

Digging Deeper into Carbon Intensity



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Biofuel carbon intensity scores: Knowns and unknowns for Illinois farmers

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Setting the table for 45Z

Carbon Intensity is an estimate of the greenhouse gas emissions associated with the materials and processes involved in creating a product. The Carbon Intensity (CI, sometimes referred to as CI score) of a biofuel is an estimate of the greenhouse gas emissions involved in the feedstock production and fuel conversion steps of a biofuel supply chain.

The IRS 45Z tax credit program is an incentive for **biofuel plants** to reduce their fuel's CI relative to a national standard. Over 50% of the CI of corn ethanol or soybean biomass-based diesel can come from the crop (feedstock) production portion of the biofuel's life cycle. Corn and soybean farmers can reduce their feedstock's contribution to a plant's overall CI score by:

- increasing crop yield
- reducing greenhouse gas emissions associated with crop production and/or
- adding or protecting carbon in their soil via cover crops or conservation tillage

Corn and soybean farmers with low CI scores could stand to profit from the 45Z tax credits paid by the IRS to biofuel plants, but how much of that benefit will pass through the supply chain to farmers remains unclear.

Here we present a brief guide for farmers on what is known and what remains unknown given the latest information.



Consider this

If you're deciding whether to participate in a biofuel plant's 45Z program here are some facts to consider. Unlike environmental market programs like the voluntary carbon market, practices do not have to be new or "additional" to an acre to count toward a CI score. This is good news for farmers who have already adopted cover crops and conservation tillage. Farmers who have not yet adopted these practices may want to weigh their options between 45Z and environmental market programs where additionality is required. Cropland acres earning a 45Z payment may not be eligible in the future for environmental market programs requiring additionality. Also know that the 45Z tax credit program [expires at the end of 2029](#) but could be renewed. Producers may stack 45Z with cost-share programs like EQIP and CSP.



Healthy Illinois soils beneath an annual rye grass - crimson clover cover crop mix. Cover crops are one way to lower a crop's CI score. Photo by ISAP.



What we know: The Final Rule

In June 2026 the USDA released their [final rule](#) on how they will account for the CI of biofuel feedstock crops. The rule contained several new pieces of information relevant to farmers.

- USDA will use a **mass balance traceability system** rather than a book and claim system. A book and claim system would have enabled any US grower to participate but would require the establishment of a registry and marketplace for claim transactions. Mass balance means that the CI score physically travels with the grain through the supply chain, but the identity is not physically separated from other grain such as with organic grain.
- Grain aggregators keep track of the proportions of grain CI scores combined in an elevator. These proportions are tracked through the supply chain. *Mass*

balance likely limits participation to growers located near biofuel plants and elevators in the biofuel supply chain.

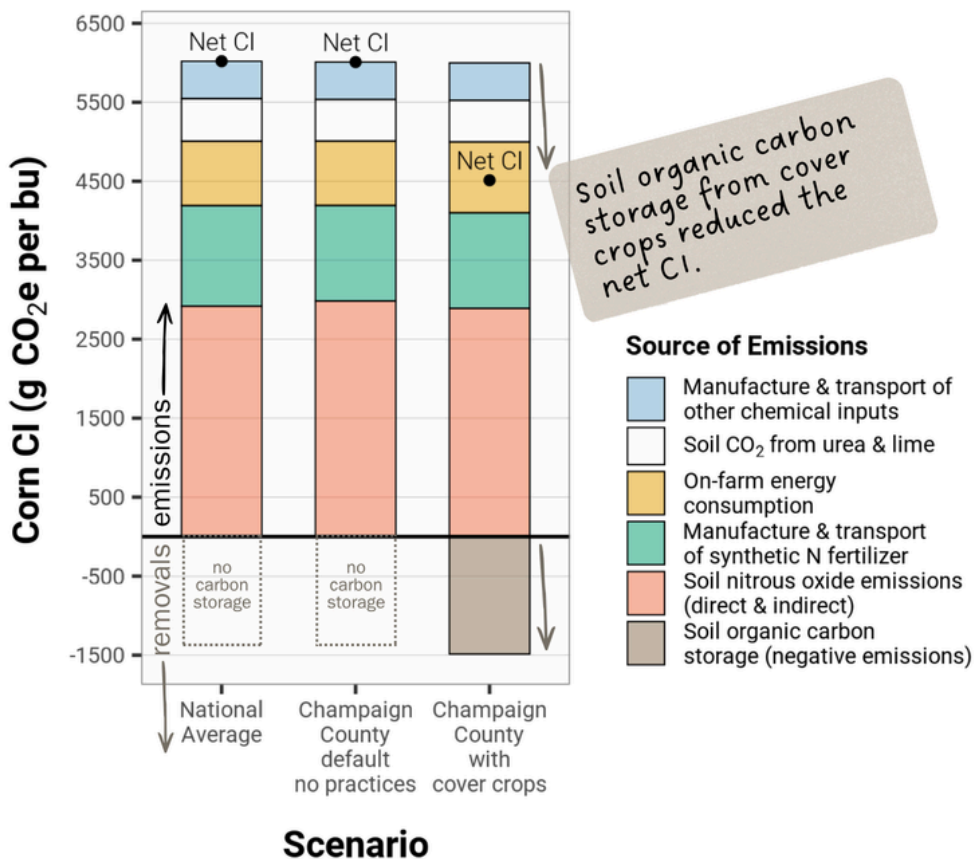
- The final rule also updated the Feedstock CI Calculator (FD-CIC) for estimating the CI of field corn, soybeans, sorghum, and spring canola. The tool is available as an [excel spreadsheet or web-based tool](#).

The calculator requires growers to provide total nitrogen (N) fertilizer used, actual crop yield, and expected crop yield (in case of a crop failure). Growers also provide details on their use of practices that may lower their CI: cover crop, tillage type, nitrification inhibitor, and manure. **Figure 1** explains the different components of a corn CI score.

- When a no-till farmer provides their CI score to the buyer they will have to provide an attestation that they “*will continue no-till on all crops in the rotation for a minimum of four out of every five years*” ([Technical Guidelines §](#)

[2100.031](#)) in order for the estimated soil carbon storage benefit to match assumptions in the FD-CIC model. In other words, if a producer includes no-till in their CI score calculation but tills more than once in the next five years, the CI score would be artificially low.

Figure 1. Components of carbon intensity in the USDA’s national average estimate for corn compared to a corn field in Champaign County, Illinois without low carbon practices and with cover crops according to the FD-CIC. Soil organic carbon storage with cover crops reduced the corn CI by 25%. See [Notes 1 & 2](#) for calculator inputs and unit conversion details.





The Final Rule (continued)

- Tillage type chosen in the CI Calculator is now dictated by a separate scoring tool called [T-DISC](#), which scores a field's tillage based on the intensity of field operations to ensure consistent tillage classifications across farms. In T-DISC, knifing in liquid manure or fertilizer moves a "No-till" field to "Reduced till," which impacts the CI score. According to results averaged across 15 Illinois counties (see [Note 2](#)), a no-till field reduces corn CI by about 2,100 g CO₂e per bu compared to the USDA national average corn CI, whereas reduced tillage only decreases the corn CI by about 480 g CO₂e per bu (**Figure 2** below).



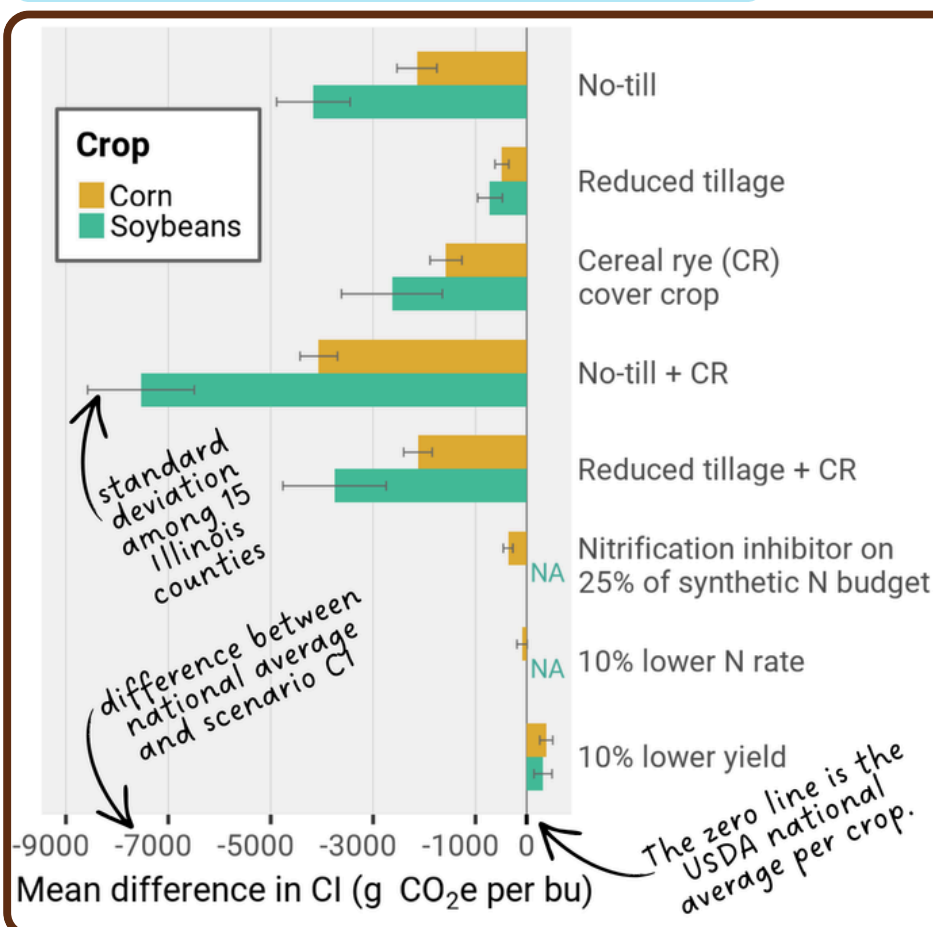
Before switching to surface application consider the water quality benefits of incorporating manure and other fertilizers compared to surface application.

- Substituting manure for part of the total N budget reduces the CI score by about 2-7% depending on manure amount, type, and N content. This reduction is due to slightly lower emissions from manufacture and transport of the manure and lower CO₂ emissions from lime for manure N compared to synthetic N fertilizer. In the calculator, manure nitrous oxide emissions and soil C storage are no different than a scenario using the same amount of N as synthetic N fertilizer.



Corn vs. soybean CI scores

Looking at Figure 2 you may wonder **why soybeans have much greater CI differences compared to corn**. Soybean yields are much lower than corn. So *reductions in emissions per bushel* are much larger for soybeans compared to corn.



Because the field's emissions are tied to crop yields, lower crop yields mean higher (worse) CI. In our calculations, a 10% yield loss increased CI by about 380 g CO₂e per bu corn and about 320 g CO₂e per bu soybean. In other words, for every one bushel yield loss, CI increased by about 18 g CO₂e for corn and 6 g CO₂e for soybeans.

Figure 2. We ran various scenarios in the USDA Feedstock CI Calculator for 15 Illinois counties. Then we subtracted the scenario CI from the national average CI for corn (yellow) or soybeans (green) and calculated the mean across the counties. Error bars indicate the standard deviation among the counties. The [USDA national average](#) CIs (zero line) are 6,020 g CO₂e per bu corn and 7,682 g CO₂e per bu soybeans. Tool inputs and conversions in [Notes 1 & 2](#).

\$ What we don't know: Payments to farmers

How a farmer's crop CI score affects the level of their payment from the buyer is not clear. The IRS tax credit goes to biofuel plants—not farmers. The payment to farmers will be less than the face value of the tax credit because of [several transactions](#) along the value chain from plant to farmer (**Figure 3** below). Plants will typically sell these clean energy tax credits in a transfer market where credits are sold to taxpayers at a discount. Plants will usually buy tax credit insurance to protect buyers in case the IRS challenges the validity of their 45Z credits. Each entity in the supply chain also has reporting and verification responsibilities that cost money to operate.

Any potential payment that passes from the biofuel plant to the farmer is unknown, because payments will be decided by each biofuel plant and supply chain entity. Any payments will likely vary greatly by crop

because of their different CI score potentials as explained above. Also, corn passes through fewer entities from farmer to ethanol plant, whereas soybeans pass through many hands, with each middleman potentially claiming a portion of that payment. Ultimately, the rule leaves it up to each plant and their supply chain to determine how much, if any, incentive payment goes to farmers. This is a major difference compared to “pay for practice” programs like EQIP or environmental market programs that pay farmers per tonne CO₂e avoided or removed.

Biofuel plants can also choose how to average the wide range of CI scores from their many producers. They could apply one average incentive payment rate per bushel to all farmers, or the incentives could be tiered by a farmer's CI score.

CI score tax credit payment rates to biofuel plants are [tiered by increments](#) of 10-15 kg CO₂e per mmBTU of their biofuel. A biofuel

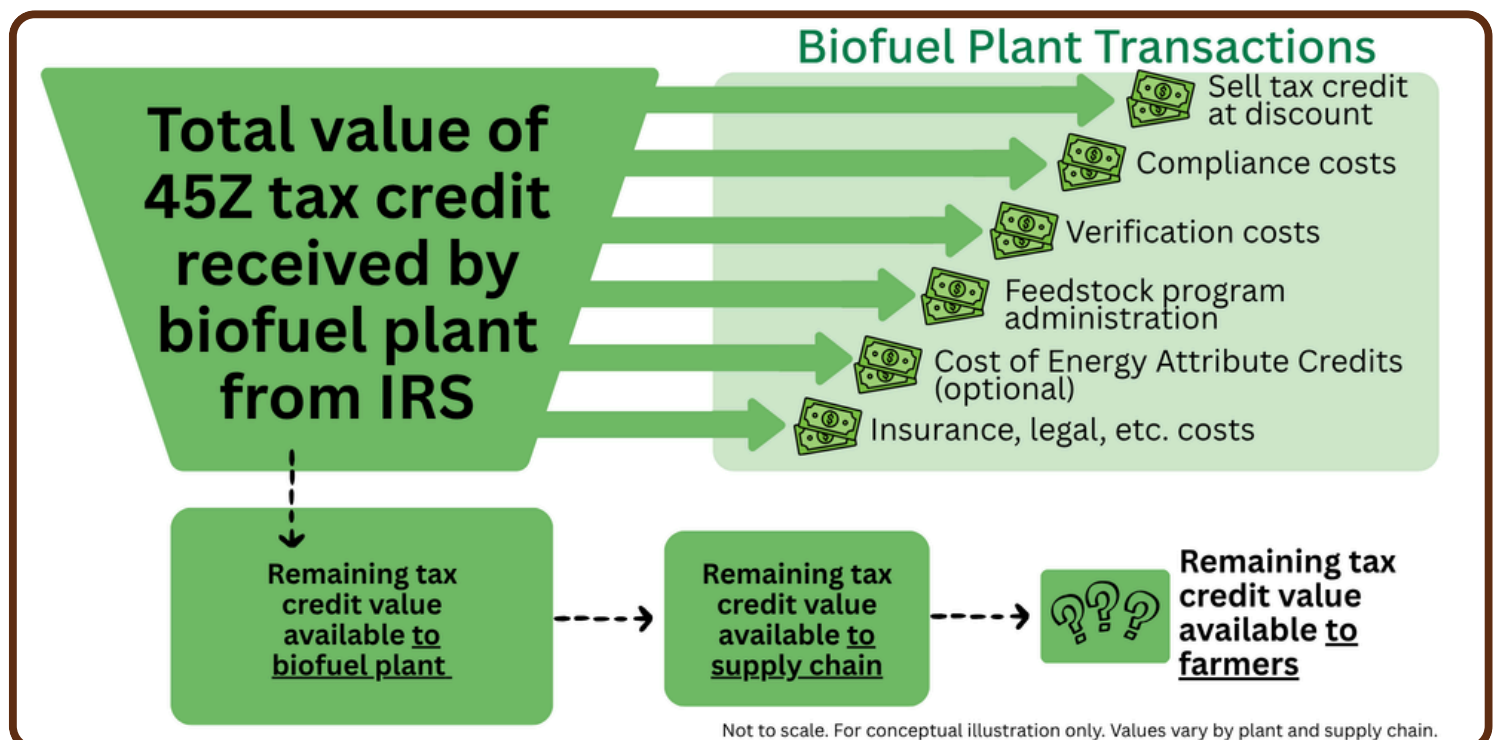


Figure 3. The difference between the 45Z tax credit to the biofuel plant and what might remain for farmers selling biofuel crops into the feedstock supply chain. Based on [this incite.ag blog post](https://thisincite.ag/blog/post) by Preston Brown with permission.

\$ Payments to farmers (continued)

producer only qualifies for a higher credit per gallon of biofuel by lowering their CI score into a whole new tier. In theory, this means that a biofuel producer that is close to moving into the next lower CI score tier would pay a higher incentive rate than a biofuel producer who is at the higher end of a tier. How this actually plays out is still unclear.

✓ Record keeping

A producer selling a crop into a biofuel supply chain must:

- Have nutrient management recordkeeping that includes [several components](#), including a nutrient budget demonstrating crop nutrient needs for N-P-K and a recent soil test or professional opinion.
- Provide the first point of aggregation (the entity buying from the farmer) with a Biofuel Feedstock Report ([what the Report must include](#) § 2100.031(e)).
- Keep records that a third party verifier can use in the case that they are audited at the first point of aggregation in a supply chain (elevator, processor, plant, etc). Farmers may, but are not required to, get their records verified by a third party independently.

➔ What you can do

What you can do: Connect with [ISAP](#) to learn more. Get the latest updates by subscribing to [The Aggregate](#), ISAP's monthly e-newsletter. Also check out ISAP's resources for producers at any step in their [soil health journey](#), including adopting the low-carbon practices discussed here.

The next section provides some questions you can ask to your grain buyer. The next page has links to learn more.

“ What to ask

Farmers may consider asking the following questions of their nearest biofuel feedstock buyer (an elevator, an ethanol plant, etc.).

- **How will I be compensated for contributing to a biofuel plant's 45Z tax credit payment? Further, is compensation calculated by farmer or is it an average among farmers with different CI scores?** *Without this information it may be hard to decide if implementing a new low-carbon practice will pay off at the farm level. If enough farmers ask these questions, it may encourage greater transparency from buyers.*
- **How will you collect my Biofuel Feedstock Report?** *This will help you correctly prepare and submit your report ([what the Report must include](#) § 2100.031(e)) in paper or electronic form. The buyer may also provide guidance on [what records you are required to keep](#) in case you are audited by their third party verifier.*

Please contact Bonnie McGill at bmcgill@farmland.org if you have questions or comments about this report.

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Learn more

- For details on unit conversions, how we used the calculator, etc. see Notes below.
- [USDA Final Rule on Technical Guidelines for the Production of Regenerative Agricultural Biofuel Feedstocks](#) (June 2026) – this page includes an informative webinar recording from USDA explaining the Final Rule
- [USDA Feedstock CI Calculator \(FD-CIC\)](#) – excel spreadsheet and web app versions available here.
- [USDA Tillage Disturbance Calculator \(T-DISC\)](#) – excel spreadsheet and web app versions available here.
- [The Section 45Z Clean Fuel Production Credit](#) – a report by the Congressional Research Service (Feb. 2025)
- American Soybean Association [A Look at Potential Soybean Farmer Premiums with 45Z](#)
- IL Corn [What Illinois Corn Farmers Need to Know About 45Z](#)
- incite.ag [The Economics Behind 45Z Feedstock Value](#)



Notes

1. Unit conversions

Looking to convert the USDA Feedstock CI Calculator output in g CO₂e per bu to kg CO₂e per mmBTU used by biofuel plants and the IRS? The following reference values are from the R&D GREET Fuel Cycle Model available at https://greet.anl.gov/greet_1_series.

Energy-yield term	Corn	Soybean	Source
BTU/gal	76330	119624	GREET
lb soybean oil/bu	NA	52.2	GREET
gal soybean oil/lb oil	NA	0.14	GREET
gal/bu	2.89	7.308	GREET
mmBTU/bu	0.2206	0.8742	calculation

Then, use the following equations where “X” is the CI from the USDA Feedstock CI Calculator.

- For corn:
$$\frac{X \text{ g CO}_2\text{e}}{\text{bu corn}} \times \frac{1 \text{ kg}}{1000 \text{ g}} \times \frac{1 \text{ bu}}{0.2206 \text{ mmBTU}} = \frac{Y \text{ kg CO}_2\text{e}}{\text{mmBTU corn ethanol}}$$
- For soybeans:
$$\frac{X \text{ g CO}_2\text{e}}{\text{bu soybean}} \times \frac{1 \text{ kg}}{1000 \text{ g}} \times \frac{1 \text{ bu}}{0.8742 \text{ mmBTU}} = \frac{Y \text{ kg CO}_2\text{e}}{\text{mmBTU biomass based diesel}}$$

Notes continue on the next page.



Notes continued

2. Inputs for running USDA Feedstock CI Calculator to produce data in Figures 1 and 2.

	North IL	Central IL	South IL
Counties	Henry, LaSalle, Lee, Ogle, Stephenson	Champaign, Christian, Hancock, Logan, McLean	Hamilton, Jasper, Randolph, Wabash, Washington,
CORN			
“Actual” Yield (bu/ac)	229	224	189
“Expected” Yield (bu/ac)	190	190	160
N fert (lb N/ac)	209	208	201
SOYBEAN			
“Actual” Yield (bu/ac)	67	69	59
“Expected” Yield (bu/ac)	60	62	53
N fert (lb N/ac) MAP & DAP	5.8	5.8	5.8

- The **actual yields and N fertilizer rates** were developed in consultation with ISAP members.
- A producer’s **expected yield** is the yield used to establish coverage on crop insurance or, in the absence of crop insurance, the county benchmark yield published by USDA RMA. The tool uses the actual yield if it falls within +/- 20% of the expected yield, otherwise the tool uses the upper or lower bounds (expected yield +/- 20%). So we chose expected yields that are within 20% of the actual yields.
- For the **nitrification inhibitor** scenario, we applied it to 25% of the synthetic N fertilizer.
- The scenarios were run on USDA FD-CIC version 1.2 released 9/11/2026.
- For R scripts to make Figures 1 and 2, email bmcgill@farmland.org.

3. Comparing corn and soybeans

This table provides more information comparing corn and soybean in terms of energy output and different units.

Energy-yield term	Corn	Soybeans	Notes
mmBTU/bu	0.221	0.874	From GREET
IL average bu/ac	210	65	Based on ISAP member input
mmBTU/ac	46.32	56.82	Soybean yield is lower but still contains more energy than corn per ac
USDA National average g CO ₂ e / bu	6,019.55	7,682.15	Values provided in USDA FD-CIC tool
USDA National average kg CO ₂ e / mmBTU	27.29	8.79	Corn has more emissions per unit energy because it has a lower energy content per bu
<i>If we adopt a practice on a corn or soybean field that sequesters 0.5 tonne OR 500 kg CO₂e/ac that can be expressed as:</i>			
g CO ₂ e / bu	2,381	7,692	Soybeans seem to sequester more than corn because the 500 is divided by a larger number for corn (bu/ac).
kg CO ₂ e / mmBTU	10.79	8.80	Soybeans seem to sequester less than corn because the 500 is divided by a larger number for soybeans (mmBTU/ac).
<i>As practices increase in kg CO₂e/ac sequestered, the difference between soybeans and corn gets bigger.</i>			