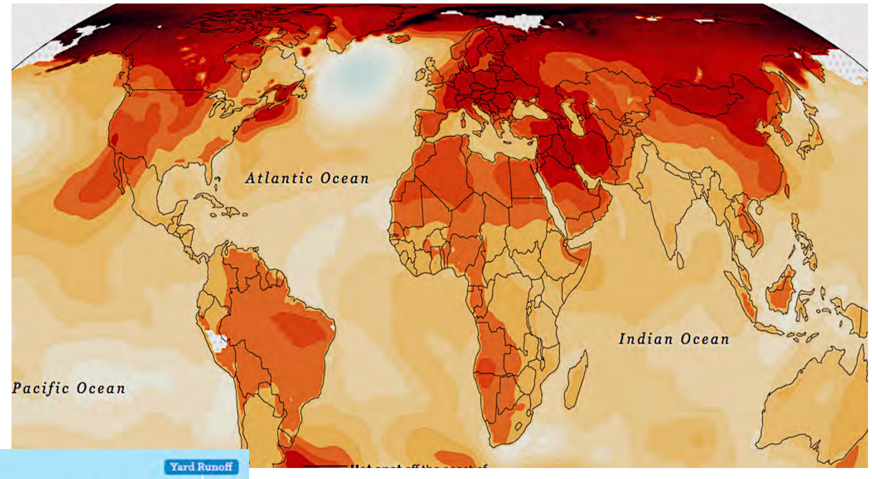
# Sequestering Carbon in Agricultural Soils: Why, What & How Much?

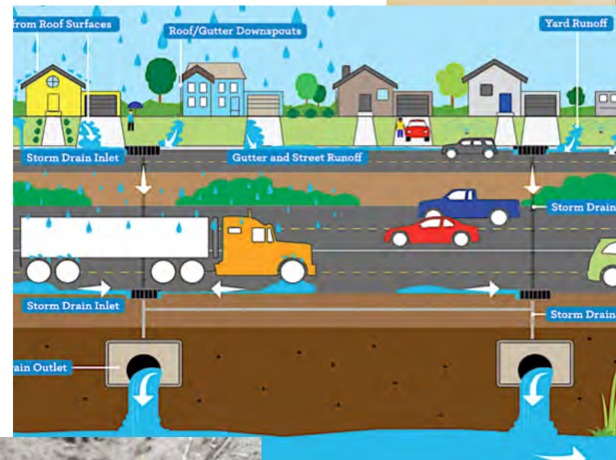
**Dr. Sara Via**
Professor & Climate
Extension Specialist
UMD, College Park
svia@umd.edu

Source: Modern Farmer

# Three critical problems

- the climate problem
- the water problem
- the soil problem





## Nature-based solutions to all three start with soil

Dr. Sara Via svia@umd.edu

# Climate: Reducing emissions is not enough

## We also need to remove $CO_2$ from atmosphere

**We can use plants for this!**

- Land-based carbon sequestration is effective, practical, low-cost & available now

**Farming practices that rebuild soil also reduce the other problems by**

- **Storing atmospheric carbon in soil & woody plants**
- **Increasing water quality & regulating water flow**

No-tillfarmer.com

Dr. Sara Via svia@umd.edu

# Solution: Conservation agriculture rebuilds soil

protrakker.com

Cornell.edu



Miller et al. 2017 Nebraska Extension.

**No-till:** less erosion, soil structure maintained, crop residue adds organic matter, soil drains & holds more water, water filtered & cleaned

**Cover crops:** reduce erosion, living roots feed soil microbes

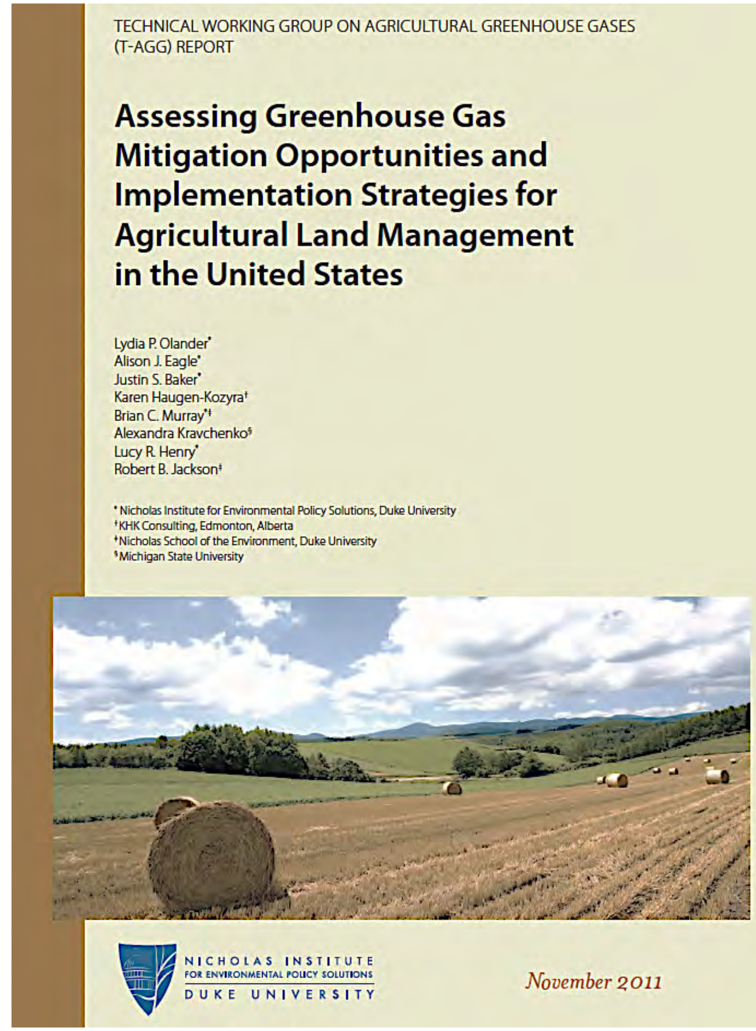
**Crop rotation:** increases diversity of plants & soil microbes

Dr. Sara Via svia@umd.edu

# Maryland: Identify research-based practices for sequestering C in agricultural soils

## Goal: Evidence-Based Policy

- **Reviewed** scientific literature on carbon sequestration
- **Evaluated** support for the sequestration potential of various practices in "conservation agriculture"
- **Developed** menu of recommended practices
- **Evaluated** GHG reductions, past and future


TECHNICAL WORKING GROUP ON AGRICULTURAL GREENHOUSE GASES (T-AGG) REPORT

Assessing Greenhouse Gas Mitigation Opportunities and Implementation Strategies for Agricultural Land Management in the United States

Lydia P. Olander[*]
Alison J. Eagle[*]
Justin S. Baker[*]
Karen Haugen-Kozyra[†]
Brian C. Murray[*‡]
Alexandra Kravchenko[§]
Lucy R. Henry[*]
Robert B. Jackson[‡]

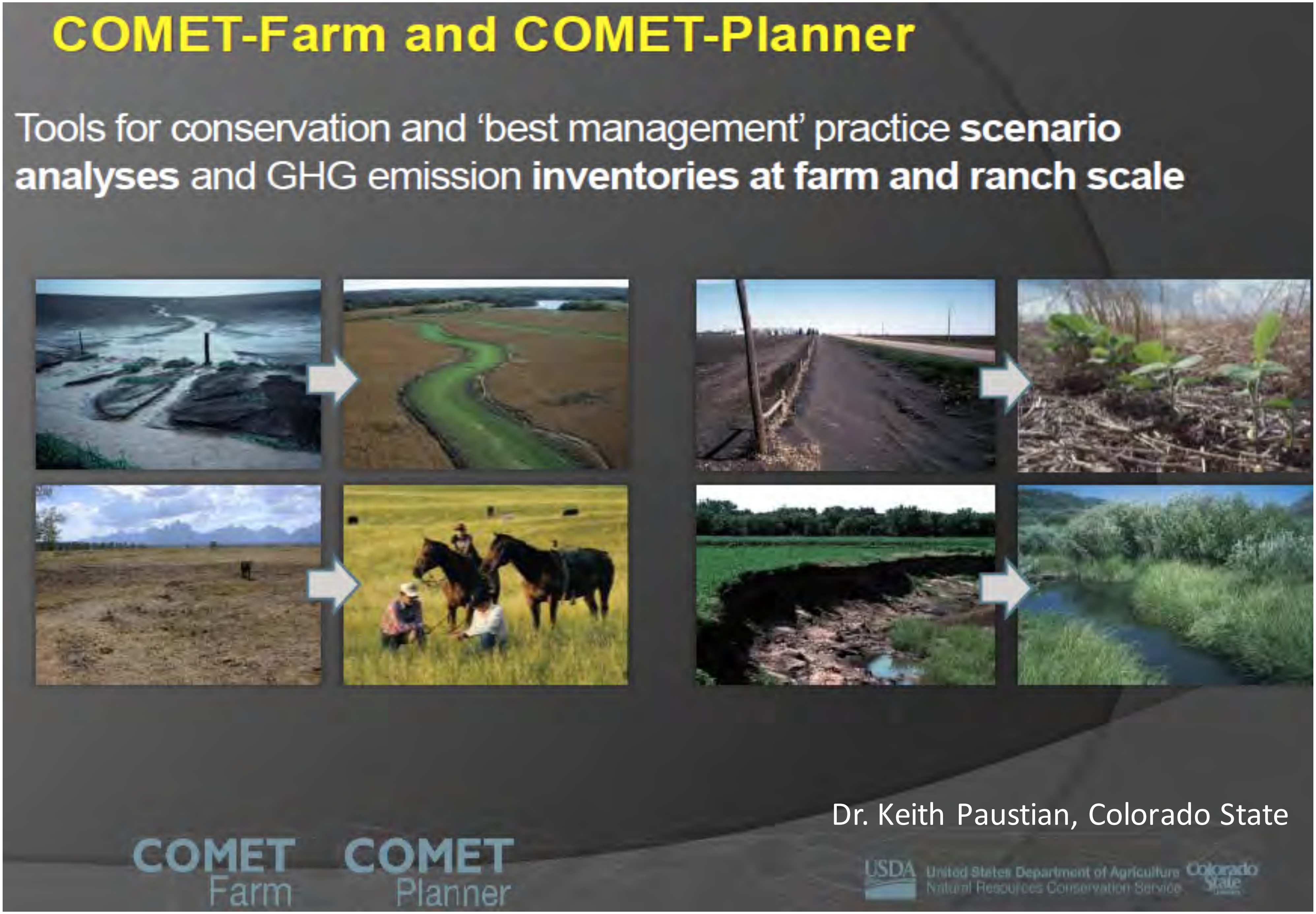
[*] Nicholas Institute for Environmental Policy Solutions, Duke University
[†] KHK Consulting, Edmonton, Alberta
[‡] Nicholas School of the Environment, Duke University
[§] Michigan State University

NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS
DUKE UNIVERSITY

November 2011

Dr. Sara Via svia@umd.edu

# From Conservation Practices to GHG reductions:




Dr. Keith Paustian, Colorado State

# Recommended NRCS practices for carbon sequestration in Maryland

| GHG estimates from comet-planner.nrel.colostate.edu/COMET-Planner_Report_Final.pdf | | GHG Reduction | | |
|---|---|---|---|---|
| **NRCS Conservation Practices** | | Mt CO2e/ac/yr | | |
| **Cropland Management** | **Description of practice** | $CO_2$ | $N_2O$ | Sum |
| **Conventional Tillage to No Till** | | 0.42 | -0.11 | **0.31** |
| **Conventional Tillage to Reduced Tillage** | Reduced tillage = strip till | 0.13 | 0.07 | **0.20** |
| **N Fertilizer Management** | Improve N fertilizer management to reduce by 15% through 4R or nitrification inhibitors | 0.00 | 0.11 | **0.11** |
| **Replace N Fertilizer w/ Soil Amendments** | Soil amendments include compost, manure | 1.75 | 0.00 | **1.75** |
| **Conservation Crop Rotation** | Decrease fallow or add perennial crop to rotation | 0.21 | 0.01 | **0.22** |
| **Cover Crops** | Add seasonal cover crop to cropland | 0.32 | 0.05 | **0.37** |
| **Insert forage planting into rotation** | Add annual or perennial forage to rotation | 0.21 | 0.01 | **0.22** |
| **Mulching** | Add high carbon mulch to cropland | 0.32 | NA | **0.32** |
| **Land use changes- add herbaceous plants** | | | | |
| **Conservation Cover** | Convert to permanent unfertilized grass, legume, pollinator or other mix, ungrazed | 0.98 | 0.28 | **1.26** |
| **Forage and biomass planting** | Convert to grass, forage or biomass plant | 0.21 | 0.01 | **0.22** |
| **Riparian herbaceous cover** | Convert area near water to permanent unfertilized grass | 0.98 | 0.28 | **1.26** |
| **Contour buffer strips** | Covert strips to permanent unfertilized grass, legume, pollinator or other mix | 0.98 | 0.28 | **1.26** |
| **Field border** | Convert strips to permanent unfertilized grass/legume to reduce runoff | 0.98 | 0.28 | **1.26** |
| **Filter Strip** | Convert strips to permanent unfertilized grass/legume | 0.98 | 0.28 | **1.26** |
| **Grassed Waterway** | Convert strips to permanent unfertilized grass/legume to filter water | 0.98 | 0.28 | **1.26** |
| **Vegetative barrier** | Plant stiff vegetative cover on hillsides or by streams to reduce erosion; can be used in critical areas | 0.98 | 0.28 | **1.26** |

Dr. Sara Via svia@umd.edu

**Highlighted practices are currently incentivized for water quality,**

All have significant or medium research support

Dr. Sara Via svia@umd.edu

# Recommended NRCS practices for carbon sequestration in Maryland

| Land use changes- add woody plants | | | | |
|---|---|---|---|---|
| Tree & shrub establishment, Incl woodlot | Plant trees and shrubs | 1.98 | 0.28 | **2.26** |
| Riparian Forest Buffer Establishment | Replace strip of cropland near water with woody plants | 2.19 | 0.28 | **2.47** |
| Alley Cropping | Replace 20% of annual cropland with woody plants | 1.71 | 0.03 | **1.74** |
| Multistory Cropping | Replace 20% of cropland with trees & shrubs of different heights, could be permaculture | 1.71 | 0.03 | **1.74** |
| Hedgerows | Replace strip of cropland with one row woody plants, could combine with Conservation Cover for pollinators | 1.42 | 0.28 | **1.70** |
| **Grazing** | | | | |
| Silvopasture | Add trees and shrubs tograzed pastures (> 20 plants/acre) | 1.34 | 0.00 | **1.34** |
| Prescribed grazing/rotational grazing * | Short-term intense grazing in small paddocks | 0.26 | 0.00 | **0.26** |

All but * have significant or medium research support

**Used number of acres each year in highlighted subset of practices incentivized for water quality to estimate GHG reduction from use of "water quality" practices**

**2006-18: ~ 6 MMt**

**= taking 1.3 million cars off the road for a year**

Dr. Sara Via svia@umd.edu

# New tool from American Farmland Trust

## <u>Ca</u>rbon <u>R</u>eduction <u>P</u>otential <u>E</u>valuation (CaRPE)

- Evaluates GHG reduction from agricultural practices using county level estimates from COMET-Planner
- Can use to see where largest increase in carbon sequestration is likely, how much more is possible


**North Carolina** cover crop adoption = **9.6%**

**Maryland** cover crop adoption ~ 47%

**National average** cover crop adoption = **3.9%** (of all cropland)

Dr. Jen Moore-Kucera

American Farmland Trust

# Target counties with greatest scope for improvement

## Top 10 counties for Cover Crop Adoption

| County | Amount of cropland without cover crops (acres) | Reduction if cover crops adopted on this cropland (MT $CO_2e\ yr^{-1}$) |
|---|---|---|
| Robeson | 203,702 | 128,112 |
| Sampson | 181,427 | 113,999 |
| Duplin | 146,758 | 92,333 |
| Union | 139,507 | 59,986 |
| Pitt | 132,661 | 84,831 |
| Beaufort | 116,502 | 74,501 |
| Wayne | 113,509 | 71,430 |
| Columbus | 109,942 | 70,309 |
| Johnston | 106,374 | 66,982 |
| Bertie | 98,022 | 62,651 |

# Project future GHG reduction

| Practice Category | Current or Remaining | Convert from | Converted to | Tonnes $CO_2e\ yr^{-1}$ |
|---|---|---|---|---|
| Cover Crop | Current | No cover | Legume | 281,361 |
| | Remaining | No cover | Legume | 2,679,308 |

Dr. Jen Moore-Kucera

American Farmland Trust

# Tool for State-level planning and assessment

## "COMET-Explorer"

**Approach:**

- Utilize point-scale data generated by COMET-Farm/ COMET-Planner to support ***county-, regional- or state-wide*** analytics for soil carbon and GHGs
- Enable user-specified ***policy adoption scenarios*** for chosen practices, available land areas and LU types, and projected adoption rates (over time)


Dr. Sara Via svia@umd.edu

# Co-benefits of carbon-sequestering practices

## Economic co-benefits to farmers:

- **Improved soil health**
- **Reduced erosion** (worth $40-140/acre)
- **Increased profits** from reduced inputs, labor & energy savings (even if yield declines initially)
  2013: no-till saved MD farmers > $10 billion in fuel
- **Climate resilience:** reduced risks from flood/drought

Dr. Sara Via svia@umd.edu

# Co-benefits of carbon-sequestering practices

## Environmental co-benefits from healthy soil

- **Water quality:** reduced nutrients, sediment, chemicals
- **Better stormwater control** & reduced flooding
- **Better water holding**, less irrigation needed
- **Improved ecosystem services**, worth up to $3500/acre

Dr. Sara Via svia@umd.edu

# Pending: Monitoring carbon sequestration

Verify that management practices increase SOC

- **Establish a set of permanent sites for regular sampling by trained techs (NRI sites?)**
  * range of soils, geography and cropping systems conventional & C-sequestering practices
  * standard sampling protocol to 50 cm (or 1m?)
  * standard soil analyses, including microbial
  * measure change in soil organic carbon (SOC)
- **Farmers submit yearly soil tests** with records of field management
  * correlate data on farm-level changes in SOM with data from permanent plots

Dr. Sara Via svia@umd.edu

**Contact me anytime with questions or comments!**

**Dr. Sara Via**
Professor &
Climate Extension Specialist
svia@umd.edu