Use of OpTIS to Track Adoption of Cover Crops and Conservation Tillage

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Agriculture Workgroup

CTIC

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regrow

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regrow

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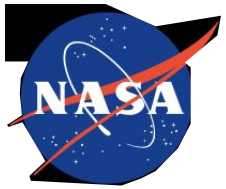
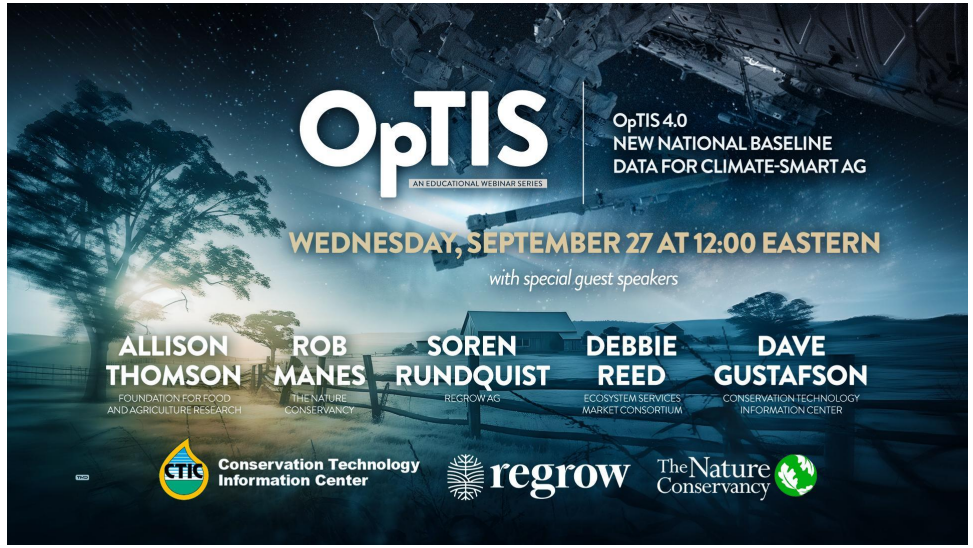


Public Webinar held September 27, 2023
Recording available at:
http://www.ctic.org/OpTIS



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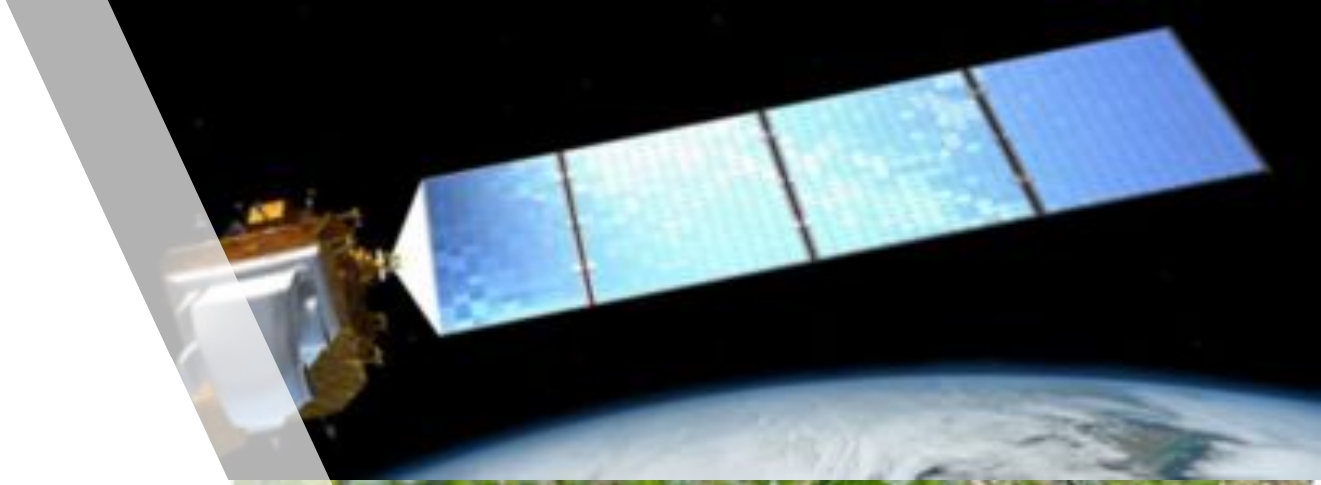
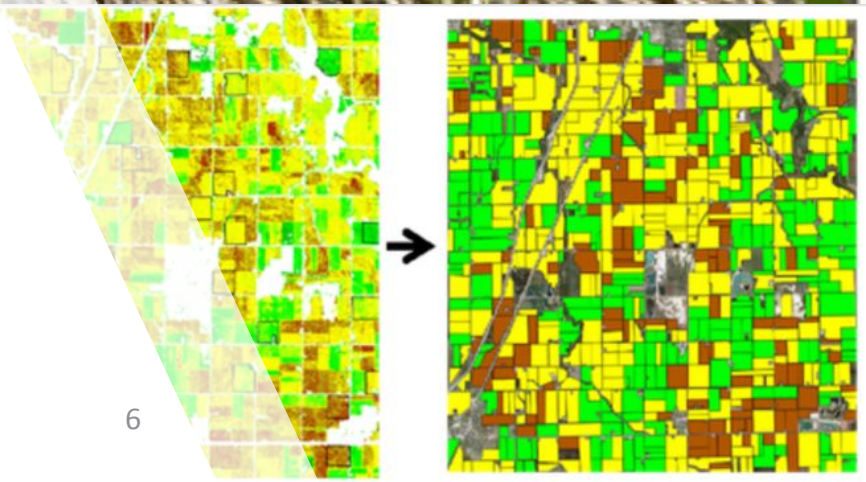
Outline for today

- OpTIS/DNDC methodology
- CONUS-wide results now available
- Exemplary uses of OpTIS data
- *Conservation Validation Network* (CVN): Phase 1 Pilot
  - Anonymized ground-truthing data for OpTIS and other systems that use remote sensing to track adoption
- What's next for OpTIS & CVN?

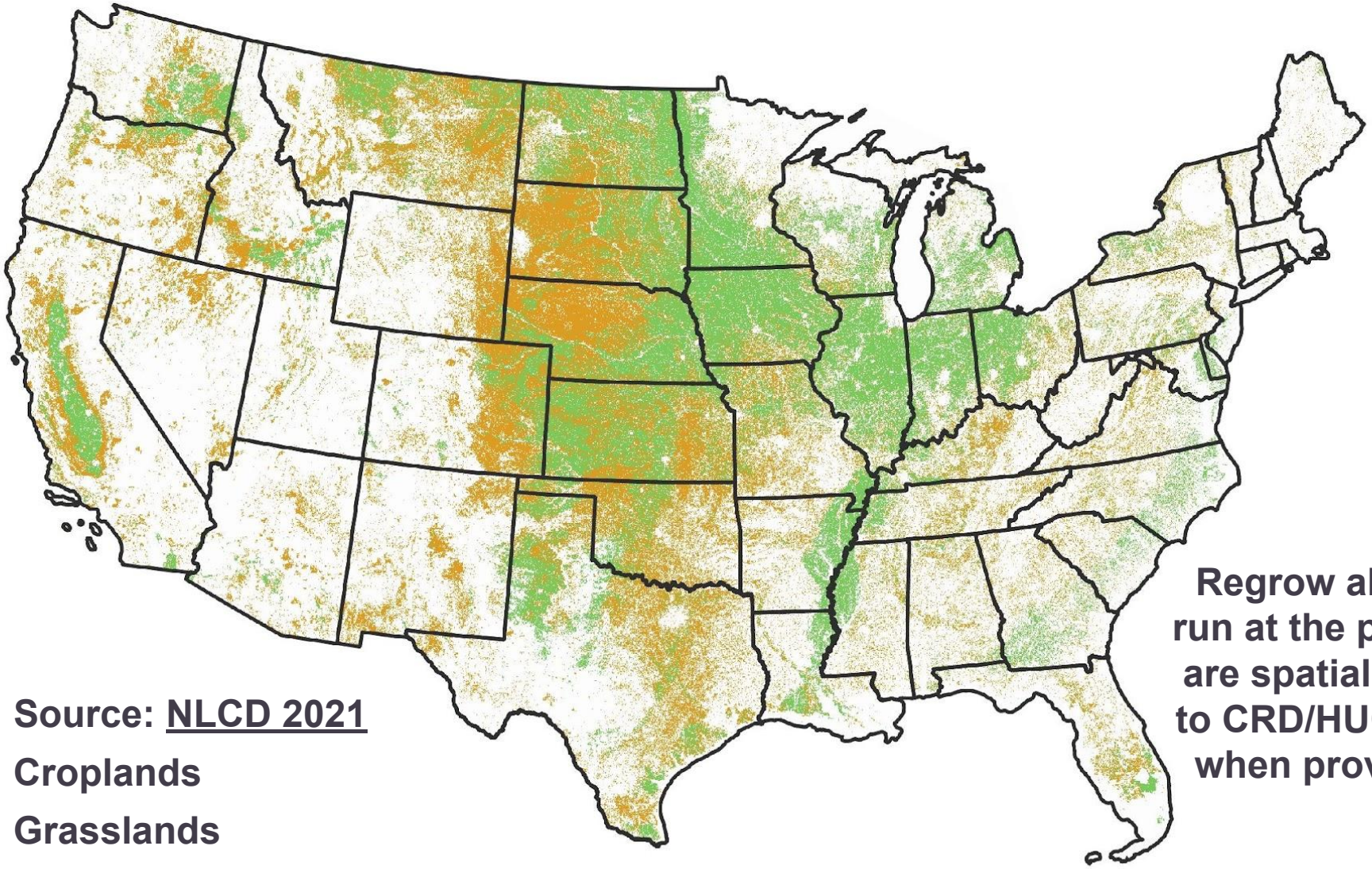
Technology from regrow



- **Op**erational **T**illage **I**nformation **S**ystem - **OpTIS**
- Uses publicly-available remote sensing data to map & monitor adoption of tillage practices and cover crops
- OpTIS data are "longitudinal," making multi-year products possible (e.g., include crop rotation overlays, etc.)
- Calculations at field-scale (30 m) but released only at HUC8 and CRD geographic scales. *Grower privacy is fully respected,*
- **Data (2015-2021) freely available at ctic.org/OpTIS**



Geographic Scope: Lower 48 (CONUS)



Source: NLCD 2021

- Croplands
- Grasslands

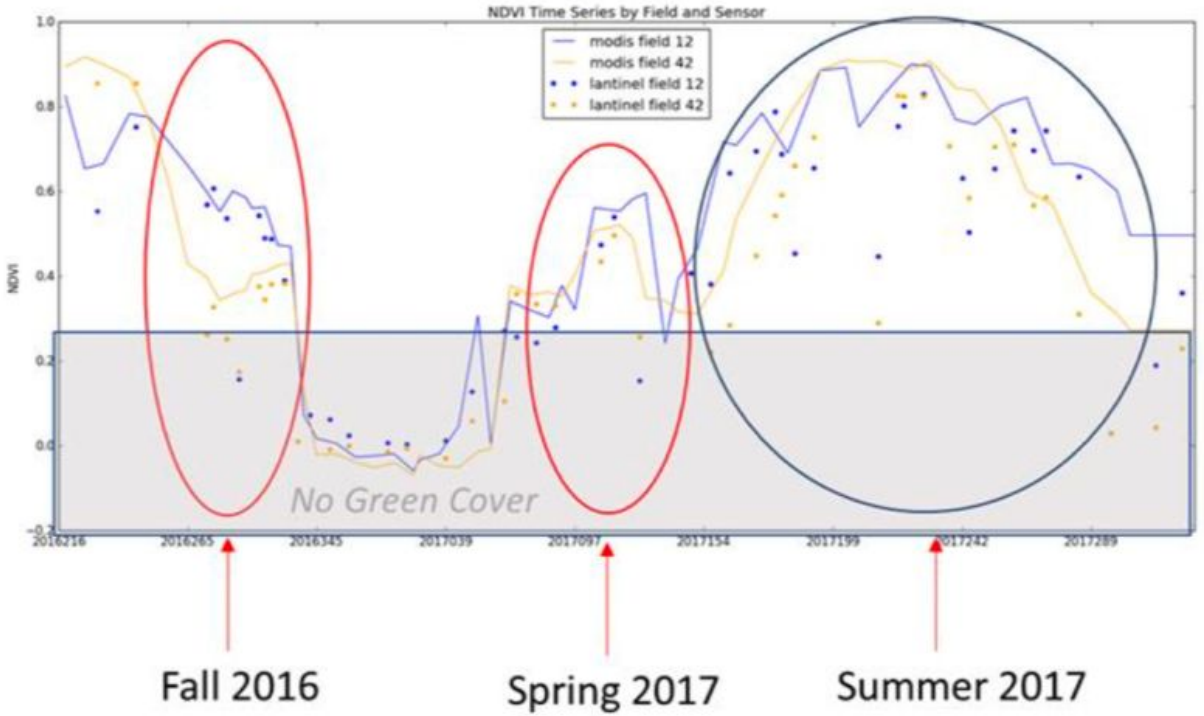
Regrow algorithms are run at the pixel-scale, but are spatially-aggregated to CRD/HUC8/EcoRegion when provided to CTIC

OpTIS: How does it work?

rye

oats

Demonstration of OpTIS estimates of winter cover



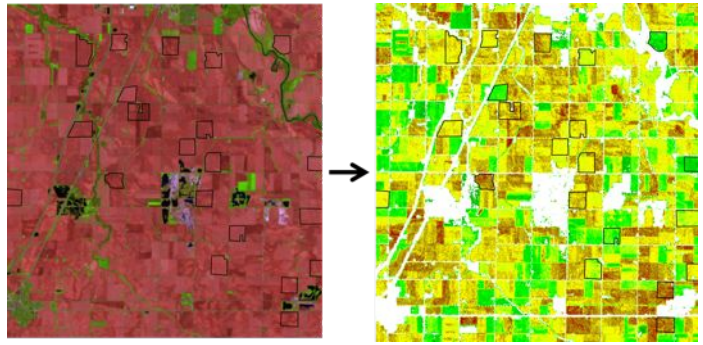
The algorithm works using a time series of Normalized Difference Vegetation Index (NDVI) as an estimate of green cover through the fall, winter and spring.

source: https://www.ctic.org/files/TNC_Methodology_Report_Sept2023.pdf

OpTIS Data: *Used as input to DNDC Model*

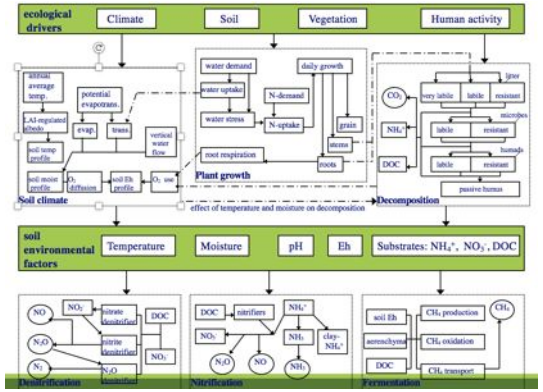
Operational Tillage Information System

OPTIS



Biogeochemical Model

DNDC



- OpTIS Data are used as input to DNDC, a process-based model that produces estimates of losses/sequestration of soil organic carbon and greenhouse gas emissions (methane, N_2O)
- DNDC was created in the 1990s, with more than 500 peer-reviewed studies

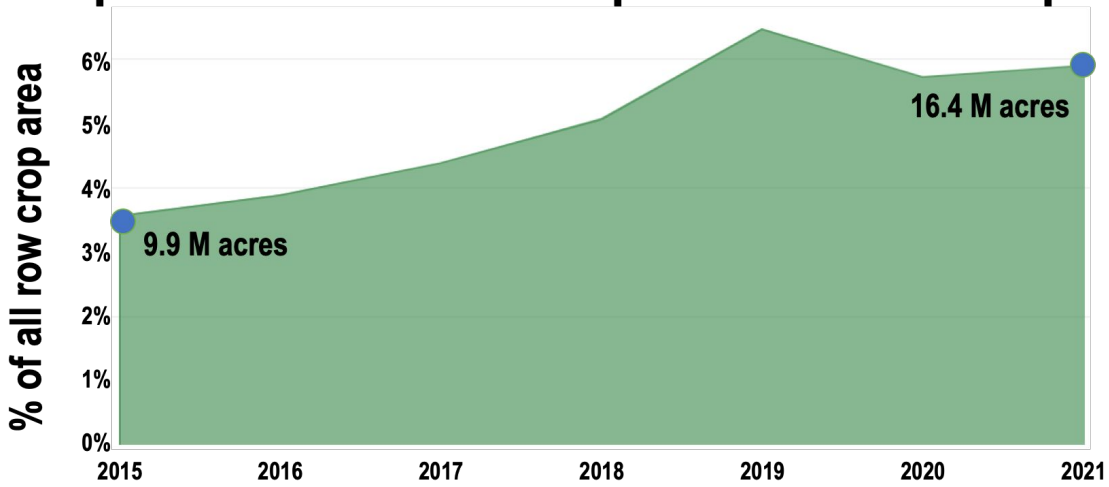
CONUS Data Available on CTIC Website

Dataset Name	Data to Display	Spatial Resolution	
OpTIS (on croplands)	Tillage categories Cover Crops	HUC8 Crop Reporting District (CRD)	September 2023
DNDC Croplands	Soil organic carbon Methane Direct N_2O Indirect N_2O	HUC8 Crop Reporting District (CRD)	
Grazing Lands Vegetation Metrics (on perennial grasslands)	NPP NPP deviation from weather Cover categories	HUC8 Crop Reporting District (CRD)	Spring 2024
DNDC Perennial Grasslands	Soil organic carbon Methane Direct N_2O Indirect N_2O	US EPA Level 3 Ecoregion	

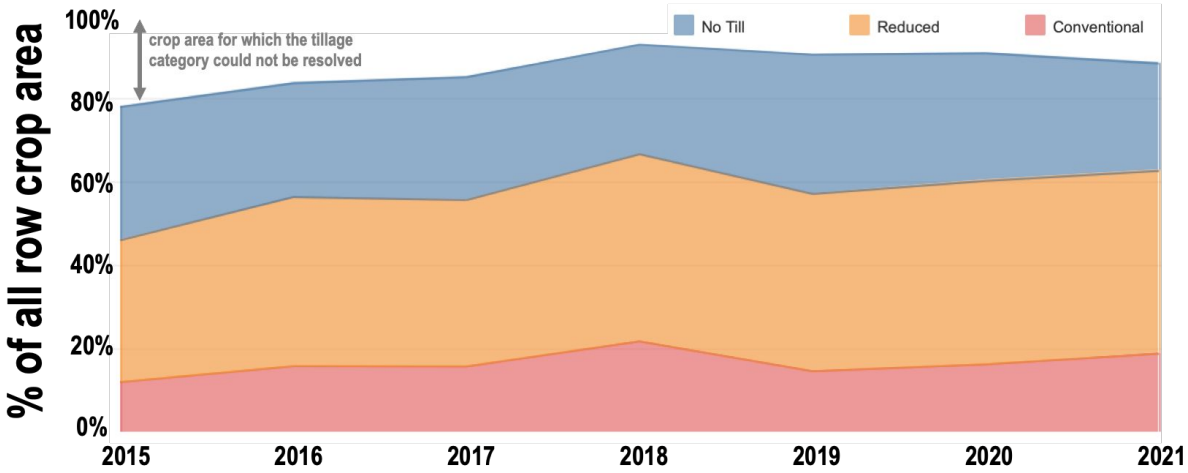
OpTIS 4.0: Row Crop Adoption of Climate-Smart Practices (2015-2021)

www.ctic.org/OpTIS

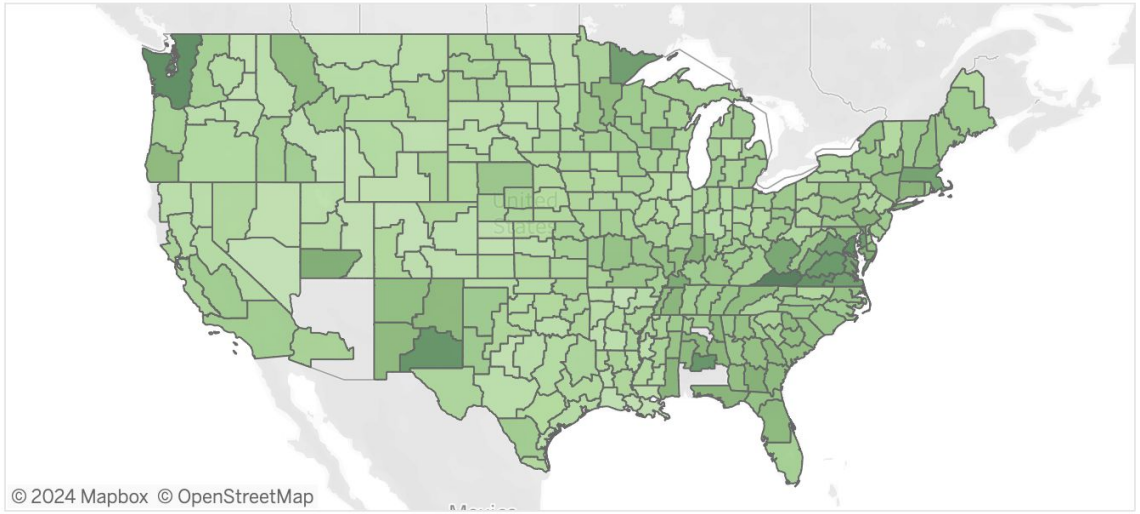
OpTIS 4.0: National Adoption of Cover Crops



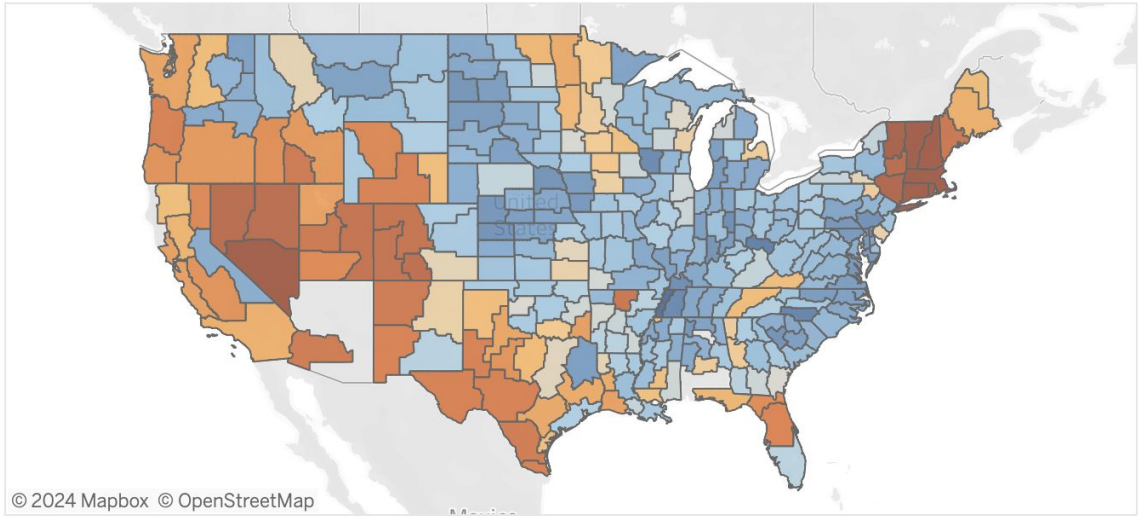
OpTIS 4.0: National Tillage Trends



Cover Crop Avg % across Selected Years



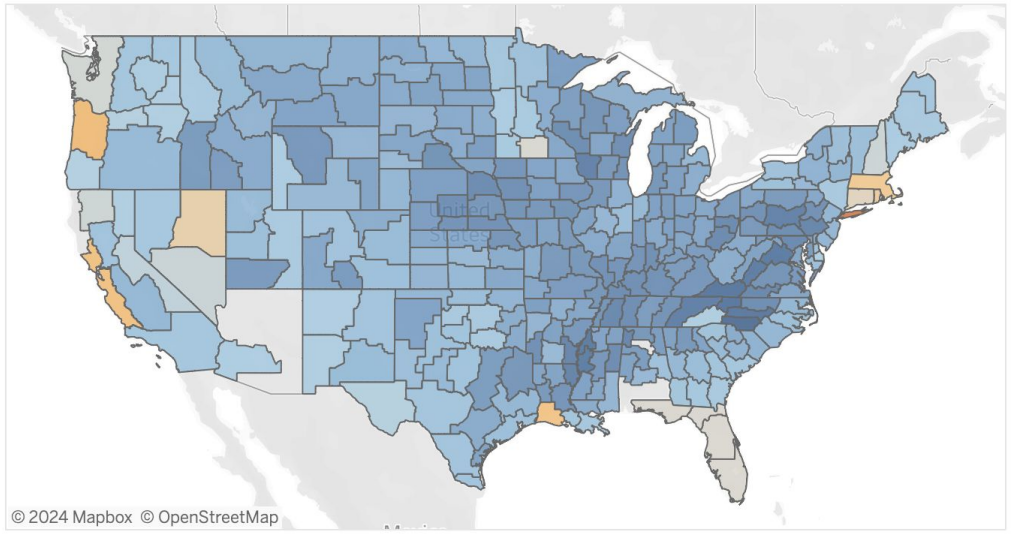
Avg % Conservation Tillage across Selected Years



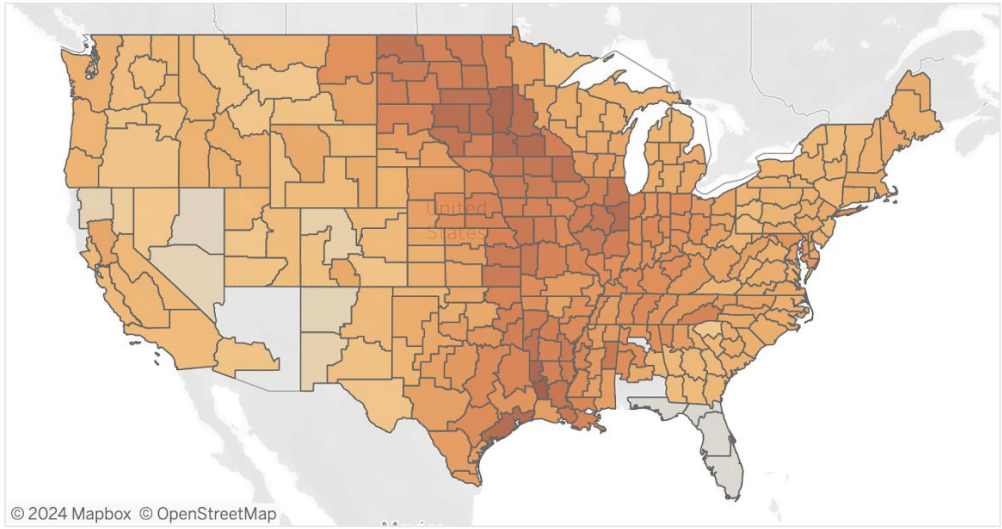
OpTIS 4.0: Row Crop DNDC Modeling Results (2015-2021)

www.ctic.org/OpTIS

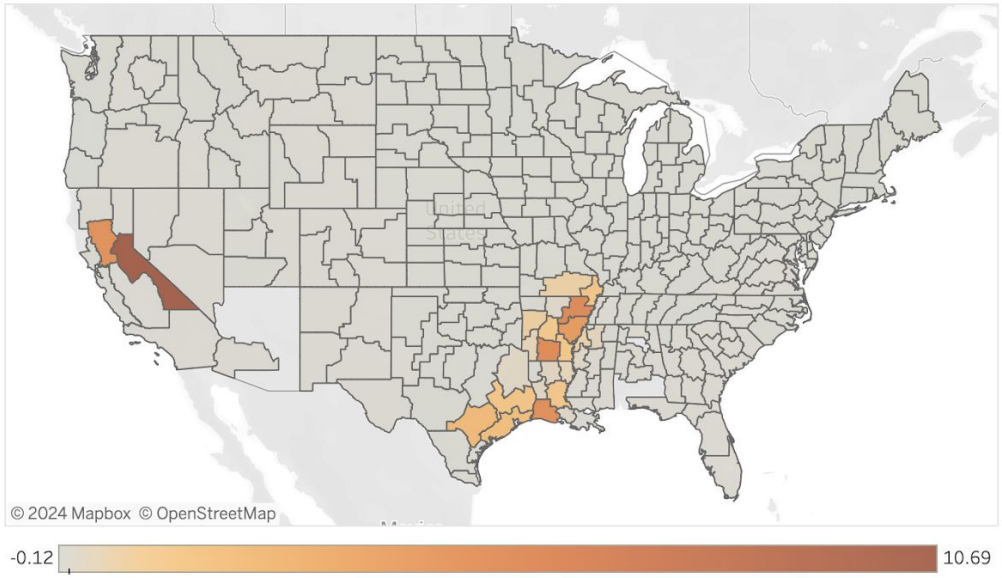
Cumulative SOC Loss (MT CO2e/acre)



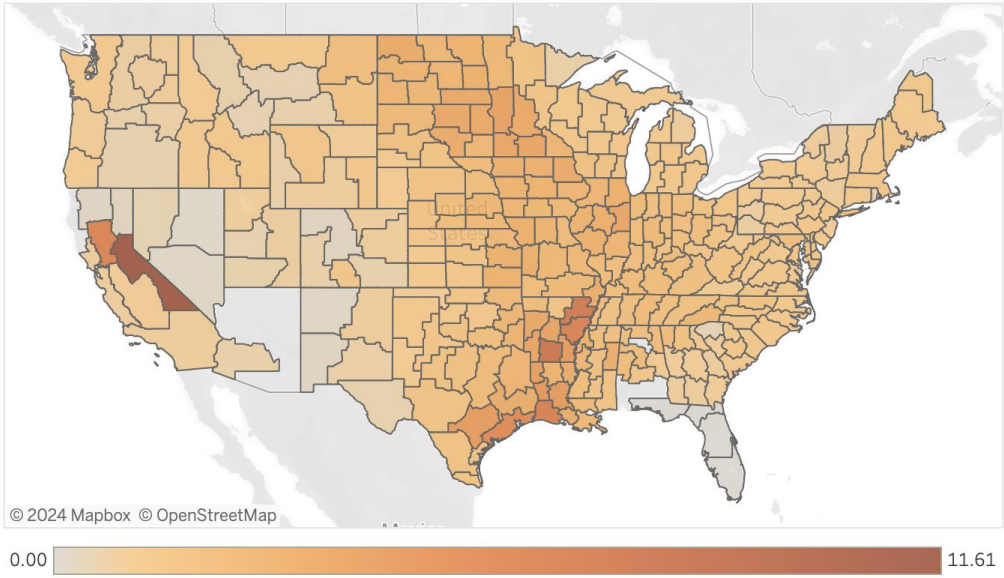
Cumulative N2O Total (MT CO2e/acre)



Cumulative Methane (MT CO2e/acre)



Cumulative Total GHG (MT CO2e/acre)



Exemplary uses of OpTIS data

- Researchers
  - Input to basin-scale water quality models
  - Analyze impact of crop insurance programs
- Industry
  - Support product development and marketing (e.g., cover crop seed companies, etc.)
- Conservation professionals
  - Target outreach to regions with lower adoption
- Agencies
  - Track adoption of practices? Not officially, so far as we know

Calibration & Validation

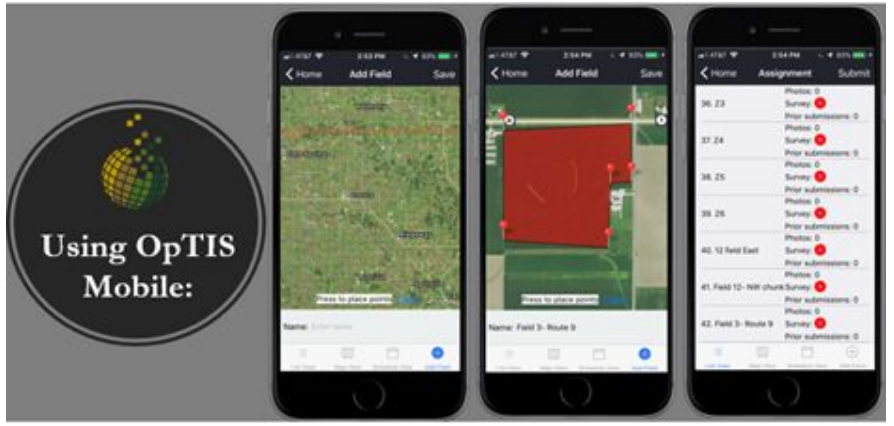
Field-scale: Compared with nearly 20,000 road-side observations of practices, as received from partners and via the OpTIS Mobile App

- OpTIS typically matches such observations 60-80%

County-scale: Compared to 2017 Ag Census

- Correlation with county-level statistics is typically 0.6 to 0.8

More info: Hagen et al., *Land* 2020, 9(11), 408 and new validation report on CTIC website.



Open Access Article

Mapping Conservation Management Practices and Outcomes in the Corn Belt Using the Operational Tillage Information System (OpTIS) and the Denitrification–Decomposition (DNDC) Model

by Stephen C. Hagen [1,*], Grace Delgado [1], Peter Ingraham [1], Ian Cooke [1], Richard Emery [2], Justin P. Fisk [1], Lindsay Melendy [1], Thomas Olson [1], Shawn Patti [1], Nathanael Rubin [1], Beth Ziniti [2], Haixin Chen [2], William Salas [1,2], Pipa Elias [3] and David Gustafson [4]

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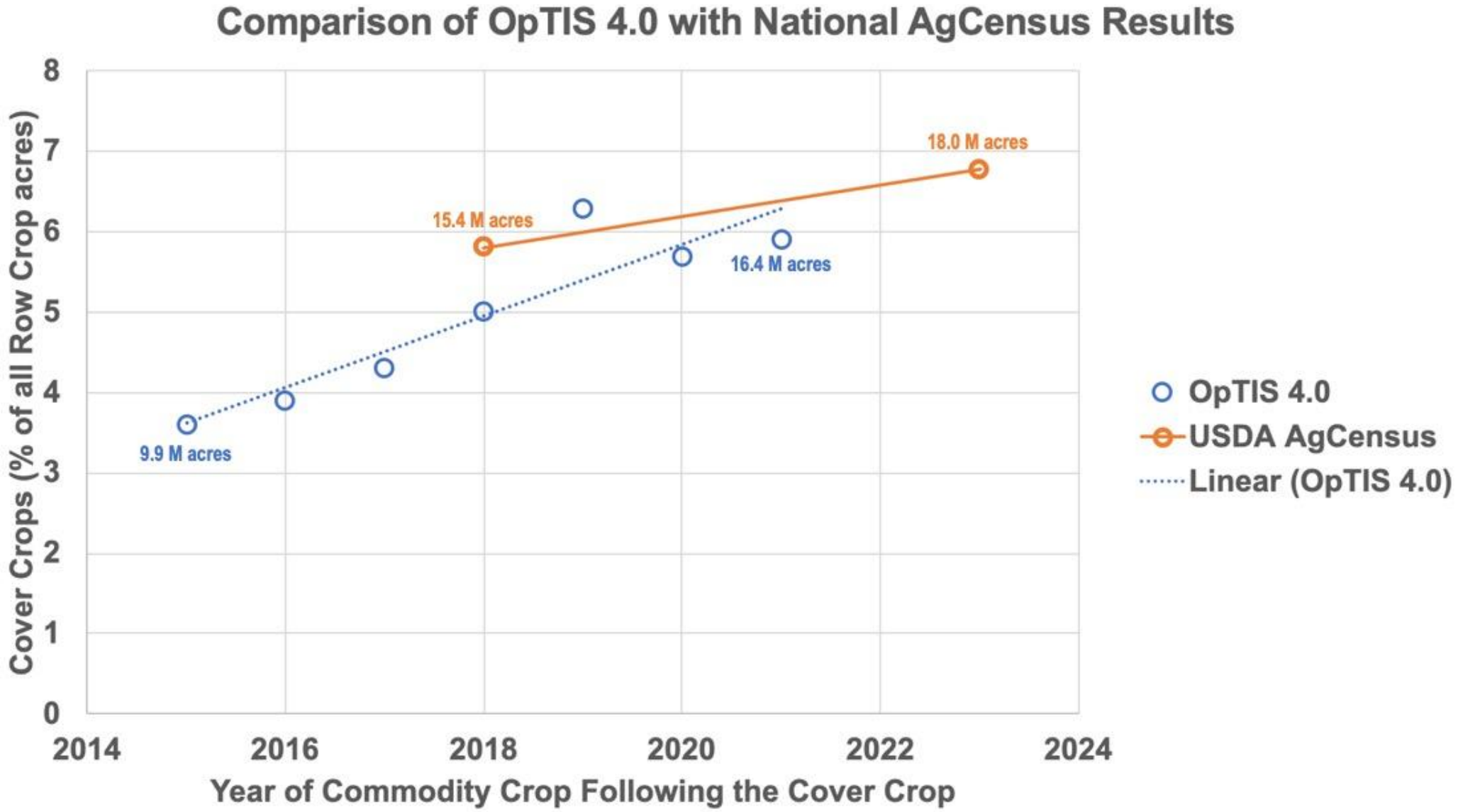
Abstract

Identifying and quantifying conservation-practice adoption in U.S. cropland is key to accurately monitoring trends in soil health regionally and nationally and informing climate change mitigation efforts. We present the results of an automated system used across 645 counties in the United States Corn Belt from 2005 to 2018, mapped at field-scale and summarized for distribution at aggregated scales. Large-scale mapping by OpTIS (Operational Tillage Information System), a software tool that analyzes remotely sensed data of agricultural land, provides trends of conservation tillage (defined as >30% residue cover), cover cropping, and crop rotations, while modeling by DNDC (Denitrification–Decomposition), a process-based model of carbon and biogeochemistry in soil, provides estimates of the ecosystem outcomes associated with the changes in management practices mapped by OpTIS. Ground-truthing data acquired via OpTIS mobile, a roadside field-surveying app, were used for verification in 30 counties. OpTIS results for the Corn Belt show adoption of cover crops after planting corn and soy increased from 1% to 3% of the mapped area when comparing 2006 to 2018. Comparison of trends for conservation tillage use from 2006 to 2018 shows a slight decrease in conservation tillage adoption, from 46% to 44%. Results from DNDC show these soils sequestered soil organic carbon (SOC) at an area-weighted mean change in SOC (dSOC) rate of 161 kgC/ha/year. Comparatively, in a scenario modeled without the adoption of soil health management practices, the same soils would have

Quick Comparison with 2022 AgCensus

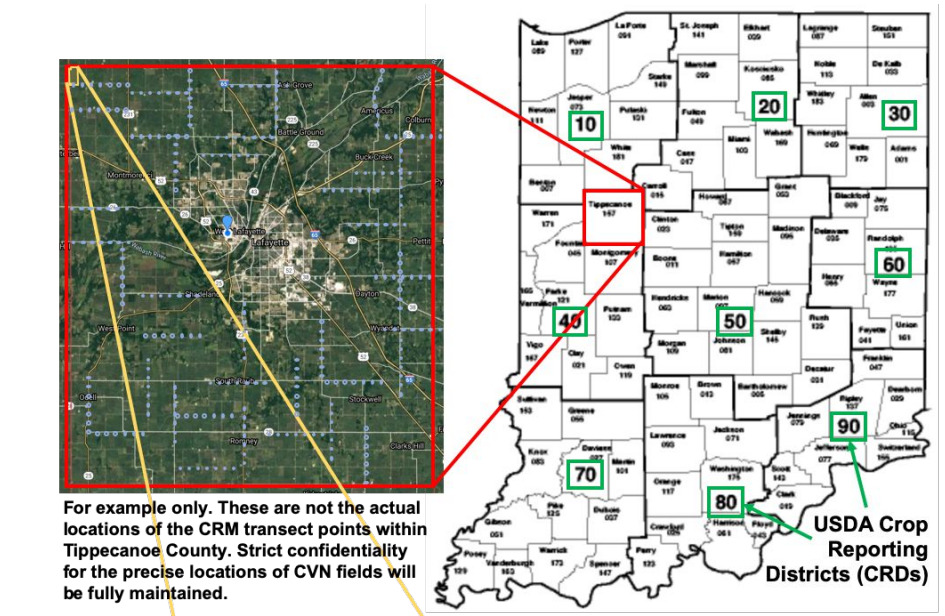


Conservation Validation Network: CVN

- A network of producers providing anonymized ground-truthing data, meant to validate and improve remote sensing methods now being developed to track the adoption of:
  - Conservation Tillage
  - Cover Crops
- Data to be held securely, support model development and validation queries, without disclosing locations

CVN: Initial Proposal to Indiana NRCS

- Submitted January 2021
- Decision deferred
- Proposed as a random sub-sample (1%) of all CRM transect points within each CRD
- Leverage existing data



For example only. These are not the actual locations of the CRM transect points within Tippecanoe County. Strict confidentiality for the precise locations of CVN fields will be fully maintained.

Field (not actual) selected for CVN. A random sample of approximately 1% of all CRM transect point observations within each CRD will be selected.

CRM Observations (approximate)

CRD	N
10	4280
20	4250
30	4320
40	4550
50	6360
60	3260
70	4770
80	2360
90	2100
TOTAL	36250

CRM Transect Point Observations. Approximately 36,250 across Indiana.

CVN Phase I Pilot Seed Funding

The Nature Conservancy (TNC)

Corteva/Granular

CVN Phase I Project Team

Conservation Technology Information Center

CTIC

- Project leadership

Corteva/Granular

- Input on system design

Arva Intelligence

- Technology provider

CVN Indiana Pilot: Phase 1 Deliverables

- Host Kickoff Workshop (25-Aug-2021)
- Design CVN Database (Dec-2021)
- Launch CVN Enrollment Webpage (Jun-2022)
  - System is now ready to accept ground-truthing data from CVN network participants
  - Phase 2 (implementation) on-hold pending funding

CVN Database Design

Grower E-mail Address

Field name (as assigned by CVN participant)

Shapefile for selected field (download instructions)

Selected Cropping Year

Crop grown in this field during the Selected Cropping Year (commercial/commodity)

Crop grown in this field during Previous Cropping Year (commercial/commodity)

Was a winter cover crop planted before the Selected Cropping Year Crop (Y/N)?

If (Y), what was the approximate % area of the cover crop that became established? (10 pct intervals)

What overall (from harvest to planting) tillage regimen was used? (pick one of 4 choices)

No-Till

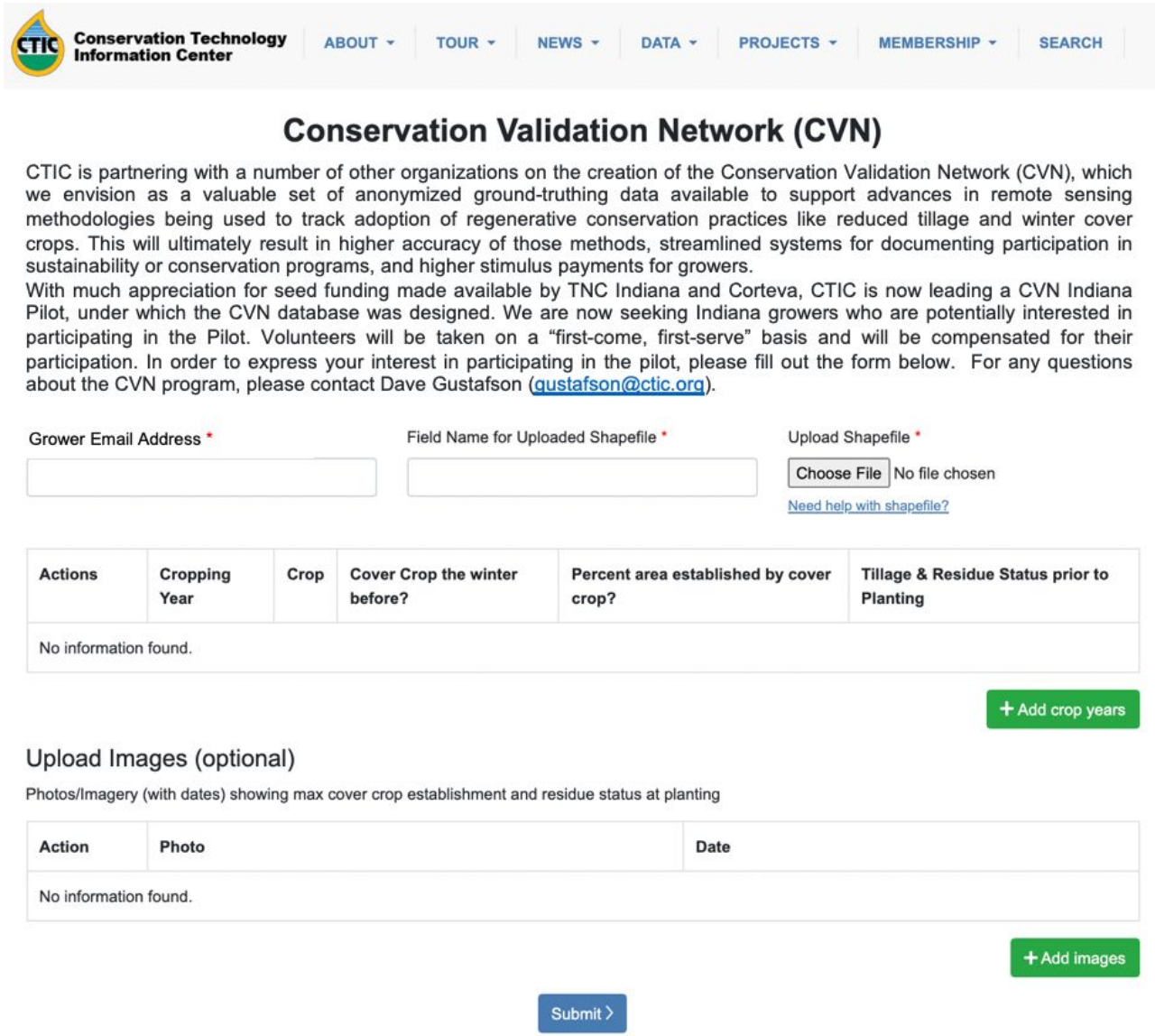
Reduced Till (>30% residue cover)

Reduced Till (<30% residue cover)

Conventional Till

OPTIONAL Photos/Imagery (with dates) showing max winter cover crop establishment and residue status at planting of Selected Cropping Year Crop

CVN Enrollment Webpage



Conservation Technology Information Center

ABOUT | TOUR | NEWS | DATA | PROJECTS | MEMBERSHIP | SEARCH

Conservation Validation Network (CVN)

CTIC is partnering with a number of other organizations on the creation of the Conservation Validation Network (CVN), which we envision as a valuable set of anonymized ground-truthing data available to support advances in remote sensing methodologies being used to track adoption of regenerative conservation practices like reduced tillage and winter cover crops. This will ultimately result in higher accuracy of those methods, streamlined systems for documenting participation in sustainability or conservation programs, and higher stimulus payments for growers.

With much appreciation for seed funding made available by TNC Indiana and Corteva, CTIC is now leading a CVN Indiana Pilot, under which the CVN database was designed. We are now seeking Indiana growers who are potentially interested in participating in the Pilot. Volunteers will be taken on a "first-come, first-serve" basis and will be compensated for their participation. In order to express your interest in participating in the pilot, please fill out the form below. For any questions about the CVN program, please contact Dave Gustafson (gustafson@ctic.org).

Grower Email Address *

Field Name for Uploaded Shapefile *

Upload Shapefile *

Choose File No file chosen

Need help with shapefile?

Actions	Cropping Year	Crop	Cover Crop the winter before?	Percent area established by cover crop?	Tillage & Residue Status prior to Planting
No information found.					

+ Add crop years

Upload Images (optional)

Photos/Imagery (with dates) showing max cover crop establishment and residue status at planting

Action	Photo	Date
No information found.		

+ Add images

Submit

CVN Vision: Public-Private Partnership

- Strawman long-term funding approach:

 Producers receive nominal annual compensation

 Users of the network data pay an annual fee, possibly a different rate for academia vs. private sector entities

 Public-sector contribution would be helpful, a logical use of new USDA/NRCS MMRV funds

What's Next for OpTIS and CVN?

- Update data visualization tool (now partnering with Saint Mary's University MN Geospatial Services)
- Add a Grazing Lands vegetation health product
- Continue to promote use of new OpTIS data via webinars, presentations, social media, etc.
- Seek support for annual OpTIS updates (2022 & beyond)
- Pursue funding options for CVN Phase 2

THANK YOU!

Dave Gustafson

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Check-out the website to explore OpTIS data for your region

www.ctic.org/OpTIS

BACKUP SLIDES

North America Regenerative Agriculture

Contributions to TNC's 2030 Goals

Collaborating with farmers and ranchers to grow food in ways that benefit people, climate and nature

Regenerative Grazing Lands

7.3M

Tackling Carbon Emissions
7.3M metric tons of CO2e
Avoided or Sequestered per year

93M
23M

Saving Healthy Lands
93M Hectares of grazing lands
23M Hectares of at-risk natural lands

308K

Benefitting People
308K people benefitted

Regenerative Crop Systems

50M

Tackling Carbon Emissions
50M metric tons per year of CO2e
Avoided or Sequestered per year

1.67M

Deepening Solutions for Our Oceans
1.67M Hectares of improved management in the Chesapeake Bay and Gulf of Mexico

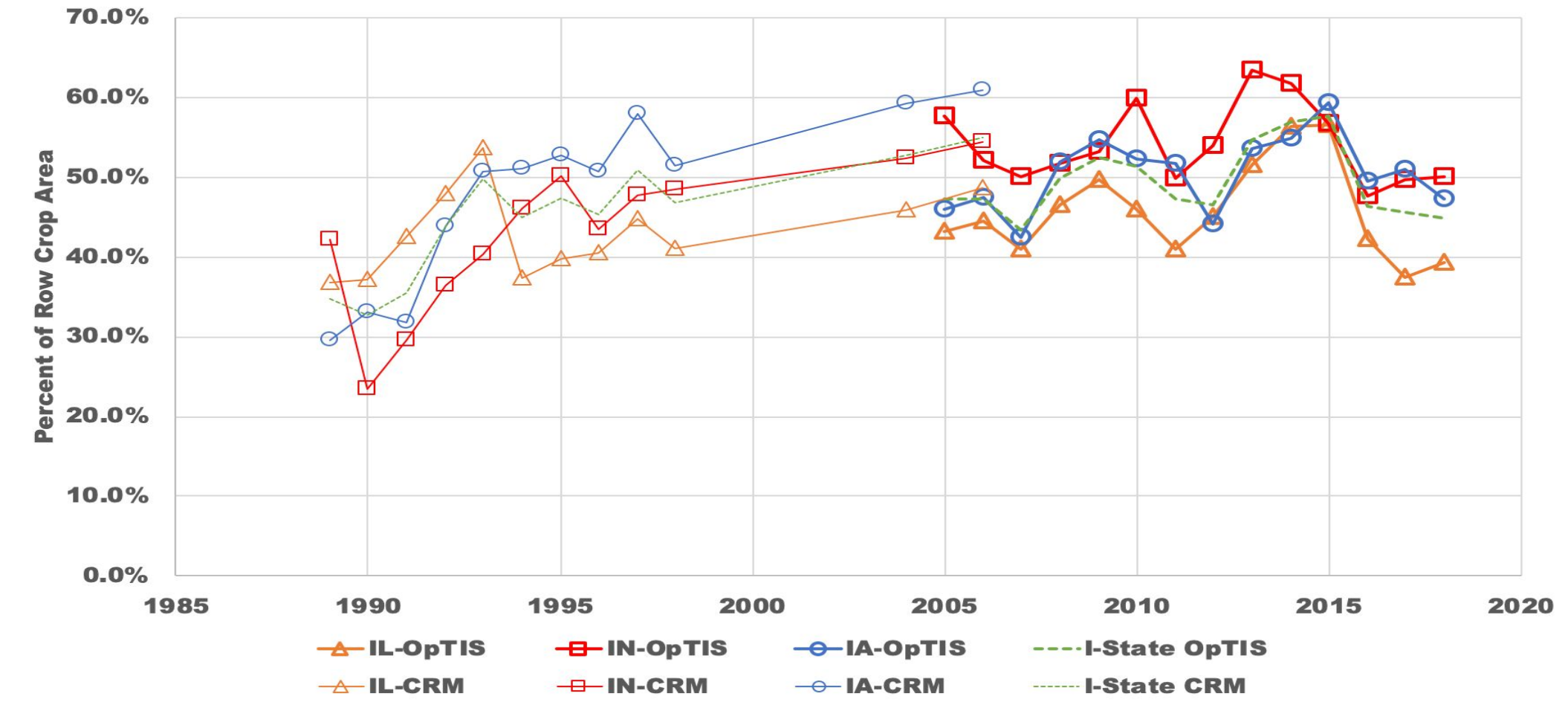
4.8M
261K

Conserving the World's Freshwater
4.8M Hectares & 261K River KM of improved management in the Chesapeake Bay, Great Lakes and Mississippi River

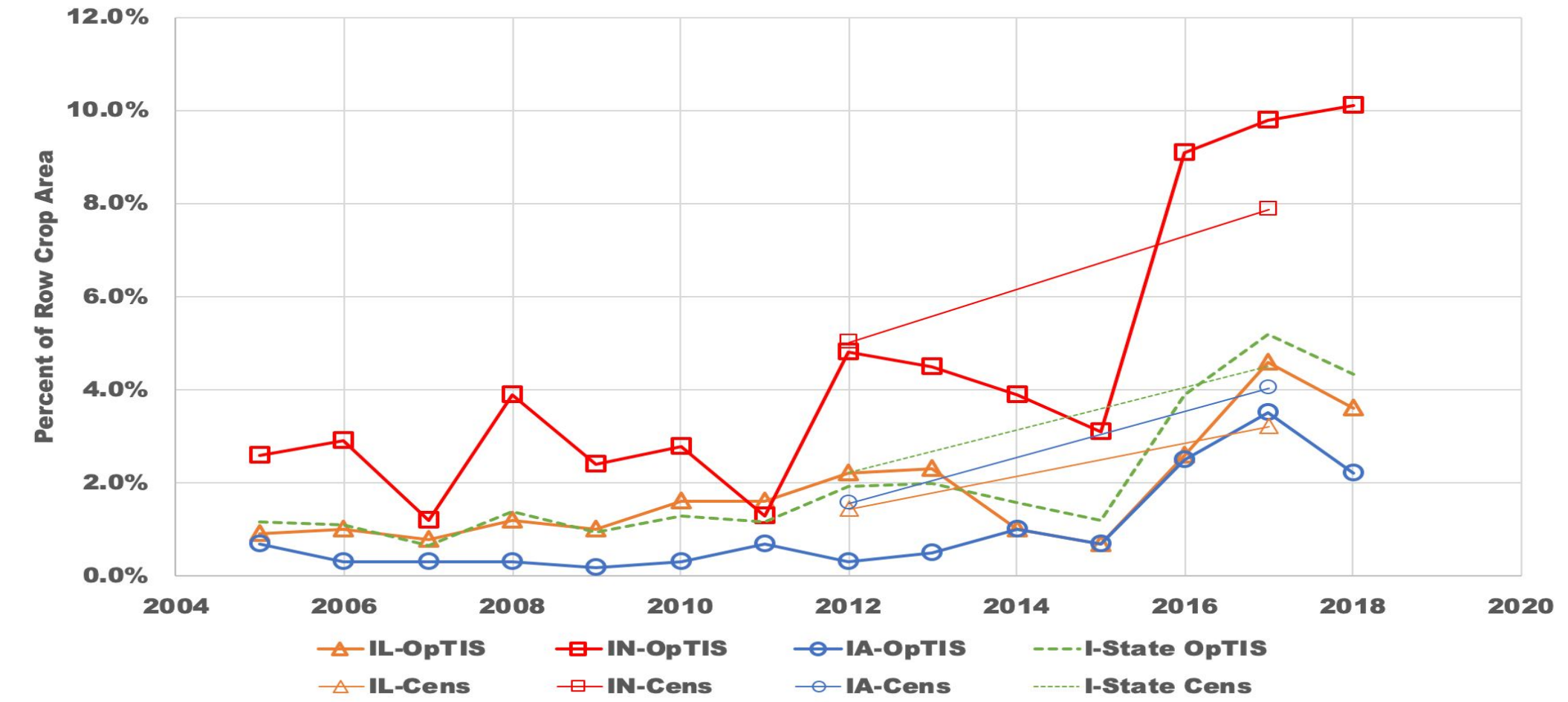
OpTIS: *USES BEYOND TILLAGE & COVER CROPS*

- Contains >1 Billion Acre-Years of DATA
- Measure SOIL HEALTH baselines and trends
- Input to WATER QUALITY models (local and basin-scale, e.g., N-Gage)
- Input to Biogeochemical models (e.g., DayCent, DNDC, etc.) to estimate GHG emissions, SOIL CARBON, NITRATE losses …
- Target CONSERVATION efforts
- Provide verification data for ECOSYSTEM SERVICES MARKETS
- And many others … (e.g., BIODIVERSITY, etc.)

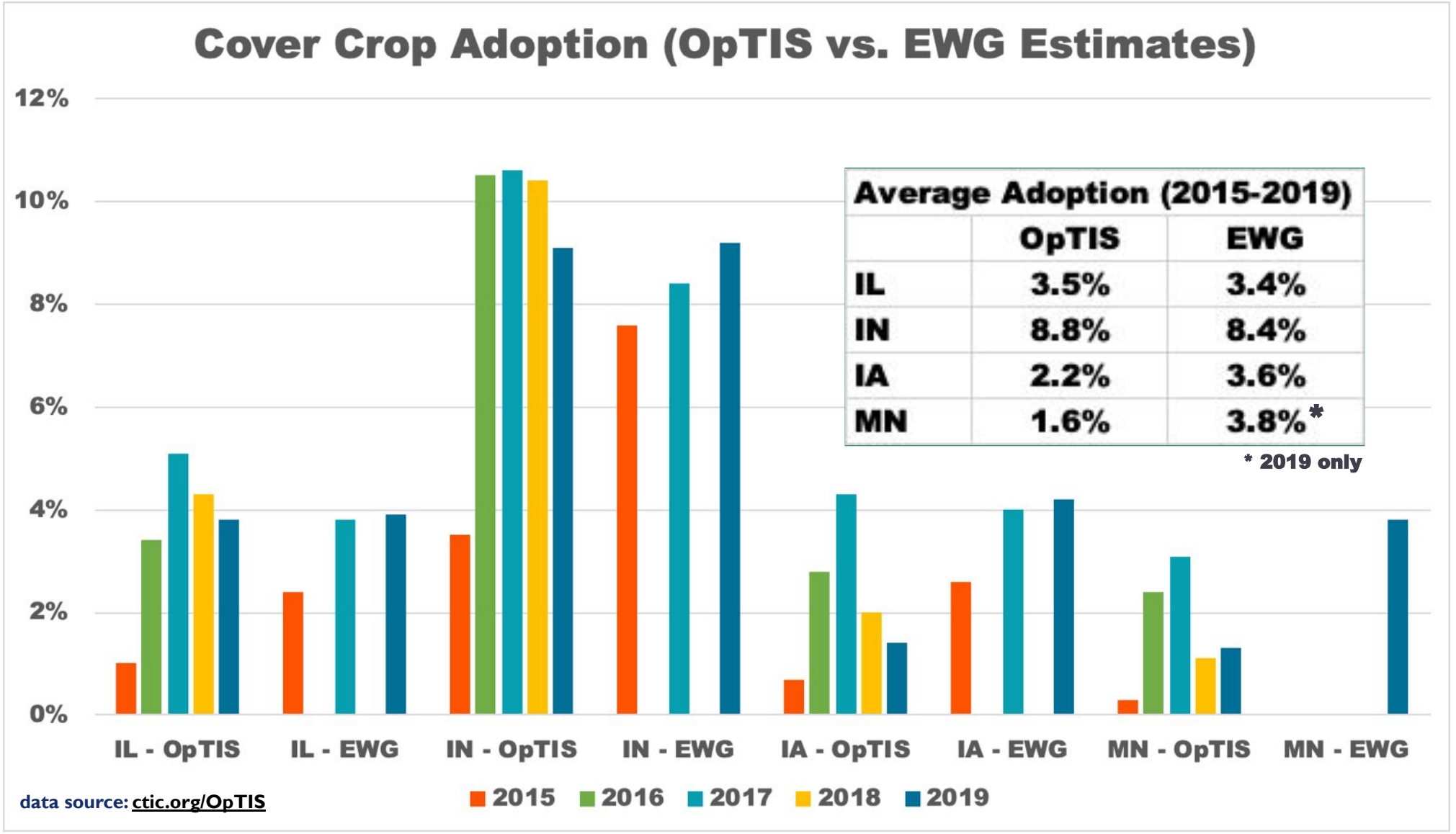
OpTIS 1.0: Comparison with CRM Data



OpTIS 1.0: Comparison with AgCensus



OpTIS 1.0: Comparison with EWG Results



Average Adoption (2015-2019)		
	OpTIS	EWG
IL	3.5%	3.4%
IN	8.8%	8.4%
IA	2.2%	3.6%
MN	1.6%	3.8%*

* 2019 only

Regrow Data Products Available from CTIC

- **Area of Interest:** Contiguous United States
- **Spatial Units:** Aggregated field data by USDA crop reporting districts and USGS HUC-8 watershed
- **Time Period:** Data set focused on 2015-2021 crop year - Year captures transition into following year
- **Crop ID:** Primary Summer crops

  1) Corn 2) Soybeans 3) Cotton 4) Rice 5) Wheat (spring) 6) Fallow 7) Perennial 8) Other Crops - Winter commodities

- **Cover Crops:** presence/absence of cover crop
- **Tillage:** classification of post harvest tillage practice
- **DNDC Results:** DeNitrification DeComposition greenhouse gas emissions

Product	Description	Resolution	Refresh Rate	Field Level Accuracy	Coverage
Crop ID	Crop map of primary commodity	10-30m	Semi-Annual	95%	CONUS, Canada, Europe, Brazil (roadmapped)
Cover Crop	Cover crop classification layer	10-30m	Annual	80%	
Tillage	Tillage practice and residue cover	10-30m	Annual	60%	

DNDC

Model inputs: Climate data, soils data, management data and vegetation data with over many 300 parameters. Much of the data comes from remote sensing (OpTIS), field measurements from scientific literature (observations), and government agencies (weather, soil).

Model calibrated and tested using validation data.

Regrow's protocol verified by Climate Action Reserve (CAR) to credit soil carbon removals and N2O emissions reductions using process models.

DNDC allows us to calculate…

- **Soil Organic Carbon**
- **Methane**
- **Nitrous oxide - Direct**
- **Nitrous oxide - Indirect**
- **Nitrous oxide - Total**
- **Greenhouse gas - Total**

*Results for Florida out of scope due to soils types and variable crop types/rotations (citrus, sugarcane, and vegetables)

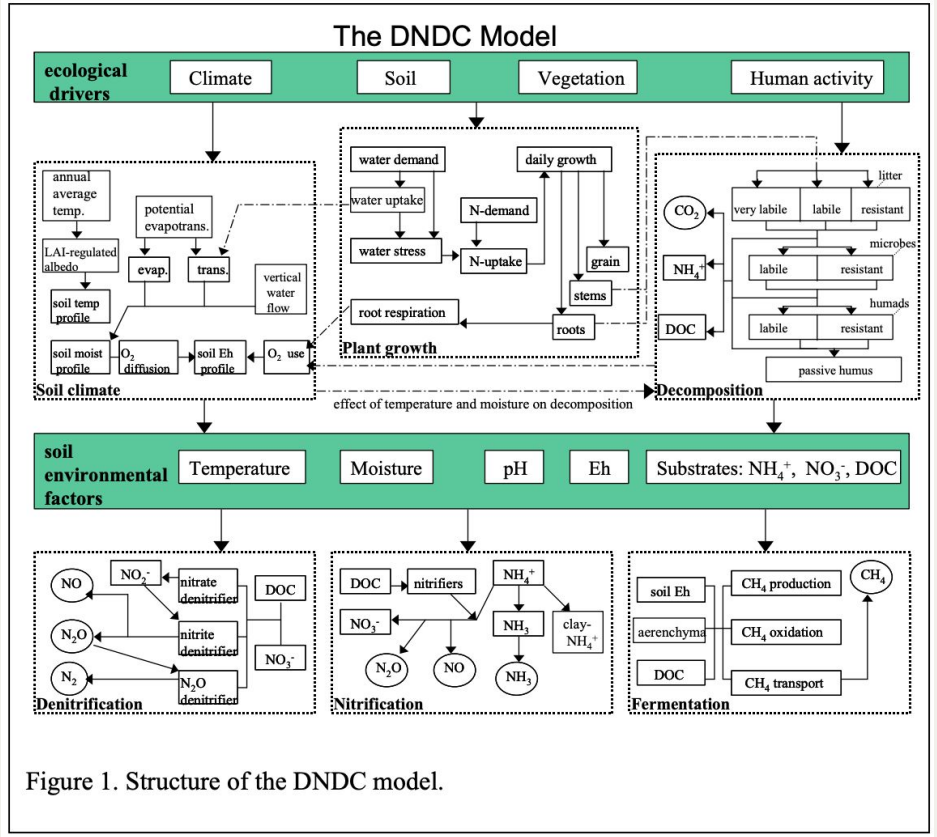


Figure 1. Structure of the DNDC model.

Source: [User's Guide for the DNDC Model]

Results

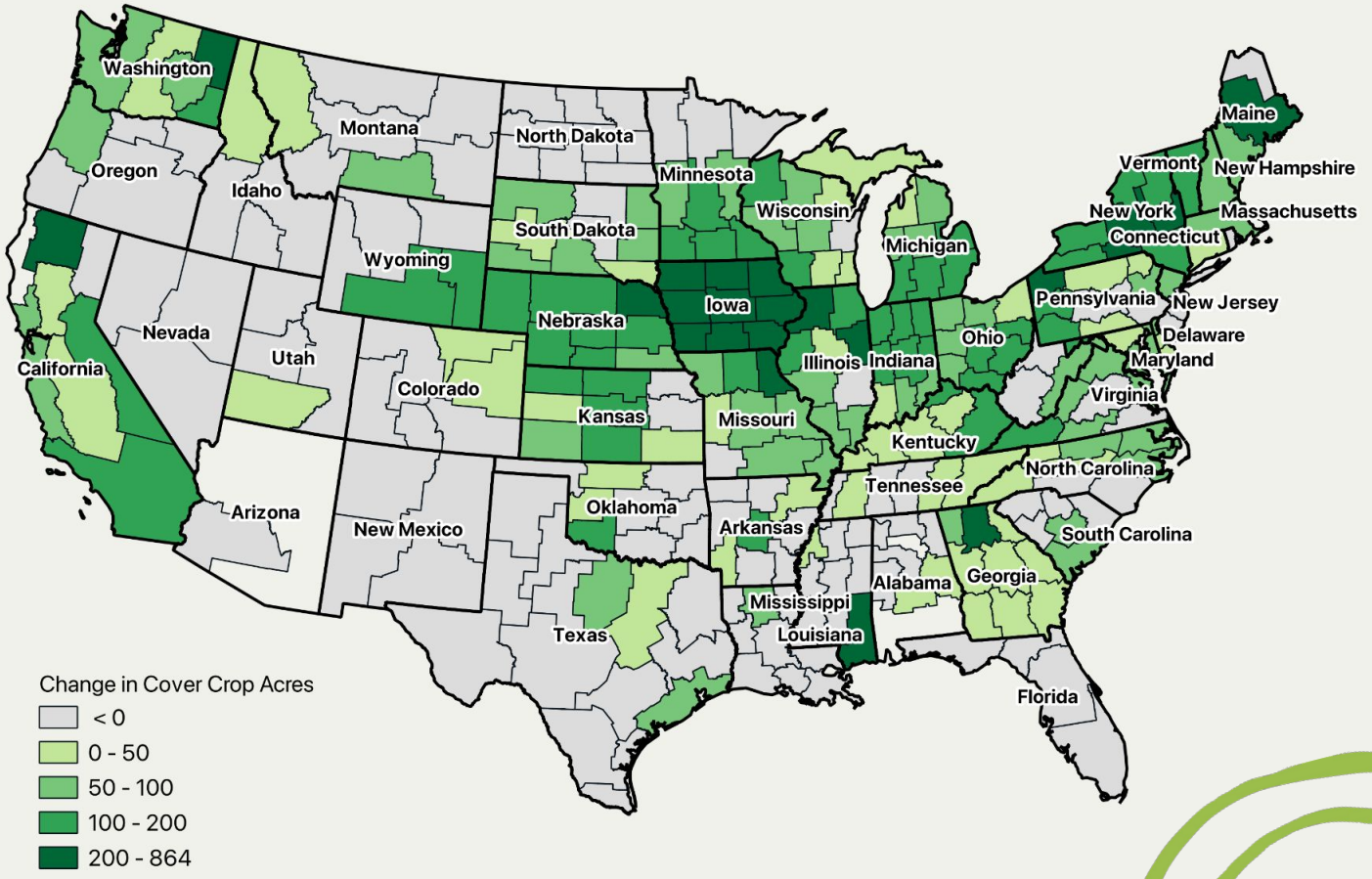
Between 2015 and 2021…

Regrow data show that cover crops in the contiguous United States acres grew 67% from 9.3 million to 15.6 million acres…

Which equates to sequestering approximately 0.33 metric tons of Soil Organic Carbon per acre in 2021…

And there is plenty of room to grow.

2021 Cover Crop Difference from Seven Year Average (2015-2021)



Cover Crops

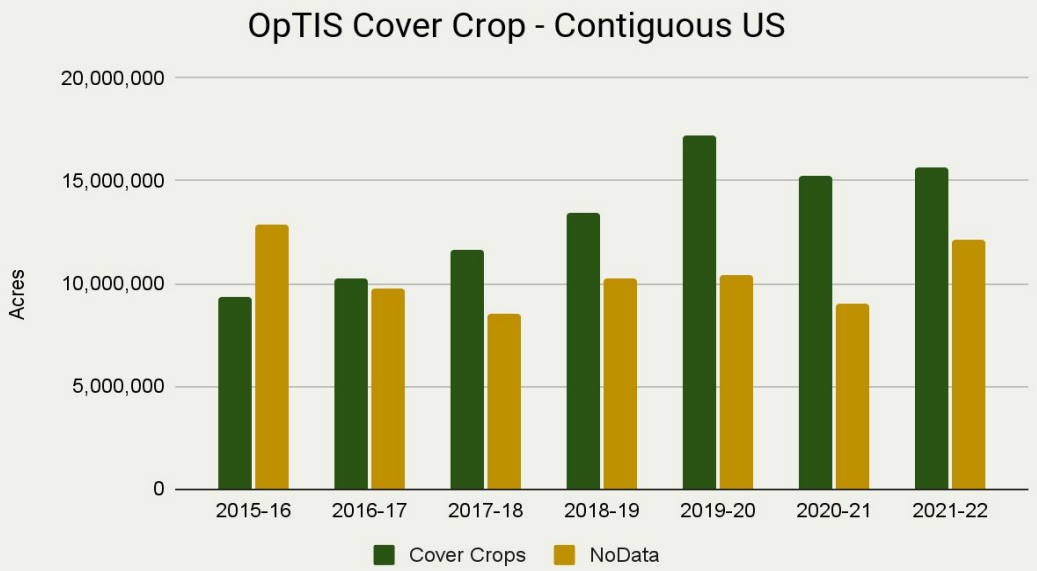
Data Inputs: Normalized Difference Vegetation Index (NDVI) - Regional NDVI thresholds
The time series of residue cover fraction at the pixel level is then analyzed for patterns and consistency, returning a residue cover fraction value together with a certainty level at the time of planting.

Residue is evaluated both in the spring and fall, with the annual tillage intensity calculated from the average residue cover observed across the two seasons.

- Harvest event: determined by observing a sharp drop in NDVI on the field
- Presence of green pixels following harvest
- Persistence of green pixels through the fall
- Increase in greenness over the spring
- Planting event: detected by observing a decrease in greenness on the field near planting time, followed by the emergence of a summer crop

Each pixel is then classified into one of three classes:

- **No cover crop -** no cover crop planting, or very weak emergence
- **Cover crop -** cover crop, with strong emergence
- **No data** - not enough data to estimate



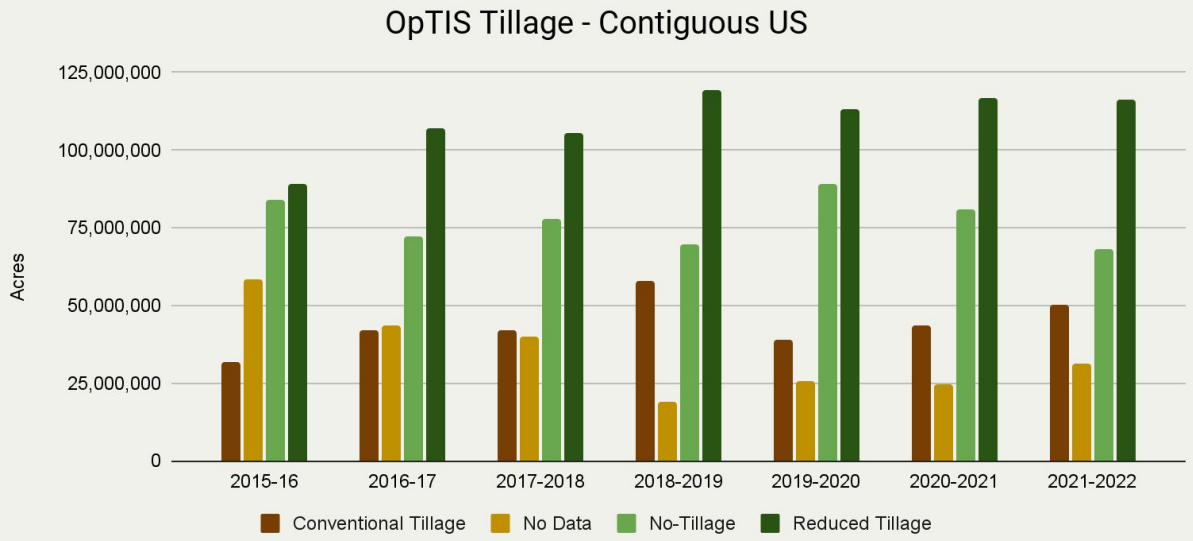
	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
No Cover Crop Acres	241 mil	245 mil	245 mil	242 mil	239 mil	241 mil	238 mil

Tillage

Data inputs: Normalized Difference Tillage Index (NDTI), Crop Residue Cover Index (CRC) and Precip Data
The time series of residue cover fraction at the pixel level is then analyzed for patterns and consistency, returning a residue cover fraction value together with a certainty level at the time of planting.

Residue is evaluated both in the spring and fall, with the annual tillage intensity calculated from the average residue cover observed across the two seasons.

- **Conventional tillage** — same as very low residue cover level (0-15%) for all previous year crop types;
- **Reduced tillage** — low to moderate residue cover (16-50%) for all previous year crop types;
- **No-till** — moderate residue cover (31-50%) where any crop except corn was the previous year's crop and high residue cover (51-100%) for all previous year crop types
- **No Data** — not enough data to estimate



US EPA Level 3 Ecoregions