Why the Need for a CI-Score Calculator?
The accompanying AgDM File A1-80 Decision Tool, www.extension.iastate.edu/agdm/crops/xls/a1-80carbonintensityscorecalc.xlsx, was designed to help United States farmers achieve four goals with minimal effort:

1) calculate the average carbon intensity score (CI-Score) of their corn production under current farming practices,
2) calculate the expected change in CI-Score under alternative farming practices,
3) project the dollar amount of the Federal Tax Credit 45Z that ethanol plants would obtain from using the corn supplied by the farmer as feedstock under (1) and (2), and
4) project the extra-revenue that a farmer could receive from the ethanol plant, depending on the share of Tax Credit passed-through.

Background Information
The Inflation Reduction Act (IRA) of 2022 and the USDA Partnerships for Climate-Smart Commodities provide multiple pathways for farmers and ranchers to expand markets for America’s Climate-Smart Commodities, leverage the greenhouse gas (GHG) benefits of Climate-Smart commodity production, and provide direct benefits to production agriculture. Direct pathways include participating in Voluntary Carbon Markets, by contracting with voluntary private carbon initiatives (VPCIs) to implement agricultural conservation practices that sequester carbon in the soil and avoid GHG emissions in exchange for monetary compensation. See AgDM File A1-76, How to Grow and Sell Carbon Credits in US Agriculture, www.extension.iastate.edu/agdm/crops/html/a1-76.html, for a side-by-side comparison of VPCIs; AgDM File A1-40, Carbon Farming: Stacking Payments from Private Initiatives and Federal Programs, www.extension.iastate.edu/agdm/crops/html/a1-40.html, to review the interaction of VPCIs and USDA cost-share programs; and AgDM File A1-78, Net Returns to Carbon Farming, www.extension.iastate.edu/agdm/crops/html/a1-78.html, to evaluate the financial impact of contracting with VPCIs for your own operation.

Indirect pathways for farmers and ranchers to participate in Climate-Smart programs include efforts to reduce the carbon intensity of feedstocks used in biofuels production. Over the past two decades, substantial reductions in GHG emissions from the electric power generation sector drove down total US GHG emissions. The next policy goal is to reduce emissions from the transportation sector. Tax credits to biofuel plants are among the chosen instruments to target this federal policy goal.

Federal Tax Credit 45Z (TC45Z), the “Clean Fuel Production Credit”, consolidates and replaces several fuel-related credits scheduled to expire at the end of 2024, including credits for the production of biodiesel, agri-biodiesel, renewable diesel, second-generation biofuel, sustainable
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aviation fuel, alternative fuels, and alternative fuels mixtures (Congressional Research Service, 2023). A major difference between TC45Z and the expiring provisions is that while the latter subsidize specific types of low-GHG emission fuels, the former is technology-neutral and is intended to subsidize the production of any transportation fuel with zero or low GHG emissions. TC45Z is expected to be available to biofuel refineries for qualifying transportation fuel produced after 2024 and sold on or before December 31, 2027. TC45Z has the potential to generate significant tax savings for US fuel production facilities able to produce “clean” fuel, defined as fuel produced with no more than 50 kilograms of carbon dioxide equivalent per 1 million British Thermal Units (50 kg CO$_2$e / 1 mmBTU). The 2022 IRA defined the formula to calculate the credit values per ton of clean fuel sold as

$$0.20 \times \left[ 1 - \left( \frac{\text{kg of CO}_2\text{e per mmBTU}}{50} \right) \right],$$

where the expression in square brackets is called the Emissions Factor (EF). The base payment rate is higher for sustainable aviation fuel (SAF) than for other fuels: $0.35 instead of $0.20. Finally, if certain wage and apprenticeship requirements are met by the refinery, the base payment rate increases from $0.20 to $1.00 for non-SAF and from $0.35 to $1.75 for SAF.

While federal agencies are still developing the rules and underlying life-cycle analysis (LCA) model for the operationalization of TC45Z, the CI-Score Calculator is based on the R&D version of GREET (Greenhouse gases, Regulated Emissions, and Energy use in Technologies): a full life-cycle model sponsored by the Argonne National Laboratory, U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy. The R&D version of GREET (Wang et al., 2023) fully evaluates the farm-to-fumes GHG emissions of advanced and new transportation fuels. The GREET model is specified in the IRA as the methodology to calculate the LCA for clean hydrogen production until a successor is approved by the Secretary of the Treasury.

How to Use the CI-Score Calculator?
The adapted version of the GREET model used in the CI-Score Calculator assumes that each farm is identical to the baseline GREET-farm in the county where it is located in all aspects but the following five attributes: fertilizer use, corn yield, cover crop use, manure use, and tillage practice. Those attributes must be defined by the user of the Calculator, along with the county where the farm is located, and the corn area under analysis.

In the “CI Calculations” tab, users must select five attributes from drop-down menus (State, County, Cover crop use, Manure use, and Tillage practice) and enter three values (Corn acres, Your fertilizer use, and Your yield) to evaluate the CI-Score, the projected value of the TC45Z, and the maximum dollar amount to be received from the ethanol plant, under “Current farming practices”.

Additionally, users must select three additional attributes from drop-down menus (Cover crop use, Manure use, and Tillage practice), and enter two additional values (Change in fertilizer use and Change in yield) to evaluate the results under “New farming practices”.

A number of assumptions (such as the conversion factor of each bushel of corn into gallons of ethanol, the corn-ethanol CI-Score, and the energy units per gallon of ethanol) are required to translate CI-Scores in grams of CO$_2$e per bushel into grams of CO$_2$e per megajule of energy (g CO$_2$e / MJ) per gallon of fuel. Users can modify the assumptions by changing the values of the highlighted cells in the “Details” tab.

How to Interpret the Results of the CI-Score Calculator?
The CI-Scores reported in Section 2 of the Calculator are approximations to a more nuanced CI-Score calculated using all variables in the GREET model, which encompasses many additional variables at the farm level that are assumed fixed at the average county level in our Calculator.
The more dissimilar an operation is with respect to the baseline GREET-farm, the more likely it is that the approximated CI-Score from our Calculator differs from the detailed CI-Score from GREET. However, even when such differences exist under Current Farming Practices, and as long as the only changes in farming practices are those from cover crop use, manure use, tillage, fertilizer use, or yield, the “Decline in Total CI Score” should be a good approximation to the change in CI Score derived from the full GREET model.

In order to consider scenarios where TC45Z might be relevant for corn farmers, Section 4 assumes that total life-cycle emissions from ethanol are already lower than the threshold of 50 kg $\text{CO}_2\text{e} / \text{mmBTU}$. Under this assumption, reductions in the farm CI Score below the Industry Average CI Score generate tax credits for the ethanol plant. If the $\text{CO}_2\text{e}$ emissions of the ethanol plant exceed the 50 kg $\text{CO}_2\text{e} / \text{mmBTU}$ threshold, the refinery cannot participate in this Tax Credit program. The set of results reported in Sections 4 and 5 of our Calculator must be interpreted only as preliminary projections of the impact of farming practices on the capacity of a corn ethanol plant to derive federal tax credits, and the maximum value that a farm can expect to receive in return for producing low-carbon intensity corn depending on the tax credit pass-through. Of course, such pass-through will depend on the relative bargaining power of corn farmers and each ethanol plant, and could take values from 0% (no pass-through) to 100% (full pass-through).

**Caveats**

The federal government is finalizing the rules and models that will be used in the implementation of the TC45Z, and the final model could differ substantially from the one used in this CI-Score Calculator. The value of this tool is purely educational and does not imply any warranties on the potential payments from the TC45Z program.

**References**

