



Tillage Intensity Classification for Greenhouse Gas (GHG) Emission Estimations

Introduction

Tillage practices can impact soil greenhouse gas (GHG) emissions, soil carbon (C) sequestration and overall soil health. Tools are available to estimate whole farm GHG inventories (N₂O, CO₂, and CH₄ emissions), field-based emissions, and C sequestration or loss. These tools often require a user to classify tillage intensity.

The Natural Resources Conservation Service (NRCS) GHG accounting system uses the Revised Universal Soil Loss Equation (RUSLE2) to calculate a Soil Tillage Intensity Rating (STIR) that can be used to classify the intensity of various tillage practices. This tool also classifies tillage intensity based on percent residue surface cover and soil disturbed.

This factsheet explains what a STIR factor is, describes how to determine percent surface residue cover, and categorize different tillage practices into tillage intensity classifications.

Soil Tillage Intensity Rating (STIR)

The STIR value of a field can range from 0-200 with high values for intense tillage (Table 1). The STIR is based on four components: tillage type, depth of operation, operational speed, and percent of soil surface area disturbed.

- **Tillage type:** This describes how a tillage pass mixes soil and crop residue. Tillage disturbance operations can include inversion and some mixing of soil, mixing and some (limited) inversion, lifting and fracturing, mixing only, and soil compression.
- **Depth of operation:** The depth to which soil disturbance and residue incorporation occur.

- **Operational speed of tillage:** This is the recommended operating speed of each tillage operation. The forward speed of a tillage implement impacts soil disturbance and mixing; faster speeds result in more significant forces and broader disturbance.
- **Percent of soil surface area disturbed:** The percentage of surface soil disturbed by the tillage pass.

Estimating Percent Residue Cover

Percent residue cover remaining on the surface following a tillage operation can be determined using the RUSLE2 equation or measured in the field using the line transect method. The line transect uses a line measuring tool (a rope or tape measure) that has 100 equally distributed and easily viewed marks (Figure 1).



Figure 1. A simple measuring tape can be used to easily determine percent residue surface cover of a field (Picture credits: <https://www.sdsoilhealthcoalition.org/soil-health-assessment-card/>).

Table 1. Tillage operations associated with intensity used in greenhouse gas (GHG) emission models, their estimated surface residue coverage (percentage) and soil tillage intensity rating (STIR) value for both NRCS estimations and other GHG emission tool estimations.

	Source of Tool	Residue ▼	Moldboard plow	Chisel plow	Field Cultivator	Tandem Disk	Row Cultivator	Strip-Tiller	No-Till Planter
		STIR ►	55-65	42-49	23	19-39	9	8-15	0
Intensive	NRCS	< 15%	X		X	X			
Full	Other	< 30%	X	X			X		
Reduced	NRCS	15-30%		X		X			
	Other	≥ 30%		X	X	X	X	X	
Mulch	NRCS	≥ 30%			X	X	X		
Ridge	NRCS	≥ 30%			X		X	X	X
Strip	NRCS	≥ 75%			X		X	X	X
No-till	NRCS	≥ 75%							X
	Other	100%							X

Typically, the measuring tool is 100 feet long with markings at 1-foot intervals or 50 feet long with marking at 6-inch intervals. To determine the percent residue surface cover of a field, stretch the tool diagonally across crop rows in a direction that is at least 45 degrees off the row direction and count the number of markings that have crop residue directly present beneath. Residue smaller than 1/8 inch in diameter should not be counted. The total count (markings with residue beneath them) is the percent residue cover for the field. This process should be repeated at least three times in different areas of the field and percentages should be averaged.

NRCS Tillage Intensity Classes

The NRCS tool groups tillage practices into six categories; intensive, reduced, mulch, ridge, strip, and no-till:

- *Intensive tillage* is full width tillage that inverts soil with high disturbance. Common equipment includes a moldboard plow.
- *Reduced tillage* occurs at full width without soil inversion, using a point chisel plow, field cultivator and/or tandem disk.
- *Mulch tillage* a single pass across the field using tools such as a tandem disk followed by field or row cultivator or similar implement.
- *Ridge tillage* creates soil ridges in the field that are rebuilt during cultivation by disturbing up to 1/3 of the row width. The soil is then undisturbed from harvest to planting.
- *Strip tillage* leaves the soil between crop rows undisturbed (Figure 2). To create a seedbed, up to 1/3 of the row width is disturbed.
- *No-till* operations plant crop seeds directly through residue of the previous crop using a no-till planter or drill.



Figure 2: Strip tillage leaves the soil between crop rows undisturbed.

Full vs. Reduced vs. No-Till

Some GHG footprint assessment tools categorize tillage practices differently, using three main categories; full, reduced, and no-till:

- *Full tillage* contributes to significant soil disturbance, fully inverting the soil (as is done with moldboard plowing) and/or performing tillage operations frequently in the same year using tools like chisel plows or row cultivators.
- *Reduced tillage* also disturbs the soil but does not fully invert the soil. Examples include one-time use of chisel plows, field cultivators, tandem disks, row cultivators, or strip-tillers.
- *No-till* practices directly drill crop seed through the residue layer with little to no disturbance to the soil. Minimal disturbance occurs in the area where seeds are planted. Common operations use a no-till planter.

In Summary

Tools available to assess whole-farm and field-based GHG inventories and C sequestration or loss require the user to classify tillage intensity. Choosing the tillage description that best fits the producers' management practices is essential for accurately assessing GHG emissions.

Additional Resources

- Tillage Equipment Pocket Identification Guide. Natural Resources Conservation Service (NRCS). https://nydairyadmin.cce.cornell.edu/uploads/doc_21.pdf
- Estimating Residue Using the Line-Transsect Method. A3533. University of Wisconsin Extension. <http://corn.agronomy.wisc.edu/Management/pdfs/A3533.pdf>

Disclaimer

This fact sheet reflects the current authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of discharge levels from agricultural land.

For more information



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