THE MANITOBA AGRICULTURAL GREENHOUSE GAS ASSESSMENT TOOL

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ABSTRACT

Manitoba Agriculture has developed an educational greenhouse gas (GHG) assessment tool that allows farmers to evaluate annual emissions from their practices and explore the impact of changing practices. Methane (CH_4) and nitrous oxide (N_2O) are potent greenhouse gases emitted by agriculture (Agriculture and Agri-Food Canada, 2025). The first phase of the GHG assessment tool provides annual estimates of N_2O and CH_4 emissions from soil and crop management practices, livestock and livestock manure. These contributions are converted to CO_2 equivalents so that their relative contributions can be compared.

Carbon dioxide (CO_2) is a GHG that is also absorbed (or sequestered) by agriculture over a long period of time (Agriculture and Agri-Food Canada, 2025). Because the GHG assessment tool provides annual estimates of N_2O and CH_4, and carbon (C) sequestration occurs on a different time scale, the GHG tool does not include C sequestration.

The annual emissions of N_2O and CH_4 generated by the tool are ballpark estimates. The calculations are based primarily on coefficients provided in Canada's National Inventory Report, which estimates GHG emissions from various activities or practices within different sectors (Environment and Climate Change Canada, 2022). Additional GHG emissions coefficients, for which there are Manitoba data, have also been included.

When using the tool, management changes should not be made based solely on the potential GHG estimates that are generated. Other important factors, such as economics, animal welfare and soil, air and water quality, should also be considered. For this paper, GHG estimates will focus on the use of synthetic nitrogen (N) fertilizer and the inclusion of enhanced efficiency fertilizers (EEFs) that are specific to Manitoba.

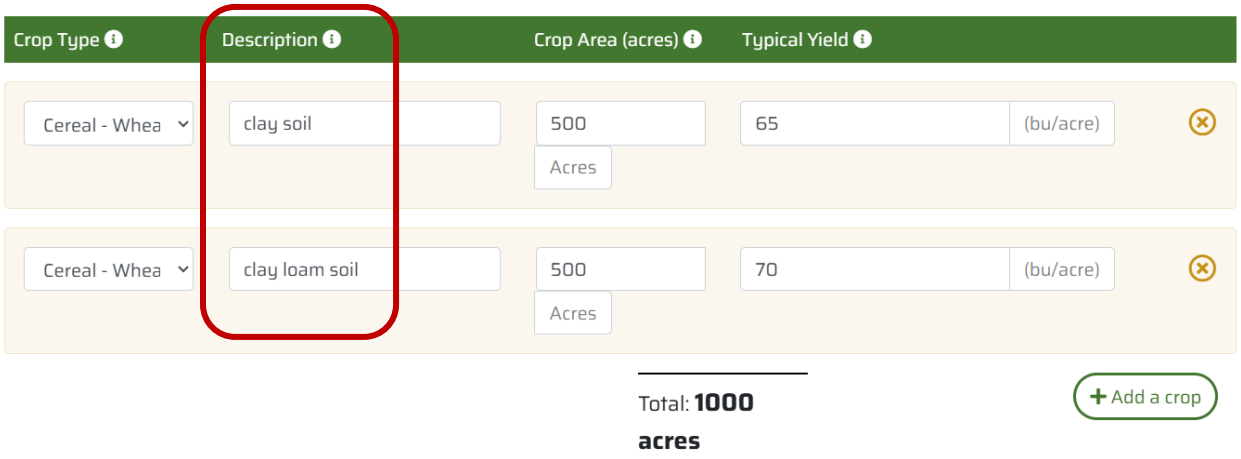
DATA ENTRY

The user must enter their data for:

- Crop types and yields
- Residue management
- Use of synthetic N fertilizer
- Use of manure and/or compost N
- Soil type, tillage practice and irrigation

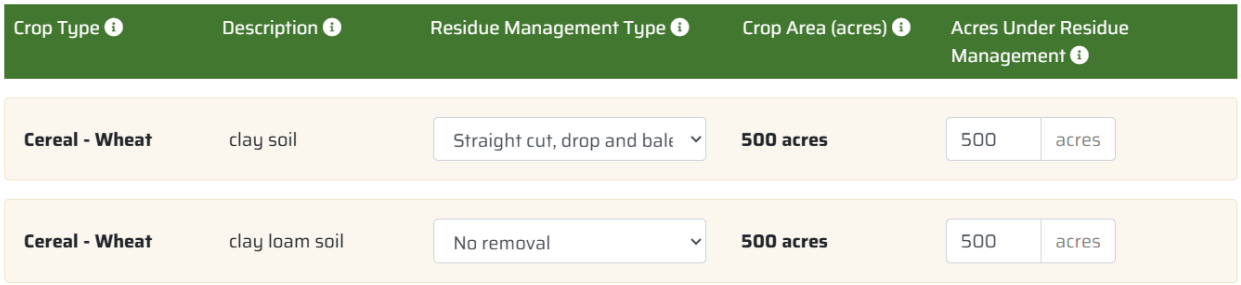
Crop Types and Yields

This tool organizes GHG emissions by crop; therefore, when entering crop type, it is possible to create more than one entry per crop if soil type or management practice varies for a particular crop. For example, if the soil type varies, those crop acres and yields can be identified by a distinct 'description' which enables the user to make management changes more specific to the soil type.



Residue Management

Residue management options include no removal, baling (either a straight cut or swathed crop), and burning. For this example, the wheat residue on the clay soil type has been baled and removed from the field. The residue on the clay loam soil has been left behind.

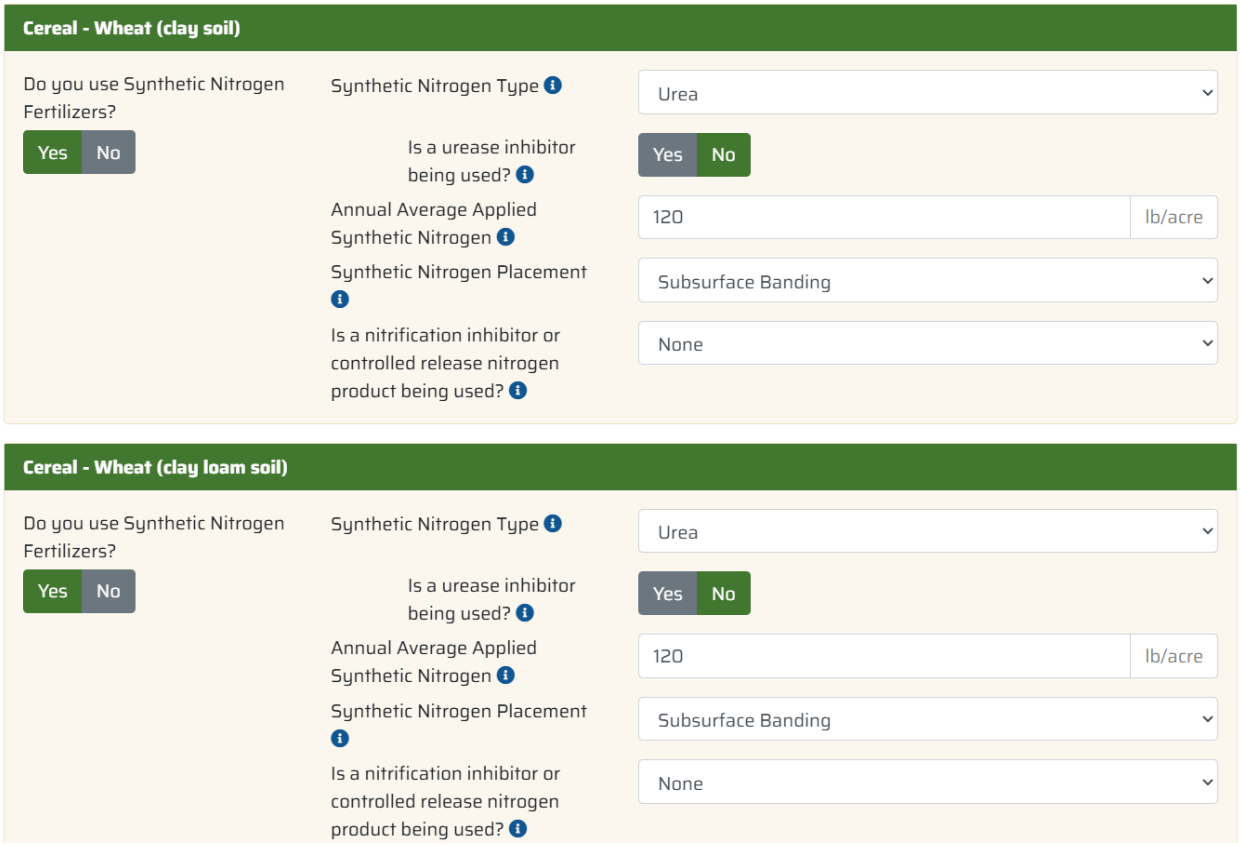


Synthetic Nitrogen Fertilizer

Synthetic N fertilizer options include the use of anhydrous ammonia, urea, UAN solution, or 'other'. The fertilizer rate chosen will be applied to all the acres identified under the crop type selected. If N rate for each crop type is similar, then an average rate should be entered, since this tool gives a general estimate of GHG emissions. However, if the rate of N applied varies widely, then the user may wish to go back and

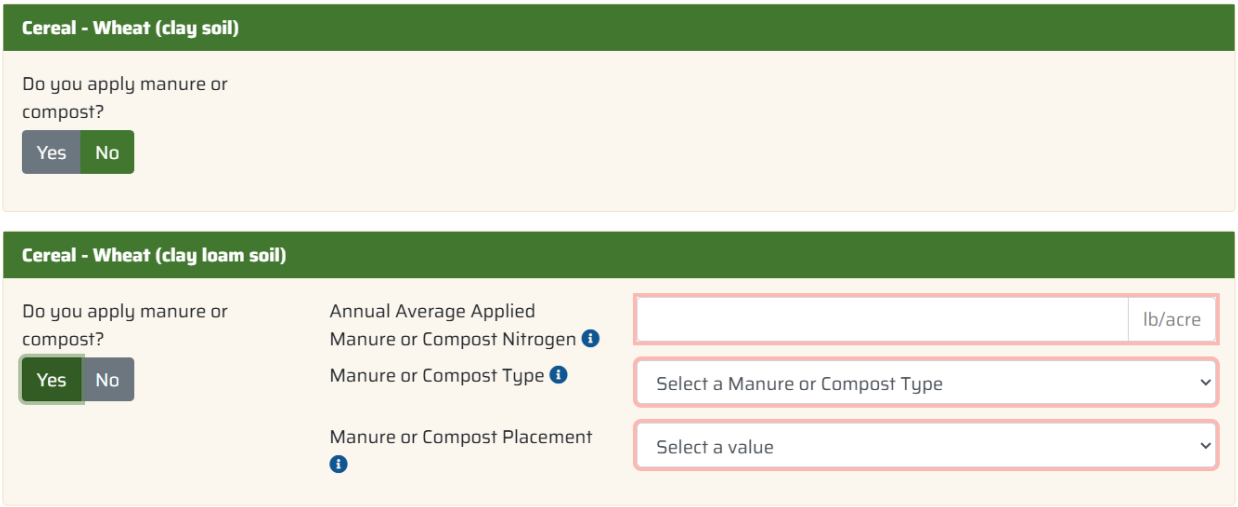
enter an additional crop under the ‘crop types and yields’ screen to allow for a more focused N rate to be applied at this stage.

Fertilizer placement and the use of urease inhibitors, nitrification inhibitors, or a controlled release N product (such as a polymer coated urea) are entered on this screen. For this example, no inhibitor has been used so it can be added as a practice change later in the assessment.



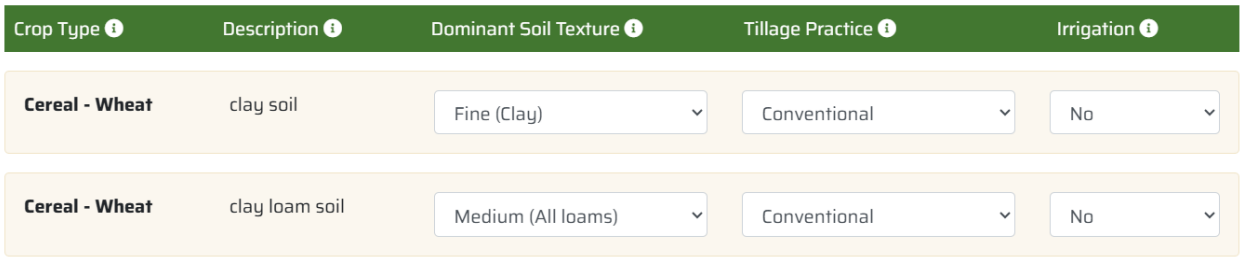
Manure/Compost Use

The use of manure or compost on cropped fields can offset the requirements for N fertilizer. For this example, no manure or compost has been identified.



Soil Properties and Practices

Finally, soil type, tillage practice and whether irrigation is used are entered for the different crop types. If soil type varies across farmed fields, such that different crops are grown on different soil textures, then this should be identified on the 'crop type and yields' screen (as was done for this example). It is possible to go back and adjust the crop types and descriptions at any point in the process. For this example, the tillage practices are conventional and the crops are not irrigated.



BASELINE EMISSIONS REPORT

Once all data has been entered, a baseline emissions report will be generated. The report is primarily based on the emissions factors identified in the National Inventory Report (Environment and Climate Change Canada, 2022) for:

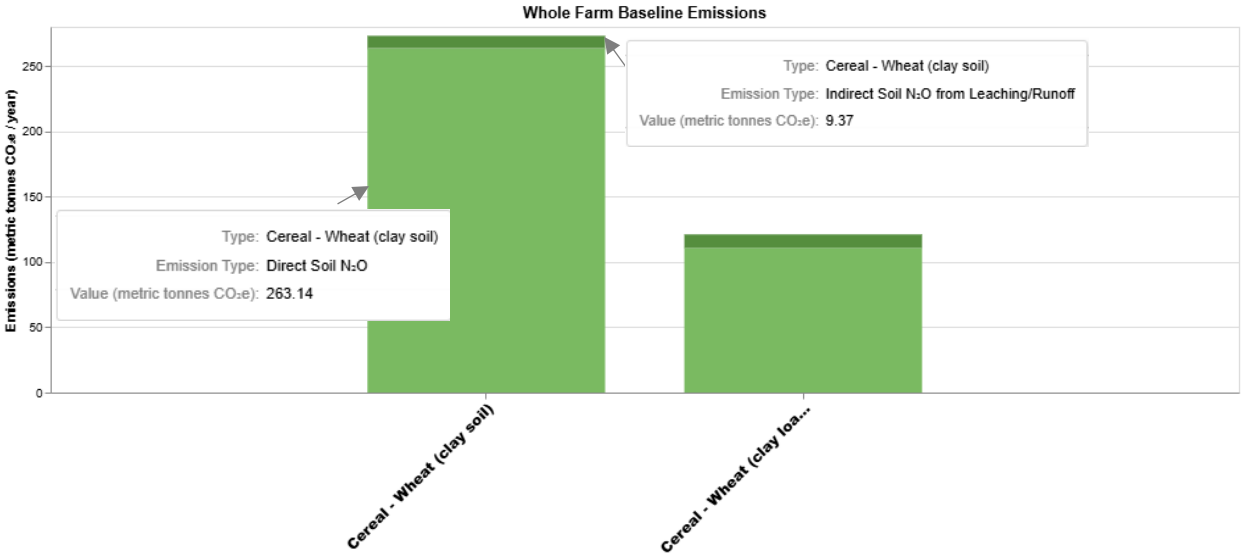
- Soil texture
- Cropping system (annual vs perennial)
- Crop type and total crop biomass
- Nitrogen source (synthetic, manure/compost, crop residue)
- Tillage (conventional vs reduced/no-till)

- Residue management (burning, baling, no removal)
- Irrigation
- Use of EEFs *(data used for nitrification inhibitors, polymer coated urea and urease inhibitors is unique to Manitoba)*

Emissions are reported in metric tonnes of CO_2 equivalent per year. They are separated into 'direct' and 'indirect' emissions:

- Direct soil N_2O – result of synthetic N fertilizer or manure/compost application, manure deposition by grazing animals, crop residue management
- Direct soil CH_4 – result of crop residue burning
- Indirect N_2O from volatilization – result of deposition and then nitrification/denitrification of volatilized ammonia-N from synthetic fertilizer or manure
- Indirect soil N_2O from leaching/runoff – result of nitrification/denitrification of N lost from field due to leaching or runoff

Emissions are displayed in a bar graph highlighting the direct and indirect emissions for all crop types identified. The data can also be viewed in a downloadable chart.



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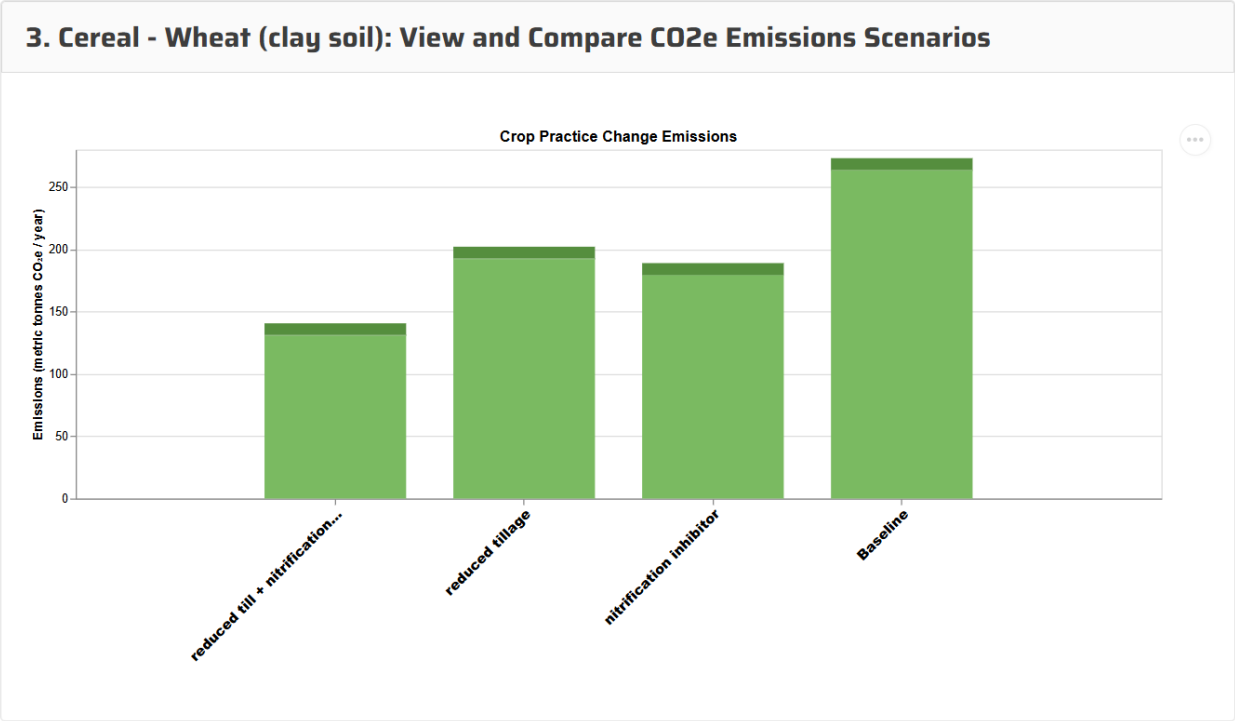
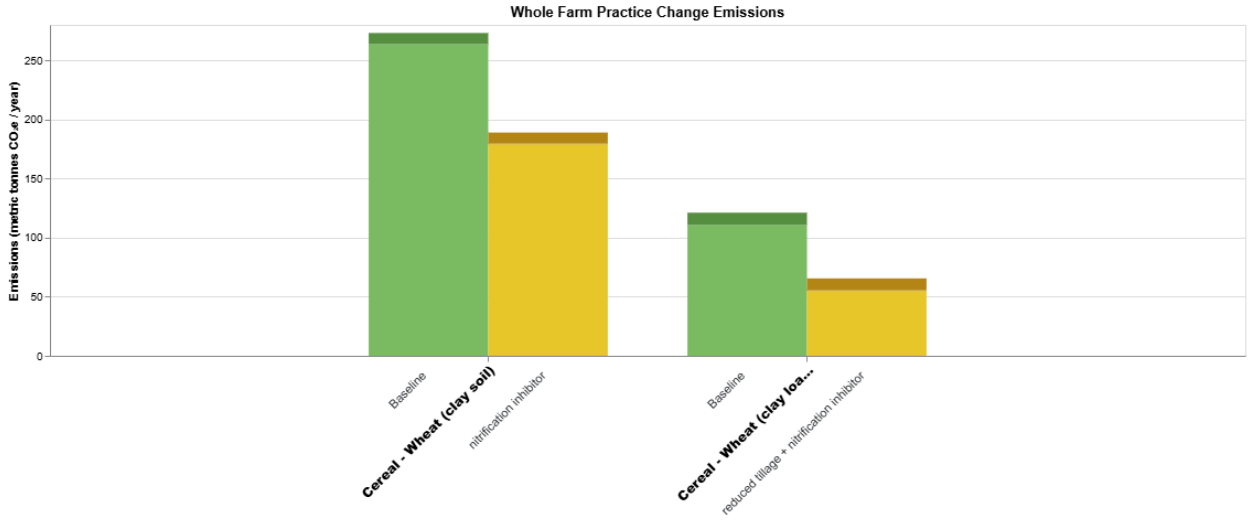
Crop Type	Description	Crop Area (acres)	Typical Yield	Yield Units	Baseline Em
Cereal - Wheat	clay soil	500	65	(bu/acre)	
Cereal - Wheat	clay loam soil	500	70	(bu/acre)	

PRACTICE CHANGE EXPLORATION

Once the baseline report has been created, practice changes can be explored for each crop type by creating practice change scenarios. Multiple practice changes can be created within a scenario or with multiple scenarios which allows the user to compare the impact of these practice changes on the potential for GHG emissions reductions.



Only one practice change scenario per crop type can be selected for the final 'practice change report'. For this example, a combination of reduced tillage and the use of a nitrification inhibitor was chosen for the wheat grown on the clay loam soil; however, reduced tillage may not be as feasible on a heavy clay soil, so only the use of a nitrification inhibitor was chosen. Other options could be to adjust how crop residue is managed, lower the N application rate, or apply compost of manure, if possible. Users can include simple or more complex management changes when creating these scenarios to see how the resulting emissions might differ.



As with the baseline emissions report, the practice change report can also be downloaded in a CSV format:

Crop Type	Crop Description	Chosen Alternative	Crop Area (acres)	Typical Yield (bu/ac)	Baseline Emission (MT CO2e/yr)	Alternative Emission (MT CO2e/yr)
Cereal - Wheat	clay soil	nitrification inhibitor	500	65	273	189
Cereal - Wheat	clay loam soil	reduced tillage + nitrification inhibitor	500	70	121	66

SUMMARY

The GHG assessment tool has been designed for general extension and education purposes. The numbers that are generated are based on national GHG emissions factors (and Manitoba-specific emissions factors where available) but may not give an accurate reflection of the actual emissions by field or crop type on a specific farm. As a result, the tool is not intended for regulatory use. Instead, users may engage with this tool to understand the relative differences in GHG emissions between current and alternative management practices.

Currently, the GHG assessment tool includes both crop and livestock components, with the livestock module covering feeding and manure storage practices. An additional component focused on on-farm energy use is under development.

REFERENCES

Agriculture and Agri-Food Canada. 2025. *Greenhouse gas emissions and agriculture* [cited 2025 Oct 30]. Available from: https://agriculture.canada.ca/en/environment/greenhouse-gases

Environment and Climate Change Canada. 2022. *National Inventory Report 1990–2020: Greenhouse Gas Sources and Sinks in Canada. Part 2*. Available from: https://publications.gc.ca/collections/collection_2022/eccc/En81-4-2020-2-eng.pdf