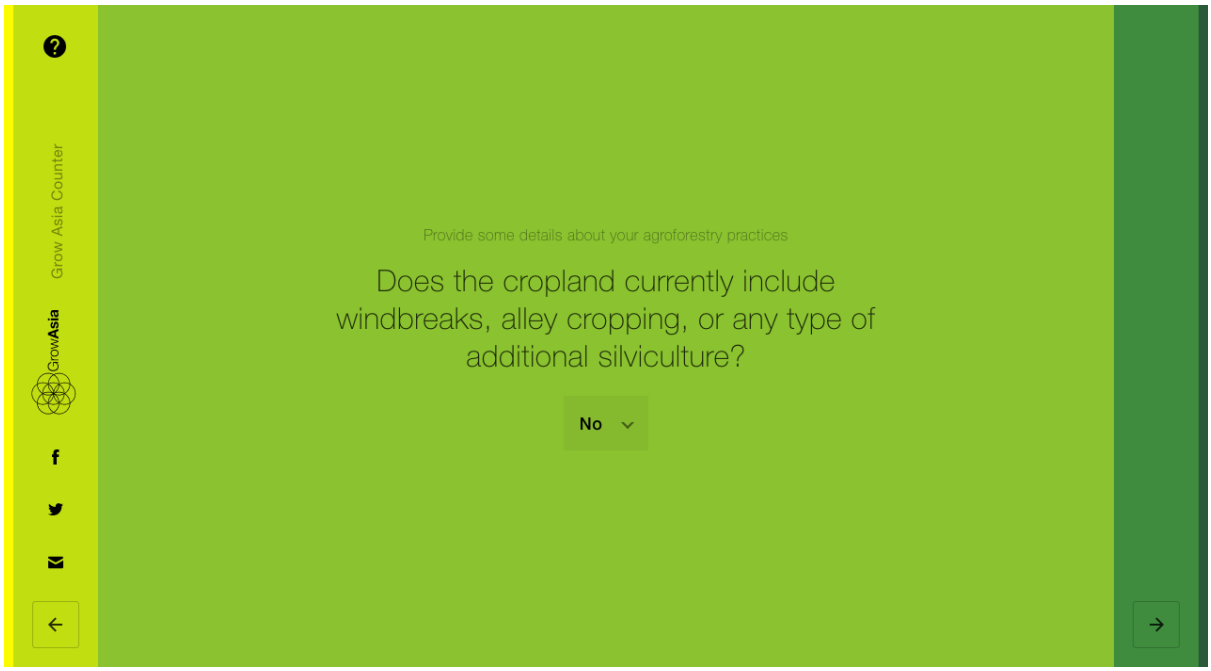
In addition to its impact on soil management emissions, whether or not crop residues are burned has impacts on greenhouse gas emissions resulting directly from the combustion of materials and from the decomposition of remaining crop residue. It is assumed in this tool that crop residue decomposition is equal to 0 when crop residue is burned.

Note that crop residues produce nitrous oxide emissions through direct emissions and leaching/run off but not through volatilization.

# 7. Agroforestry Practices

On this page you indicate whether or not you use any agroforestry practices. The application of agroforestry practices in crop systems removes carbon dioxide ($CO_2$) from the atmosphere by sequestering it in new plant biomass. Examples of agroforestry practices include (but are not limited to) the following practices:

- **Shade trees** which are trees planted with broad canopies to provide needed shade for such crops as coffee and cacao.
- **Windbreaks** which are linear plantings of trees and shrubs around cultivated areas.
- **Alley cropping** is planting rows of trees at wide spacings with a companion crop grown in the alleyways between the rows.



# 8. Liming Practices and agrochemical use

On these two page you will be asked about your liming and dolomite practices, as well as your agrochemical use. If you use any of them, we will also ask how much you use.

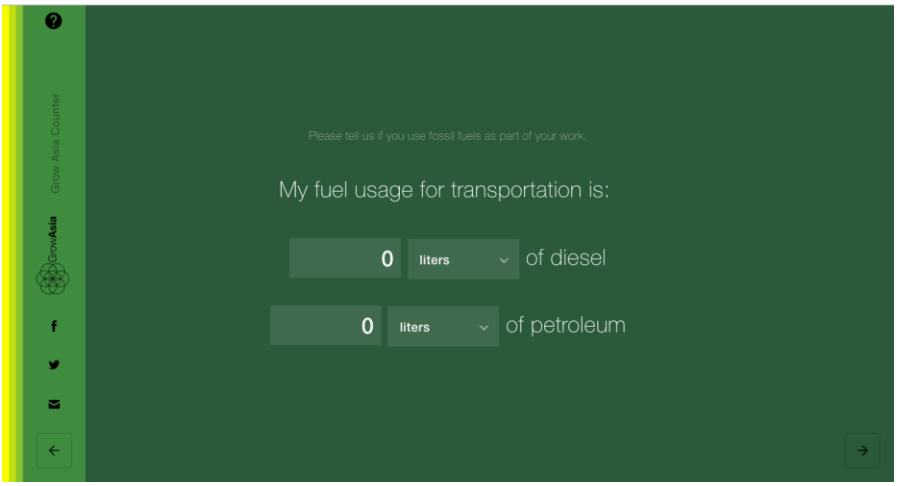

The application of lime (e.g., calcic limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$) to soil is a source of carbon dioxide ($CO_2$) emissions as a result of the dissolution of the carbonate lime.

Agrochemical use includes the use of synthetic pesticides and/or herbicides. Emissions calculations are based on Bellarby et al. (2008)[2] that estimated that the application of agrochemicals results in greenhouse gas emissions from fossil fuel and energy use in farm operations and production of chemicals for agriculture to range of 180-3,700 kilograms of carbon dioxide equivalents ($CO_2$-eq) per $km^2$. The mean value for this range (1,940 kg $CO_2$-eq/$km^2$) is used. This is equivalent to an emissions value for agrochemical use of 19.4 kg $CO_2$/ha.

# 9. Fossil Fuel Use

You will be asked a series of questions about how you use fossil fuels in your agricultural activities, like transport, irrigation and other purposes.

[2] Bellarby, J., Foereid, B., Hastings, A., and Smith, P. (2008). Cool Farming: Climate impacts of agriculture and mitigation potential. Greenpeace. Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&sqi=2&ved=0ahUKEwjPnOHS2YLOAhUI_IMKHXZcB1MQFggcMAA&url=https%3A%2F%2Fwww.organicconsumers.org%2Fsites%2Fdefault%2Ffiles%2Fcool-farming-full-report.pdf&usg=AFQjCNHFVVfb02FtSeGG97uMTjOVNND6Rw&sig2=Pfw6tb4RTI6NyHQ3OU0cpQ&bvm=bv.127521224,d.amc




The combustion of fossil fuels is one of the most well-known sources of carbon dioxide ($CO_2$) emissions in the atmosphere. The amount consumed and the type of fossil fuel (in this tool, diesel and petroleum) used influences the amount of emissions.

# 10. Paddy Rice Specific Questions

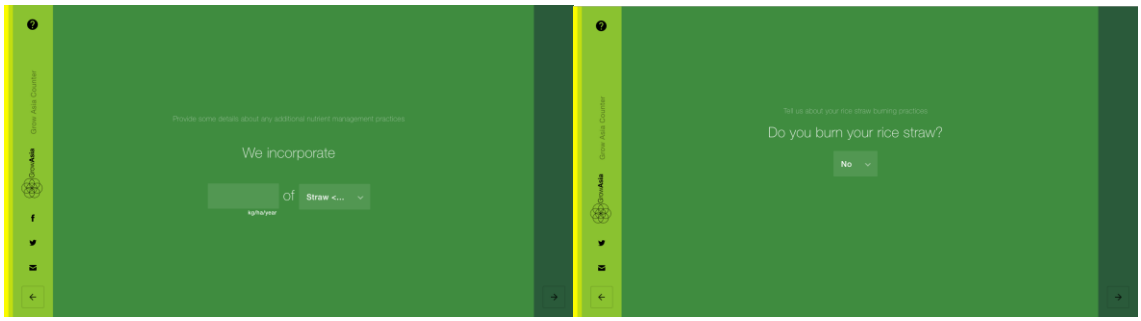
If you grow rice in paddy fields, you will see a few different screens. First we will ask you about your irrigation processes. Then you will be asked for more specifics about your rice cultivation. The number of cultivation days and the number of annual cultivation cycles are mandatory fields.


When rice fields are flooded, anaerobic decomposition (in other words, decomposition in the absence of oxygen) of organic material takes place. A byproduct of this anaerobic decomposition is methane ($CH_4$), a greenhouse gas. A key variable impacting the amount of methane released is the type of irrigation regime used during cultivation.

In addition to the specific irrigation regime applied, the flooding regime used prior to cultivation, length of cultivation, and the number of cultivation cycles all influence methane emissions.

The application of rice straw and the timing of this application, as well as the application of compost, farm yard manure, and manure, also has an impact on the methane emissions resulting from flooding. You will be asked to fill in this information on this page. The organic material from these applications will lead to greater $CH_4$ emissions. You will also be asked if

you burn rice straw. The combustion of rice straw has impacts on greenhouse gas emissions resulting directly from the combustion of materials.

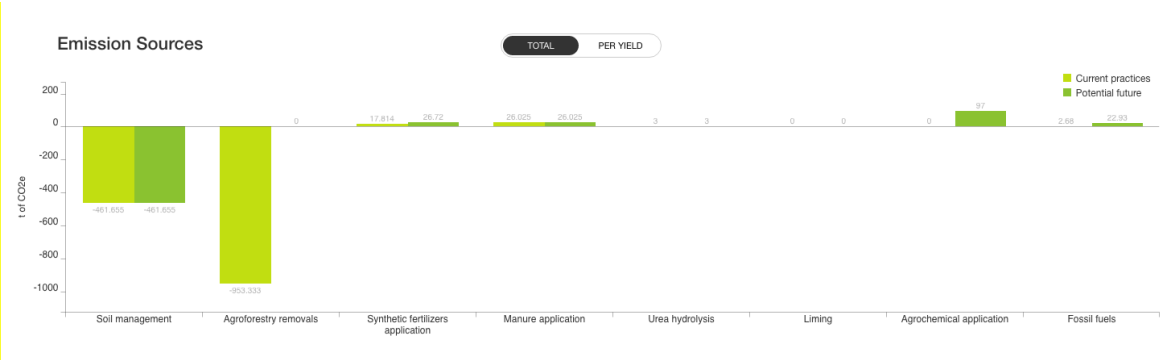



# 11. Analysis page

After completing these questions, you will be presented with your results.


Based on user input on the previous pages, annual greenhouse gas emissions are calculated in terms of tonnes of carbon dioxide equivalent ($CO_2e$). $CO_2e$ is used to present the emissions of different greenhouse gases in a common unit. It is calculated for any given greenhouse gas based on its global warming potential (GWP), which is a measure of how much energy the emissions of 1 unit (e.g., 1 tonne) of gas will absorb over 100 years in comparison to the emissions of the same quantity (1 tonne) of carbon dioxide. Annual emissions are presented in terms of total emissions from the agricultural system being analyzed, and in terms of emissions per unit of yield ($CO_2e$ per tonne of product).

On the right sidebar, the user can change their agricultural practices in potential future scenarios to estimate how they would impact their emissions. Both current practices and future potential practices will appear in the bar graph to allow users to compare the two scenarios (as shown below).




Users have multiple options to save and share their results. Each analysis has a unique ID, so if you want to return to your analysis you simply need to save the URL. You can do this by clicking the save button or bookmarking the page (ctrl/cmd + d). You can also print the results as a pdf file, or they can be shared via Linkedin, Twitter, or email.