Interpreting The Metric

Greenhouse Gas Emissions

Why It Matters

Greenhouse gases hold heat inside the Earth's atmosphere, causing the atmosphere to warm and weather patterns to become more volatile. Warmer temperatures extend pest and disease pressure and increase plant heat stress and irrigation requirements. Extreme weather events like prolonged drought and severe flooding can cause catastrophic crop losses.

The primary approach to reducing greenhouse gas emissions for many projects is avoided emissions. This includes implementing practices that can lead to reductions in three important greenhouse gases: carbon dioxide (CO_2) when soil organic matter is oxidized by aerobic respiration; nitrous oxide (N_2O) from nitrate in fertilizer, manure, or other organic matter; and methane (CH_4) released from water-saturated rice fields. Key practices that reduce greenhouse gas emission include reducing soil disturbance, keeping the soil covered and following nutrient management techniques.

How It Is Measured In The Fieldprint® Platform

Greenhouse gas emissions are reported in the Fieldprint® Platform as pounds of carbon dioxide equivalent (CO_2e) per crop unit produced (e.g. bushels or pounds). "CO_2e" simply means the N2O and CH4 emissions are converted to the equivalent amount of CO_2 to provide a common unit of all emissions in one measure, which is comparable over time and influenced by all the actions a farmer takes.

The Fieldprint® Platform uses standard U.S. government assumptions regarding fuel use, such as the 22.3 pounds of CO_2 that are emitted per gallon of diesel combusted. Emissions also result from electricity and fuel usage as well as from burning crop residues.

Nitrous oxide emissions from a field are determined using a look-up table from detailed crop modeling performed for the annual U.S. government inventory of emissions. The Fieldprint Platform uses data on crop type, region of the country, and soil texture to determine the "emissions factor", which means how much N_2O results from additions of nitrogen (N). This factor is used to convert N from fertilizer and manure additions into N_2O.

For some corn and wheat producers, there is an option to respond to questions about adoption of advanced nutrient management practices relevant to their system to reduce agricultural N_2O emissions. Determining the right time, rate, place as well as the right source of N inputs is known as the "4R's of nutrient stewardship" and can be adopted at either beginning, intermediate or advanced levels to reduce emissions.

As noted above, methane is only calculated for rice. Methane is the byproduct of the anaerobic fermentation of soil organic matter that occurs when atmospheric oxygen is cut off from the soil and soil airspace is filled with water. Field flooding of wetland rice production creates the anaerobic environment required for methane production. The degree and timing of methane production depends on the soil and environmental conditions during flooding. Methane emissions from wetland rice fields are therefore based on region- and country-specific data. Water management, organic matter and fertilizer amendments, and other management practices are key to decreasing CH_4 emissions.

Low scores are desirable and indicate less greenhouse gas emitted per unit of crop produced.

Management Factors

- Greenhouse gas emissions are directly related to energy use. Energy-intensive practices that produce CO_2 as a by-product are:
  - Manufacturing crop seed, protectants and fertilizers
  - Grain drying
  - Irrigation pumping
  - Transportation to first point of sale
  - Field equipment passes
- Practices that produce other greenhouse gas emissions (N_2O and CH_4) are:
  - Burning crop residues to prepare a field
  - Nutrient management practices and the amount of applied nitrogen in fertilizer or manure
  - Water management, inputs and other management practices for rice fields

Strategies to Reduce Greenhouse Gas Emissions

While strategies to support a farmer in reducing greenhouse gas emissions will vary by crop and region, there are several practices that can lead to improved outcomes across multiple cropping systems and geographies, including:

- Following the principles of 4R nutrient stewardship to ensure optimal uptake of fertilizers and reduce embedded energy use.
- Minimizing soil disturbance by reducing or eliminating tillage.
- Reducing on-farm and embedded energy use.
- For irrigated crops, use of irrigation scheduling technology to improve water use efficiency and reduce the amount pumped, thereby reducing energy use.

Other Factors for Farmers to Consider

- Reducing on-farm and embedded energy use
- For rice producers, consider region-specific alternative irrigation and management options available to manage field flooding, organic matter content, and fertilizer
- Manage crop residues without burning.

The Greenhouse Gas Emissions Metric in the Fieldprint Platform offers Continuous Improvement Projects the ability to document and demonstrate progress in emissions reductions. If your project wishes to estimate carbon removals from specific practice interventions, two pathways are available to evaluate the extent to which certain farming practices remove CO2 from the atmosphere and sequester it in soil.

Farmers face agronomic and financial risks when adopting new conservation practices. While some practices that reduce input and energy use can lead to immediate cost savings, many practices require up-front investment. An essential component to supporting farmers in reducing greenhouse gas emissions is designing effective incentive strategies to support farmers and help share in the agronomic and financial risk inherent in transitioning to new practices. Please note detailed strategies for emissions reductions by crop will be available Fall 2021.

[1] *IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. R.K. Pachauri and L.A. Meyer (eds.) IPCC, Geneva, Switzerland, 151 pp. Available at http://www.ipcc.ch/report/ar5/syr*