SOIL HEALTH & CLIMATE CHANGE
ADAPTATION & MITIGATION

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Find our education, outreach, and peer-reviewed materials here:
http://blogs.cornell.edu/woodbury

Soils and Climate Change

- This talk is focusing on how Farms, Landowners, and citizens can promote resiliency through the soil:

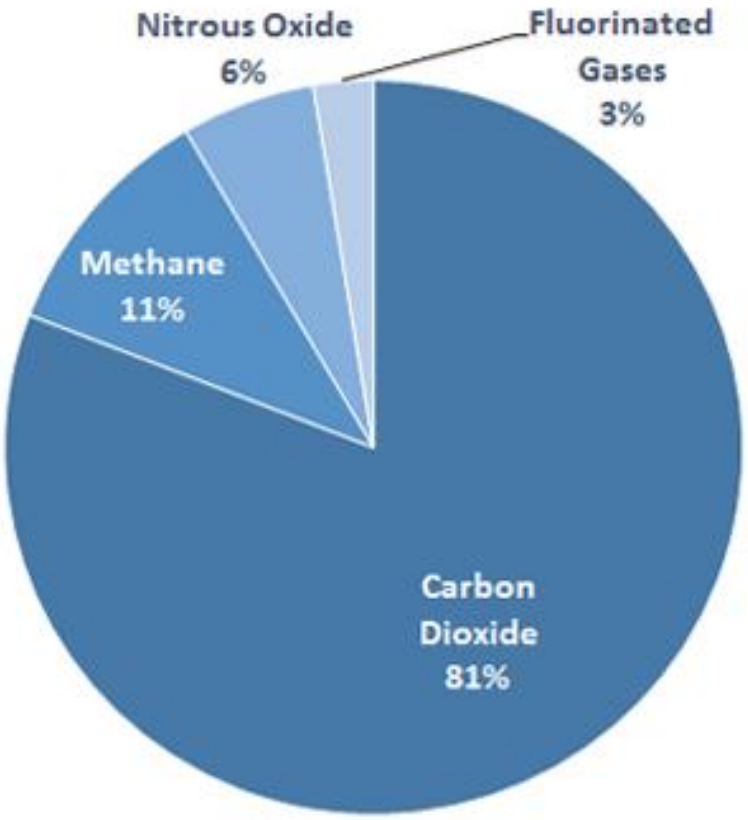
- FOR EXAMPLE: Double Cropping
  - Slow the rate of change (through carbon sequestration)
  - Increase resiliency (reduce erosion)
  - Reduce impact (better able to absorb extreme precipitation)
  - Increase productivity (double crop, e.g. winter wheat/soybean)

  - Resulting in local and global sustainability
    - Increasing knowledge
    - Minimizing impacts for future generations

NYS Greenhouse Gas (GHG) Emission Reduction Goals

- Governor Cuomo
- Executive Order No. 166, June 1, 2017
  - 40x30: 40% reduction of 1990 level GHG by 2030
  - 80x50: 80% reduction of 1990 level GHG by 2050 (from ALL sectors)
    - Programs include NY Sun-solar, Green Bank, methane reduction plan, Clean Energy Standard, Clean Energy Fund, Environmental Protection Fund, NYSERDA, RGGI, Transportation and Climate Initiative (TCI), Ocean Action Plan, Climate Risk and Resiliency, Climate Smart, Climate Resilient Farming

GHG by Type – Most is from CO_2



GHG by type and sector (Source: US EPA 2016)

Common Farm & Forest Greenhouse Gases (GHG)

- **Carbon Dioxide (CO_2)**
  - – e.g. combustion of fossil fuels, released from soils, burned forests
- **Methane (CH_4)**
  - – e.g. cow rumen, manure
- **Nitrous Oxide (N_2O)**
  - – e.g nitrogen fertilizer

Global Warming Potential (GWP)

- Different GHGs can have different effects on the Earth's warming.
  - their ability to absorb energy (their "radiative efficiency"),
  - how long they stay in the atmosphere (their "lifetime").

- The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases.

Global Warming Potential (GWP)

- CO_2, by definition, has a GWP of 1

GWP values and lifetimes from 2013 IPCC AR5 p714 (with climate-carbon feedbacks)[7]	Lifetime (years)	GWP time horizon	
		20 years	100 years
Methane	12.4	86	34
HFC-134a (hydrofluorocarbon)	13.4	3790	1550
CFC-11 (chlorofluorocarbon)	45.0	7020	5350
Nitrous oxide (N_2O)	121.0	268	298
Carbon tetrafluoride (CF_4)	50000	4950	7350

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- Methane (CH_4) and Nitrous Oxide (N_2O) are Important Land-based GHG

How Do We Avoid Emitting GHG?

Some Examples involving CO_2 and N_2O

- Avoid producing carbon-based GHG
  - Reduce tractor passes -> reduce fossil fuel use
  - Reduce tillage
  - Reduce synthetic N purchase (fuel intensive process)
- Avoid the GHG impact from nitrogen processes
  - Reduce synthetic N use to reduce field N_2O (GWP =298)
  - Manage manure-N to reduce field N_2O

How Do We Mitigate (Reduce) GHG?

Some Examples involving CO_2

- Sequester the CO_2 in soil, products, root systems, wood
  - Promote vegetative cover: perennials, cover crops
  - Improve pasture and grazing
  - Add biochar to soils
  - Increase yields by double cropping
  - Plant rows of trees, buffer strips, reforest marginal lands
  - Manage woodlots (increase C in trees and soil)

Carbon Sequestration - permanence

- For carbon sequestration to have a meaningful impact on the atmosphere it is necessary to ensure that the carbon remains sequestered and is not released back into the atmosphere.

- For example, years of carbon built up and stored in soils can be released back into the atmosphere from just one instance of tillage.

- Some strategies are permanent, others are not (but may have other benefits).

Conserve/Improve vegetative cover

- Protect agricultural and forest lands from development
- Move toward soil sequestration mechanisms including perennials, double crops, cover crops, reduce tillage, biochar, improved pasture and grazing
- WHY?
- These practices sequester carbon, improve productivity, reduce erosion, improve water quality and improve soil health

Improve Nutrient management

- Reduce synthetic nitrogen consumption (energy intensive process) on Agricultural lands, yard/landscaping

- Manage manure and synthetic Nitrogen use to reduce N_2O field emission and it's high GWP (298x CO_{2e})

- WHY?
- These practices remove emissions from fertilizer manufacturing, improve profitability, improve water quality, improve air quality, and improve soil health

Improve Forest Management

- **More than 60% of our state soil is forested!**
- **30% of Ag. land is wooded**

- Manage woodlots, privately owned forests, plant riparian buffer strips, reforest marginal lands

- WHY?
- These practices sequester carbon in tree trunks, soil, and profitable long-lived wood products, reduce erosion, improve water quality, air quality, and soil

Improved Soil Health Reduces GHG emissions

- Farms can increase soil carbon,
  - which improves soil health,
  - crop productivity,
  - water infiltration and retention,
  - and can also sequester carbon in soil and products.

- Mechanisms include
  - tillage practices,
  - soil amendments, manure, biochar
  - annual versus perennial crop options for maximizing soil carbon storage
  - cover crops/double crops
  - Plant forests on marginal lands, add buffer strips, manage woodland

PRELIMINARY Benefits

	Permanent GHG mitigation	Verifiable GHG mitigation	Build Climate Resiliency	Improve Productivity
Avoid Land Conversion (Defense)	x	x	x	x
Forest Management	x	x	x	Retirement income
N-management	x	x		Cost-effective
Biochar	x	x		Nutrient store
Double-cropping			x	Additional income
Move to Perennials			x	Reduce field passes
Soil Amendment			x	Reduced inputs

Current or Recent Opportunities

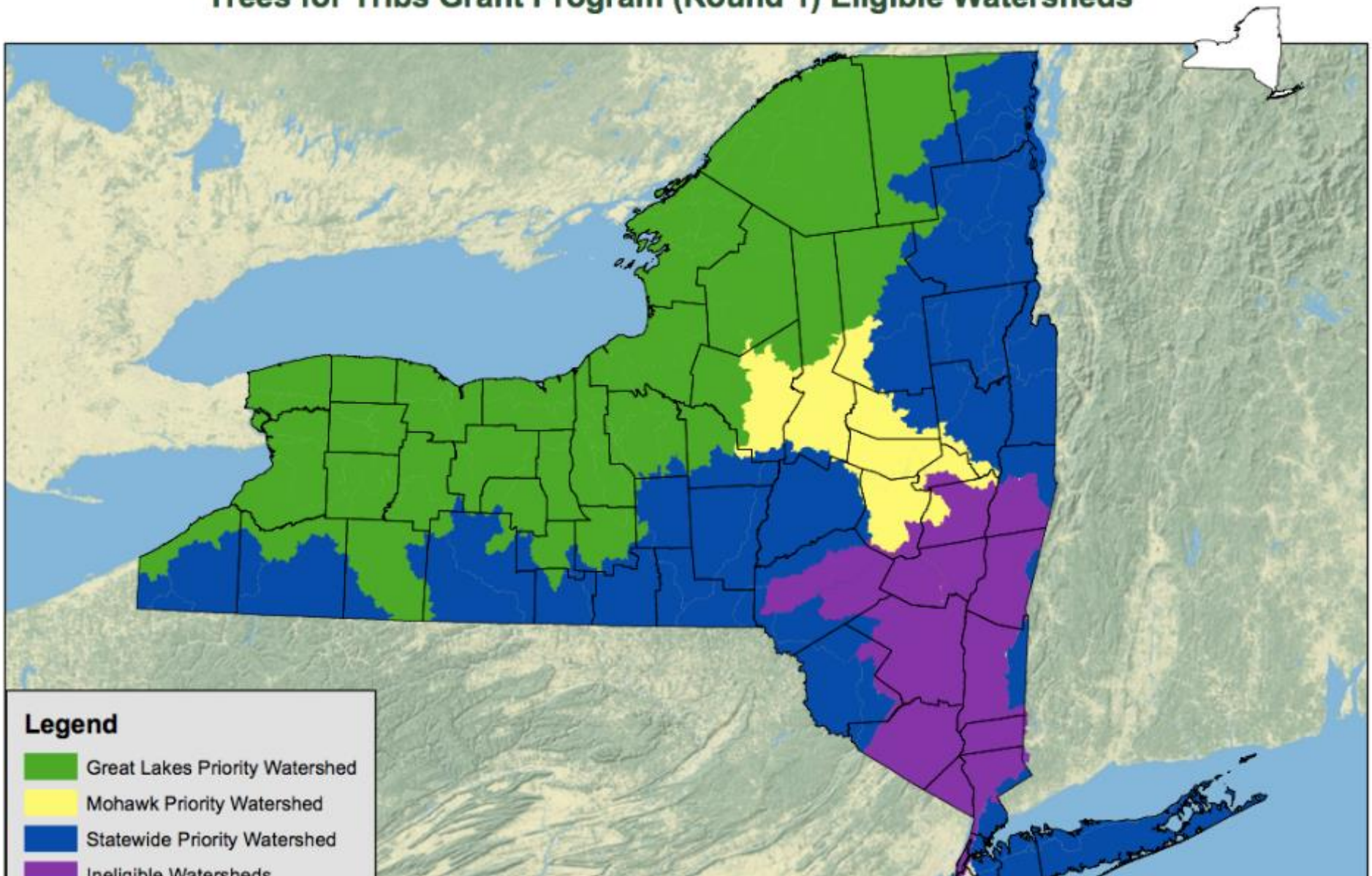
Climate Smart Community Grants, July 27! ($10k -100k from $8.8 million pool)

- https://www.dec.ny.gov/docs/administration_pdf/cscrfa(1).pdf
- For municipalities

- Such projects include, but are not limited to, reduction of future flood risks

- Implementation of municipal food waste/composting programs

Trees for Tributaries (DEC), due September 2018



Climate Resilient Farming, due Feb 2018 Maybe again in 2019? (NYSDAM)

- $2 million available, covers 75% of costs
- https://www.nys-soilandwater.org/programs/crf.html

- Agricultural waste storage cover and flare systems
- Riparian Buffer System
- Stream Corridor
- Erosion Control
- Prescribed Rotational Grazing
- Soil Conservation System

Horizon: Climate Action Reserve (CAR) – N-management credits

- CAR is currently revising protocols for N-management accounting for possible sale.

- http://www.climateactionreserve.org/how/protocols/nitrogen-management/

Future Needs: Assessment

- Better quantify financial and environmental benefits/costs
- Improve assessment of overall environmental performance among and between practices and end-goals (water/air/soil/productivity)

Future Needs: Promote Practices

- Promote best management practices that include GHG mitigation, Climate change adaptation, and long-term resiliency
- Educate current and future farmers
- Educate current and future policy makers

Future Needs: Create Policies

- Provide science-based information to policy makers as they negotiate a multitude of societal needs.
  - Farm productivity
  - Farm profitability
  - Water quality
  - Air quality
  - Soil health
  - Societal resiliency

Please share suggestions of Needs

Thank you

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- http://blogs.cornell.edu/woodbury

- Support from NYS Department of Agriculture and Markets