Climate Action Commission | Agriculture Carbon Sequestration

Basic overview (including current status):

7,300 farm operations in Vermont actively manage 1,250,000 acres of land, impacting 20.3% of the total land in the state (USDA NASS 2016). The most intense management includes 100,000 acres growing corn, soybeans, cereal grains and other annual crops; 338,000 acres producing hay for livestock feed and biomass crops for bedding and mulch hay; 139,000 acres of permanent pasture; 536,000 acres woodland; the balance in farmsteads, roads, unfarmed land and conserved wetlands.

In 2016, a total of $776 M of agriculture products were sold; $505 M from milk sales.

Growing plants use sunlight and CO_2 to produce plant biomass and roots that accumulate carbon and nitrogen in cell structures and in stored carbohydrates. Approximately 50% of the plant growth is roots that stay in the soil. Soils store this plant accumulated carbon in the form of stable organic matter (OM) and humus. The addition of livestock manures also increases stable organic matter in the soil. Typical Vermont soils contain 2 to 5% organic matter that is composed of 58% organic carbon, currently retaining from 23 to 58 tons of organic carbon per acre. A loss of soil held carbon comes from a loss of the organic matter with soil erosion and aerobic microbial consumption. A crop grown without soil disturbance increases OM content over time and can reach 8 to 10% OM content depending on specific soil type.

Future trends (without additional action):

Farming practices that disturb soils with a variety of primary and secondary tillage (plow, harrow, cultivate) expose organic matter in the soil to microbial degradation and release CO_2 back into the atmosphere. Current efficiencies in Nitrogen utilization from fertilizers and manure used to grow crops is widely variable (10 to 90%) and releases N_2O back into the atmosphere.

In Vermont, there is a major shift going on how farmers grow crops to protect the soil resources and protect water quality. Reduced tillage with no-till farming, cover crops, manure injection and improved pasture management increase soil carbon sequestration by increasing soil organic matter. Farmers are shifting to these reduced tillage methods as a direct response to weather pattern changes that impact timeliness of planting and harvest operations. A secondary concern is a desire to reduce fuel expenses.

Potential opportunities & challenges:

Opportunities

A 1% increase in soil organic matter content across all annual and perennial cropland (577,000 ac) has the potential to accumulate an additional 13,386,400 tons of organic carbon. Increasing OM content in soils to sequester carbon must be supported with a reduction of C and N losses or there is no net gain. It is easier to lose OM than to create it.

A 50% reduction in Nitrogen losses from fertilizer and manure through Nutrient management Plans that are required for most farms now with passage of Act 64 and Required Agricultural Practices.

Adoption of new farming practices:

- Reduced Tillage / No-Till
    - Increase conversion of CO2 to organic carbon
    - Reduce C loss - Retain Soil Organic Carbon by reducing soil erosion.

    - Reduce diesel fuel use with fewer passes of equipment per acre.
- Cover Crops in annual crops and conversion to perennial hay crops and managed pasture.
    - Increase C input - plant photosynthesis uses CO_2 and provides raw materials to increase soil organic matter to stabilize organic carbon and nitrogen.
    - Reduce C Loss - reduce erosion
- Manure Storage and Treatment - membrane covers, stabilizer products, methane digesters
    - N losses range up to 30% from storage plus up to 90% for field applications.
- Nutrient Management - fertilizer, compost, manure
    - Nitrogen Conservation - method of application & timing, reduce volatilization losses N_2O

Challenges

- Increasing OM in soils is a long-term process and is limited to a 2 to 5% soil OM increase.
- Increased cost of equipment investment for reduced tillage practices.
- Financial stability of current agriculture industry in Vermont.

Technical potential

- 1% OM increase on 577,000 acres is enough to offsets 229,570 automobiles over 20.66 years.
- Cover crops rates of carbon sequestration due to cover cropping would be 0.11 t/ac/yr. Best case scenario would be 0.22 t/ac/yr. (Lal, 2015)
- Improved Nutrient Management can reduce agricultural N loss up to 90% depending on application method and timing (UVM, 2017). N_2O is 310 times as potent GHG as CO_2 .

References and Links for more information

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