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RUTGERS–NEW BRUNSWICK
New Jersey Climate Change Resource Center

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New Jersey Agricultural Experiment Station

Overview

- To understand opportunities for natural and working lands to sequester, or store carbon for mitigating climate change.
- Mitigation potential of soil carbon in agriculture
- PES models applicable for NJ agricultural sector
- Literature review and semi-structured interviews (Federal and State agencies, ngos, academia, private sector)
- Primary focus on agricultural lands: tillable and grazing practices.
  - Included others such as forest
    - Woodlands can be active agricultural use
    - 20% of land in use by farms in NJ is woodland
- Focus limited to carbon sinks but there are other approaches/methods for agriculture to reduce ghg emissions (e.g., on farm use of renewables, manure management, reduced fertilizer use).

Mgmt Practices & Methods to Increase Soil Organic Carbon

- Maintenance and Improvement of Native Ecosystems and Perennial Cropping
- Agricultural Management Practices
  - Reduced or no tillage allows greater accumulation of SOC
  - Cropping Decisions
  - Organic Matter Amendment
  - Improved Grazing Land Management

No-till planting of corn into a barley cover crop. www.nrcs.usda.gov

Winter cover crop following corn. www.nrcs.usda.gov

Compost windrows and mature compost. Duke Farms. (Photo: S. Murphy)

Cows on pasture under rotational grazing system. www.kbs.msu.edu/2018/07/grazing-gas

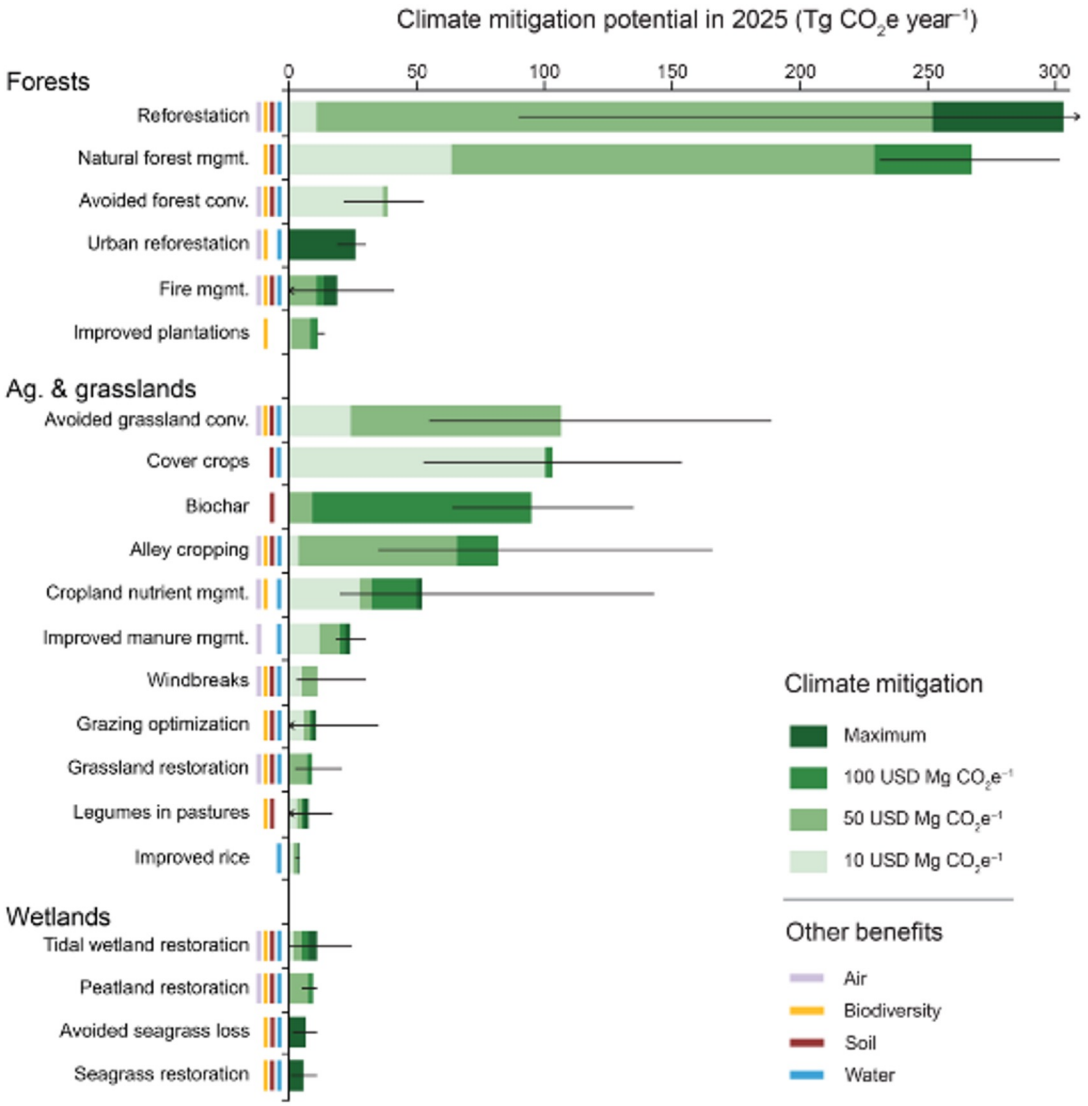


Fig. 1. Climate mitigation potential of 21 NCS in the United States. Black lines indicate the 95% CI or reported range (see table S1). Ecosystem service benefits linked with each NCS are indicated by colored bars for air (filtration), biodiversity (habitat protection or restoration), soil (enrichment), and water (filtration and flood control). See the Supplementary Materials for detailed findings and sources.

Reference: https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/2/7553/files/2019/04/NaturalClimateSolutionsUnitedStates_Fargione2018.pdf

Considerations for Carbon Sequestration in Soil

- Saturation
  - Maximum amount of organic matter that a mineral soil can preserve at equilibrium
  - Saturation point depends on soil properties, climate, management, etc.
- Permanence/Persistence
  - Consider only the carbon retained for an extended period of time
  - Use period of offset credits? (100 yrs for forest systems)
- Additionality
  - Carbon must be additional to business-as-usual scenario
  - Account for any new GHG emissions caused by the new practices that are intended to sequester carbon (life-cycle assessment)
- Measurement and Verification
  - For scientific estimates ***and*** for incentive or carbon market credits
  - Increase in total soil organic carbon stock: addition ***or*** avoidance of loss

Co-benefits of Increasing Soil Organic Carbon

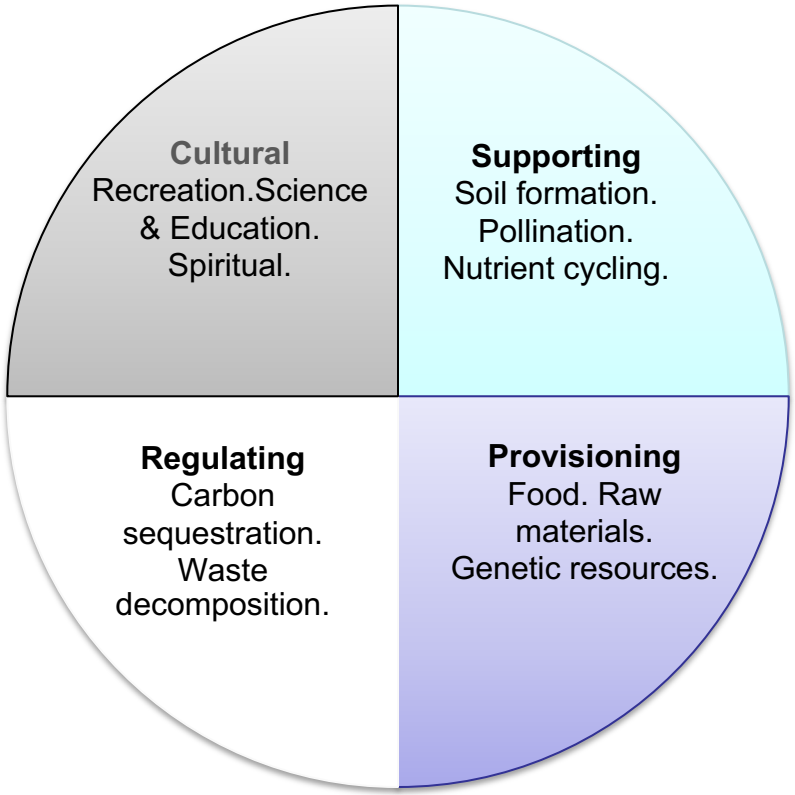
- Providing additional Ecosystem Services
  - Soil health benefits of soil organic matter
    - Fertility & nutrient-holding capacity
    - Water-holding capacity
    - Soil structure development – implications for infiltration/runoff & erosion
    - Biological diversity
  - Resilience/Risk avoidance
  - Water quality, air quality
  - Waste reduction – cycles/recycling

Confluence of Raritan and Millstone Rivers. raritanbasin.org

Ecosystem Services

Payment For Ecosystem Services (PES) Policies compensate individuals or communities for undertaking actions that increase the provision of ecosystem services such as water purification, flood mitigation or carbon sequestration.

Regulatory and voluntary markets drive the purchase of PES.



There are 500+ PES programs worldwide. Annual transactions US$36-$42 Billion.

Co-benefits of PES:

- *Adaptation*
- *Biodiversity*
- *Public Health*
- *Green Jobs*
- *Social Justice*
- *Participatory Gov.*

Outcome-Based
Quantification of GHG emissions reductions achieved or amount of carbon stored

Source: N. Palmer, CIAT

Practice-Based
Programs that pay for implementation of practices to sequester carbon or reduce GHG emissions

Source: J. Vanuga, USDA

Payment for Ecosystem Services Programs

Compliance Programs	Voluntary Markets	Practice-Based Incentive Programs
• Cap-and-Trade • Incentive-Based Regulatory	• Forest • Grassland • Agriculture	• Government • Nongovernment

Compliance Programs

- Cap-and-Trade

Examples:

Regional Greenhouse Gas Initiative (RGGI)

California Cap-and-Trade

Cap-and-Trade
Limits air pollution (tightens limits over time) and puts a price on it, creating a market for allowances and offsets (pollution reductions, typically purchased by regulated industries).

Two mechanisms to incorporate PES:

1) Develop projects to generate carbon offsets (price you can get selling carbon offsets in the compliance markets is often higher than in the voluntary markets)
2) Use cap-and-trade revenue to advance climate progress (e.g., a portion of CA program revenue helps fund Healthy Soils Program that pays farmers to implement conservation practices).

Voluntary Markets

Photo: Jan Kopriva from Pexels

- Educational Commitments
  - (Colleges and Universities)
- Anticipation of Regulation (CORSIA phase-in)
- Institutional Investors
- Corporate Social Responsibility(CSR) (e.g., Science Based Target Initiative or SBTi)

Whirlpool Corporation
Cargill
nrg
MARS
Walmart
Port Authority NY NJ Air Land Rail Sea
Mondelēz International

Practice-Based Incentive Programs

Source: Stephanie Murphy

State of California Healthy Soils Program (since 2017)

- Cap-and-trade and SB-5 (bond act)

State of Maryland Healthy Soils Program (2017)

- Atlantic Coast & Bays Trust Fund
- Moore Administration

State of New York Climate Resilient Farming Program (2015)

- NYS Environmental Protection Fund

Restore California Perennial Farming Initiative

- NGO; Voluntary dining surcharge and membership

Ducks Unlimited Cover Crop and Livestock Integration Project

- NGO: Philanthropy and USDA grant

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Inflation Reduction Act $ 2023-2027

Ranking of GHG Benefit of Various Practices on the NRCS Climate-Smart Mitigation Activities List

USDA **Partnerships for Climate-Smart Commodities Projects**
Expanding Climate-Smart Commodity Markets

$3.1bn

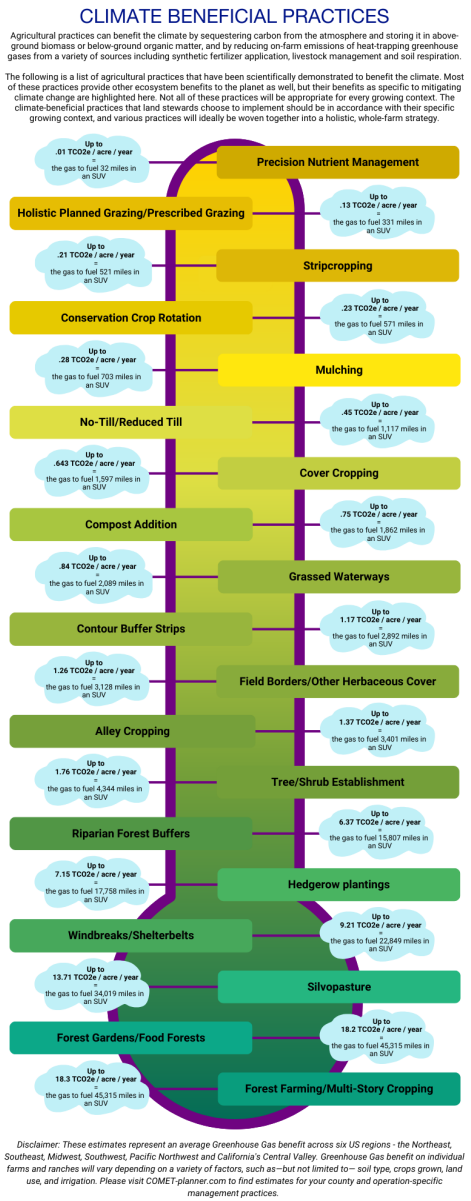
18	41	100	$501.03 M
Projects	Major Commodities	Practices	Federal Funding*

Climate Smart Practices Tech & Financial Assistance

Pilot innovative & cost-effective GHG MMRV methods

Develop markets for Climate Smart Commodities

Source: USDA Accessed March 2024



Source: NCAT/ATTRA
Accessed March 2024

Opportunities & Considerations for NJ

Mitigation potential of soil carbon in agriculture

Compliance Programs	Voluntary Markets	Practice-Based Incentive Programs
• Cap-and-Trade • Incentive-Based Regulatory	• Forest • Grassland • Agriculture	• Government • Nongovernment

C Sequestration & Mitigation Quantification Considerations

NJ Specific

Authoritative baseline of C stocks, ID & assess priority areas for increasing soil C & conduct scenario analyses of potential NJ ag C gain pathways

County sentinel sites to evaluate agronomic practices & localized factors to improve modeling

Evaluate most appropriate conservation practices based on specific soil, terrain, and agriculture type

Customize programs/practices to NJ ag: specialty crops; small acreage; part-time farmers; leased farmland; strong organic agriculture niche.

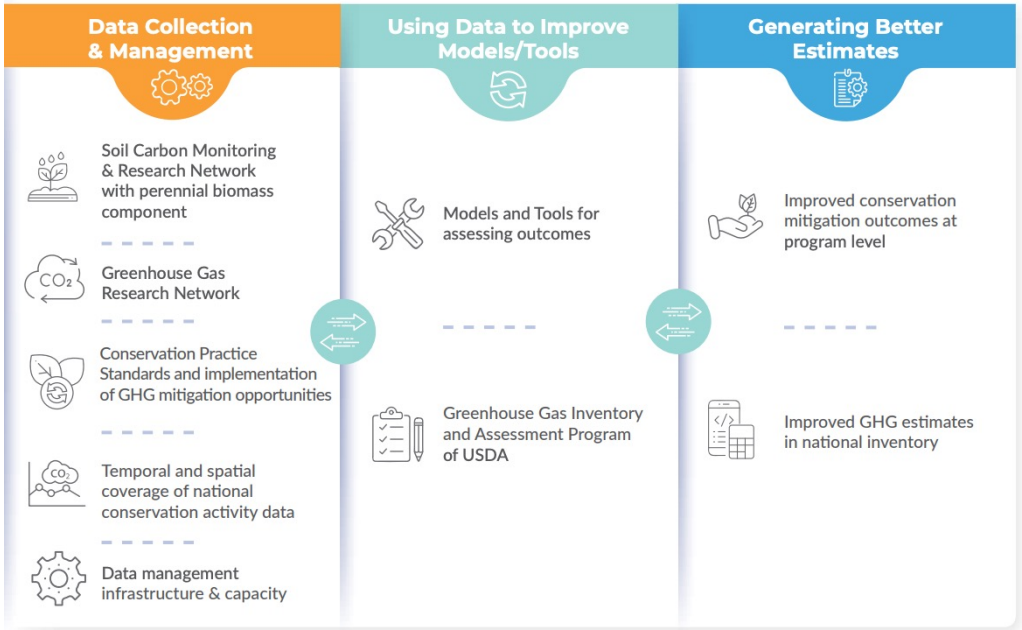
USDA Investment in Improved GHG Measurement, Monitoring, Reporting and Verification for Agriculture and Forestry through the Inflation Reduction Act

FSA CRP Monitoring, Assessment & Evaluation

NRCS Conservation Evaluation & Monitoring Activities

- C Sequestration and GHG Mitigation Assessment (CEMA 218)
- Soil Organic C Stock Monitoring (CEMA 221)
- + $4m Regional Research Programs

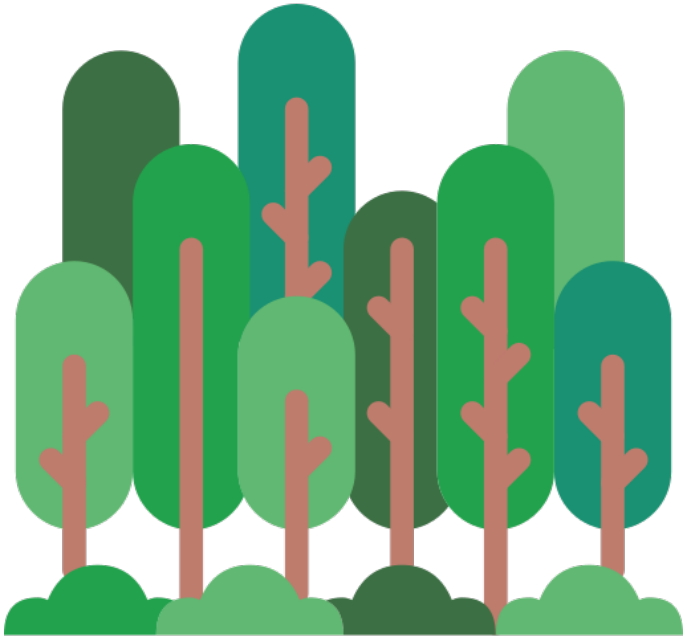
IRA $300 million – 8 yrs



Source: USDA 2023

Compliance Market Considerations

Generation of **carbon offsets acceptable for compliance in the California Cap-and-Trade Program - through reforestation, improved forest management, avoided conversion of forestland** to a non-forest land use, or urban forestry projects - **can be an opportunity for New Jersey landowners** to sequester carbon through regulatory compliance markets.



Generation of **carbon offsets acceptable for compliance within the RGGI region** - through reforestation, improved forest management, or avoided conversion of land located in New Jersey - is a **potential (albeit considered unlikely)** avenue for New Jersey landowners to sequester carbon through regulatory compliance markets.

Voluntary Market Opportunities

Farmers & landowners generate C offsets via practices to sequester carbon (e.g., reduced tillage, improved crop planting and harvesting, improved grazing practices, avoided conversion of grasslands or forest land, compost addition to grazed grassland).

Project Developers (conservation organizations +/or private-sector provide tech, financial + admin assistance) & partner w/ property owners who realize agricultural, conservation, and financial benefits to produce C offsets.

To meet CSR goals, corporations give farmers direct support for conservation practices (such as reduced tillage and precision nutrient management) to address greenhouse gas emissions if they are in their "supply shed" to reduce supply chain emissions.

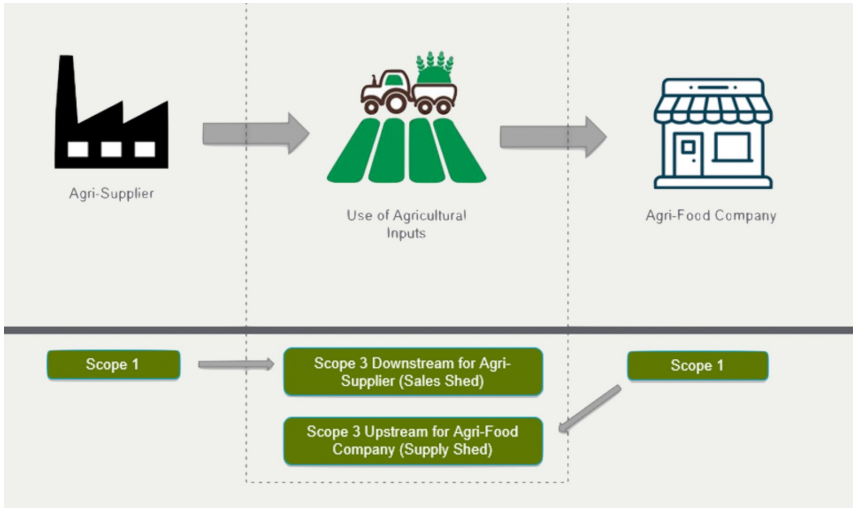


Image Source: Regrow

Corralling The Voluntary Market and PPPs

Commodities Future Trading Commission (CFTC)

- Environmental Fraud Task Force (2023)
- Voluntary Market Convenings (2022, 2023)

SEC Climate-Related Disclosure For Investors (2024)

Growing Climate Solutions Act

<u>Barriers to producer participation in Voluntary C markets</u>

- High transaction $: GHG quantification; verification; reporting
- Conservative accounting of benefits generated
- Limited access to early adopters
- Stringent permanence requirements
- Small scale of ag projects
- Market confusion around different programs, requirements, compensation
- Lack of demand

<u>GHG Technical Assistance Provider & 3rd Party Verifier Program</u>

- Reduce market confusion by trusted authority
- Educational resources and greater transparency
- Evaluate and list widely accepted protocols
- List Technical Assistance Providers
- List Third-Party Verifiers
- General Assessment every 4 years
- Advisory Committee
- Leveraging other resources to improve GHG quantification

SUSTAINS Act

- USDA Authority to accept contributions of private funds to conservation programs

Source: The Independent

The significant variability in agriculture and forestry systems makes it challenging to quantify the GHG impacts of projects in these systems (USDA 2023)

The continued generation of carbon credits from agriculture and forestry projects will be influenced by farmers, ranchers, and landowners' willingness and ability to participate in carbon markets and credit purchaser confidence in credit integrity. (USDA 2023)

Voluntary Practice Based Opportunities

Develop a regional testing program where, for example, Cooperative Extension (suggested by NRCS interviewee) could test out various practices on NJ farmland and **conduct more demonstrations and on-farm trials to help farmers understand which practices work.**

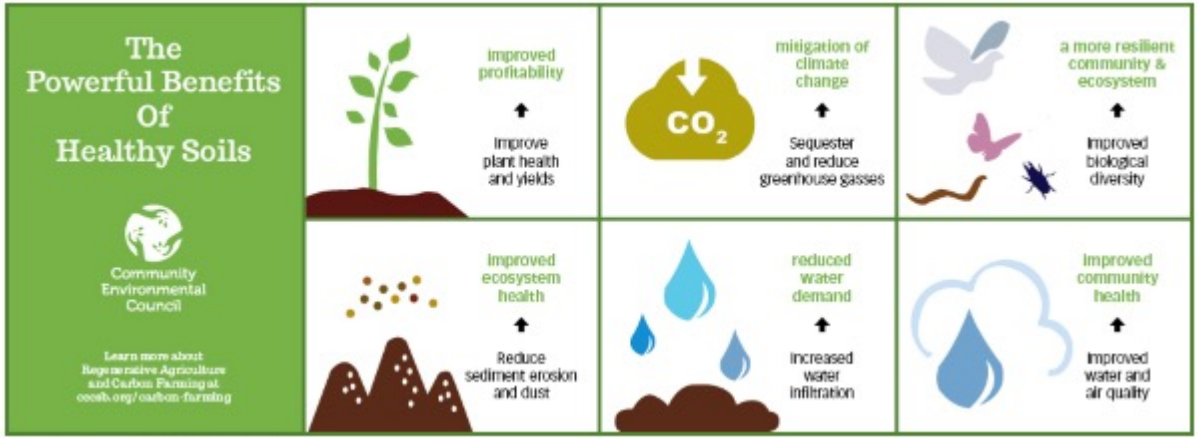
Develop a deeper **understanding of agricultural producer uptake for incentive programs** (including state-based and non-profit funded), including an evaluation of the payment level and duration of incentive necessary to make participation in agricultural practices that can enhance sequestration worthwhile in order to expand participation in current programs or in designing and implementing complementary programs.

Consider a **New Jersey Healthy Soils or Climate Smart/Resilient Farming** program as a complement to, and potential expansion of, practices in current federal program offerings, including practices that allow whole farm climate benefits - to sequester carbon, mitigate greenhouse gas emissions, and enhance climate resiliency - in addition to soil health. **Include resources that enable technical service providers to support and assist farmers in navigating applications, planning and practice implementation**.

Voluntary Practice Based Opportunities: Enumerating Benefits

Quantify and communicate economic benefits of BMPs that can sequester carbon, including but not limited to improved crop yields, machinery cost savings, reduced nutrient losses, reduced labor costs, increased income, etc.

Develop a **methodology for assessing co-benefits of ecosystem services**, including public health, habitat, climate resiliency, and other endpoints, and quantify and communicate these co-benefits to the public, legislators, and other key constituencies.



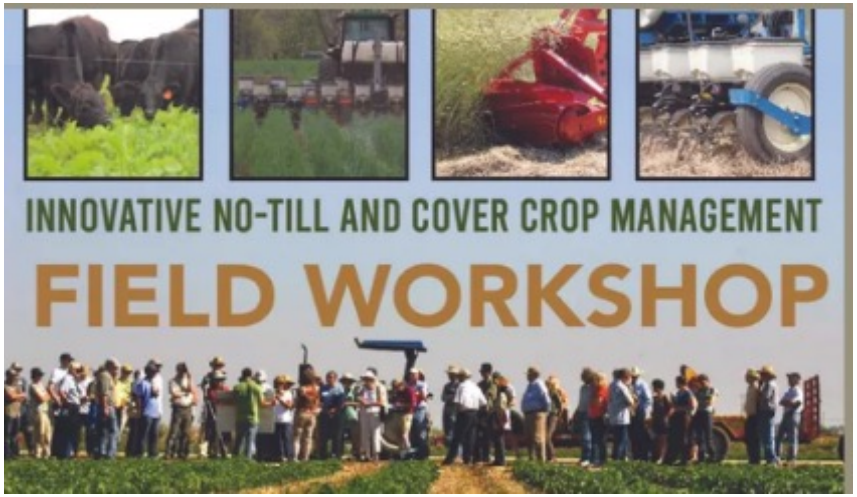
Source: Community Environmental Council

Voluntary Practice Based Opportunities: Education, Training, Technical Assistance

- **Demonstration projects** such as those funded through the California Healthy Soils program that take field measurements, showcase practices, conduct analysis on cost/benefits, demonstrate sequestration potential for other practices for which greenhouse gas quantification methods are not currently available, and require peer-to-peer outreach.

- **Expand training of New Jersey-based technical service** providers regarding carbon sequestration management practices and methods. Such a program could build from others such as Northeast Climate Adaptation Fellowship Program which is piloting training for technical service providers (including those in New Jersey) and producers on climate adaptation and mitigation.

- **Support TSPs in assisting producers w/ implementing BMPs** for C sequestration, healthy soils, and/or climate resilient farming



Source: North Jersey RC&D

Voluntary Practice Based Opportunities: Equipment Costs

- As recommended by a New Jersey-based NRCS interviewee, consider a regional program where producers could work with Extension to test out equipment on their land.

- Consider opportunities to provide for equipment purchases, lending, or rental, as well as trade-in or selling of equipment by New Jersey producers for practices that enhance carbon sequestration through state grants, loans, or tax incentives such as those provided in other Northeastern states.

Source: USDA, NRCS

Voluntary Practice Based Opportunities: Financing Considerations

- County Agriculture Development Boards
- SADC soil and water conservation grants
- Partner w/ ZFP/Restore California-like program for New Jersey and engage consumers, food service businesses, restaurants, and other food service institutions in a table-to-farm model that provides social-impact financing to implement agricultural practices that can sequester carbon.
- Create a nonprofit natural and working lands carbon mitigation bank supported by donors, CSA members, who may want to offset their personal greenhouse gas emissions (e.g., travel) and reinvest $ in implementing carbon sequestration practices on participating farmers' land.

Source: NJ State Agriculture Development Committee

Source: ZFP/Restore California

Source: USDA, National Agriculture Library

Opportunities for Adapting Farmland & Farmland Preservation

Explore policy/regulatory changes and potential need for legislation to further C sequestration through reforestation on agricultural land (preserved farmland as well as farmland not in the Farmland Preservation Program)….

Explore consideration of a “whole farm” easement approach that would value preserved farmland for production agriculture, as well as conservation practices that provide ecosystem services….

Explore development of potential changes to statutes and/or rules, if necessary, to improve soil resiliency through the Preserve NJ Act and evaluate the authority to fund equipment to implement concomitant soil conservation practices.

Emerging Goals: Draft Targets Agriculture & Priority Climate Actions NWL

NJDEP/NJDA Draft Targets Agricultural Lands

Recommendation Type	Target	2030 Recommendation	2050 Recommendation
Management Practices			
Compost Cropland Harvested		**1% of land**	**3% of land**
	Apply compost to X acres each year - North	750	2400
	Apply compost to X acres each year - Central	1100	3300
	Apply compost to X acres each year - South	2300	7000
	TOTAL	**4150**	**12700**
Compost Cropland Pastured		**3% of land**	**8% of land**
	Apply compost to X acres each year - North	230	600
	Apply compost to X acres each year - Central	320	850
	Apply compost to X acres each year - South	200	500
	TOTAL	**750**	**1950**
Compost Permanent Pasture		**3% of land**	**8% of land**
	Apply compost to X acres each year - North	750	2000
	Apply compost to X acres each year - Central	950	2600
	Apply compost to X acres each year - South	700	1900
	TOTAL	**2400**	**6500**

Agricultural Lands (cont.)

Cover Crops	Plant X acres of Cropland Harvested and Cropland Pastured with cover crops - North (baseline is 0.7%)	1.5% of land 1250	10% of land 8300
	Plant X acres of Cropland Harvested and Cropland Pastured with cover crops - Central (baseline is 1.4%)	2% of land 2200	10% of land 10800
	Plant X acres of Cropland Harvested and Cropland Pastured with cover crops - South (baseline is 2.03%)	3% of land 6400	10% of land 21200
	TOTAL	**9850**	**40300**
Monitoring (Livestock practices)	Gather baseline data on "early adopters" of rotational grazing and pasture restoration by seeding native warm-season grasses	X	-
Funding (Livestock practices)	Provide financial incentives for adoption of rotational grazing and pasture restoration by seeding native warm-season grasses	X	X
Education (Livestock practices)	Provide education on rotational grazing and native warm season grasses through land grant institutions research effort	X	-
Outreach (Livestock practices)	Conduct outreach for interested producers	X	-
Agro-Forestry	Facilitate research and development of commercial scaling of practices including alley cropping, riparian buffers, forest farming, silvo-pasture, and windbreaks and/or hedgerows	X	-
	Collaborate with NJ forest service on program development for alley cropping, riparian buffers, forest farming, silvo-pasture, and windbreaks and/or hedgerows	X	-
	Provide financial incentives to producers who implement alley cropping, riparian buffers, forest farming, silvo-pasture, and windbreaks and/or hedgerows.	-	X

Agricultural Lands (cont.)

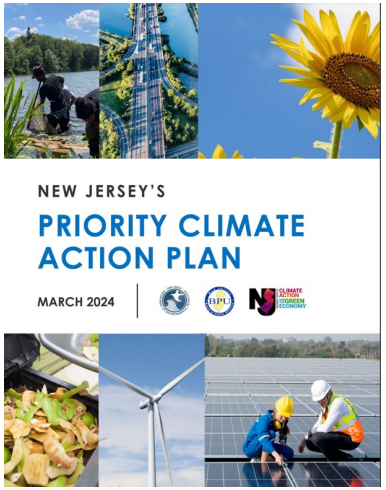
Policy Recommendations			
Climate-Smart Practices	Develop Grower/Producer cooperatives	X	-
	Increase available Technical Service Providers for access to conservation assistance	X	-
	Initiate state-specific breeding initiatives	-	X
	Enhance productivity of soils by incentivizing practices that increase soil health	X	-
	Identify funding sources to facilitate adoption of climate-smart practices including reduced tillage and keyline plowing, exclusionary fencing, and diversified cropping rotations	X	X
Funding	Make incentives available for adoption of climate-smart practices	X	-
	Arrange insurance protection for farmers who change practices for the benefit of additional carbon sequestration	-	X

Source: NJDEP 2023

NJDEP Priority Climate Actions Natural & Working Lands – March 2024

Table 3.6.2. *Priority Measure 12 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Plant 250,000 street/shade trees by 2030	2024 - 2030	NJDEP, NJDA, Local Governments
Identify and restore 800 degraded acres of forested lands by 2030	2024 - 2030	NJDEP, Local Governments
Develop a nursery supply and production initiative	2025	NJDA
Complete 1 tidal reconnection project per year (total of 6) by 2030	2024 - 2030	NJDEP, Local Governments
Install 7,800 linear feet of living shoreline per year by 2030	2024 - 2030	NJDEP, Local Governments
Relaunch conservation cost share program	2025 - 2030	NJDA



Source: NJDEP 2024

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Emerging Goals: NJDEP/NJDA Draft Targets Forested Land

Recommendation Type	Target	2030 Recommendation	2050 Recommendation
Management Practices			
Afforestation	Identify & Plant non-forested land to a forested condition	1,600 ac (200 ac/yr)	4,000 ac (200 ac/yr)
	Select appropriate species for planting	X	X
	Land Management Review for suitable sites	Maintain	Maintain
	Creation of afforestation Best Management Practices	X	X
	Afforest state-owned golf courses/bogs/etc.	-	X
Avoided Conversion	Minimize conversion of forested lands to non-forest uses	Maintain (4,000 ac/yr)	Reduce (2,000 ac/yr)
	Private Landowner enrollment in forest stewardship program	Increase by 115 prop/yr	All properties enrolled
	Increase acreage of land purchased by Green Acres	-	X
Avoided Emissions	Thin forests to reduce stress/competition	1,500 ac/yr	1,500 ac/yr
	Prescribed Burning to reduce fuel loads	25,000 ac/yr	25,000 ac/yr
	Damage Causing Agent Surveys	Expand	Expand
Improved Forest Management	Forest Inventory and Analysis (FIA) Inventory Agreement	Include Phase 3 plots	Include Phase 3 plots
	Creation of a Forest Management Optimization Model	Complete	-
	Review current forestry contracts	X	-
	Provide 10 years of predictive forest management implementation opportunities consistent with the New Jersey State Forest Action Plan	X	X
	Plan ecological forest management	100,000 ac	200,000 ac
	Complete DTSP Natural Resource Stewardship Plan	2,700 ac	-
	Inventory state forest lands	40,000 ac/yr	40,000 ac/yr
Reforestation	Assess regeneration status of forest lands that have been affected by wildfires or damage causing agents	Annually	Annually
	Survey state lands & identify areas where ecosystem function is disrupted	Annually	Annually
	Prioritize sites for reforestation actions	10 sites	40 sites
	Identify & restore degraded forests	800 ac	2,000 ac
Nurturing Forests with the NJ Forest Service Nursery	Increase nursery production to annually service more municipalities & private landowners	20% increase	20% increase
	Nursery Planning & Improvement (Diversify/Propogate Rare, Plant Climate-Resilient, Produce Insect and Pathogen-resistant, & Restore Native)	X	X
Outreach and education focused on educating NJ citizens and landowners on the value of forests and forest management	Improve forest management outreach, programming, and curriculum at State facilities, and add 10 NJ Forest Service-led forest management programs annually	X	X
	Increase geographical reach of forestry programs	X	X
	Webpage on DEP website dedicated to carbon, climate & forest management	X	X
Outreach and education focused on educating NJ citizens and landowners on the value of forests and forest management	Include importance of active forest management in all carbon sequestration messaging to the public	X	X
	Public events that focus on forest & forest management	4/year	6/year
	Meetings with internal stakeholders to expand opportunities for outreach & education	Quarterly	Quarterly
	Utilize and enhance State facilities & partner with other DEP programs to enhance NJFS outreach & education	X	X
	Develop & implement a NJFS Interpretive Plan	X	X
	Engage a wider audience by embracing technological advances and installing kiosks throughout state with forest management information	X	X
	Establish a forestry cooperative with the state's land grant institution	-	X
Promote urban forests and street trees through stewardship in order to maintain and grow the current carbon resource in urban communities	Annually, 10 new municipality management plans, 10 new/updated inventory grants, & CORE train 100 participating individuals	X	X
	Continue to provide annual grants for tree planting & resiliency planning / ensure compliance from participants	X	X
	Urban FIA Inventory Agreement	Maintain	Maintain
	Implement a state-wide inventory program so that data collection amongst municipalities is consistent	X	-
	Revisit No Net Loss Program & capacity to hire full-time employees	X	-
	Enroll all municipalities in Urban Stewardship programs by 20 years	-	X
Maintain and increase carbon storage through durable forest products sourced from local forests	Revisit IMPLAN study to review wood products being brought into the state their uses	X	-
	Maintain & update the list of Forest Industry Professionals working & running their businesses using local NJ forest products	X	-
	Maintain working relationship with external organizations that support local forest products	X	-
	Support & collaborate with businesses that are interested in starting niche forest product markets in NJ	-	X
	Improve consumer awareness of the "New Jersey Grown" agricultural designations for wood products to help combat carbon leakage	-	X
Policy Recommendations			
Afforestation	Urban and Community Forestry grants program for urban planting & maintenance	Expand	-
	Private lands incentive programs for afforestation projects	Maintain	Maintain
	Coordinate with NJDEP Fish & Wildlife for opportunities with Connecting Habitat Across New Jersey (CHANJ)	X	X
	Incentivize Green Acres/Ag to afforest their properties where appropriate	-	X
Avoided Conversion	Enroll state forest land into a carbon market	75,000 ac	dependent on market
	Establish carbon markets for private lands in NJ	X	-
Reforestation	Encourage reforestation on Private Lands	Annually	Annually
Support programs that provide incentives to landowners for improved forest management	Continue the trend of about 115 additional properties per year utilizing improved forest management	X	-
	Provide cost share to properties using Regional Greenhouse Gas Initiative funding for improved forest management	100 properties / year	500 properties / year
	All properties eligible for programs be enrolled	-	X
Maintain and increase carbon storage through durable forest products sourced from local forests	Incentivize/ Subsidize keeping harvested wood out of landfills in state contracting	Incentivize	Subsidize
	Explore updating building codes to accommodate & incentivize the use of emerging carbon-positive construction materials such as mass timber over the use of concrete & steel which have significantly larger associated carbon footprints	-	X
	Incentivize the creation of forest products	-	X
	Encourage wood utilization by supporting the creation of a NJ state chapter of the Urban Wood Network	X	-

Source: NJDEP 2023

Thank you

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