Sustainability of Animal Agriculture Is Affected By Crop Management

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Link

Food
Opinion

The Guardian
US edition

Animal agriculture is choking the Earth and making us sick. We must act now

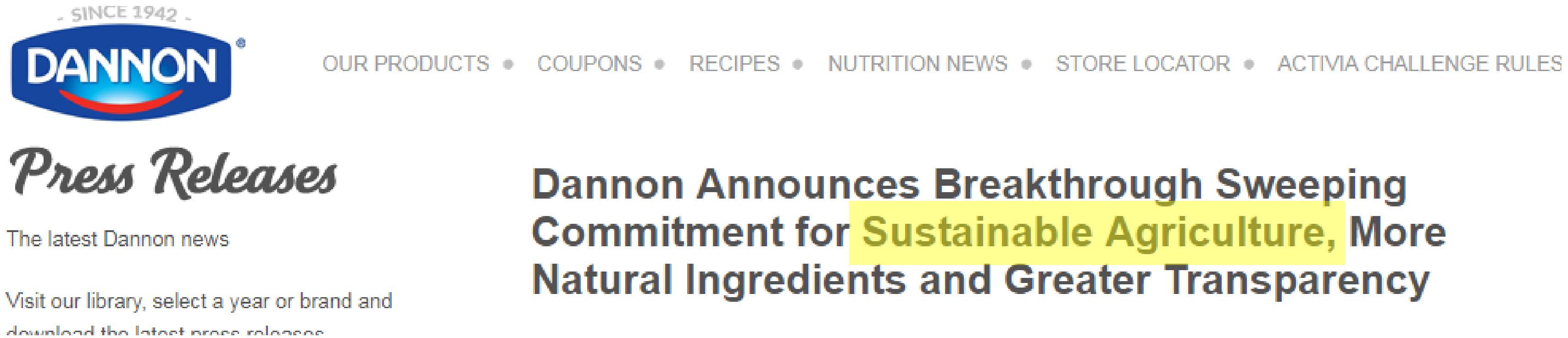
James Cameron *and* **Suzy Amis Cameron**

Mon 4 Dec 2017 08.26 EST

21,795
1,157

If we want the US's majestic national parks, clean air and water for future generations we must press leaders to address food's environmental impact

▲ 'Raising livestock for meat, eggs and milk generates 14.5% of global greenhouse gas emissions.' Photograph:



Press Releases

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Dannon Announces Breakthrough Sweeping Commitment for Sustainable Agriculture, More Natural Ingredients and Greater Transparency

– Dannon commits to bring all products from **three flagship brands (Dannon®, Oikos® and Danimals®)**towards the use of **fewer and more natural ingredients that are not synthetic and non-GMO.** Importantly, Dannon also commits that for these brands the **feed of its farmer's cows will be non-GMO,** within a transition period of 3 years. The ambition is to evolve the remaining brands over time.

AGRICULTURE

Dairy farmers in California say anti-flatulence law stinks

Jane Wells | @janewells

Published 9:39 AM ET Mon, 17 Oct 2016

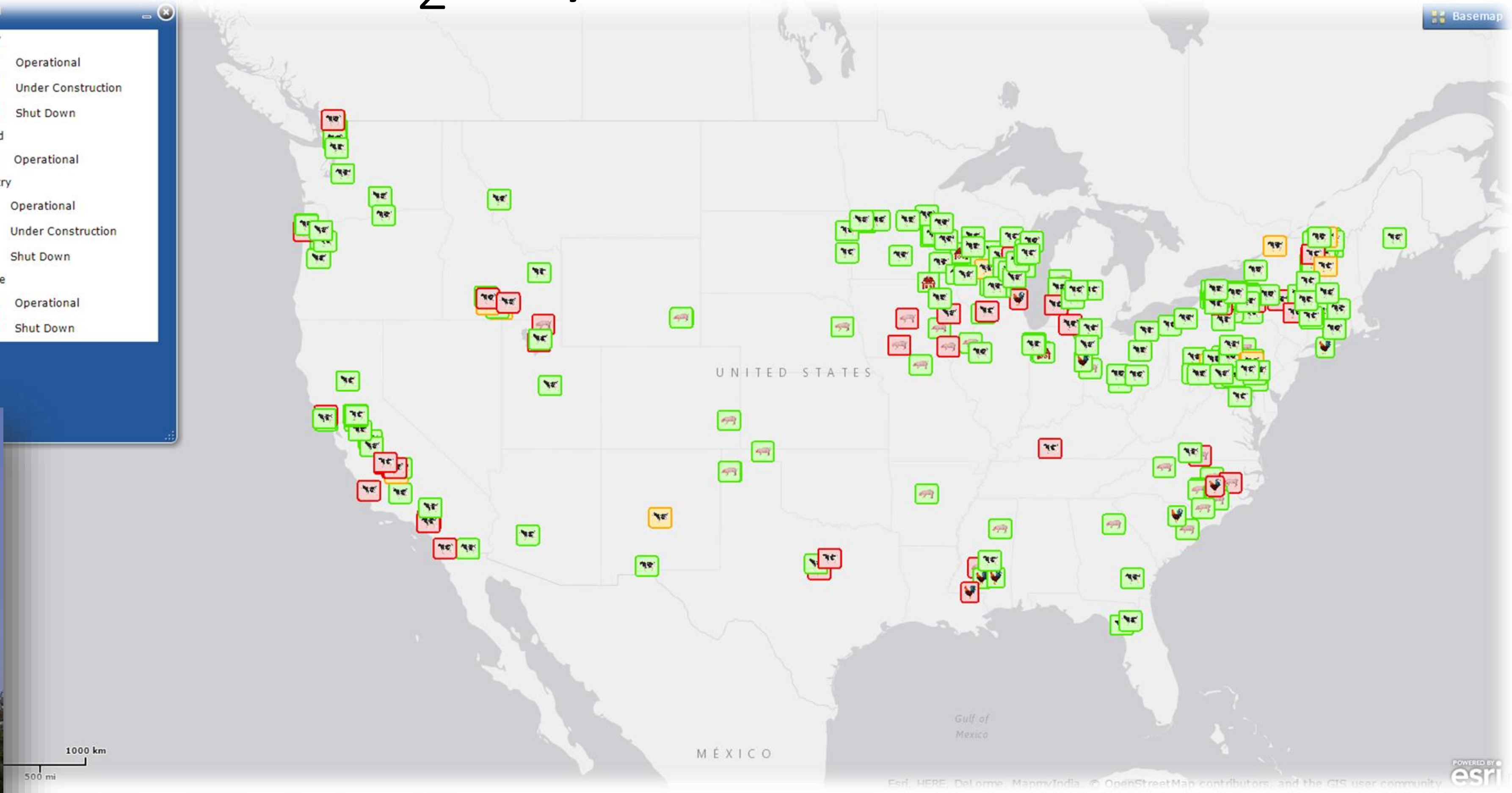
Alex Gallardo | Reuters

Dairy cows feed in Chino, California.

Happy cows may come from California, but their farts could be overheating the atmosphere.

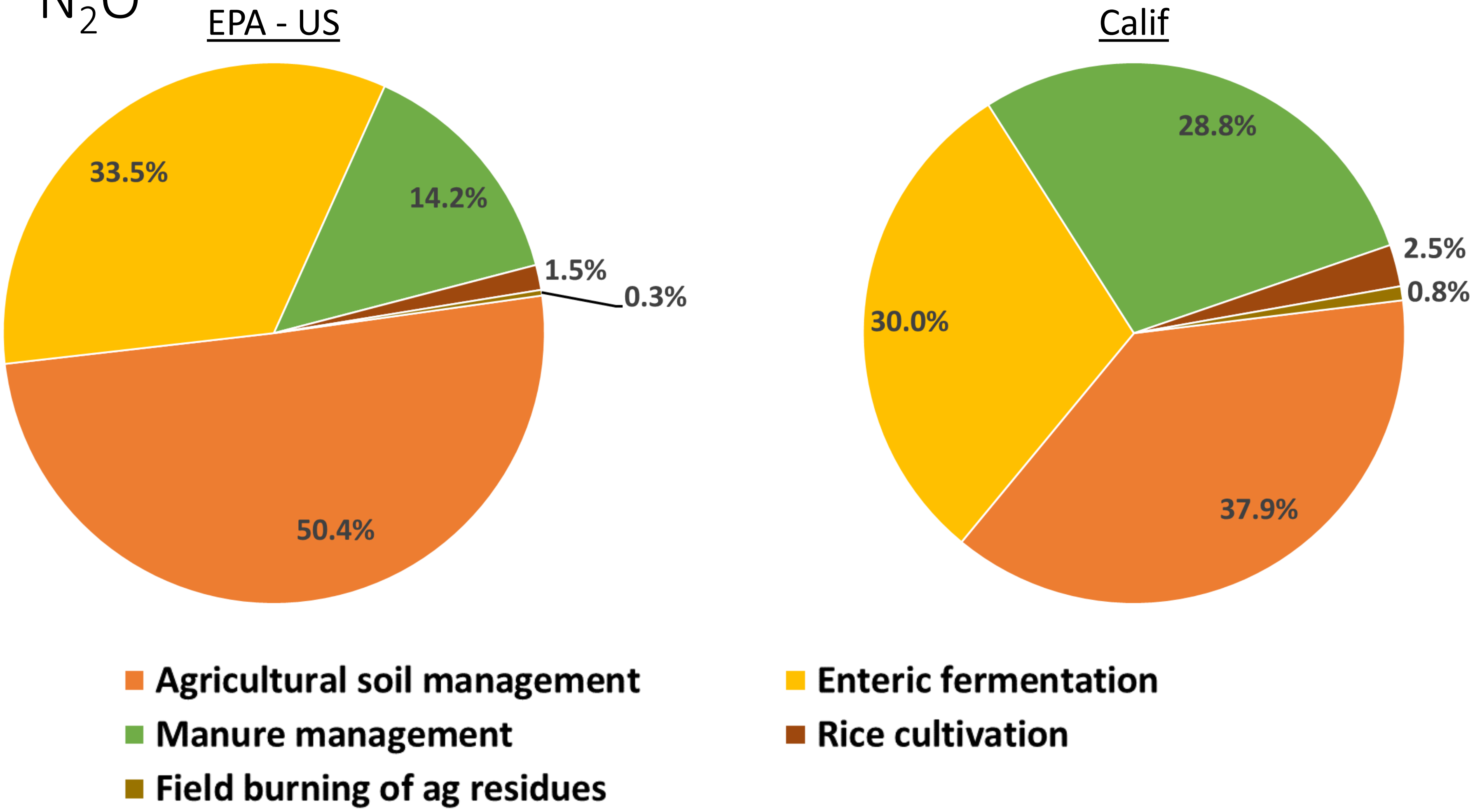
A new state law aims to reduce methane from cows, but the cattle industry thinks the regulation stinks.

265 Manure digesters in US that can capture 5.3 million MT CO_2 e/yr



https://www.epa.gov/agstar/agstar-national-mapping-tool

Agriculture in the US represents 5.8% of total anthropogenic GHG (CO_2 e); 32% of CH_4; 68% of N_2O



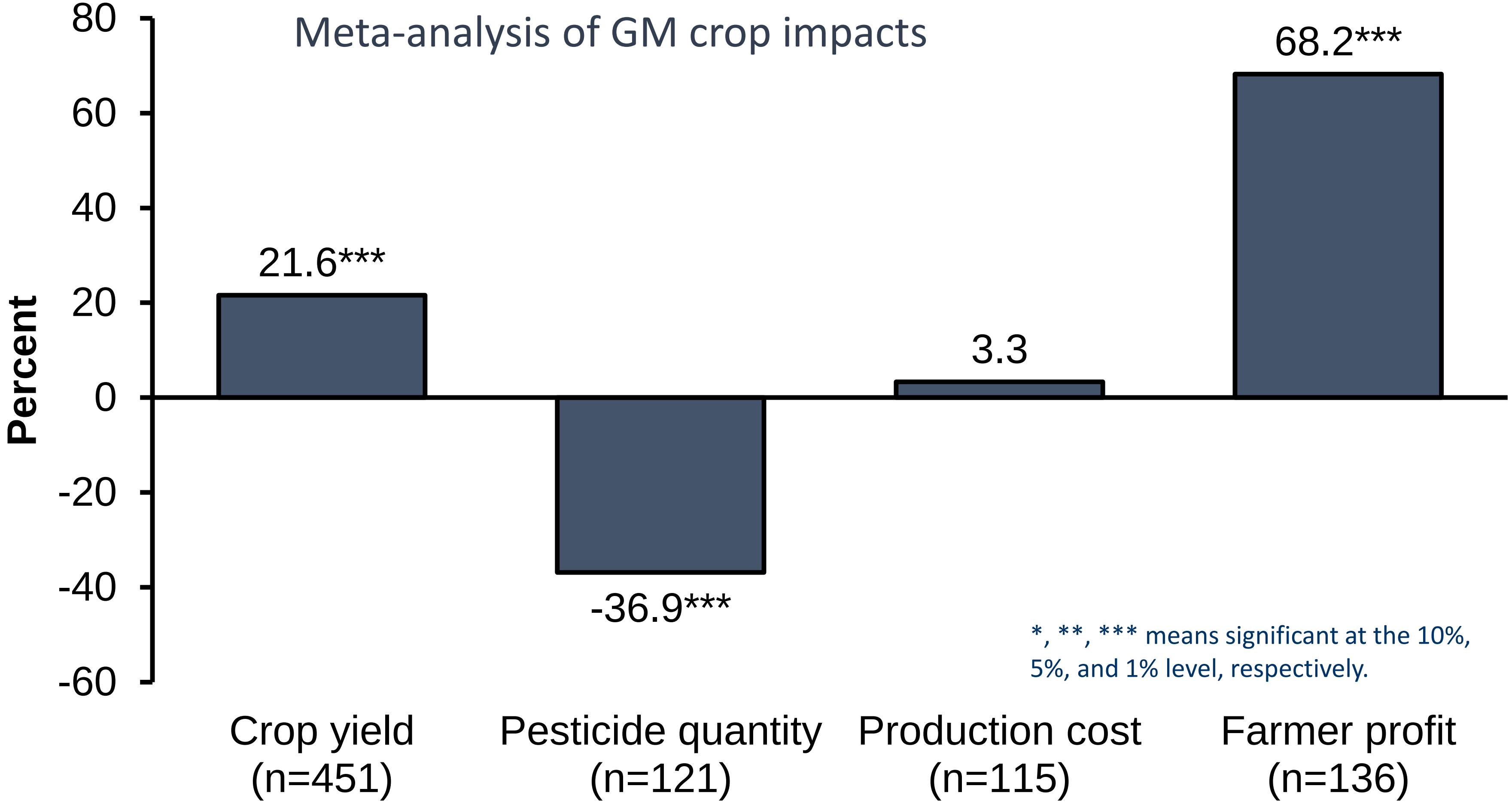
Adapted from Pitesky, Stackhouse & Mitloehner (2009)

No-Till Farming

- Began after WWII
- Not widely adopted in1960s
- Most tillage practices bury or remove large amounts of crop residue. No-till retains 90% of crop residue
- Reduced soil erosion
- Uses less fuel
- Reduces CO_2 loss
- Improved soil organic matter
- Global potential of C sequestration if all cropland converted to no-till = 1 Pg C/yr

Lal R, Reicosky DC, Hanson JD (2007) Evolution of the plow over 10,000 years and the rationale for no-till farming. Soil and Tillage Research 93:1-12

The agronomic and economic benefits of GM crops are large and significant


Meta-analysis of GM crop impacts

*, **, *** means significant at the 10%, 5%, and 1% level, respectively.

Klümper and Qaim (2014, *PLoS ONE*)

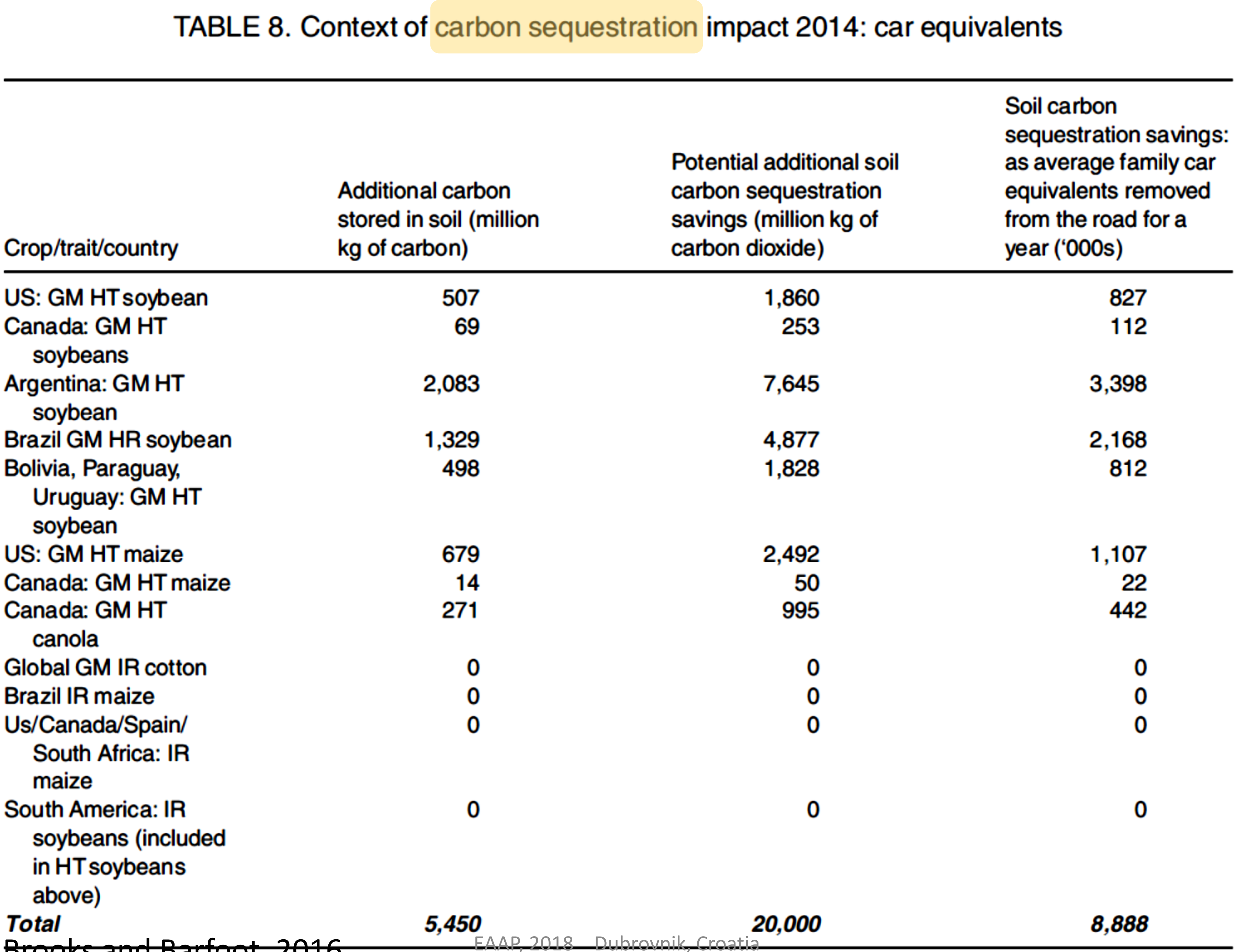


TABLE 8. Context of carbon sequestration impact 2014: car equivalents

Crop/trait/country	Additional carbon stored in soil (million kg of carbon)	Potential additional soil carbon sequestration savings (million kg of carbon dioxide)	Soil carbon sequestration savings: as average family car equivalents removed from the road for a year ('000s)
US: GM HT soybean	507	1,860	827
Canada: GM HT soybeans	69	253	112
Argentina: GM HT soybean	2,083	7,645	3,398
Brazil GM HR soybean	1,329	4,877	2,168
Bolivia, Paraguay, Uruguay: GM HT soybean	498	1,828	812
US: GM HT maize	679	2,492	1,107
Canada: GM HT maize	14	50	22
Canada: GM HT canola	271	995	442
Global GM IR cotton	0	0	0
Brazil IR maize	0	0	0
Us/Canada/Spain/ South Africa: IR maize	0	0	0
South America: IR soybeans (included in HT soybeans above)	0	0	0
Total	***5,450***	***20,000***	***8,888***

Brooks and Barfoot, 2016

Objective

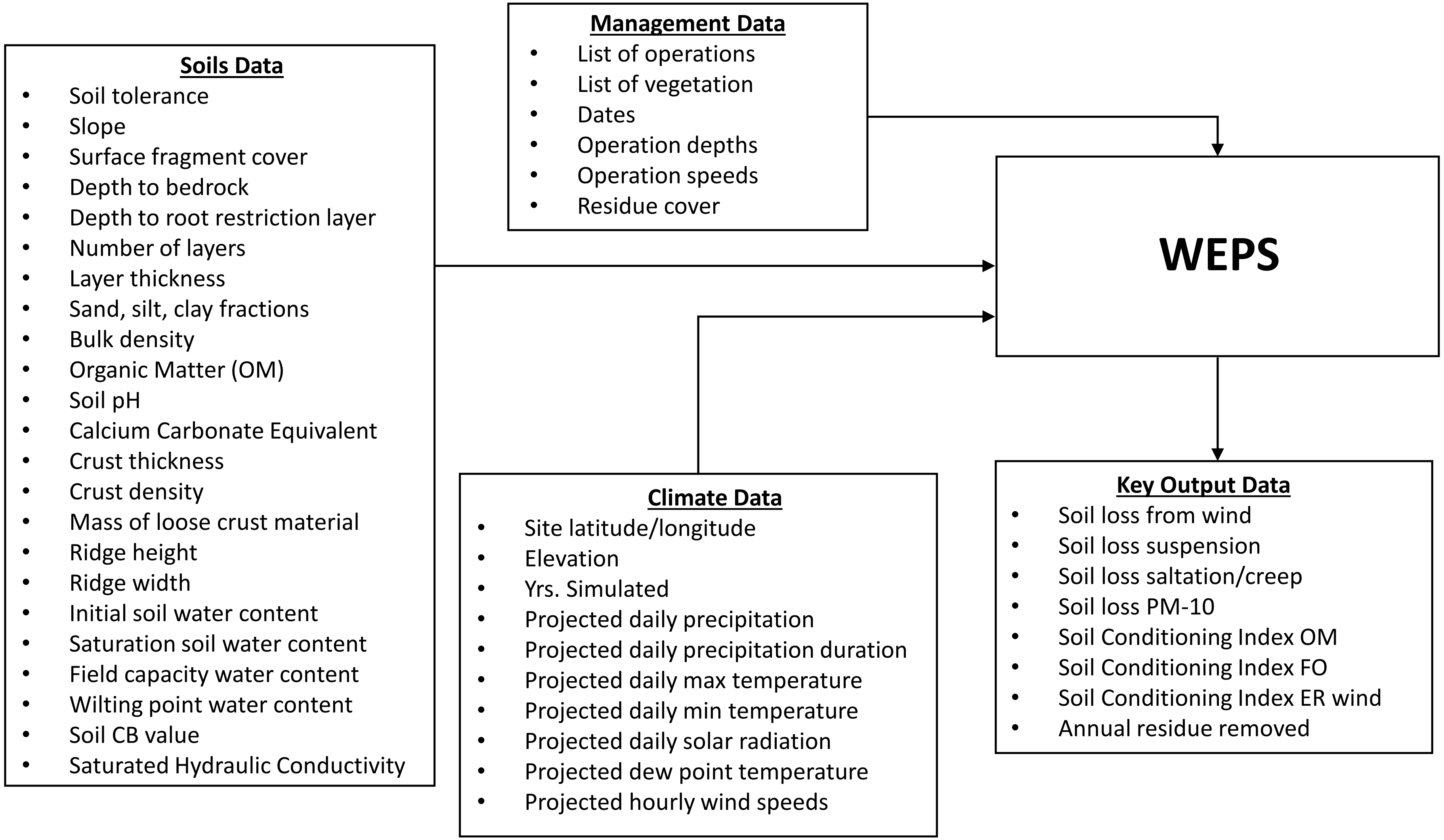
- Develop a modeling and simulation approach to estimate greenhouse gas emissions associated with different land management practices.
    - Works at subfield to regional scales to estimate spatial impacts.
- How it works: The model uses empirical and mechanistic methods based on soil, crop, climate, and management using site specific input data.
- Link DNDC with SSURGO and Daymet Weather

Data Tools Allow Modeling Crop Management Impacts on Sustainability

https://energy.gov

- Environmental analysis platform
- Uses models and data sources that are integrated within Landscape Environmental Assessment Framework (Bioenergy Technologies Office, Energy Department)
- Integrates
    - Environmental models
    - Publicly available data sources
    - Financial performance tools
- Modeling performed by AgSolver®

Wind Erosion Prediction System (WEPS; USDA)



Management Data

- List of operations
- List of vegetation
- Dates
- Operation depths
- Operation speeds
- Residue cover

Soils Data

- Soil tolerance
- Slope
- Surface fragment cover
- Depth to bedrock
- Depth to root restriction layer
- Number of layers
- Layer thickness
- Sand, silt, clay fractions
- Bulk density
- Organic Matter (OM)
- Soil pH
- Calcium Carbonate Equivalent
- Crust thickness
- Crust density
- Mass of loose crust material
- Ridge height
- Ridge width
- Initial soil water content
- Saturation soil water content
- Field capacity water content
- Wilting point water content
- Soil CB value
- Saturated Hydraulic Conductivity

WEPS

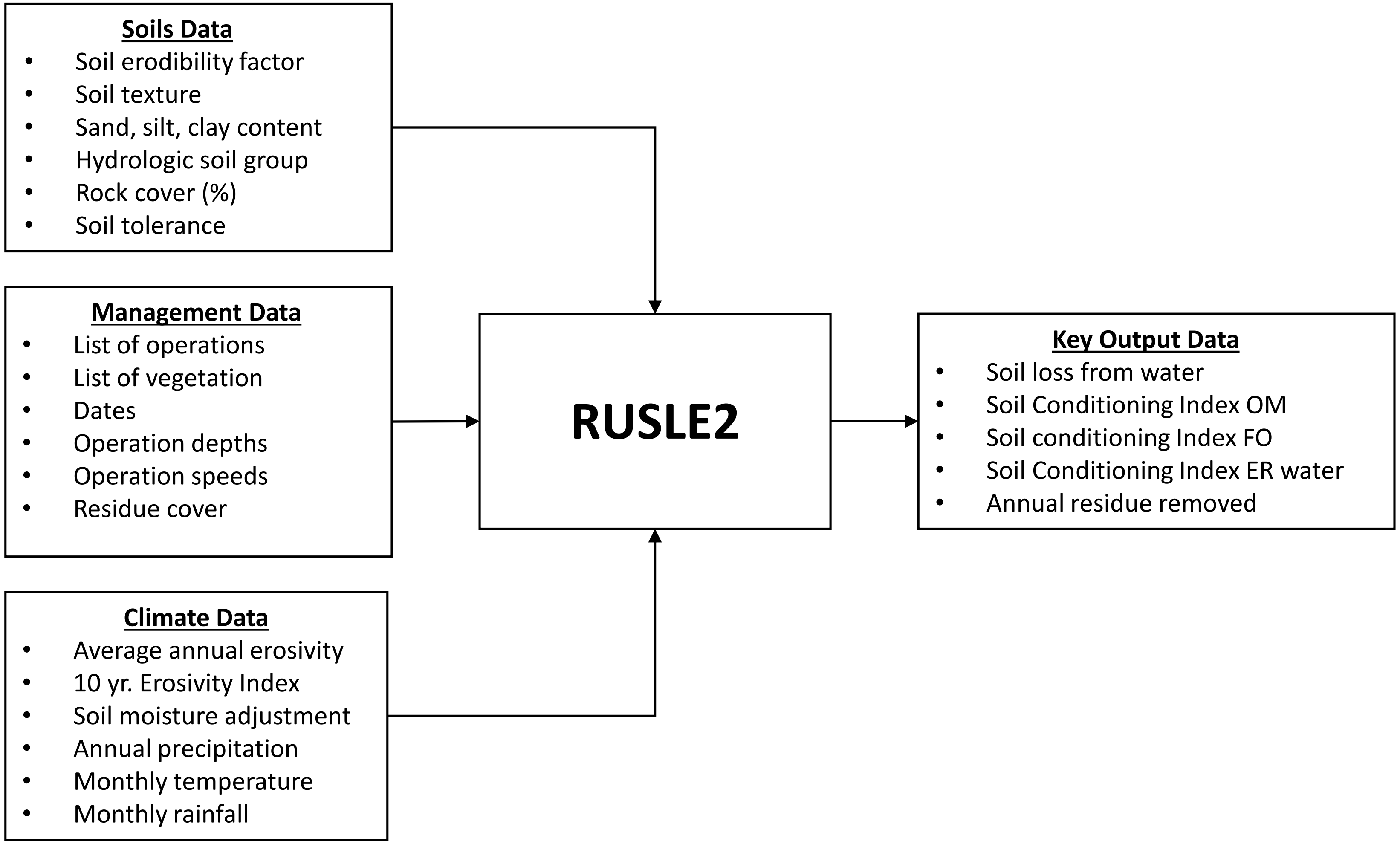
Climate Data

- Site latitude/longitude
- Elevation
- Yrs. Simulated
- Projected daily precipitation
- Projected daily precipitation duration
- Projected daily max temperature
- Projected daily min temperature
- Projected daily solar radiation
- Projected dew point temperature
- Projected hourly wind speeds

Key Output Data

- Soil loss from wind
- Soil loss suspension
- Soil loss saltation/creep
- Soil loss PM-10
- Soil Conditioning Index OM
- Soil Conditioning Index FO
- Soil Conditioning Index ER wind
- Annual residue removed

Revised Universal Soil Loss Equation, Version 2 (RUSLE2; USDA)



Soils Data
- Soil erodibility factor
- Soil texture
- Sand, silt, clay content
- Hydrologic soil group
- Rock cover (%)
- Soil tolerance

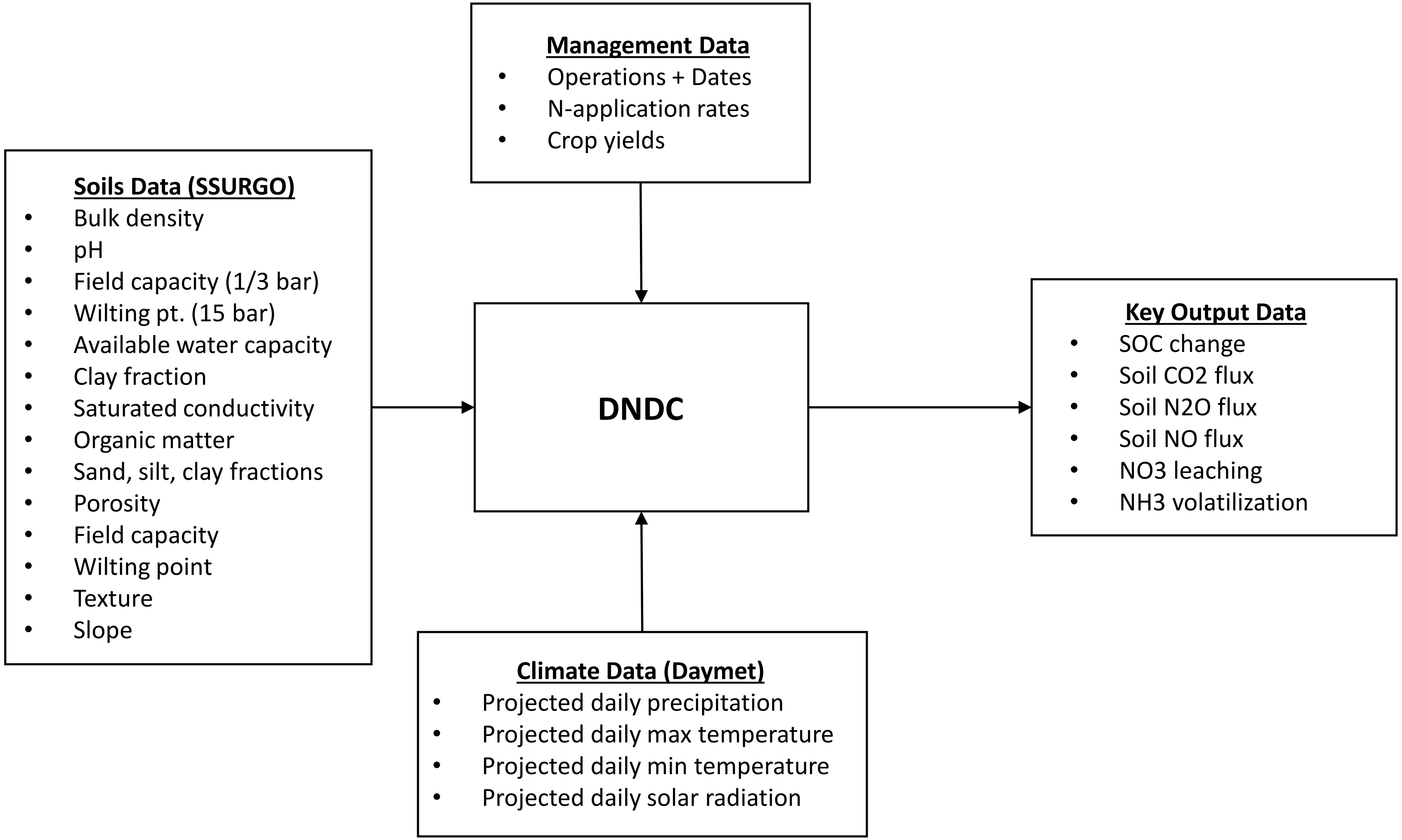
Management Data
- List of operations
- List of vegetation
- Dates
- Operation depths
- Operation speeds
- Residue cover

Climate Data
- Average annual erosivity
- 10 yr. Erosivity Index
- Soil moisture adjustment
- Annual precipitation
- Monthly temperature
- Monthly rainfall

RUSLE2

Key Output Data
- Soil loss from water
- Soil Conditioning Index OM
- Soil conditioning Index FO
- Soil Conditioning Index ER water
- Annual residue removed

Denitrification-Decomposition (DNDC) Model (EPA)



Management Data
- Operations + Dates
- N-application rates
- Crop yields

Soils Data (SSURGO)
- Bulk density
- pH
- Field capacity (1/3 bar)
- Wilting pt. (15 bar)
- Available water capacity
- Clay fraction
- Saturated conductivity
- Organic matter
- Sand, silt, clay fractions
- Porosity
- Field capacity
- Wilting point
- Texture
- Slope

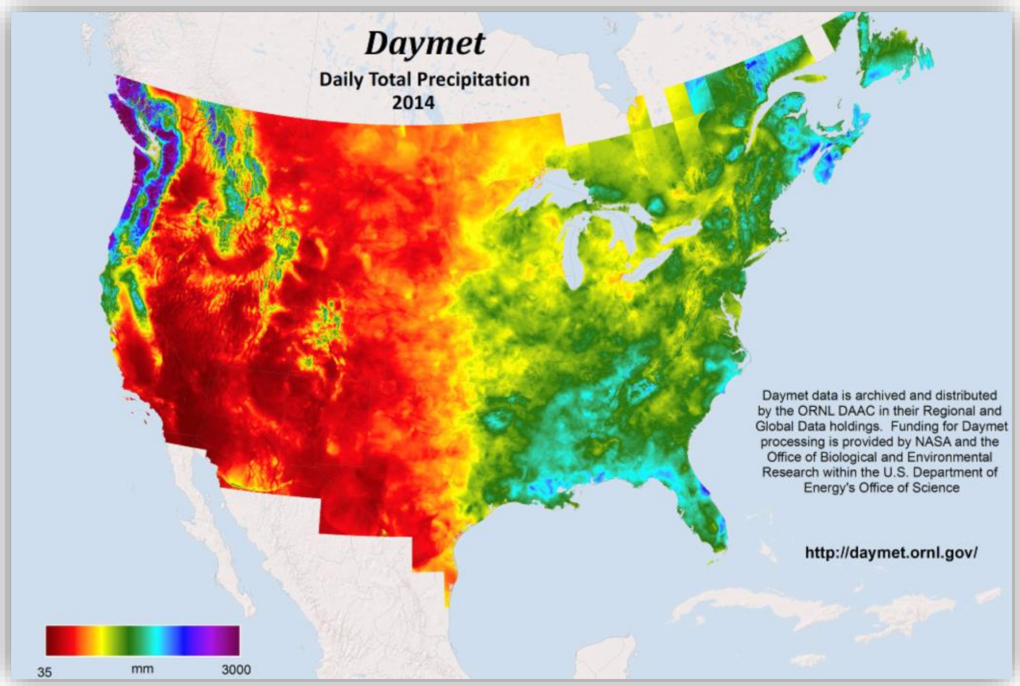
DNDC

Key Output Data
- SOC change
- Soil CO2 flux
- Soil N2O flux
- Soil NO flux
- NO3 leaching
- NH3 volatilization

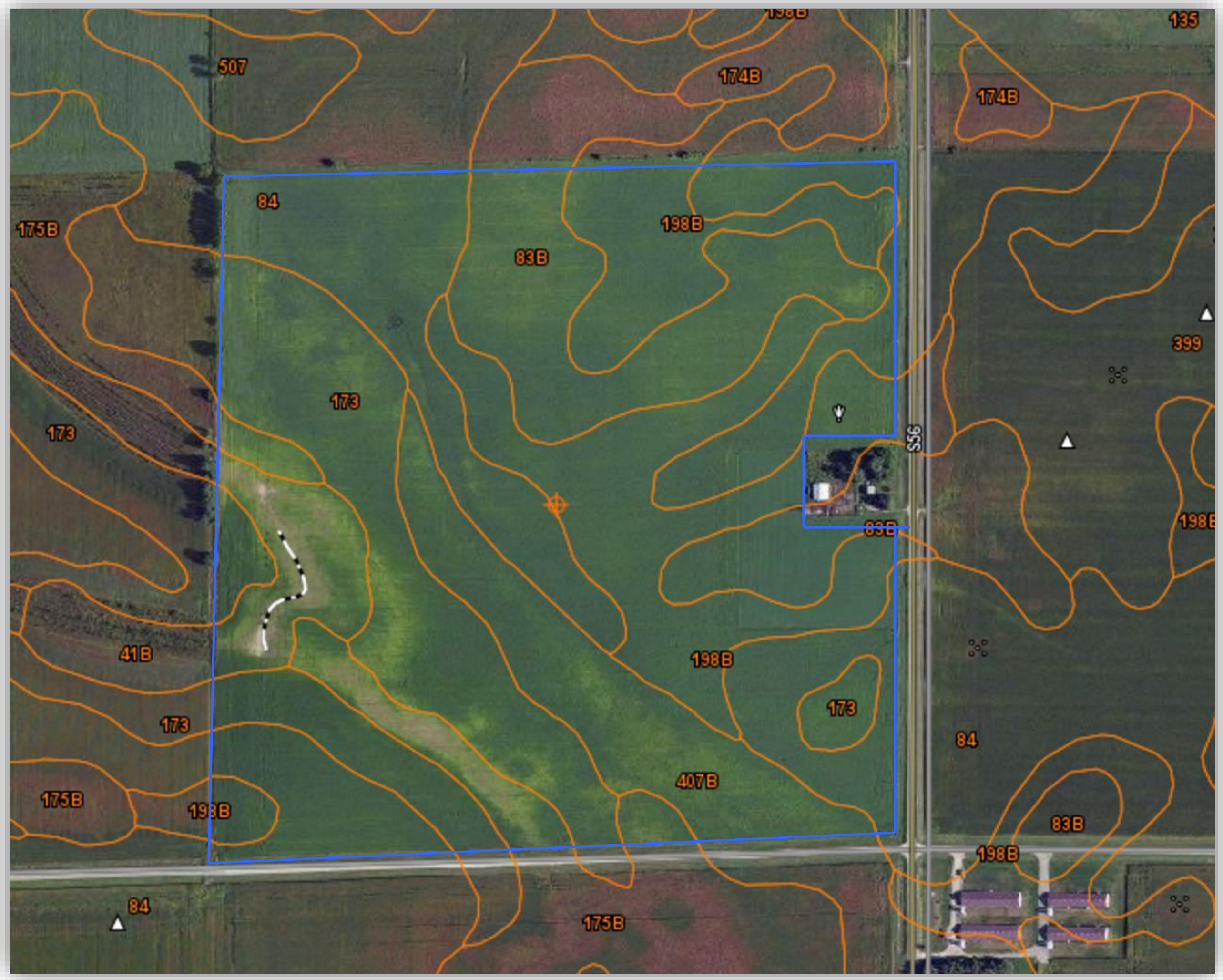
Climate Data (Daymet)
- Projected daily precipitation
- Projected daily max temperature
- Projected daily min temperature
- Projected daily solar radiation

Daymet Weather Data (NASA)

- Daily weather Data
  - Precipitation
  - Max. temperature
  - Min. temperature
  - Solar radiation
- Available from 1980-2014
- Interpolated to 1 km^2 grid

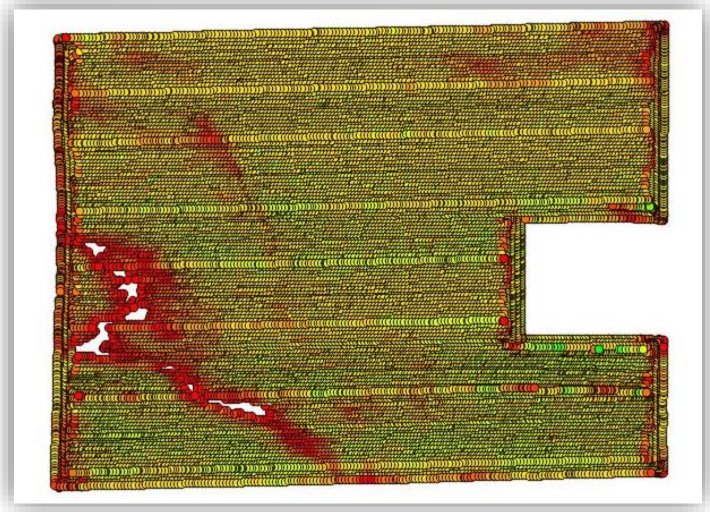


SSURGO Soils Database



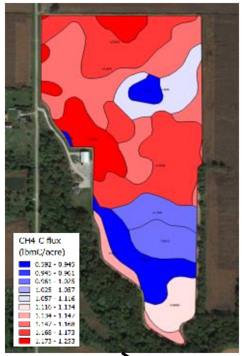
Crop Productivity Data Sources

- Per Soil Yields
  - ISPAID (Iowa)
  - NCCPI
- NASS county average calibration
- Precision yield monitor data

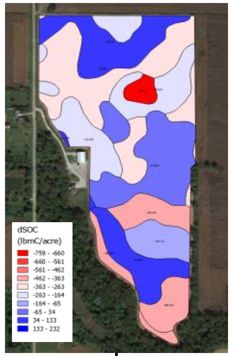


Gridded Sub-field Analysis

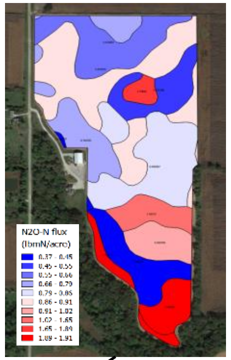
CH_4 flux

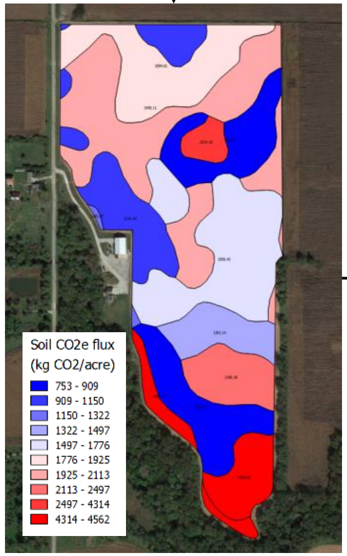


dSOC



N_2O flux



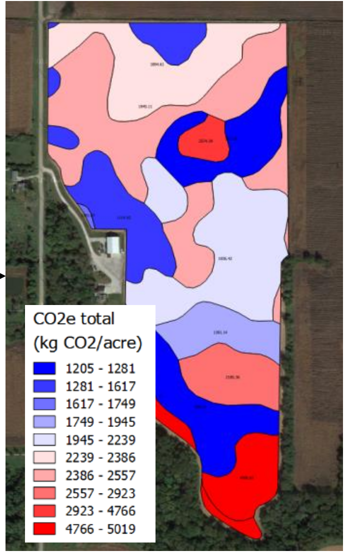


Soil CO_2e Profile

Irrigation

Diesel use

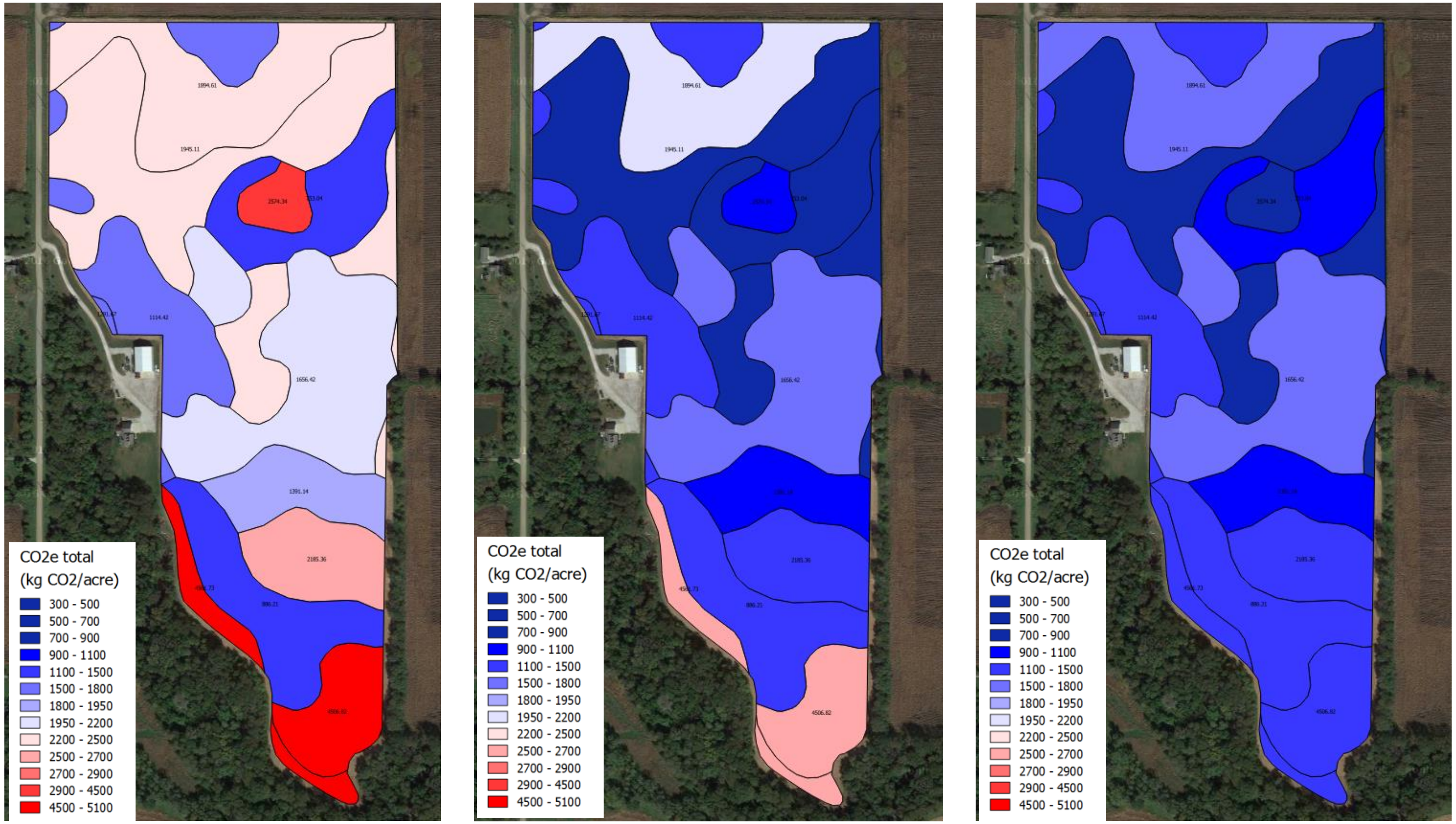
Fertilizer production



Farm-gate CO_2e

CO_2e Can be Modeled for Different Cropping Systems

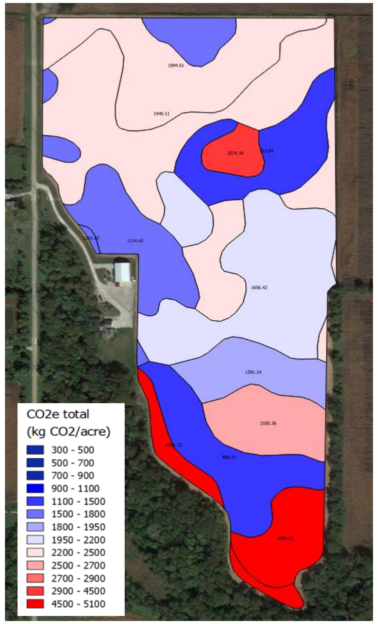
Tillage:	Conventional	Conventional	No-Till
Cover crop:	None	Rye	Rye



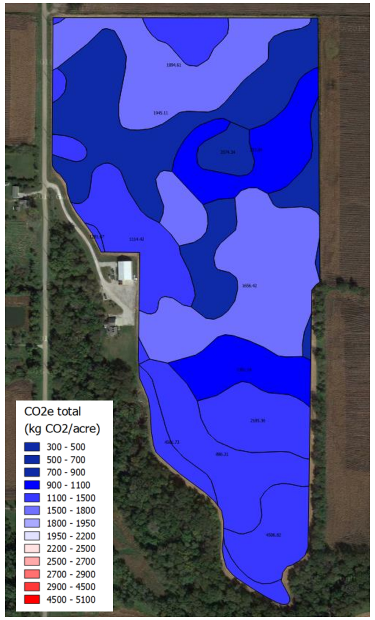
Gridded Sub-field Analysis

Field Averages

Rotation	Tillage	Cover Crop	CH_4 flux (lb C/ac)	dSOC (lb C/ac)	N_2O flux (lb N/ac)	Nitrate Leach (lbm N/acre)	Total CO_2e emissions (kg CO_2e/ac)
CG,CG,CG,CG	CT	NCC	-9.18	-135.66	3.02	74.36	2505.95
CG,CG,CG,CG	NT	RYE	-9.15	-15.78	1.39	32.13	1295.64



CG,CG,CG,CG-CT-NCC



CG,CG,CG,CG-NT-RYE

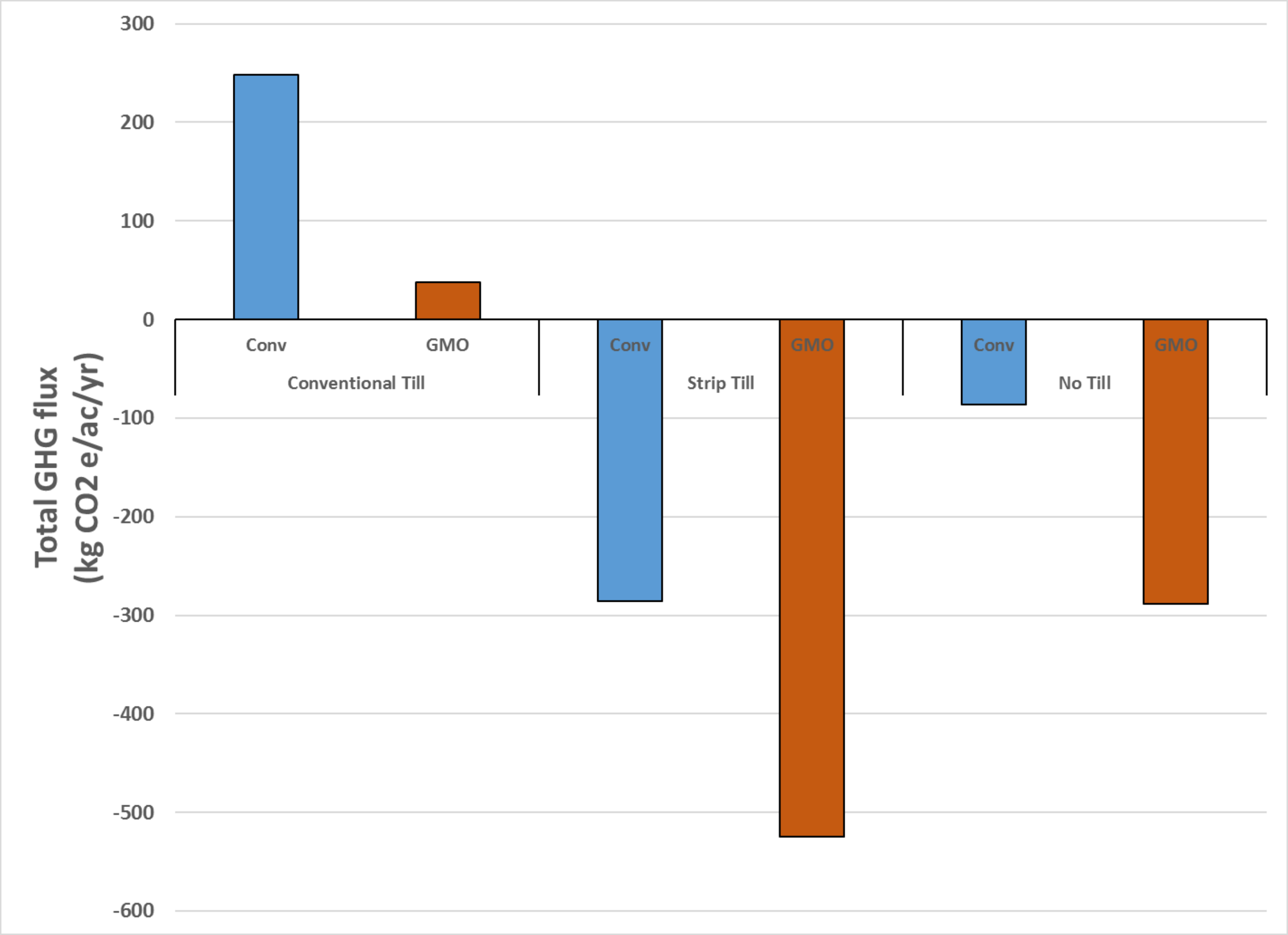
Results can be for a farm, county, state or the entire corn belt

Iowa data	Conventional Till		Strip Till		No Till	
	Conv	GMO	Conv	GMO	Conv	GMO
Total GHG flux (kg CO_2 e/ac/yr)	450	217	-327	-560	-219	-437
Δ Soil SOC (kg CO_2 e/ac/yr)	-310	-617	-725	-994	-827	-1099
Soil N_2O flux (kg CO_2 e/ac/yr)	540	584	384	418	378	400
Soil total GHG Flux (kg CO_2 e/ac/yr)	231	-33	-341	-576	-448	-699

Average GHG Emissions and Soil Loss Were Modeled for the 12-State Corn Belt Region

		Irrigated						Not Irrigated					
		Conventional Till		Strip Till		No Till		Conventional Till		Strip Till		No Till	
		Conv	GMO	Conv	GMO	Conv	GMO	Conv	GMO	Conv	GMO	Conv	GMO
CCSCCS	Total GHG flux (kg CO_2 e/ac/yr)	239	35	-336	-588	26	-162	818	692	-27	-228	30	-151
	Δ Soil SOC (kg CO_2 e/ac/yr)	-434	-664	-932	-1200	-574	-778	367	187	-296	-529	-200	-399
	Soil N_2O flux (kg CO_2 e/ac/yr)	123	132	110	117	114	120	338	375	207	229	169	176
	Soil total GHG Flux (kg CO_2 e/ac/yr)	-311	-532	-822	-1083	-460	-658	705	562	-89	-300	-32	-222
CCCCCC	Total GHG flux (kg CO_2 e/ac/yr)	-313	-614	-495	-758	-315	-553	461	241	-23	-227	-157	-390
	Δ Soil SOC (kg CO_2 e/ac/yr)	-1086	-495	-1162	-1454	-992	-1259	-85	-385	-408	-673	-461	-726
	Soil N_2O flux (kg CO_2 e/ac/yr)	148	161	139	151	149	161	379	429	294	337	213	228
	Soil total GHG Flux (kg CO_2 e/ac/yr)	-938	-1269	-1023	-1303	-843	-1098	294	44	-114	-336	-248	-499

Averages


Total GHG flux
(kg CO2 e/ac/yr)
300
200
100
0
-100
-200
-300
-400
-500
-600
Conv
GMO
Conventional Till
Conv
GMO
Strip Till
Conv
GMO
No Till

Average GHG Emissions and Soil Loss Were Modeled for the 12-State Corn Belt Region

	Reduced Till Conventional	No-Till GM
Δ Green house gas emissions (kg CO2e/bu)	**↓8.7**	**↓14.3**
Δ Soil Loss due to water and wind erosion (tn/ac)	**↓10.9**	**↓13.6**

Conclusions

- Many conclusions about animal ag and sustainability are the result of outdated assumptions/perceptions.
- Animal Scientists need to communicate with the public about the significant achievements in animal ag.
- Crops are a significant part of the GHGs from animal ag.
- GM crops and no-till can reduce or even facilitate sequestration of GHGs.