Working Group Topic: Sequestration in agricultural soils

Commission Members: Marie Audet, Paul Costello, Robert Turner
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Agricultural Sequestration

Background

Primarily composed of carbon, the organic matter in soils plays a role in four important ecosystem services including resistance to soil erosion, soil water holding capacity, soil fertility for plants, and soil biodiversity. Even small changes in the soil carbon pool have large-scale effects both on agricultural productivity and on greenhouse gas balance. Maintaining carbon-rich soils, restoring and improving degraded agricultural lands and, more generally, increasing soil carbon, play an important role in addressing the three-fold challenge of food security, adaptation of food systems and people to climate change, and mitigation of anthropogenic emissions. According to the "4 by 1000" initiative—launched by participants during the 2015 COP 21 in Paris-- an annual growth rate of 0.4% in the soil carbon stocks, or 4‰ per year, would halt the increase in the CO2 concentration in the atmosphere related to human activities.

Farmers in Vermont manage 1,250,000 acres of land, impacting 20% of the total land in the state. About half of that land is in active crop production including nearly 100,000 acres of corn, soybeans, cereal grains and vegetables; 338,000 acres of hay for livestock feed and biomass crops for bedding and mulch; 139,000 acres of permanent pasture. The rest is over 500,000 acres of farmer woodlots plus farmsteads and undeveloped land (USDA NASS, 2016). In 2016, a total of $776 M of all agriculture products were sold including $505 M from milk sales.

Existing Condition and Trajectory:

With an estimated one-third of the arable land in agriculture globally, it is critical that we find ways to increase soil carbon in agricultural systems. This can be influenced in several ways including decreasing soil disturbance, reducing erosion, increasing organic matter inputs to soil through crop residues and organic nutrient sources, and maintaining continuous living plant cover as much as possible through the year. Many farmers are already doing a variety of practices that can claim climate benefits, and these practices must increase to achieve water quality goals, with the co-benefit of carbon sequestration. These are practices that increase soil resilience, maintain or enhance productivity, sequester carbon in soil, and in many cases, reduce the emission of greenhouse gasses. Cover cropping helps keep soil in place, reduces moisture stress, increases soil organic matter, and adds nitrogen and other nutrients. Pasture management, including rotational grazing and adding compost, increases productivity, soil carbon and plant diversity. Nutrient management reduces run-off and fertilizer expense and can curb GHG emissions from soils in the form of nitrous oxide.

Growing plants and trees are the most fundamental way we reduce CO_2 in our atmosphere. Plants breathe in carbon dioxide and through photosynthesis, convert a portion of the carbon to plant biomass, both above and below ground. The science around carbon sequestration in soils is complex, yet research points to some practices that are clearly beneficial. Reasonable estimates

suggest practices can add a ton of sequestered carbon per acre per year, on the average, for 10 to 20 years. Some soils can add more, and some have a lower potential. Overall, the moist soils of the northeast are better able to sequester carbon than the arid conditions of the west.

Extrapolating under reasonable assumptions, a xx% increase in acres under carbon-friendly agricultural practices have the potential to offset XX% of our annual state emissions.

Adoption by Vermont farmers of these practices has resulted in the rebuilding of soil health qualities. As importantly, these soil health improvements have the co-benefits of improving water quality and enhancing flood resiliency while increasing sequestered carbon in the soil and decreasing Green House Gas (GHG) emissions from agricultural lands. There has been an increased emphasis and implementation of these practices for their water quality value, in new regulations (Vermont Clean Water Act), as well as increased funding and education. Vermont farmers are, in many cases, also ahead of the curve, trying new innovative practices like a roller crimper that increases the return of organic matter in cover crop residues to a field, with less chemical inputs.

Many of these practices being implemented by farmers additionally have the potential for benefits over time to the farmer, in enhancing productivity, decreasing fertilizer costs, and reducing volatility of weather-related yield swings, essentially creating cropping systems that are more resilient to the impacts of climate change. Many farmers have adopted these practices voluntarily, but there is still a financial cost to farm businesses. It is critical that these practices continue, once implemented, since some research shows reverting to previous conditions can quickly reverse nearly all the prior gains. Since the potential for capturing annual CO2 emissions, both locally and globally, through agriculture is high, and so clearly connected to other co-benefits, it is critical to recognize the value of enhancing these practices through future policies. Education and demonstration of such conservation practices, that allow for farmer-to-farmer communication are also critical for increased adoption, and have been shown to one of the most effective means of changing management.

<u>Goal:</u>

The goals stated in the CEP include reducing GHGs within the state and from outside the state's boundaries caused by the use of energy within the state by 50% by 2028 and 75% by 2050. Sequestration is an important and overlooked strategy to reduce atmospheric carbon dioxide. The CEP mentions carbon sequestration mainly in the context of forests. Generally, agriculture plays a small role in the CEP, focused mainly on the potential for energy generation (and emission reductions) from anaerobic digestion. However, the implementation of agricultural practices that can increase sequestration demonstrates that the contributions of agriculture to our climate goals can be significant. Our recommendations identify key leverage points and policy actions needed to systematically recognize and advance the existing and potential contributions of agriculture to achieving the state's climate goals.

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Recommendations

Ensure continued funding for the agricultural practices that have the multiple benefits of sequestration, water quality improvement and flood resiliency.

Ample information exists about the rates of sequestration and emission reductions under various soil health improvement practices. These same practices also have the co-benefit of water quality improvement, and farm economic and management improvement, therefore the existing goals of water quality improvement must be combined with the parallel goals of sequestration, to increase practice implementation that benefits both. Tracking of soil health practices (reduced tillage, cover crops) over the past five years demonstrate the increased implementation. Between X and Y, over 25,000 acres of cover crops have been planted, and continue throughout the state. An alignment of BMP adoption levels for water quality goals with BMPs for climate change mitigation goals will demonstrate additional value of investments in related programs that facilitate implementation. Based on the modeling estimates of the Lake Champlain TMDL and estimates by USDA/Natural Resources Conservation Service subwatershed planning, it is reasonable to assume the potential for a *minimum 40-50% increase* in many of these practices over the next ten years.

Funding for implementation of these practices is relatively robust through 2020, however, a precipitous drop is expected that will cut not only the implementation of new practices, but also the continuation of ones already installed. Dairy milk prices are volatile and at a dramatic low in 2018, with little improvement expected in 2019. During times of farm income that is well below the cost of production, practices considered voluntary (not required by law or contributing a direct source of income) often cease.

Documenting the value of agricultural contributions to climate change mitigation is necessary to ensure the continued support for implementation. Vermont is one of the few states that targets agriculture with its *Potential Impacts of Climate Change on Agriculture in Vermont (2010),* yet neither the Comprehensive Energy Plan nor Vermont's Climate Change Adaptation Framework *(2013)* include substantial recommendations for agriculture. These guiding documents need to be expanded and brought up-to-date to include the substantial contributions of agriculture, including the multiple benefits, to help ensure the continuation of critical funding and support to the farming community.

Ensure messaging to farmers about the co-benefits of the water quality improvements they are currently undertaking, as well as the cost-benefit to the farmer him/herself.

The University of Vermont Extension System has done extensive work to quantify the financial costs and returns to farmers for implementation of these carbon-friendly practices, but the sequestration benefits have not been as widely shared with the agricultural community as the

water quality benefits. A priority should be on a comprehensive package of costs and benefits to each practice to help influence implementation and quantify the cost-benefit to the State.

*Track these improvements in a coordinated manner with the current water quality tracking process underway at the Dept of Environmental Conservation.*An important part of messaging to farmers is also the benefit of the practices they install to the public and the state. VT DEC is required to provide regular documentation to the EPA regarding progress in meeting the state's water quality goals through the Lake Champlain TMDL and the state Act 64, Vermont's Clean Water Act. The practices tracked in this effort are the same as those proposed as carbon-friendly, and the state must provide the resources to include the sequestration benefits of these practices. This includes not only practices implemented with the assistance of state or federal dollars, but also those done voluntarily by farmers around the state.

Increase implementation of practices by the development of a "BMP Challenge" program

UVM as well as state agencies are continually assessing what motivates a farmer to change practices. The first step is strong education and outreach to explain the value of the practice change, both to the farmer and for carbon and water quality values. Furthermore, while practice implementation is critical, continuation of these practices is necessary in order to maintain gains in soil carbon.

Financial incentives are strong motivators, obviously, as farming is a business and must be able to incur and continue to cover the expense of these practices. But even with financial incentives, practices such as no-till are a major management change, incurring high costs through equipment purchase. Opportunities that provide farmers to "test" a formerly untried practice prior to a major financial investment are essential to behavioral change. A "BMP Challenge" program that provides a safety net for farmers during a transition to new practices will increase implementation, but also the likelihood of long-term acceptance of a practice; critical to carbon sequestration and water quality.

Support a pilot study for the sale of carbon offsets

There are numerous programs and protocols that allow for the development and sale of offsets and it would be valuable to identify the best fit between programs, practices, soils, and our local agricultural mix. However, this should not be done in a vacuum, without recognition of the practice co-benefits. Other private entities are considering opportunities for water quality nutrient trading, another method of incentivizing implementation, but also not without challenges. In addition, farmers are overwhelmed with the regulatory and financial concerns, and are likely to be uninterested in a process that solely addresses carbon sequestration, a process that many may know as a benefit to their soil, but not as a trading potential. Any process to study offsets must coordinate with water quality improvement efforts.

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