Chapter 15. Agriculture and Forestry

15.1 State of the Sector

Overview

Agriculture and forestry encompass multiple economic sectors that include livestock, crops, dairy, timber, wood products, and bioeconomy products. Greenhouse gas (GHG) emission sources include farm and forestry equipment, livestock, cropland, forest fires, decomposition of dead trees, and development of agricultural and forest areas. Emissions from farm and forestry equipment are addressed in *Chapter 11. Transportation* (Strategy T2). The agriculture and forestry sectors can also implement practices that enhance carbon sequestration, as forestland and cropland have the ability to sequester carbon dioxide (CO_2) from the atmosphere and store it in trees, plants, and soils. Practices can also reduce fossil fuel use through the adoption of best management practice systems that help farmers make more efficient use of inputs such as manure and other nutrients. In addition, these sectors have the potential to drive emission reductions outside of the State by reducing the demand for imported goods and providing substitutions for more fossil fuel-intensive products. Each strategy will include increased technical services and financial assistance to improve access to programs and reduce barriers to access for historically unrepresented farmers and forest landowners. The New York State Department of Agriculture and Markets (AGM) Diversity and Racial Equity Working Group's report will serve as a guide for related strategies outlined in this chapter.[257]

> **Emissions Overview**
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> Agricultural emissions consisting of methane, nitrous oxide (N_2O) and a small amount of carbon dioxide (CO_2) represented approximately 6% of statewide emissions in 2019 from livestock (92%) and soil management practices (8%). However, agriculture and forestry also provide carbon sequestration benefits and can provide significant contributions toward achieving net zero total emissions from all sectors in the State. For example, annual carbon sequestration in forestlands (77%) and urban forests (14%) and long-term storage of carbon in harvested wood products (5%) provided 97% of the State's greenhouse gas (GHG) emissions removals in 2019. The remaining greenhouse emissions removals are from natural and working lands. These benefits are also described in *Chapter 19. Land Use*.

The strategies described in this chapter address mitigation of agricultural GHG emissions, primarily methane and nitrous oxide (N_2O) as well as carbon capture (or sequestration) primarily through the growth of trees and other plants but also through well-managed and healthy trees, plants, soils, and wood or bio-based products. Maximizing the carbon sequestration and storage potential in the agriculture

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[257] New York State Department of Agriculture and Markets. 2021. *Diversity and Racial Equity Working Group Report.* 2021. Accessed at https://agriculture.ny.gov/system/files/documents/2021/08/diversityracialequityreport_1.pdf.

and forestry sectors is a key strategy for achieving the Climate Act goal of net zero emissions across all sectors of the economy by 2050.

Vision for 2030

In contributing to the statewide 2030 GHG emissions reduction requirement, the agricultural sector will execute actions to reduce methane and N_2O emissions. To reduce methane and N_2O emissions, the agricultural sector will implement recommendations for livestock operations and cropland management. In addition, both the agriculture and forestry sectors will undertake measures to facilitate broad carbon storage and sequestration. Actions to maintain and increase carbon storage and sequestration on the land base in New York and in agricultural and forestry products include protecting farm and forest lands from conversion and development, afforestation and reforestation, improved forest management practices, cropland management practices (such as soil health management practices), and the long-term storage of carbon in harvested wood products (such as mass timber). Together, these actions will achieve approximately 30 million metric tons (MMT) carbon dioxide equivalent (CO_2e) net sequestered annually. This chapter will focus on specific management practices and *Chapter 19. Land Use* will discuss strategies related to avoided conversion, afforestation, and reforestation.

Vision for 2050

The 2050 goal of the Climate Act is to achieve net zero GHG emissions statewide and a required 85% reduction in GHG emissions. Emissions reductions beyond 85% of 1990 statewide levels can be achieved through approximately 60 MMT CO_2e net annual sequestration in the forestry and agricultural sectors and related land use practices (*Chapter 19. Land Use*). In addition, in 2050, agricultural GHG emissions will need to be further reduced from 2030 levels,[258] which will require additional development of research, technology, and market solutions where the technical potential has yet to be reached. Support for New York's bioeconomy is recommended to meet the Climate Act requirements and goals and will serve to grow the agriculture and forestry industries in New York by substituting products grown and produced in New York for imported fossil fuel-intensive products, which will contribute to reducing global GHG emissions and increasing sequestration in New York.

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[258] Wightman, Jenifer, and Woodbury, Peter. 2020. *New York Agriculture and Climate Change; Key Opportunities for Mitigation, Resilience, and Adaptation.* Cornell University. https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/2/7553/files/2020/07/CarbonFarming_NYSAGM_FINAL_May2020.pdf.

Existing Sectoral Mitigation Strategies

New York has 18.6 million acres of forests and 6.9 million acres of agricultural lands in production.[259,260] Over the last decade, farmers and foresters in New York have continued their efforts and investments to advance environmental sustainability and efficiency, both of which increase carbon benefits and climate resilience. There are several examples of these efforts:

- New York dairy farmers made significant strides in reducing the carbon footprint per hundredweight of milk through greater efficiencies in precision feed management, reducing enteric emissions from cow digestion.

- The New York State Methane Reduction Plan (May 2017) identified and set targets for reducing methane emissions from the agricultural sector.[261]

- A suite of technical assistance and planning resources were developed through the Agricultural Environmental Management (AEM) framework on farm and forest GHG emission mitigation opportunities.

- New York's Climate Resilient Farming (CRF) grant program, which demonstrates how climate-responsive efforts can be integrated alongside existing environmental and water quality agricultural programming, has awarded over $20 million in project funding, resulting in an estimated 370,000 MT CO_2e reduced/sequestered.

- Thousands of landowners have been assisted with forest management on more than two million acres of private lands through programs like the Forest Stewardship Program, Environmental Quality Incentives Program (EQIP), the 480-a Forest Tax Law program, Partnerships for Regional Invasive Species Management, Forest Health rapid response programs, and the Forest Health Diagnostic Lab.

- The Forest Stewardship Council® and Sustainable Forestry Initiative® has provided Green certification on 800,000 acres of State forests.

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[259] Albright, Thomas A., Brett J. Butler, Susan J. Crocker, Jason M. Drobnack, Cassandra M. Kurtz, William H. McWilliams, Randall S. Morin, Mark D. Nelson, Rachel Riemann, Lance A. Vickers, Brian F Walters, James A. Westfall, Christopher W. Woodall. 2020. "New York Forests 2017." *Resource Bulletin NRS-121.* Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 118 p. https://doi.org/10.2737/NRS-RB-121.

[260] U.S. Department of Agriculture. National Agriculture Statistic Service. 2019. "2017 Census of Agriculture, Volume 1, Chapter 1: Part 32 State Level Data: New York." Accessed at https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_State_Level/New_York/nyv1.pdf.

[261] New York State Department of Environmental Conservation, New York State Department of Public Service, New York State Department of Agriculture & Markets, Soil and Water Conservation Committee, NYSERDA. 2017. *Methane Reduction Plan.* Albany. Accessed at https://www.dec.ny.gov/docs/administration_pdf/mrpfinal.pdf.

To continue to enable farmers to reduce GHG emissions and increase sequestration in soils through site-specific practices on lands under their management, New York should utilize the AEM framework, overseen by AGM and the New York Soil and Water Conservation Committee (SWCC) and locally led and implemented by county Soil and Water Conservation Districts (SWCD). This existing framework should be coupled with new and expanded initiatives, research, development, and demonstration (RD&D) of novel approaches to reducing emissions and increasing sequestration capacity and increasing workforce capacity to scale up programs and initiatives.

Management of New York's forests, to promote tree health, recreation, wildlife habitat, and wood products, among other reasons, also has many implications for long-term carbon storage and sequestration. The New York State Department of Environmental Conservation (DEC) should continue to provide best management practices (BMPs) and guidance to foresters, promote programs including, but not limited to Regenerate NY, 480-a, Urban and Community Forest Grants, Partnerships for Regional Invasive Species Management, and forest health rapid response programs, as well as work closely with landowners to increase carbon benefits and climate resilience.

Key Stakeholders

Key stakeholders include landowners, organizations involved in outreach, education, and landowner assistance, private sector cooperatives and companies, agricultural support groups, forest product organizations, workforce development organizations, affected workers and unions, research entities, and the Legislature. Stakeholders involved in these roles are described below; however, this should not be considered an all-inclusive list. Stakeholders involved in more than one role are only listed once.

- Stakeholders that hold forest land in New York include DEC, New York State Office of Parks, Recreation, and Historic Preservation (OPRHP), New York State Department of Transportation (DOT), New York Power Authority (NYPA), land trusts, utility companies, municipalities, municipal associations, local communities, timber investment management organizations, and private landowners.
- Stakeholders involved in outreach, education, and other forms of landowner assistance include U.S. Department of Agriculture (USDA), New York State Department of State (DOS), New York City Department of Environmental Protection, county Soil and Water Conservation Districts (SWCDs), Cornell Cooperative Extension (CCE), the Society of American Foresters, International Society of Arboriculture, New York Society of Arboriculture, New York State Urban Forestry Council, ReLeaf, Master Forest Owners, Arbor Day Foundation, Forest Connect,

the Nature Conservancy, New York Forest Owners Association, New York Tree Farm, Empire State Forest Foundation, hunting stakeholders, arborists, and foresters.

- Stakeholders involved in the creation, promotion, and use of forest products include the New York State Energy Research and Development Authority (NYSERDA), Regional Economic Development Councils (REDCs), Dormitory Authority of the State of New York (DASNY), Empire State Development (ESD), Empire State Forest Products Association, the Wood Products Development Council (WPDC), U.S. Green Building Council, American Society of Civil Engineers, American Institute of Architects, U.S. Department of Energy, Port Authority of New York and New Jersey (PANYNJ), Commercial Aviation Alternative Fuels Initiative, the Business Council of New York State, New York City Department of Buildings, pulp and paper manufacturers, lumber and veneer mills, furniture manufacturers, wood pellet plants, wood-fired power plants, and waste materials stakeholders.

- Stakeholders involved in workforce development include Paul Smith's College, Boards of Cooperative Education Services, the Workforce Development Institute, and affected workers and unions. Stakeholders involved in research efforts include State University of New York (SUNY) College of Environmental Science and Forestry (ESF), and Cornell University College of Agriculture and Life Sciences (CALS). Stakeholders involved in incentive programs and legislation include the New York State Department of Taxation and Finance and the State Legislature.

- Farmers, State and federal agencies, the State Legislature, colleges and universities, county SWCDs, CCE, outreach and education agencies/facilitators, nonprofits, land trusts, farm organizations, private sector professional engineers and planners, financial lenders, watershed coalitions, municipalities, nongovernment organizations (NGOs), food processors and cooperatives, agricultural associations, and others may be integral to implementing strategies of the agricultural sector. Specific implementation leads and stakeholders are listed below for each strategy.

15.2 Key Sector Strategies

New York's forests serve as a major carbon sink that hold 1,911 MMT carbon,[262] nearly 10 times the amount of carbon produced by all sectors each year. In addition, forests sequester approximately

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[262] Domke, Grant M., Brian F. Walters, David J. Nowak, James E. Smith, Stephen M. Ogle, J.W. Coulston, T.C. Wirth. 2020. "Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990-2018." *Resource Update FS-227*. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. https://doi.org/10.2737/FS-RU-227.

26.6 MMT CO_2e annually.[263] Recommended strategies to mitigate GHG emissions and sequester and store additional carbon from the agriculture and forestry sectors are discussed in the sections below. Although also connected to the agriculture and forestry sectors, additional strategies related to land use including avoided conversion of agricultural and forest lands, afforestation, and reforestation are included in *Chapter 19. Land Use*. The strategies contained in this chapter provide long-term, integrated approaches to achieving GHG emissions reductions while also ensuring food security, the creation of wood products, and promoting agricultural and forest adaptation in the face of a changing climate, while minimizing the potential for emissions leakage by farmers and foresters moving operations out of State. In addition, the recommendations presented below affect many other non-emission Climate Act goals. The key strategies within this sector are organized into four themes, as shown in Table 16.

Table 16. Agriculture and Forestry Sector Key Strategies by Theme

Theme	Strategies
Promote Sustainable Forest Management	AF1. Identify Where Forest Management Provides the Greatest Benefits AF2. Prevent Forest Pests, Diseases, and Invasive Species and Restore Degraded Forests AF3. Maintain and Improve Sustainable Forest Management Practices and Mitigation Strategies AF4. Assist Landowners in Implementation of Sustainable Forest Management and Mitigation Strategies AF5. Support Local Communities in Forest Protection and Management AF6. Monitor Progress and Advance Forestry Science and Technology AF7. Conduct Education and Outreach on Forest Management
Advance Livestock Management Strategies	AF8. Advance Alternative Manure Management AF9. Advance Precision Feed, Forage, and Herd Management
Improve Soil Health, Nutrient Management, and Agroforestry	AF10. Advance Agricultural Nutrient Management AF11. Adopt Soil Health Practice Systems AF12. Increase Adoption of Agroforestry AF13. Develop Agricultural Environmental Management Planning for Climate Mitigation and Adaptation AF14. Monitor and Benchmark Agricultural Greenhouse Gas Emissions AF15. Establish a Payment for Ecosystem Services Program AF16. Bolster Local Agricultural Economies

[263] Domke, Grant M., Brian F. Walters, David J. Nowak, James E. Smith, Stephen M. Ogle, J.W. Coulston, T.C. Wirth. 2020. "Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990-2018." *Resource Update FS-227*. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. https://doi.org/10.2737/FS-RU-227.

Theme	Strategies
Promote a Climate-Focused Bioeconomy	AF17. Develop Forestry Training Programs to Support Expanding Workforce and Climate Knowledge AF18. Expand Markets for Sustainably Harvested Durable Wood Products AF19. Develop a Sustainable Biomass Feedstock Action Plan for Bioenergy and Low-Carbon Products AF20. Increase Market Access for New York Low-Carbon Products AF21. Provide Financial and Technical Assistance for Low-Carbon Product Development AF22. Advance Bio-Based Products Research, Development, and Demonstration AF23. Advance Deployment of Net Negative Carbon Dioxide Removal

Promote Sustainable Forest Management

New York has 18.6 million acres of forests, covering approximately 62% of New York's total land area.[264] Through photosynthesis, forests absorb and store CO_2 that can offset GHG emissions and reduce the impacts of climate change. New York's forests hold an estimated 1,911 MMT of carbon,[265] which is equivalent to the CO_2 that would be produced to power all the houses in New York for the next 100 years.[266] However, there has been a trend in the loss of forested area in the past 10 years that has contributed to a decline in the net amount of CO_2 absorbed by forests each year, from 30.3 MMT CO_2e in 1990 to 26.6 MMT CO_2e in 2019.[267] Further, annual carbon sequestration by forests is expected to decline slightly statewide by 2050 due to increased impacts from invasive species, forest pests, drought, flooding, storm damage, and lowered planting and regeneration success due to climate change. In addition to forest area loss as New York's forests have aged, their annual carbon sequestration rate has slowed.

Promoting a wide diversity of site-specific forest management strategies across the landscape, including harvesting, thinning, and/or leaving mature forests intact, will best help increase New York's carbon sequestration, storage, and climate resilience. New York's forests are managed for a wide variety of

[264] Albright, Thomas A., Brett J. Butler, Susan J. Crocker, Jason M. Drobnack, Cassandra M. Kurtz, William H. McWilliams, Randall S. Morin, Mark D. Nelson, Rachel Riemann, Lance A. Vickers, Brian F Walters, James A. Westfall, Christopher W. Woodall. 2020. "New York Forests 2017." *Resource Bulletin NRS-121.* Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 118 p. https://doi.org/10.2737/NRS-RB-121.

[265] Domke, Grant M., Brian F. Walters, David J. Nowak, James E. Smith, Stephen M. Ogle, J.W. Coulston, T.C. Wirth. 2020. "Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990-2018." *Resource Update FS-227.* Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. https://doi.org/10.2737/FS-RU-227.

[266] U.S. Environmental Protection Agency. 2021. "Greenhouse Gas Equivalencies Calculator. Division of Energy and Environment." Accessed June 4, 2021, at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator. Average emissions rates were used for this calculation.

[267] Domke, Grant M., Brian F. Walters, David J. Nowak, James E. Smith, Stephen M. Ogle, J.W. Coulston, T.C. Wirth. 2020. "Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990-2018." *Resource Update FS-227.* Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. https://doi.org/10.2737/FS-RU-227.

reasons including promotion of tree health, downstream water quality, recreation, wildlife habitat, and wood products. How a forest is managed has implications for long-term carbon storage and sequestration depend on factors like forest age, health, and tree species, as well as how the wood is utilized following harvest. Guidance is needed to promote forest management regarding carbon storage and sequestration, climate resilience, and other climate-related issues using the strategies described below. The Climate Justice Working Group (CJWG) supports the strategies under the Sustainable Forest Management theme, however, suggests there is an over-reliance on voluntary incentive-based programs.

AF1. Identify Where Forest Management Provides the Greatest Benefits

Well-managed forests provide a wide array of benefits to humans and the natural environment including wildlife habitat, flood mitigation, recreational opportunities, health benefits, reduced heating and cooling costs, protection of air and water quality, and carbon sequestration and storage. Forest management actions need to be site-specific and targeted to provide the greatest benefits to New Yorkers.

Identifying and prioritizing locations for forest management is an enabling strategy that will allow the State to target areas for forest management to maximize carbon sequestration and storage and climate resilience. DEC is currently working with SUNY ESF to develop site-specific models of aboveground forest carbon across the landscape which is expected to be complete in 2023, with updates and improvements expected to be ongoing. Barriers to this strategy include the ability to obtain and update light detection and ranging technology data, quantification of forest benefits such as forest resilience, and mapping of forest benefits.

Components of the Strategy

- **Prioritization models:** DEC should continue to work with partners such as SUNY ESF to select, implement, and develop prioritization models for forests in need of management, including those in urban areas, and small parcels owned by family forest owners.

AF2. Prevent Forest Pests, Diseases, and Invasive Species and Restore Degraded Forests

Invasive species means a species that is nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.[268]

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[268] 6 NYCRR 575.2(s), 576.2(e).

Invasive species may include plants, animals, insects, and diseases. In forests, invasive plants can rapidly change an area's hydrology, displace native species, and prevent forest regeneration. Invasive plants were found in 55% of the most recent forest inventory analysis survey plots[269] and 56% of private landowners were concerned about invasive plants in the most recent National Woodland Owner survey.[270] Invasive insects and diseases such as emerald ash borer and hemlock woolly adelgid can cause rapid mortality to trees or contribute to a loss in tree health due to increased stress, contributing to mortality in the long-term. In the most recent National Woodland Owner survey, 74% of private landowners were concerned about invasive insects and disease.[271] By altering the forest ecosystem, preventing regeneration, reducing the growth and vigor of trees, and causing direct mortality, invasive species negatively impact the ability of New York's forests to store and sequester carbon.

DEC enforces 6 NYCRR Parts 575 and 576, regulatory programs regarding invasive species and 6 NYCRR Part 192 for forest insect and disease control, and AGM enforces 1 NYCRR Chapter III related to insect and disease control. These programs seek to accomplish prevention, outreach, rapid response, and research on invasive forest species and diseases through its Invasive Species and Ecosystem Health program, Partnerships for Regional Invasive Species Management, the New York Invasive Species Research Institute, and the Forest Health Diagnostic Lab, as well as partners statewide. Climate change is expected to increase the competitiveness of invasive plants and increase the range and survival of native and invasive insects and diseases. Prevention, response, and restoration will be ongoing as new invasive species are introduced and the ranges and competitiveness of existing species in New York expand.

Components of the Strategy

- **Increase prevention of invasive species:** Currently, most of DEC's invasive species prevention takes place through education and outreach activities. To increase efficacy, DEC and AGM should increase resources and strengthen its partnership with the USDA Animal and Plant Health Inspection Services to increase prevention of invasive forest pests and diseases entering New

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[269] U.S. Department of Agriculture Forest Service. 2020. "Forests of New York, 2019." *Resource Update FS-250*. Madison, WI. 2p. https://doi.org/10.2737/FS-RU-250.

[270] Butler, Brett J., Jaketon H. Hewes, Brenton J. Dickinson, Kyle Andrejczyk, Sarah M. Butler, Marla Markowski-Lindsay. 2016. "U.S. Department of Agriculture Forest Service National Woodland Owner Survey: national, regional, and state statistics for family forest and woodland ownerships with 10+ acres, 2011-2013." *Res. Bull. NRS-99*. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 39 p. https://doi.org/10.2737/NRS-RB-99.

[271] Ibid.

York and the U.S. (such as Tree-SMART Trade) through strengthened regulations, inspection, and enforcement of wood packaging material and live plant imports.

- **Expand statutory authority:** The State should enact legislation to expand the scope of ECL § 9-1709 to provide DEC with more statutory authority to strengthen and amend 6 NYCRR Parts 575 and 576 to allow more rapid listing of invasive species for regulation.

- **Support programs that combat invasive species:** DEC already has response and monitoring programs for some of the major forest pests and invasive species in New York including kudzu, hemlock woolly adelgid, oak wilt, and southern pine beetle supported through federal grant funding and New York's Environmental Protection Fund (EPF); however, additional staff resources and funds are needed to further reduce the loss of forest carbon due to forest health issues on private and public forest. DEC should facilitate additional capacity for rapid response teams for forest pest and disease outbreaks and invasive vegetation issues that negatively impact forest carbon (such as forest regeneration) as well as continue to aggressively implement forest and other management efforts that can help prevent impacts. Priority should focus on intervening where rapid, extensive loss of forest carbon sequestration capacity could occur.

AF3. *Maintain and Improve Sustainable Forest Management Practices and Mitigation Strategies*

Improving and expanding the use of sustainable forest management practices and mitigation strategies is ongoing and has direct benefits for carbon storage and sequestration. Current efforts by DEC include sustainability certification on State lands, the Forest Stewardship Program, EQIP run by USDA Natural Resources Conservation Service (NRCS), the 480-a Forest Tax Law program, and the Regenerate NY cost share grant program.

Components of the Strategy

- **Invest in forest carbon research:** DEC should work with partners like SUNY ESF, Cornell CALS, and others to support research, develop BMPs, guidance documents, and decision trees to inform forest management regarding carbon storage, carbon sequestration, climate resilience, and other climate-related issues including on improving forest resilience and vigor, regeneration, forest soils, and prevention of high-intensity wildfire. DEC should also work with partners to expand funding for and conduct peer reviewed climate, forest carbon, and applied forest management research in New York such as improving forest resilience, vigor, regeneration, and forest soil carbon storage.

- **Establish a Forest Carbon and Climate Resilience working group:** DEC should lead a working group to improve communication on carbon and climate best practices and improve implementation coordination. This working group should bridge the gaps and implementation needs of science, management, outreach, and on-the-ground practices.

- **Research carbon benefits of old-growth forests:** DEC should work with partners such as the New York Natural Heritage Program to evaluate the carbon benefits associated with old-growth forests, including evaluating the carbon stocks of old-growth forest soils.

- **Develop best practices:** DEC and AGM should develop guidance on forestry management practices to maintain or increase forest carbon stocks across the landscape while producing an annual sustained yield of durable wood products.

- **Implement forest carbon certification program:** DEC should develop and implement a Forest Carbon Certification Program, where qualified forester participants with a certification credential would be able to work under State-funded forest programs and forest carbon programs.

- **Restore degraded forest assets:** DEC should work with forest landowners to implement restoration measures in degraded forests through Regenerate NY and other programs to improve carbon storage, carbon sequestration, and climate resilience such as extending harvest intervals, uneven aged harvests, rehabilitating high graded and under stocked stands, and invasive species management and prevention. Restoration should be implemented on small forests parcels in addition to larger forested blocks. With current estimates of 1.1 million acres of understocked forests in New York, immediate action and substantial funding is necessary to rehabilitate these acres to increase their carbon sequestration potential.

- **Invest in financing options for upgrades and best practices:** DEC should work with the WPDC, ESD, and NGOs to provide funding for low interest loans or grants for upgrading to new logging or manufacturing equipment to facilitate increased utilization, improved forest management, or BMPs to lower site impacts (such as machine tracks for wheeled harvesters to lower soil impacts).

AF4. Assist Landowners in Implementation of Sustainable Forest Management and Mitigation Strategies

Of New York's forests, 73%, or 13.7 million acres, are owned by private landowners.[272] The majority of all the carbon sequestration and storage occurs on these lands. Of these privately owned forests, only

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[272] USDA Forest Service. 2020.

about 27% received professional advice within the past five years, only 18% had a written management plan,[273] and only 9% (1.2 million acres) were under professional forest management through the 480-a Forest Tax Law Program, which provides tax incentives to landowners for forest management.[274] In addition, the costs of maintaining a healthy forest, forest dieback due to pests and diseases, annual taxes, and shifts to smaller parcel sizes, these landowners have been facing increasing pressures to subdivide and develop their forested lands and convert forests to other uses, such as to agriculture, with more than 65,000 acres converted in 2019.[275] New programs should focus on landowners with smaller land holdings to increase the target audience and allow for diverse management objectives beyond strictly timber management. In addition to the 480-a program, other ongoing DEC programs that assist forest landowners include the Forest Stewardship Program, Regenerate NY cost share grant program, and USDA NRCS-run EQIP. The large number of private landowners who need to be reached could present a possible barrier to this strategy; however, improving sustainable forest management and mitigation strategies will help improve carbon storage and sequestration in New York, as well as climate resilience.

Components of the Strategy

- **Expand education and outreach:** DEC should work with partners such as CCEs, SWCDs, NGOs, SUNY ESF, Cornell CALS, the NY Forest Owners Association, and other organizations and universities across the State to provide, expand, and improve outreach and technical assistance on forest carbon and forest management to landowners including information about estate planning, intergenerational transfer, and the importance and contribution of working forestlands through programs such as the Forest Stewardship Program, AEM, Partnerships for Regional Invasive Species Management, and Master Forest Owners.

- **Amend Real Property Tax Law § 480-a:** The State should enact legislation to amend Real Property Tax Law § 480-a to create tracks for forest carbon management, induce greater landowner participation and integrate stronger sustainability provisions (such as forest regeneration) with the primary goal to remain unchanged and encourage sustainable timber

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[273] Butler, Brett J., Jaketon H. Hewes, Brenton J. Dickinson, Kyle Andrejczyk, Sarah M. Butler, Marla Markowski-Lindsay. 2016. "U.S. Department of Agriculture Forest Service National Woodland Owner Survey: national, regional, and state statistics for family forest and woodland ownerships with 10+ acres, 2011-2013." *Res. Bull. NRS-99*. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 39 p. https://doi.org/10.2737/NRS-RB-99.

[274] New York State Department of Environmental Conservation. 2020. "New York State Forest Action Plan: December 2020." Albany. Accessed at https://www.dec.ny.gov/docs/lands_forests_pdf/nysfap.pdf.

[275] Malmsheimer, Robert, Patrick Heffernan, Steve Brink, Douglas Crandall, Fred Deneke, Christopher Galik, Edmund Gee, John Helms, Nathan McClure, Michael Mortimer, Steve Ruddell, Matthew Smith, John Stewart. 2008. "Forest management solutions for mitigating climate change in the United States." *Journal of Forestry* 106.

management. The tax abatement benefit for landowners should remain unchanged with up to 100% reimbursement to municipalities.

- **Enact new legislation:** The State should enact legislation to create a new real property tax incentive (new Real Property Tax Law § 480-b) to allow private forest landowners to manage for multiple benefits (such as wildlife habitat, water quality, wood products, carbon sequestration, and carbon resilience) and, if desired, conserve their forests in natural conditions to participate in tax programs. Tax benefit to landowners should increase as the year of commitment increase, recognizing the accumulated annual sequestration benefits over time. This program should require a forest management plan written by a certified forester if harvesting is required. To be eligible for this program, a landowner would be required to enroll at least 15-acres of contiguous forested land. Initial benefits should start at a lower level than Real Property Tax Law § 480-a and a new Real Property Tax Law § 480-c with up to 100% reimbursement to municipalities.

- **Enact new legislation:** The State should enact legislation to create a real property tax incentive (Real Property Tax Law § 480-c) to provide forest landowners a tax incentive to undertake practices that increase carbon storage, carbon sequestration, and climate resilience while addressing the need for additionality (additional carbon or climate benefits generated due to practices above the current baseline state). This program should be practice- and carbon inventory-based and require a forest management plan written by a carbon certified forester if harvesting. To be eligible for this program, a landowner would be required to enroll at least 15-acres of contiguous forested land. The tax benefit to landowners should increase as the years of commitment increase to recognize accumulated sequestration benefits over time with up to 100% reimbursement to local municipalities.

- **Support programs that provide technical assistance to private landowners:** The State should expand the funding for cost share programs, such as Regenerate NY and AEM to assist forest landowners in increasing carbon storage, carbon sequestration, and climate resilience on private forestland, including restoration of degraded forests and implementing BMPs for forest carbon. The first round of the Regenerate NY program will help restore and afforest 503 acres of land to forest; however, support for this program will need to substantially increase to have a measurable impact on forest carbon benefits. The formal addition in 2019 of Forest Conservation Planning and BMP implementation into the AEM framework now provides technical assistance and funding from SWCDs to farmers with forestland to improve management of forest resources for multiple benefits, including carbon storage and sequestration.

- **Establish equipment caches:** DEC, SWCDs, NGOs, and the WPDC should establish equipment caches across the State to allow landowners and operators to borrow forestry and logging equipment to implement low-impact forest management for approved practices.

AF5. Support Local Communities in Forest Protection and Management

Local governments including counties and municipalities own approximately 1% of forested areas large and productive enough for wood production and have jurisdiction over land use planning and restrictions for forests within their boundaries.[276] In addition, tree canopy covers 1.3 million acres of urban and community areas, storing about 32.1 MMT of carbon (equivalent to the CO_2 that is produced to power all the houses in New York for one and a half years) and contribute to 1 million tons of gross carbon sequestration each year (equivalent to the CO_2 that is produced to power 400,000 homes for one year).[277,278] Increasing forest protection and management in local and urban communities will increase carbon sequestration and storage as well as climate resilience. In addition, trees in urban areas reduce overall energy use (such as through the reduced use of air conditioning) and therefore reduce GHG emissions. Current efforts by DEC include the Urban and Community Forestry Program, which provides education, outreach, guidance, and a grant program to local and urban communities, and the Community Forest Conservation Program, which provides funds to municipalities to acquire local forest lands to create community forests. However, urban and community tree cover is declining by about 6,720 acres annually.[279] In addition, many municipalities lack a comprehensive plan and/or zoning ordinance or laws for forests, and often these documents do not clearly address forest retention and/or uses. In some cases, restrictions within municipal jurisdictions on forest management drive local landowners to develop their land.[280] In addition, similarly to private landowners, the costs of maintaining a healthy forest, forest

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[276] Daniels, Katherine H. 2005. *A Municipal Official's Guide to Forestry in New York State.* New York Planning Federation, Department of Environmental Conservation and Empire State Forest Products Association. 31p. Accessed June 9, 2021, at http://cceonondaga.org/resources/municipal-officials-guide-to-forestry-in-new-york-state.

[277] U.S. Environmental Protection Agency. 2021. "Greenhouse Gas Equivalencies Calculator." Division of Energy and Environment. Accessed June 4, 2021, at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator. Average emissions rates were used for this calculation.

[278] Nowack, David J., Eric J. Greenfield, Robert E. Hoehn, and Elizabeth Lapoint. 2013. "Carbon storage and sequestration by trees in urban and community areas of the U.S." *Environmental Pollution* 178, 229-236.

[279] Nowack, David J., and Greenfield, Eric J. 2018. "Declining urban and community tree cover in the United States." *Urban Forestry & Urban Greening* 32, 32-55.

[280] Malmsheimer, Robert W., and Donald W. Floyd. 1998. "The Right to Practice Forestry: Laws Restricting Nuisance Suits and Municipal Ordinances." *Journal of Forestry* 96(8): 27-32. https://doi.org/10.1093/jof/96.8.27.

dieback due to pests and diseases, annual taxes, and shifts to smaller parcel sizes, municipalities have been facing increasing pressures to subdivide, develop, or allow development on their forested lands.[281]

Components of the Strategy

- **Provide guidance and support:** DEC should work with partners, like SUNY ESF and Cornell CALS, to provide guidance, support, and funding to local communities to plan and implement forest maintenance projects that help communities adapt to climate change.

- **Provide BMPs:** DEC should work with partners like SUNY ESF and Cornell CALS to provide BMPs for urban forests including what trees to plant for carbon sequestration and climate resilience and ways to increase the lifespan of urban trees through improved maintenance.

- **Increase funding:** The State should increase the funding levels and scope of Urban and Community Forestry Grants to assist local municipalities and private landowners in the management of the urban forests, including planning, planting, and maintenance of trees. Round 15 of DEC's Urban and Community Forest Grants funded 38 projects across the State; however, support for this program will need to increase to have a greater impact on urban forest carbon benefits.

- **Develop guidance and support:** DEC and SWCDs should develop guidance for and provide support to local communities to establish or expand youth and young adult conservation corps to employ, and train youth for maintaining and improving urban forest management.

- **Support research:** DEC should work with partners like Cornell CALS and SUNY ESF to increase urban forestry and forest carbon research on ways to maximize the carbon and other benefits of establishing and maintaining urban forests.

AF6. Monitor Progress and Advance Forestry Science and Technology

Tracking the carbon sequestered and stored by New York's forests is critical to enabling and evaluating the success of carbon sequestration and storage. Monitoring forest carbon progress will help the State identify successful forest management strategies and provide further insight into what land use patterns can lead to the greatest carbon sequestration and storage. Monitoring will also help identify areas of the State that have low regeneration or stocking and areas that have been impacted by invasive species, wildfire, and other disturbances that need restoration efforts. DEC is currently working with SUNY ESF

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[281] Malmsheimer, Robert, Patrick Heffernan, Steve Brink, Douglas Crandall, Fred Deneke, Christopher Galik, Edmund Gee, John Helms, Nathan McClure, Michael Mortimer, Steve Ruddell, Matthew Smith, John Stewart. 2008. "Forest management solutions for mitigating climate change in the United States." *Journal of Forestry* 106.

to monitor forest carbon on a statewide level to support the annual GHG emissions inventory and additional efforts are underway by other organizations throughout the state and the northeast. DEC will work with partners to continue to track forest carbon and improve monitoring.

Components of the Strategy

- **Monitor forest carbon:** DEC should continue to work with partners like the U.S. Forest Service Forest Inventory and Analysis program, SUNY ESF and Cornell CALS to monitor forest carbon and evaluate tactics to determine efficacy and maximize efficiency.
- **Create science-based decision tools:** DEC should work with partners like SUNY ESF and Cornell CALS to create science-based decision tools to help make the most efficient and cost-effective decisions on forest-based climate change initiatives.
- **Improve forest carbon soils knowledge:** DEC should work with partners to research carbon within forest soils and the associated belowground dynamics of this carbon pool.

AF7. Conduct Education and Outreach on Forest Management

Education and outreach to New York's private and public landowners who can implement forest management practices and mitigation strategies is needed to ensure and enable the success of the strategies described in this chapter, which will in turn increase carbon sequestration and storage and climate resilience. In addition, the benefits forests and wood products provide should be promoted to the public to increase their use and for a better understanding of why protecting and managing forests is beneficial for carbon sequestration, wildlife, and the people of New York. DEC currently conducts education and outreach through individual programs such as the Forest Stewardship Program, EQIP, Regenerate NY, the Urban and Community Forest program, through partners like SWCC, and through efforts like #ForestryFridays on social media. Additional proactive education efforts could be beneficial for reaching new audiences.

Components of the Strategy

- **Promote forest management:** DEC should work with partners to build public acceptance for forest management and increase the adoption of climate focused forest management on all landownership types.
- **Expand outreach:** DEC should continue to provide stewardship foresters, cooperating foresters, urban foresters, city planners, and local officials with outreach training, technical assistance, resources, and toolkits to better engage landowners and other stakeholders on climate change.

- **Support urban forestry:** DEC should continue to increase the promotion of urban forestry and tree care through TreeLine USA for utilities, TreeCity USA for communities, Tree Campus for college campuses, and ReLeaf efforts in communities across the State.

- **Support education and outreach:** DEC should bolster urban forestry and natural resource education and outreach, especially in historically marginalized communities by identifying and working with local partners.

- **Promote New York wood products:** SUNY ESF and WPDC should work with DEC to engage social media influencers and wood product manufacturers to promote New York wood products, including traditional and emerging wood products and utilization, as trendy, local, and sustainable.

- **Provide education and outreach:** DEC should engage partners to provide education and outreach to the construction industry, architects, engineers, building designers, and the public about mass timber construction, harvested wood product applications, and the carbon mitigation benefits of substituting wood products instead of those that are fossil fuel-based. Education and outreach should include workforce training on the installation and use of wood in buildings and infrastructure.

Advance Livestock Management Strategies

The highest level of agricultural emissions, primarily methane and secondarily N_2O, is attributed to livestock. Enteric fermentation from dairy and other livestock farms represents approximately two-thirds of agricultural methane emissions with manure management making up the balance. Therefore, the following strategies contribute to the deepest reductions in agricultural emissions, addressing methane reduction through manure management practices and precision animal feeding. Alternative manure management strategies rely heavily on the advancement of current programs led by the AGM, SWCC, NYSERDA, and county SWCDs. Precision feed, forage, and herd management strategies rely mainly on increased training and support to the farm community by Cornell CALS, CCE, nutritionists, and feed industry professionals; expanded use of monitoring and decision tools; and continued and enhanced research and development of feed supplements and additives for further methane reductions.

AF8. Advance Alternative Manure Management

The storage of manure is an important practice to facilitate nutrient management, reducing the need for synthetic fertilizers and mitigating runoff for the improvement of water quality. However, the treatment and storage of livestock manure can produce methane through the anerobic decomposition of the manure. Manure storages have caused the single highest increase in agricultural emissions from the 1990 baseline

year to today.[282] Mitigation of this source of emissions ranges from technically feasible to challenging depending on the use of available strategies and technologies or through more innovative and advanced manure management system approaches. Manure methane reductions require an evaluation of new processes, technologies, and costs; overcoming storage retrofit and livestock bedding challenges; operating and maintaining systems for methane prevention or optimal capture and destruction to minimize methane loss and leakage; filling gaps in applied research as well as in-field leak monitoring processes; balancing nutrients and methane inputs with increases in imported organic waste processing; and improving quantification and verification of outcomes.

This strategy can reduce methane emissions by implementing practice systems specifically planned and designed for each farm, including but not limited to cover and methane capture systems, anaerobic digester systems, composting, and other innovative systems that collect, capture, and destroy methane from manure storages or prevent methane production through alternative manure management practice systems. This strategy can also lead to creation of a renewable, alternative fuel to self-supply farm energy needs. The on-site use of biogas captured from manure management, where feasible and practical, is preferred before refinement of biogas into renewable natural gas (RNG) for on-site use and with emphasis placed on non-combustion applications such as use in fuel cells. The limited supply of biogas or RNG should be targeted to strategic uses such as locations where it can provide electric system capacity for buildings and transportation electrification by alleviating system constraints. Infrastructure needs for biogas or RNG from manure management should be consistent with the framework outlined in *Chapter 18. Gas System Transition*.

Air quality, health, and GHG benefits should be identified before implementation, including requirements to avoid localized pollution in Disadvantaged Communities. Specific components of this strategy, which include utilizing existing State programs and planning tools through AGM and the SWCC, can begin implementation immediately and can scale with additional resources dedicated to these programs. Through six rounds of funding, the CRF program has awarded $6.2 million for manure storage cover and methane capture systems, assisting 20 farms. While resources for this program have increased over the last seven years, increases in both public and private investment and outreach will be needed to have a greater impact on methane reductions. Longer timeframes will be required for other components relating to landowner and farmworker education, outreach, research, and market connections with NYSERDA and

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[282] Wightman, J.L., and P.B. Woodbury. 2016. "New York Dairy Manure Management Greenhouse Gas Emissions and Mitigation Costs (1992–2022)." *Journal of Environmental Quality* 45: 266-275.

SWCDs as key partners. These strategies rely on the New York AEM Framework and strong incentives to implement alternative manure management systems.

The CJWG favors imposing regulations on dairy and other livestock farmers to reduce emissions. The strategies described below rely more heavily on long established technical assistance and cost-share programs to achieve methane reductions from manure management. Feedback from the CJWG indicates a preference for manure management strategies upstream of the manure storage or that reduce animal waste generation at its source.

Components of the Strategy

- **Expand funding for current programs:** AGM and SWCC should continue to significantly expand CRF program funding to assist farmers in implementing alternative manure management practice systems that reduce methane emissions.
- **Expand private sector and NGO partnerships:** AGM and SWCC should collaborate with NGOs and private industry partners such as the U.S. Dairy Net Zero Initiative and dairy cooperatives who are currently doing essential work to reduce emissions in the dairy sector to combine resources and expand outreach.
- **Expand farmer access:** AGM and SWCC should increase farmer access to technical and financial assistance. This should prioritize historically unrepresented farmers and beginning farmers. Specifically, continue developing outreach strategies, gathering information, and gaining understanding of the experiences of historically unrepresented and beginning farmers.
- **Strengthen program policies:** AGM and SWCC should refine current grant program policies to encourage manure management systems funded through State programs to incorporate methane prevention or mitigation strategies, including, site specific strategies that minimize methane emissions, and retrofit capacity for existing anaerobic storages.
- **Expand SWCD capacity:** The State should expand capacity of SWCDs and partners to aid on-farm implementation of GHG emissions reduction and sequestration management practices.
- **Expand technical assistance:** AGM, along with stakeholders, should increase technical assistance and engineering capacity for feasibility assessment, planning, design, operation, maintenance, and monitoring of alternative manure management systems.
- **Expand training:** AGM and SWCDs should expand training to technical service providers and farm staff to design, build, operate, and maintain alternative manure management systems.

- **Develop new funding opportunities:** AGM should develop a State-funded loan guarantee program to stimulate investment in alternative manure management systems.

- **Expand purchasing opportunities:** AGM and SWCC should explore the development of bulk buying programs to reduce core material and equipment costs (such as cover and methane capture systems, separators, standardized controls, and other components), similar to the solar industry and energy-efficient heating programs.

- **Advance energy production:** NYSERDA, along with AGM, should expand support for the advancement of energy production and methane mitigation following a full life cycle analysis, including measurement and abatement of methane leakage, consideration for avoided emissions, and future innovations based upon the recommendations from the biomass action plan. Programs that incentivize anaerobic digestion should require systems be built (or retrofit) for maximum methane mitigation to ensure development of well-managed, low emissions biogas or RNG production such as utilizing emissions minimizing technologies and techniques, minimizing fossil fuel use in biogas or RNG production, minimizing emissions from biosolids/digestate, and consideration of a regulatory framework to ensure best practices.

- **Minimize fugitive methane and co-pollutant emissions from energy production:** AGM and NYSERDA should develop and apply standards for leak detection and repair from energy production systems. These standards will also include monitoring to guide management to minimize losses and optimize GHG emissions reduction benefit. DEC should use permitting, monitoring, and enforcement to limit methane and co-pollutant emissions from energy production such as anaerobic digesters.

- **Align market opportunities:** AGM and NYSERDA should align manure management systems designed for energy production, organic waste management, and methane mitigation with markets and private-sector investments (e.g., clean transportation standard, industry net zero initiatives, and others). NYSERDA and DPS, along with utilities and energy market participants, should identify energy pricing models and conduct a market-based study for waste-generated biogas.

- **Make market connections:** AGM and NYSERDA should improve connections and markets between farms with alternative manure management systems and other businesses able to supply organic co-products or use products generated by such on-farm systems (such as electricity, heat, gas, and organic soil amendments).

- **Support research and outreach:** AGM should implement long-term funding support for alternative manure management applied research and outreach, including evaluation of new processes, technologies, and GHG quantification and verification methodology for manure

management systems, quantification of methane leakage and detection, processes for realizing additional value from manure, and analyses for strategic development/siting of methane mitigating manure and organic waste management systems. Research efforts should also seek to improve estimates of methane emissions from anaerobic digestion and methods to reduce or eliminate these emissions.

AF9.   Advance Precision Feed, Forage, and Herd Management

Methane is produced as part of normal digestive process in animals, especially ruminants. During digestion, microbes present in the animal's digestive system ferment feed consumed by the animal. This microbial fermentation process, referred to as enteric fermentation, produces methane as a biproduct, which can be exhaled or eructed by the animal. Although methane from feed digestion represents the highest percentage of agricultural emissions, dairy and other livestock farms have improved feed efficiency, reducing methane emissions per unit of milk and other products since the 1990 baseline.[283] Additionally, over time, New York dairy farmers have made significant strides in reducing the carbon footprint per hundred weight of milk through greater efficiencies in precision feed management, reducing enteric methane emissions from cow digestion.[284]

Deep reductions are required for New York agriculture to meet the Climate Act emission limits. Mitigation of methane emissions from enteric fermentation range from feasible to challenging from the implementation of precision feed, forage, and herd management through continued and enhanced training and support to the farm community to the expanded research and testing needs, of methane-reducing feed additives to determine long-term efficacy, safety, and scalability.

To reduce methane and N_2O emissions while achieving desired ruminant growth and lactation goals, this strategy requires the evaluation of new processes, technologies, costs, and returns; demands sustained adaptive management by farmers and advisors; flattening the learning curve by farmers, advisors, and the feed industry; filling gaps in applied research; and overcoming weather and market disruptions that can

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[283] Capper, J. L,. and R. A. Cady. "The effects of improved performance in the United States dairy cattle industry on environmental impacts between 2007 and 2017." *Journal of Animal Science*, Volume 98, Issue 1, January 2020, skz291. https://doi.org/10.1093/jas/skz291;
Capper, J. L., R. A. Cady, and D. E. Bauman. 2009. The environmental impact of dairy production: 1944 compared with 2007. J. Anim. Sci. 87:2160–2167. doi:10.2527/jas.2009-1781;
Wightman, J.L. and P.B. Woodbury. 2016. New York Dairy Manure Management Greenhouse Gas Emissions and Mitigation Costs (1992–2022). Journal of Environmental Quality 45: 266-275.

[284] Ibid.

lower performance (producing lower quality forage). This strategy acknowledges that additional methane emission reduction may be realized from feed additives developed in the future and supports research to evaluate their potential. Research in combination with incentives may lead to substantial reductions in emissions. Some components of this strategy that include utilizing existing programs and planning tools can begin implementation immediately and be scaled up with additional resources dedicated to them. Longer timeframes will be required for other components relating to applied research and market development of feed additives with Cornell CALS and CCE as key partners for implementation.

Components of the Strategy

- **Expand precision feed and forage education:** AGM should work with partners such as Cornell CALS to expand outreach and education of precision feed and forage management to more ruminant livestock farmers, nutritionists, and feed industry professionals. Other stakeholders essential to this effort include milk cooperatives and processors.

- **Expand access to monitoring tools:** AGM should work Cornell CALS to expand access to precision feed and forage management monitoring and decision tools (such as the Cornell Net Carbohydrates and Proteins System) applicable to a range of farm conditions and management. Farm use of the methane module within Cornell's system should be increased and statewide benchmarks should be developed to gauge improvement overtime.

- **Support research and outreach:** AGM and SWCC should implement long-term funding support for precision feed, forage, and herd management basic and applied research and outreach, including research for methane mitigating feed additives and outreach, training, and other forms of assistance to nutritionists and industry professionals regarding GHG reductions through feed management.

- **Expand SWCD capacity:** The State should expand capacity of SWCDs and partners to aid on farm implementation of precision feed and forage management practices.

- **Establish co-product markets:** DEC should explore establishment of a co-product market for food "wastes" supplied from food processors, retailers, or institutions for best uses, including as livestock feed.

- **Invest in science-based herd management:** AGM should work with partners such as Cornell CALS to develop a science-based strategy focused on improving herd management decision-making, which positively impacts cow efficiency to reduce GHG emissions while optimizing milk yield and return on investment.

- **Facilitate technical assistance:** AGM should facilitate technical assistance to improve access to programs, planning and monitoring tools, and financial assistance for on-farm implementation of precision feed-forage and herd management practices.

Improve Soil Health, Nutrient Management, and Agroforestry

Healthy soils and nutrient management provide for many functions and ecosystem services including sustaining the biological activity and diversity of the soil, water quality protection, nutrient cycling, and carbon sequestration. Practices that improve soil health help to buffer many of the impacts of climate change also increasing a farm's resiliency. The following strategies focus on N_2O reduction and increasing carbon sequestration.

N_2O makes up approximately 9% of all agricultural GHG emissions in New York. Improving nitrogen fertilizer and manure management is an effective GHG emissions reduction strategy that also provides other environmental and economic benefits. Efficient use of nitrogen fertilizer and manure can reduce N_2O emissions from cropland, improve water quality, and save the farmer money.

Improving soil health can increase soil organic matter to sequester carbon as well as maintain and enhance soil structure to increase water infiltration reducing drought stress; decreased runoff after heavy storms leads to better water quality; proper uptake of nutrients by plants reduces excess nutrients entering waterbodies; and maintaining or potentially increasing crop yields promotes food security. Existing soil health and water quality initiatives can be utilized to include GHG mitigation, taking a comprehensive approach to meeting multiple State environmental management goals.

Agroforestry practices systems that add trees into areas of agricultural production have the potential to elevate local food production and resiliency; improve water and air quality; provide storm and flood mitigation increase drought resiliency; provide habitat, scenic vistas, and agritourism; and increase economic development and jobs. Some emission and sequestration strategies are long-term approaches. It can take decades to develop additional tree cover and years to build soil carbon.

Although this chapter does not address fossil fuel emissions directly, advancing nutrient management and soil health management practice systems can reduce the number of farm equipment passes thus reducing the amount of fossil fuel use and fuel cost to farmers.

These strategies rely mainly on the continuation and expansion of current State efforts with implementation beginning immediately. Leads for these strategies include AGM, SWCC, DEC, SWCDs, Cornell CALS and CCE. Other key stakeholders include but are not limited to American Farmland Trust, land trusts, the Nature Conservancy, the Farm Bureau, and the fertilizer industry.

AF10. Advance Agricultural Nutrient Management

Farmers in New York have improved nutrient management on lands while increasing crop yields. Comparatively, N_2O emissions from farms in New York are lower than in many other agricultural systems nationally and globally, making this mitigation strategy relatively easy to implement. However, continued emission reductions, including improved measurement of existing and future efforts, require comprehensive training in the use of nutrient management tools and in some cases new equipment and data collection. Further, extreme precipitation driven by climate change can aggravate nutrient loss from farm fields. As a result, implementation of this strategy requires sustained, adaptive management by farms and crop advisors.

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments is the continual process of nutrient management. Farms across New York will continue to reduce N_2O emissions and nitrogen pollution to waterways while achieving desired yield and quality through continued and expanded nutrient management planning and implementation on crop fields, hay fields, pastures, orchards, vineyards, and other agricultural lands receiving nutrients. Agricultural productivity and food security are important drivers for climate policy. Nutrient management monitoring and tracking programs, like those led by Cornell's Nutrient Management Spear Program,[285] have aided farms to decrease nitrogen and phosphorus imports resulting in lower losses to the environment. Dairy and crop farmers will need additional applied research and aid to deploy effective tools to reduce GHG emissions on crop lands from fertilizer use. The CJWG is supportive of efforts to reduce N_2O emissions through more efficient use of nitrogen fertilizers and has suggested consideration of a fee on such fertilizers as a potential mechanism to reduce their use. Fossil fuel prices and factors impacting global commerce drive fertilizer prices, and increases in fertilizer costs for farmers often result in expanded

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[285] Cornell University's Nutrient Management Spear Program works to conduct applied, field and laboratory-based research, facilitate technology and knowledge transfer, and aid in the on-farm implementation of beneficial strategies for field crop nutrient management, including timely application of organic and inorganic nutrient sources to improve profitability and competitiveness of New York State farms while protecting the environment. Accessed at http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/DairySustainabilityIndicators.html.

utilization of manure and nutrient management.[286] Introducing a fee on top of unstable fertilizer prices could place undue burden on farmers who are already facing thin margins.[287] A fertilizer fee structure could reduce New York's food security and cause emission leakage if farms struggle to remain viable or are unable to operate.

Components of the Strategy

- **Expand funding and technical assistance:** AGM and SWCC should increase support for planning, technical assistance, and soil health or nutrient management practice implementation through the AEM Framework and associated programs, including the CRF and Agricultural Nonpoint Source Abatement and Control (AgNPS) water quality program. This should include funding to quantify climate and co-benefits related to farm-level GHG emission accounting and reduction strategies.

- **Engage with and expand program participants:** AGM, SWCC, and SWCDs should seek feedback from historically unrepresented and beginning farmers who are not currently engaged in practices and programs to remove obstacles for participation (such as holding focus groups, surveys, and farm-to-farm education).

- **Expand cost-share eligibility for historically unrepresented farmers and capital-intensive equipment:** AGM and SWCC should expand cost-share eligibility for equipment needed by farms to implement more advanced soil health and nutrient management practices. Emphasis should be on improved access to technical and financial support for historically unrepresented and beginning farmers.

- **Expand SWCD capacity:** New York should expand capacity of SWCDs and partners to aid on-farm implementation of GHG emissions reduction and sequestration management practices.

- **Enhance workforce training:** AGM and SWCC should continue and enhance training for technical assistance providers, agricultural planners, farmers, and farm workers.

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[286] Schnitkey, G., N. Paulson, C. Zulauf, K. Swanson and J. Baltz. September 27, 2022. "Fertilizer Prices, Rates, and Costs for 2023." *farmdoc daily* (12):148, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign.

[287] Outlaw, J. L., H. L. Bryant, J. M. Raulston, G. M. Knapek, B. K. Herbst, and B. L. Fischer. "Economic Impact of Higher Fertilizer Prices on AFPC's Representative Crop Farms." Agricultural and Food Policy Center, Texas A&M University, College Station, Texas. *AFPC Briefing Paper 22-01*, January 2022. Available at https://afpc.tamu.edu/research/publications/files/711/BP-22-01-Fertilizer.pdf

- **Support implementation services:** AGM and SWCC should support expanding capacity of custom farming service providers to aid on-farm implementation of nutrient management practices.

- **Increase use of existing tools:** AGM should work with partners such as Cornell CALS, CCE, and others to increase the use of improved methods of monitoring performance via crop yield measurement, nitrogen use efficiency, and Whole Farm Nutrient Mass Balances (for farm-wide nitrogen management). These benefits of nutrient management should be documented and shared with farmers, policymakers, and the public.

- **Collaborate with industry led initiatives:** AGM and partners should collaborate with industry led nutrient management initiatives and services, such as the 4R Nutrient Stewardship Program.[288] They should also initiate and expand nitrogen efficiency and yield crop contests for peer-to-peer competition and informational opportunities.

- **Increase funding for applied research:** AGM should implement long-term funding support for nutrient management applied research and outreach (such as management approaches and technology).

- **Increase outreach:** The State should increase outreach to all farmers with the research and technical standards used in New York. The State should also increase outreach to consumers on the benefits of nutrient management, such as water quality improvements.

AF11. Adopt Soil Health Practice Systems

This strategy focuses on reducing net GHG emissions as well as increasing carbon sequestration and other environmental benefits through adoption of soil health management practice systems (such as combinations of cover and double crops, conservation crop rotations, perennial crops, prescribed grazing, and nutrient management), also referred to as regenerative agricultural practices. Implementing soil health management practice systems can also have the added benefit of reducing nitrogen fertilizer inputs, reducing operating costs, and improving a farm's financial viability associated with the impact of extreme weather events caused by climate change. New York's CRF program, launched as a pilot in 2015 to address climate change on farms, to date has awarded $20 million in project funding. Integrated into the AEM planning framework and modeled after the AgNPS grant program, the CRF program demonstrates

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[288] 4R Nutrient Stewardship provides a framework to achieve cropping system goals to incorporate the Right fertilizer source at the Right rate, at the Right time and in the Right place. New York State Agribusiness Association. Accessed at https://www.nysaba.com/4r-ny.

how climate-responsive efforts can be integrated alongside existing environmental and water quality agricultural programming.

The State's AEM framework provides cost-share funding and technical assistance for GHG emissions reduction activities for the practices described in the paragraph above, as well as other soil health management practices. Increasing funding opportunities for existing efforts such as the CRF program and enhancing technical assistance provided through County SWCDs will result in a higher rate of implementation and provide a familiar process to farmers within an infrastructure that already exists. CRF has awarded projects through six rounds of funding that are estimated to reduce emissions on farms by 370,000 metric tons of CO_2e. A significant amount of funding will be necessary to make further impacts on emission reductions.

The CJWG supports soil health and climate resiliency and emphasizes removing barriers for historically unrepresented farmers, which aligns with the components of this strategy.

Components of Strategy

- **Expand funding for current programs:** AGM and SWCC should increase financial support for currently available and implemented practices. This includes expanded funding for CRF, AEM Base, AgNPS, increased payment rates, increased access, building equity into programs, reducing barriers that limit access in applications, increased technical assistance, encouraging adoption of a system of practices, developing a soil health standard, and establishing an annual goal for common practices. This should also include increasing awareness and support for urban soils and agriculture.
- **Engage with and expand program participants:** AGM and SWCC should seek feedback from groups/communities not currently engaged in practices and programs (such as holding focus groups, surveys, farm-to-farm educational events and addressing urban soils and urban agricultural operations). Improving access reflects the need to ensure that all farmers can take part in these practices and programs.
- **Increase adoption of soil health practices on rented lands:** AGM should increase practice adoption on rented and leased land. AGM should seek feedback regarding support needed for farmers not currently engaged in practices and programs and engage, educate, and incentivize landowners to increase adoption of practices on land they rent to farmers.
- **Expand capacity of SWCDs:** The State should expand capacity of SWCDs and partners to aid on farm implementation of GHG reduction and sequestration management practices.

- **Increase perennial plant systems:** AGM and SWCC should support converting annual cropland to perennial hay land/pasture and forests where appropriate (such as steep slopes and highly erodible lands). This is a current effort supported through the State's AgNPS and CRF programs. Research and trials should continue to determine the efficacy of perennial grains systems in New York State.

- **Increase integrated planning efforts:** AGM and SWCDs should conduct comprehensive on-farm planning to include carbon sequestration goals, GHG emission, nutrient management, water quality, and soil health.

- **Increase use of precision and digital agricultural tools:** AGM should support continued development and implementation of precision/digital agricultural tools and sustainable intensification, which is the sustainable increase in yields on current cropland to reduce stress on marginal cropland to support this mitigation strategy.

- **Develop tools for quantification of benefits:** AGM, SWCC, and partners such as Cornell CALS should develop tools for verification of benefits and invest in remote sensing to quantify adoption of practices and environmental benefits.

- **Support research for monitoring and verification:** AGM, SWCC, and partners such as Cornell CALS should establish and maintain a comprehensive RD&D strategy for monitoring and verification of soil health that address additionality and permanence to support State climate goals and enable federal and private funding of GHG emissions mitigation practices.

- **Support research for new innovative practices:** AGM and partners such as Cornell CALS should establish and maintain a comprehensive research strategy in soil health to bring new practices and approaches (such as enhanced rock weathering and biochar) that increase sequestration rates, productivity, other environmental benefits, and scale for adoption.

- **Develop a business case for practices:** The State should identify practice systems that can generate revenue and/or added value to the farm, as well as identify a variety of public and private funding sources.

- **Educate consumers:** AGM should make efforts visible to the public through outreach campaigns making information more available, expand regenerative agricultural practices in marketing programs (such as New York Grown & Certified), and improve information provided to the public to help customers understand the practices involved in products they purchase.

- **Educate farmers and farmworkers:** AGM, SWCC, and SWCDs should expand education and outreach to include all farmers and farmworkers and to support practice adoption and encourage coupling of practices into systems for maximum benefit. They should support farm-to-farm and peer-to-peer networking to elevate long-term adoption of soil health management practice

systems (such as through local farmer discussion groups). Collaboration with private industry and NGOs such as cooperatives will also be beneficial to support both farmer and consumer education.

- **Educate students:** AGM, SWCC, SWCDs, and partners such as Cornell CALS and CCE should support agricultural and soil health instruction in schools and connect students with farms and farmers and the knowledge of the ecological benefit of healthy soils.

AF12. Increase Adoption of Agroforestry

Adding trees into areas of agricultural production increases carbon sequestration and other environmental benefits. Some examples of these production and conservation practices exist in New York. Current programs, technical services, and support should be leveraged to increase agroforestry adoption while new programs, increased investment in technical support, and capacity will be necessary. Challenges and barriers to wider adoption exist and must be overcome, including addressing the upfront costs to practice adoption; addressing land access and transfer issues/opportunities; filling gaps in research field trials, pilot projects, and market analysis in agroforestry systems; and addressing long-term management and maintenance needs and availability of appropriate tree species and survivability.

Agroforestry adoption can contribute toward afforestation and reforestation goals, hence having a high GHG emissions mitigation potential. Implementation leads for this strategy include AGM, SWCC, Cornell CALS, SWCDs, and CCE. Other key stakeholders include American Farmland Trust, land trusts, The Nature Conservancy, New York Farm Bureau, and other farm-led organizations. The CJWG supports aiding historically unrepresented farmers in opportunities for securing farmland, aligning with strategies for long-term farm leases and land transfers necessary for perennial systems.

Components of Strategy

- **Increase adoption of practices:** AGM and SWCC should expand the CRF program to incentivize agroforestry and set acreage targets for priority practices.
- **Increase riparian buffers:** AGM and SWCC should continue to emphasize forested buffers through the State's AgNPS and Source Water Buffer Program, DEC's Trees for Tributaries Program, and the USDA Conservation Reserve Program/Conservation Reserve Enhancement Program.
- **Increase silvopasturing:** AGM, SWCC, DEC, SWCDs, and CCE should expand programs that plan, design, and implement silvopasture systems. Silvopasture systems integrate tress, livestock, and forage in intensively managed rotational grazing systems with a focus on proper site and

species selection for adding trees to ensure appropriate and responsible implementation of silvopasture systems.

- **Expand funding for existing programs:** DEC should expand the Trees for Tributaries Program, the Non-Agricultural NPS Program, and Division of Fish and Wildlife Programs.

- **Advance alley cropping practices:** AGM, SWCC, SWCDs, and partners such as Cornell CALS, SUNY ESF, and CCE should conduct field trials and pilot projects and expand landowner and farmworker education and technical assistance for alley cropping.

- **Increase SWCD capacity:** The State should expand capacity of SWCDs and partners to aid on-farm implementation of GHG emissions reduction and sequestration management practices.

- **Expand education and technical assistance:** AGM, along with partners such as Cornell CALS, CCE, SWCDs, should expand education and technical assistance for agroforestry practices for beginning farmers and farmers experiencing or planning for generational transfer. Long-term planning is required for perennial systems.

- **Support long-term agricultural land transfers:** AGM, American Farmland Trust, and land trusts should assist farmers in securing long-term leasing and farm transfer to historically unrepresented and beginning farmers; long-term leases are required for long-term perennial systems.

- **Support business planning and market development:** AGM and SWCC should assist farmers with business planning and modeling for value-added practices in agroforestry. They should assist to expand supply chain development for new products in agroforestry.

- **Conduct outreach to financial lenders:** AGM should work with partners such as CCE and Cornell CALS to conduct outreach on the environmental and potential economic benefits of agroforestry systems to financial lenders and insurance providers.

- **Collaborate with federal partners:** The State should collaborate with federal partners to better align federal and State policy priorities.

AF13. Develop Agricultural Environmental Management Planning for Climate Mitigation and Adaptation

New York's AEM framework, overseen by the AGM and the SWCC and locally led and implemented by county SWCDs, will continue to enable farmers to reduce GHG emissions and increase sequestration in soils and forests through site-specific practices on lands under their management. As climate change-driven extreme weather impacts both farmland and watersheds across the state, AEM planning for climate mitigation and adaptation will improve water quality downstream by prescribing BMP systems that lead to a higher level of farmland resiliency.

AEM planning for climate mitigation and adaptation or the development of "Carbon Farm" Planning has the potential when implemented to elevate local food production and resiliency, water quality, air quality, storm and flood mitigation, public infrastructure protection, drought resiliency, habitat, scenic vistas, tourism, economic development, and jobs. A suite of technical assistance and planning resources should be developed through the AEM framework on farm and forest GHG mitigation and carbon sequestration opportunities, allowing for further planning and implementation of regenerative agricultural practices. This strategy is essential to the successful planning and implementation of practice systems that are tailored farm-by-farm for the reduction of GHG emissions, increased carbon sequestration potential, and elevated adaptation and resiliency on farmland. AEM planning resources should continue to be designed and made available in ways that are accessible and applicable to all farmers.

Components of the Strategy

- **Develop carbon farm planning protocols:** AGM and SWCC should develop planning protocols for Carbon Farm Planning by identifying gaps for future development, striving for compatibility among State and federal programs, and designing methods for collection and aggregation of outcomes from planned and implemented practice systems (such as estimates for GHG emissions, sequestration, and metrics for adaptation).
- **Pilot carbon farm planning:** AGM, SWCC, and SWCDs should conduct on-farm piloting of Carbon Farm Plans.
- **Conduct outreach and education:** AGM, SWCC, and SWCDs should provide communication of AEM Planning for climate mitigation and adaptation with farmers (such as case studies, learning from pilot farmers, training on farmer developed planning protocols/tools, and others).
- **Integrate carbon farming with existing programs:** AGM should include planning protocols in AEM Base Programs and compatibility with federal programs. Priority practice systems from plans will lead to implementation of practices that reduce emissions and increase adaptation and resiliency, thereby reducing soil and nutrient losses to the watersheds. BMP systems will be implemented through direct investment by farmers, other private investors/lenders, as well as State and federal cost-share programs.

AF14. Monitor and Benchmark Agricultural Greenhouse Gas Emissions

Annual monitoring and benchmarking of GHG emissions mitigation, carbon sequestration, and adaptation performance across applicable areas of management on farms in New York is critical to determining success in meeting targets and providing further insight into what strategies lead to the greatest achievements. Information products provide useful, farm-level data for confidential benchmarking by

farmers as well as publicly available data through farm case studies (with farmer agreement) and aggregated datasets (at the State level, rather than the farm level) to support future policy, research, and implementation. Like the farm-level AEM planning strategy, this strategy is central to the success of all other agricultural mitigation efforts.

Components of the Strategy

- **Establish funding:** AGM and DEC should establish funding for an agricultural benchmarking and monitoring program for GHG emissions. This should be a partnership effort among groups such as Cornell CALS, CCE, SWCDs, famer groups, and agricultural industry groups.
- **Monitoring and benchmarking:** AGM should develop methods for monitoring and benchmarking (including program staff and advisory committee). Benchmarking at the farm level for farmer use should be based on comparisons with the farm's historical performance as well as the performance of similar types of farms (each kept anonymous). Benchmarking should also occur at the county and State level with aggregated, anonymous data based on comparisons with our historical performance.
- **Outreach:** AGM and SWCC should introduce monitoring and benchmarking program with farmers and farm advisors.
- **Make data available:** AGM should deliver data summaries of BMP implementation and associated estimates of GHG mitigation or sequestration levels for confidential farm-scale use and aggregated summaries for public use. Additional key performance metrics would be developed by the advisory committee/expert panel.

AF15. Establish a Payment for Ecosystem Services Program

Currently, farmers and forest landowners do not capture direct financial benefits from generating ecosystem services through their existing land management techniques. Agricultural and forested lands implementing conservation BMPs provide countless environmental benefits for surrounding communities including improved water quality, climate mitigation, carbon sequestration, increased biodiversity, and pollinator services. Establishing a payment for ecosystem services mechanism to provide a new structure for establishing and maintaining practice systems that reduce GHG emissions and sequester carbon in addition to providing other environmental benefits would provide additional incentives to farmers and forest landowners. A payment for ecosystem services program can be designed through existing programs and frameworks to address multiple services and evolve with changing needs and priorities of the State. This strategy supports the implementation of other strategies in this sector that rely on increased adoption of regenerative agricultural practices.

Components of the Strategy

- **Dedicate funding:** AGM and DEC should establish funding for a payment for ecosystem services program to be developed for agricultural producers and forest landowners.

- **Develop and design program:** AGM, SWCC, and DEC should research and design a payment for ecosystem services approach that will sustain our natural capital; provide ecosystem services of water quality, flood resilience, and climate stability; and include fair compensation for program participants.

- **Conduct outreach:** AGM, SWCC, and DEC should conduct education and outreach regarding payment for ecosystem services program and benefits to local communities.

- **Pilot payment for ecosystem services program:** AGM, SWCC, and DEC should pilot a payment for ecosystem services program for agricultural producers and forest landowners to ensure continued implementation of practices or actions that lead to increased ecosystem services.

AF16. Bolster Local Agricultural Economies

This strategy supports emission reductions by enhancing existing programs, and promoting the expansion of those programs, that encourage farm viability and resilient communities through the production and consumption of local food. Climate impacts, as well as COVID-19 impacts, have shown an elevated importance in the need for food security. This strategy is designed to enhance the expansion of markets and support for New York's farming community. This strategy will help to enhance viability of New York's diverse agricultural enterprises. To realize the full goals of our mitigation and sequestration strategies, the economic solvency of the agricultural community must be addressed. Much of this strategy relies on bolstering existing programs and initiatives. Implementation of these strategies are ongoing and will be scaled with increasing resources made available. AGM, OGS, ESD, and CCE are implementation leads and main partners in this strategy. This strategy speaks directly to the support of diverse farm operations including historically unrepresented and beginning farmers.

Components of the Strategy

- **Expand procurement programs for New York products:** AGM, OGS, and ESD should expand existing programs in the State that support local procurement of New York agricultural products (such as the Fresh Connect Checks Program, Farmers Market Nutrition Program, Farm-to-School, and Nourish NY).

- **Increase engagement and participation in State programs:** AGM, New York State Council on Hunger and Food Policy, and ESD should engage with communities and producers to advertise these opportunities.
- **Expand education and outreach for new farmers:** AGM should work with partners such as CCE to expand education and technical assistance for beginning farmers and generational transfer. They should assist farmers with business planning and modeling.
- **Support new agricultural products:** The State, led by AGM, should help expand supply chain development for new agricultural products in New York such as agroforestry and perennial plant system products.

### *Promote a Climate-Focused Bioeconomy*

The bioeconomy produces sustainable, renewable bio-based feedstocks, rather than fossil fuel-based feedstocks, to produce products that achieve the climate and social justice requirements of the Climate Act. New York's forest product industry produces a diverse range of products and jobs. New York's forests and wood products industries are directly responsible for nearly 40,000 well-paying jobs and more than $13 billion of economic output and are indirectly responsible for another 53,000 jobs and nearly $10 billion of economic activity.[289] In addition, there is an opportunity for enhanced carbon storage as long-term, durable wood products store carbon. Furthermore, substitution of wood products for fossil fuel-based and fossil fuel-intensive products displaces GHG emissions, such as in housing construction (see Figure 27).[290]

However, there has been a decline in the number and diversity of primary wood products manufactured in New York directly from logs such as veneer, pallets, and boards over the last two decades, which has limited management options for forest landowners. To expand the wood products industry to store more carbon and facilitate sustainable forest management, additional wood product markets, further use of wood feedstock and residues, and more training is needed in these industries.

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[289] New York State Department of Environmental Conservation. 2020. "New York State Forest Action Plan." Albany. 144p. Accessed at https://www.dec.ny.gov/docs/lands_forests_pdf/nysfap.pdf.

[290] Perez-Garcia, J., B. Lippke, J. Comnick, and C. Manriquez. 2005. "An assessment of carbon pools, storage, and wood products market substitution using life-cycle analysis results." *Wood and Fiber Science* 37: 140–148.

Figure 27. Carbon in Forests, Wood Products, and Concrete Substitution Benefits
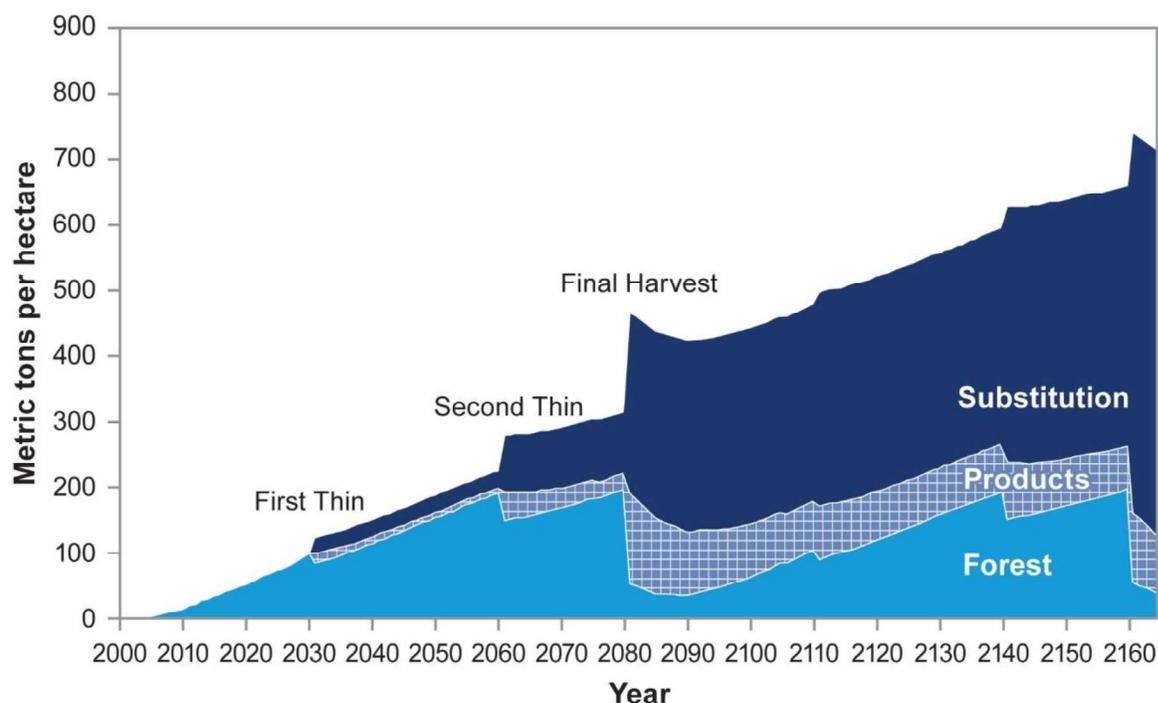
Adapted from: Perez-Garcia, J., B. Lippke, J. Comnick, and C. Manriquez. 2005. An assessment of carbon pools, storage, and wood products market substitution using life-cycle analysis results. Wood and Fiber Science 37: 140–148.

AF17. Develop Forestry Training Programs to Support Expanding Workforce and Climate Knowledge

As additional efforts to create additional wood product markets and the expansion of afforestation, reforestation, and other forest management efforts to enhance the long-term storage of carbon increase, an expansion in New York's forestry workforce will be needed. There needs to be information on forest carbon management and climate resilience incorporated into existing forestry trainings and education programs to help encourage such an expansion. In addition, training programs focused on carbon sequestration, carbon storage, wood product development, and other carbon and climate-related areas need to be developed and promoted within the forestry sector to meet ongoing new demands. Information presented by existing programs will need to be aligned based on BMPs.

Components of the Strategy

- **Support workforce development and training:** DEC should work with partners such as the WPDC to develop and support workforce development and training programs for the forest sector, including incorporating forest carbon management into curriculums at the high school (such as the Boards of Cooperative Education Services) and college level and supporting existing training apprenticeship programs for careers in forestry and the forest product supply chain.

- **Integrate forest carbon into education and outreach:** DEC should integrate and support forest carbon, forest carbon management, climate change, and climate resilience into existing forestry training and continuing education programs.
    - **Enhance cooperating consulting forester policy:** DEC should add a requirement for continuing education in forest carbon or forest carbon management to Cooperating Consulting Forest Policy, CP-36, and approve rigor and accountability of the program.
    - **Integrate forest carbon management:** DEC should integrate forest carbon and forest carbon management into urban forestry and utility forestry training programs.
    - **Bolster logger training:** DEC and New York Logger Training should bolster support for the Trained Logger Certification Program and implement new training modules including forest carbon BMPs into the Trained Logger Certification program, including increasing carbon sequestration.

- **Provide outreach and education:** SUNY ESF and Cornell CALS should provide outreach and education to the construction industry, architects, engineers, and the public on mass timber construction and use of harvested wood products (fire safety, high-rise applications). Education and outreach should include workforce training on the use and installation of wood in buildings and infrastructure.

AF18. Expand Markets for Sustainably Harvested Wood Products

Use of durable, long-lasting wood products, especially as a substitute for fossil fuel-intensive products like steel, concrete, brick, or vinyl, can reduce overall emissions for construction projects. Use of long-lasting, durable wood products can reduce GHG emissions when they replace fossil fuel-based products, as illustrated in Figure 28.

These products reduce net building and infrastructure GHG emissions and provide long-duration carbon storage. Some of the components in this strategy relate closely to those presented in *Chapter 12. Buildings* (Strategy B11) and *Chapter 14. Industry* (Strategy I2). In addition to substituting emissions for fossil fuel-intensive products, use of and markets for both high- and low-grade wood products benefits forest landowners and provides an economic driver for forest conservation, including to advance forest health and forest carbon sequestration. Execution of and carbon impacts from the strategy components listed below is expected to take five or more years, so implementation should begin as soon as possible to help reach long-term carbon sequestration goals.

Figure 28. GWP per Floor Component
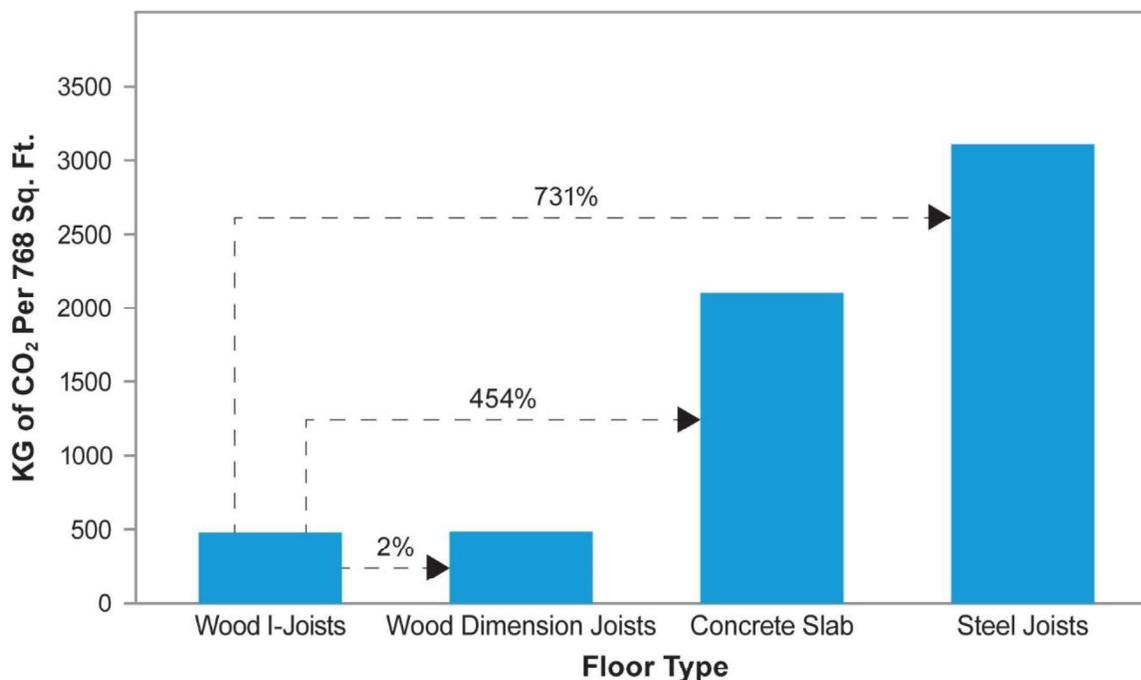
Adapted from: Lippke, B., and L. Edmonds. 2006. Environmental performance improvements in residential construction: The impact of products, biofuels, and processes. Forest Products Journal 56(10):58–63.

Components of the Strategy

- **Promote carbon storing materials:** SUNY ESF, WPDC, ESD, and DEC should promote long-term, durable wood products that store carbon and are substitutes for energy efficiency materials that are fossil fuel-based (such as cellulosic fiber insulation and hemp insulation replacing foams and research potential on uses for residues from wood and hemp product creation). In general, more long-term durable products should be incentivized over production of shorter-term and shorter-lived products; however, the market for wood residues and low-grade wood should not be disincentivized to prevent the degradation of existing forests and to allow for improved forest management practices that enhance sequestration and climate resiliency.

- **Advance building code changes:** DOS and the New York City Department of Buildings should advance building code changes to adopt the International Code Council 2021 International Building Code.

- **Develop standards:** NYSERDA should work with SUNY ESF, Cornell CALS, and DEC to set standards and specifications for a minimum portion of harvested wood products, such as mass timber or wood flooring, in new construction in certain State-funded/supported buildings and infrastructure projects when New York's supply chain can cost-effectively meet the demand.

- **Revise State procurement standards:** OGS, DEC, GreenNY, and DASNY should revise State procurement specifications that limit the eligibility of wood products that meet the technical performance standards and set minimum standards for use of wood products in new State-funded construction and infrastructure projects as feasible.

- **Remove barriers:** DOT, DEC, NYSERDA, PANYNJ, and EFC should remove barriers and create incentives for using wood for infrastructure applications, including bridges, sound barriers, transportation hubs, utility poles, marine and foundation pilings, retaining walls, solar energy infrastructure, docks, and piers.

- **Enhance supply chain:** NYSERDA, SUNY ESF, and Cornell CALS, with consultation from DEC, should enhance New York's supply chain for harvested wood products and fund innovation to develop mass timber applications using northern hardwoods.

- **Support research:** NYSERDA, DEC, AGM, SUNY ESF, and Cornell CALS should support research and development demonstration, and technology transfer of wood utilization and wood innovations to scale the use and climate benefits of wood in the built environment.

- **Conduct research:** DEC should work with partners to conduct research on emerging forest products and markets related to bioeconomy and harvested wood product initiatives.

AF19. Develop a Sustainable Biomass Feedstock Action Plan for Bioenergy and Low-Carbon Products

As detailed in this Scoping Plan and modeled by the integration analysis, widespread and rapid electrification is necessary to achieve the emission limits. Opportunities exist to utilize bioenergy resources to meet strategic needs in order to more effectively advance this aggressive electrification trajectory. The selection of feedstock, production method and end use for bioenergy products create highly variable outcomes for GHG emissions reductions, co-pollutant emissions, and health and environmental impacts. Additional research is needed to identify bioenergy product pathways that contribute to achievement of the emissions limits by reducing GHG emissions and supporting the pace of electrification envisioned in this Scoping Plan.

A Sustainable Biomass Feedstock Action Plan will identify feedstock volumes and production methods that utilize New York biomass resources (wood and wood processing wastes, agricultural crops and waste materials, organics in municipal solid waste, animal manure, and wastewater treatment byproducts) in a sustainable, emissions-reducing and substitution-maximizing manner. The Sustainable Biomass Feedstock Action Plan will also consider other uses for these feedstocks, such as uses in low-carbon product development as described in Strategies AF20 and AF21. The Sustainable Biomass Feedstock

Action Plan should identify bioenergy and low-carbon product development pathways that demonstrate air quality and health benefits, including requirements to avoid localized pollution in Disadvantaged Communities.

The CJWG expressed concerns about the combustion of biomass and biofuels due to their release of emissions, which are presented in *Chapter 8. Public Health*. Biomass and biofuel emission concerns raised by the CJWG will be addressed through their limited application, sustainability guidelines, life cycle analyses, and standards presented in the components below. Where it applies, biomass and biofuel use should be further integrated into and detailed within the components presented in *Chapter 11. Transportation*, *Chapter 13. Electricity*, and *Chapter 16. Waste*. All research and development strategies should leverage federal resources.

Components of the Strategy

- **Develop sustainability guidelines:** NYSERDA, AGM, and DEC should establish rigorous energy, GHG, and environmental sustainability guidelines and metrics for bioenergy products using life cycle analyses. Sustainability guidelines should also include the analysis of potential air quality and health impacts of producing and utilizing bioenergy products and include best practices to minimize these impacts, especially for Disadvantaged Communities.
- **Define sustainable feedstocks:** NYSERDA should define sustainable feedstock production for bio-based processing to determine feedstock volume and practices that minimize total emissions as part of a biomass action plan. This should include an evaluation of cost-effectiveness and an assessment of activating former agricultural and underused lands (including former industrial lands) for more productive uses.
- **Incentivize residue feedstock use:** NYSERDA, AGM, and DEC should work with SUNY ESF and Cornell CALS to establish preferential pricing to prioritize use of feedstocks that are residues from existing agricultural, forest, and waste systems (e.g., low-grade wood, wood residues, waste materials, and processing wastes). Feedstocks and products with the lowest GHG emissions following life cycle GHG accounting and analysis should be prioritized for incentives. Further, the potential for negative or positive impacts on other economic sectors, such as waste management, should be considered.
- **Develop net zero energy systems:** NYSERDA and DPS should develop energy systems that can best support a net zero emissions economy in New York, including programs that leverage private capital to invest in conversion technology for bio-based feedstock into bio-based products.

- **Identify efficient bioenergy pathways:** NYSERDA should work with Cornell CALS and SUNY ESF to identify bioenergy pathways with high life cycle energy efficiency and high emissions reductions (from feedstock production, conversion, and delivery to the end user) that complement and support wide-scale electrification. NYSERDA and DEC should develop alternative fuel strategies for challenging to electrify applications.

- **Address hard to decarbonize fuel needs:** NYSERDA and DPS should work with SUNY ESF and Cornell CALS to identify 2050 hard-to-decarbonize fuel needs (such as high-quality distillate jet fuels) and potential bioenergy development (feedstock supply chain, conversion systems, and end use markets) to meet these needs. The State should continue to follow developments on the federal level and be positioned to capture opportunities related to these future needs.

AF20. Increase Market Access for New York Low-Carbon Products

In the emerging field of low-carbon products, agricultural and forest residues are converted into biochemicals and biomaterials that are replacements for the petrochemicals used to create packaging, cosmetics, binders, absorbents, concrete strengtheners, and other products. These substitutes for fossil fuel products and fossil fuel-based products can reduce overall GHG emissions. However, production capabilities for low-carbon products are lacking in the Northeast and additional defining, monitoring of markets, research, and education are needed for use and promotion of these products. These efforts are expected take many years to be fully implemented and monitoring and promotion would need to be ongoing. Some of the components in this strategy relate closely to those presented in *Chapter 14. Industry* (Strategy I2).

Components of the Strategy

- **Track low-carbon product market:** ESD and NYSERDA should begin tracking and reporting on this market to spot emerging trends, innovative applications, external market opportunities, growth opportunities to guide the development.

- **Incentivize innovation:** OGS should spur innovation through lead-by-example in low-carbon procurement requirements for State government (such as bio-based products and low-carbon concrete).

- **Identify substitutes that can be used now:** NYSERDA should commence a technology readiness level analysis of low-carbon substitutes for fossil fuel-based products and fuels and identify the high value products from bio-based processing of New York grown feedstocks and invest in production facilities.

- **Incentivize low-carbon products:** NYSERDA should provide strategic use of incentives to drive the scale-up of high-demand products when the low-carbon product alternative is not yet cost-competitive with the fossil fuel-based option.

- **Define standards for low-carbon products:** DFS, the NY Green Bank, and the GreenNY Council should develop standards and guidelines for defining a low-carbon product, including ensuring sustainable feedstock production as defined by the biomass action plan (see *AF19*).

- **Incentivize existing businesses:** NYSERDA, ESD, and DFS should expand access to low-interest loans or grants for existing New York State businesses to develop new low-carbon products lines by educating local banks on emerging biotechnologies and offering NY Green Bank loan guarantees.

- **Connect suppliers to corporations:** NYSERDA should create a low-carbon products portal to facilitate connecting New York producers to corporations and other buyers that have made GHG emissions reduction commitments. The State should expand the NY Grown program to cover more products and add a low-carbon aspect.

- **Expand agroforestry forest products:** AGM should help to expand production of high-value agroforestry products that contribute to maintaining healthy forests (sap/syrup production, nuts, mushroom cultivation, and ginseng production).

- **Provide education and outreach:** DEC and AGM along with SUNY ESF should enhance the public's understanding of the bioeconomy and its role in reducing GHG emissions.

- **Build buyer confidence:** NYSERDA should provide consumer and business-to-business education on bio-based products and low-carbon products in order to build buyer confidence.

AF21. Provide Financial and Technical Assistance for Low-Carbon Product Development

In addition to State support for increasing market access, financial and technical assistance is needed to grow bioprocessing industries for low-carbon products from low-grade wood and other biomass residuals to create bio-based substitutes for fossil fuel-based products. This assistance must also include an evaluation for any potential emissions of co-pollutants from these processes and measures to reduce or avoid those emissions. Providing this assistance will ensure this strategy mitigates GHG emissions without unintentionally emitting co-pollutants. Some of the components in this strategy relate closely to those presented in *Chapter 14. Industry* (Strategy I2).

Components of the Strategy

- **Quantify bioprocessing investments:** NYSERDA should develop criteria for qualifying near-term bioprocessing capacity investments.

- **Promote high value outputs:** NYSERDA, the Department of Taxation and Finance, and ESD should provide financial and technical initiatives to identify and promote the high value outputs from New York bioprocessing inputs.

- **Attract bioprocessing and bio-based products to the State:** ESD should create an economic development initiative focused on attracting bioprocessing/bio-based product businesses to New York.

- **Incentivize low grade feedstocks:** DEC and AGM should have preferential pricing for in-State low grade feedstocks that maximize carbon sequestration (organic waste streams, wood residues, marginal land). Creating market value for low-grade wood products can incentivize forest owners to manage their forests in a way that increases sequestration.

- **Invest in conversion technology:** NYSERDA and the NY Green Bank should develop programs that leverage private capital to invest in conversion technology for bio-based feedstock into bio-based products.

AF22. Advance Bio-Based Products Research, Development, and Demonstration

Bio-based products have the potential to replace fossil fuel and fossil fuel-based products, including for hard-to-decarbonize uses, to lower GHG emissions. Currently, incentives are required to make bio-based and low-carbon products economically competitive for use by industries. In addition, there is a potential for improved efficiency in bio-based and low-carbon products and further development of new products. To drive research and development, this strategy recommends developing a demonstration and pilot project portfolio to drive investment in the areas of alternative fuels, low-carbon products, and related sequestration that considers intersection of industrial or manufacturing, agriculture, transportation, and power generation sectors and funding innovation challenges and projects that can scale beyond business as usual to provide GHG emissions reduction benefits. These strategies are not currently underway in New York, and it is expected to take several years to develop products and complete research activities. The research agenda should include rigorous energy, GHG, and environmental sustainability guidelines and metrics, analysis of the potential air quality and health impacts and best practices to minimize these impacts, mitigation of localized impacts in Disadvantaged Communities, life cycle GHG accounting with priority utilization provided for feedstocks with the lowest GHG emissions, with strong preference given to zero- or negative-emissions sources, evaluation of emissions controls that reduce/eliminate emissions,

and the potential for negative or positive impacts on other economic sectors, such as waste management or agriculture. Research must quantify criteria pollutant emissions, ecosystem services, and bioremediation potential of deep decarbonization and net sequestration pathways analyzed under roadmap. This will enable pathways that contribute to improvements in these areas to be considered for pilot funding.

Components of Strategy

- **Determine product gaps:** NYSERDA, with partners such as SUNY ESF and Cornell CALS, should develop a research agenda scope for bio-based products by compiling a list of existing products and product efficiencies and evaluating these for gaps and potential improvements.
- **Solicit demonstration projects:** NYSERDA should develop a solicitation to perform research and identify promising pilot/demonstration projects.
- **Fund demonstration projects:** NYSERDA should fund research and pilot/demonstration projects identified in the research agenda scope as listed in the component above.

AF23. Advance Deployment of Net Negative Carbon Dioxide Removal

Carbon dioxide removal (CDR) pathways create a negative emissions profile for bioeconomy products and other economic sectors (long-duration carbon storage beyond net zero), helping to ensure that replacement of fossil fuel and fossil fuel-based products results in lower GHG emissions. Net negative CDR can provide permanent storage of atmospheric carbon.

Many CDR feedstocks (such as agricultural waste and dedicated energy crops) provide ecosystem and bioremediation services during growth. CDR technology biochar is being used in the western U.S. to remove residual waste products from forest thinning to reduce wildfire risk, and it shows promise for urban organics management or as a replacement for fly ash in concrete. However, CDR biochar has not been widely used in northeastern forests and may be the most useful in ecosystems that need to have residual wood removed due to high wildfire risk. Carbon capture directly from the atmosphere is currently extremely expensive and as such is not widely used. DEC and NYSERDA, with assistance from SUNY ESF and Cornell, would need several years to begin to set up standards, identify CDR technologies and pathways, and identify research and development priorities.

Components of Strategy

- **Set goals for CO_2 removal:** NYSERDA and DEC should set clear goals regarding the use of net negative removal technologies, evaluate solutions viable today and monitor solutions that could be viable in the future.

- **Identify CDR technologies:** NYSERDA, with SUNY ESF, should support the identification of verifiable and maintainable CDR technologies and pathways, such as direct chemical carbon capture and CDR options for biomass energy generation (biochar, capture, and storage).

- **Prioritize research needs:** NYSERDA, with SUNY ESF, DEC, and Cornell, should develop RD&D agenda and priorities with initial work to focus on nature-based CDR pathways while examining the role of technology-based pathways in the future.

- **Fund demonstration projects:** NYSERDA should fund demonstration projects of CDR technologies, such as such as direct chemical carbon capture and CDR options for biomass energy generation (biochar, capture and storage) to show the GHG benefits of these techniques over the life cycle of projects.