Maine Earth Smart

"Farming for the Future"

Management Practices to Reduce Agricultural Emissions on Maine Farms
2012

Susan Gammon, Androscoggin Valley Soil and Water Conservation District
Mark Hedrich, Maine Department of Agriculture, Conservation and Forestry
Arthur Grindle, Kennebec County Soil and Water Conservation District
Andrew Whitman, Manomet Center for Conservation Sciences
Richard Kersbergen, University of Maine Cooperative Extension
Laughlin Titus, AgMatters

Maine Earth Smart

"Farming for the Future"

A SPECIAL THANK YOU TO THE CONTRIBUTING PARTNERS
WHO MADE THIS PROJECT POSSIBLE

Northeast SARE Sustainable Agriculture Research & Education

Androscoggin Valley Soil & Water Conservation District

1865 The University of Maine Cooperative Extension

AgMatters LLC

Manomet Center for Conservation Sciences

Farm Credit Northeast AgEnhancement

Maine Department of Agriculture, Conservation and Forestry

Time and Tide Resource Conservation and Development Area

Kennebec County Soil & Water Conservation District

Maine Association of Conservation Districts

USDA NRCS United States Department of Agriculture Natural Resources Conservation Service

Maine DEP

National Wildlife Federation

FB

Gund Institute for Ecological Economics, Rubenstein School of Environmental and Natural Resources, University of Vermont

Maine Earth Smart

"Farming for the Future"

Maine Earth Smart is a voluntary Maine agricultural emissions reduction certification program developed by collaborating partners to recognize farmers for good stewardship. The program's goal is to encourage farm stewardship, including the use of best management practices that will help farmers address agricultural greenhouse gas emissions in a way that will also benefit their business. It focuses on practices that reduce greenhouse gas emissions and costly inputs such as fertilizers and fuels and on practices that will enhance productivity and soil health, profitability and the farm financials. It recognizes that good stewardship can only come with improvements in the bottom-line.

Each farm is different, thus the program has been developed to allow a farmer to pick practices that will work best for their farm, within the framework of a modular system. Six modules, crop and land, pasture, energy, forest, manure and fertilizer management are included. Within the six modules are management practices that have been selected by agricultural and forest scientists that will reduce agricultural emissions and provide other co-benefits. The practices chosen are backed by the most relevant scientific research. The program is fluid, practices can be added or eliminated as research continues and documentation is provided.

All program materials and Instructions are available at www.androscogginswcd.org.

Maine Earth Smart

"Farming for the Future"

Crop and Land Management

Implementation of certain crop and land management practices has significant potential to reduce GHG emissions by increasing carbon sequestration and to a lesser extent decreasing nitrous oxide emissions. In all cases, attention must be paid to effects of implementation on productivity and yield, co-benefits and cost. Increased carbon sequestration depends on climate, soils, topography, crops grown, tillage nutrient management, etc. The practices selected have the best chance of reducing emissions in Maine, however, that said, they still will require careful consideration on an individual farm basis prior to including in a GHG Management Plan.

Practices eligible for certification include: long-term rotation of annual and perennial crops (alfalfa or grass hay), cover crops, switching from conventional to zone tillage combined with cover crops (at least 30% residue cover on the surface after planting), no-till combined with cover crops, irrigation improvements, change from annual to perennial crops and conservation set-aside. While any one of these practices generally can be expected to yield some decrease in emissions, depending on climate and soils etc., greater benefit may be gained by the combination of multiple practices, such as long-term rotation combined with cover crops and/ or no-till. No-till alone in Maine may not be the best solution to sequester additional carbon in all areas or on all soils, however it can yield enough other benefits, such as decreased use of fossil fuel (accompanied by a decrease in emissions), to warrant inclusion into the certification program.

Accepted Management Practices

Practice	GHG Benefit	Co-Benefit	Co-Benefit
Crop Rotation	Increase carbon sequestration	Increased organic matter and increased carbon sequestration. Increased soil health, decreased nitrogen application and related emissions, less erosion, increased wildlife, decreased denitrification	Immediate payback as long as yield is not reduced.
Cover Crops	Increase carbon sequestration	Increased organic matter and increased carbon sequestration. Increased soil health, decreased nitrogen application and related emissions, less erosion, increased wildlife, decreased denitrification	Immediate payback as long as yield is not reduced and increased fossil fuel use is minimal.
Change from Annual to Perennial Crops	Increase carbon sequestration	Increased organic matter and increased carbon sequestration. Increased soil health, decreased nitrogen application and related emissions, less erosion, increased wildlife	Payback related to equipment cost and overall reduction of fossil fuel, if any.
Switch from Conventional to Zone Tillage with Cover Crop	Increase carbon sequestration	Increased organic matter and increased carbon sequestration. Increased soil health and decreased erosion	Payback depends on equipment needed versus increased productivity.
No-till with Cover Crop	Possible increase in carbon sequestration depending on area, reduced fossil fuel use	Reduced fossil fuel use, reduced potential for water quality degradation, better soil quality, less soil erosion, increased wildlife, increased organic matter	Payback depends on equipment needed versus decreased fuel use and labor.
Conservation Set-aside-all CRP eligible crop land as defined by NRCS.	Increased carbon sequestration, reduced nitrous oxide if not fertilized	Reduced fossil fuel use, reduced potential for water quality degradation, better soil quality, less soil erosion, increased wildlife habitat	Payback depends on production loss versus CRP payments and reduced cropping expenses.
Irrigation Improvement-Drip Irrigation, Center Pivot	Decreased nitrous oxide emissions, may be decreased NH_3 if fertigating	Decreased leaching, improved water management, reduced erosion, reduced water withdrawal, reduced odors, less pumping and less engine emissions, improved crop uptake	Payback depends on equipment cost versus yield and water use.

Maine Earth Smart

“Farming for the Future”

Fertilizer Management

Agriculture produces 73% of the total nitrous oxide emissions in the United States (about3.1% of all GHG emissions EPA, 2010), a large part of which is associated with the use of nitrogen fertilizers. A number of studies have shown a positive correlation between emissions and fertilizer application rates. As application rates increase beyond the needs of the plant, nitrous oxide emissions increase through nitrification and denitrification. Improved fertilizer management can reduce emissions while reducing the potential for water quality degradation. The 4R concept, right source, right time, right rate, and right placement when implemented will reduce potential emissions by taking into account environmental conditions at the site (soil, climate, weather etc.) and plant utilization.

Laughlin Titus, AgMatters, states, “The utilization by crops of applied nitrogen sources is a very "leaky" system. Some studies show that only 30% is utilized by the crop. Nitrogen is lost in numerous ways. It leaches in wet conditions, it volatilizes into the air in warm and moist conditions, and it is lost through denitrification under cool and wet conditions. Applying nitrogen at a time when the crop cannot utilize it can result in more potential ways and times that the nitrogen can be lost to the environment. The right rate may seem obvious, but nitrogen has been cheap in the past and putting too much on has been a common practice by farmers as a cheap insurance policy to obtain yield. Right placement indicates that nitrogen needs to be in the soil (as opposed to on top of it) and in close enough proximity to the crop roots for them to utilize the nitrogen. Current trends indicate there is more use of liquid fertilizers (easier to put right rate, right time, right place and in most cases it is a "more" right material) and more use of fertilizer additives (there are several and they work in different ways, but they all strive to keep the N more available to plants for a longer period of time in the soil). There is also more monitoring of in-season crop nitrogen via tissue sampling or soil sampling to determine if the pre-season planning of N applications was accurate and if more needs to be added to produce the desired yield goal.”

Accepted Management Practices

Practice	GHG Benefit	Co-Benefit	Cost, Payback
Application rate reduction to optimal crop needs to maintain yield	Reduction of nitrous oxide	Reduced expense, reduced potential for water quality degradation.	Immediate payback as long as yield is not reduced
Band placement near, below and to side of seed row	Reduction of nitrous oxide-depth may depend on soil, crop and climate-address in FMP	Reduced potential for water quality degradation if rate does not exceed crop uptake.	May require additional equipment. Payback related to equipment cost and overall reduction of application rate.
Injection into root zone	Reduction of nitrous oxide-depth may depend on soil, crop and climate-address in FMP	Reduced potential for water quality degradation if rate does not exceed crop uptake.	May require additional equipment. Payback related to equipment cost and overall reduction of application rate.
Synchronize application with crop growth (crop uptake) (spring application, split application tied to N tests)	Reduction of nitrous oxide, optimize plant uptake	Reduced potential for water quality degradation if rate does not exceed crop uptake.	Immediate payback if less fertilizer is needed
Switch to enhanced efficiency fertilizer	Reduction of nitrous oxide	Reduced potential for water quality degradation if rate does not exceed crop uptake.	Depends on increased cost of fertilizer compared to reduced rate of application
Cover Crops (No-Till) (scavenging potential)	Reduction of nitrous oxide	Reduced potential for erosion, captures excess N or N from fall applied manure, reduced crop nitrogen need, depending on cover crop.	Payback depends on reduced nitrogen needs versus cost of planting
Banding or injecting into sod, split applications	Reduction of nitrous oxide, better uptake	Reduced potential for water quality degradation	Payback related to equipment cost, reduction of application rate

Maine Earth Smart

"Farming for the Future"

Manure Management

The primary direct GHG emissions related to manure are methane and nitrous oxide. Methane is generated from enteric fermentation by ruminants and from anaerobic decomposition when manure is stored. Nitrous oxide is emitted when manure is stored and/or spread. Emissions are affected by temperature, moisture, nutrient source, and oxygen level, which in turn are affected by manure type, storage and handling, application method and livestock diet. Stored liquid waste (lagoons) generates considerably more methane than solid and untreated solids generate more than composted solids. Spreading increases generation of nitrous oxide emissions through the denitrification process. Application of manure to crop and pasture land utilizing best management practices will generally increase or maintain soil organic matter and carbon sequestration.

The certification program does not currently address management practices to reduce enteric fermentation-however there is research that shows changing the diet of ruminants to include more easily digested feed and/or feed that has a high polyunsaturated fatty acid content can reduce methane emissions, as can improving production efficiency through improved grazing management, improving genetics and other practices.

Manure management in Maine is regulated by the 7 M.R.S.A. Chapter 747, Nutrient Management Act and a nutrient management plan is required under certain conditions, including confining and feeding 50 or more animal units, utilizing or storing more than 100 tons of manure or compost per year not generated on the farm and storing or utilizing regulated residuals.

Accepted Management Practices

Practice	GHG Benefit	Co-Benefit	Cost, Payback
Methane Digester	Reduction of methane, can incorporate liquid manure, increase in carbon dioxide emissions is offset by decrease in methane	Possible use as energy source, decrease of pathogens, effluent retains nutrients	High, long payback can be reduced by using as energy source and/or sale of offsets
Composting- product spread or incorporated according to NMP and BMP's.	Reduction of methane, best used for solids	Reduction of volume, more usable form of nutrients, decrease of pathogens, increases organic matter, odor control	Low to moderate. Payback depends on equipment purchased versus less transportation costs related to lower volume and reduction of commercial fertilizer use.
Injection into root zone	Reduction of nitrous oxide	Nutrient availability, increased organic matter, increased carbon sequestration, odor control	Moderate-requires equipment. Payback depends on equipment cost and reduction of commercial fertilizers.
Cover existing lagoons	Reduction of methane emitted via collection/flaring	Odor control, reduction of rain entering system, less volume, methane removal	Moderate to high depending of method of removing gases and cost of cover
Improved Distribution (banded manure spread-according to BMP)	Reduction of nitrous oxide	Availability of nutrients, increased organic matter	Low to moderate depending on equipment purchased. Payback depends on equipment cost and commercial fertilizer reduced.

Maine Earth Smart
"Farming for the Future"

Pasture and Grazing Management

Implementation of certain pasture and grazing management practices has potential to reduce agricultural greenhouse gas emissions (GHG) by increasing carbon sequestration and/or decreasing methane emissions. In all cases, attention must be paid to effects of implementation on productivity and yield, co-benefits and cost. Increased carbon sequestration depends on climate, soils, topography, pasture composition, tillage and nutrient management and it can be greatly improved using managed intensive rotational grazing (MIRG). The practices selected have the best chance of reducing emissions in Maine; however they will still require careful consideration on a farm basis prior to including in a GHG Management Plan.

Practices eligible for certification include: conversion of marginal cropland to permanent pasture with MIRG, conversion of full confinement operations to partial confinement operations with MIRG, conversion from full or partial confinement to year round MIRG, conversion of unmanaged pasture to MIRG. Any one of these practices generally can be expected to yield a net decrease in emissions via increased carbon sequestration and plant productivity and/or reduction in methane (compared to a confined operation), depending on climate and soils. *"Grazing animals emit more methane than confined ones. However, grazing (particularly MIRG) farms have lower net CO2 emissions because they do not heavily rely on grain for fee. Confined livestock feedstock requires soil tillage, cultivation, irrigation, fertilization, pesticide application, and machinery, transport, drying, processing packaging and delivery. All these processes, if accounted, surpass MIRG carbon emissions. Moreover, a significant feedstock percent is lost due to inefficiencies in the whole process further increasing the carbon emissions toll. The manure pit or lagoon accounts for most of the methane emissions of the confinement system".* Juan P. Alvez, Ph.D. Gund institute for Ecological Economics, Rubenstein School of Environmental & Natural Resources, University of Vermont.

Accepted Management Practices

Practice	**GHG Benefit**	**Co-Benefit**	**Cost, Payback**
Conversion of marginal cropland to permanent rotational pasture	Increase carbon sequestration, decreased emissions	Increased organic matter and increased carbon sequestration. Increased soil health, less erosion, increased wildlife, reduced water quality impact, decreased expenses, decreased nitrogen	Immediate payback via reduced expenses
Conversion from full confinement to partial confinement and rotational grazing or year round rotational grazing	Increase carbon sequestration, decrease methane emissions	Better herd health, better feed utilization, reduced expenses, less chance of water quality impact from feed yard runoff.	Immediate payback via reduced expenses.
Conversion of unmanaged pasture to managed rotational grazing	Increased carbon sequestration, reduced emissions	Increased organic matter and increased carbon sequestration. Increased soil health, less erosion, better productivity.	Immediate payback with better utilization.

Maine Earth Smart

"Farming for the Future"

Forest Management

Primary direct GHG emissions associated with forest occur when forest lands are converted to other uses (deforestation) or when management intensity increases such that average standing biomass is reduced over the long-term. The greatest greenhouse gas emissions (GHG) occur when forests are converted to other land uses. Standing biomass can also be reduced when management operations change and maintain forest trees that are smaller and younger than before or the rotation length is shortened. Forest soils store about half the carbon in a forest and will retain most of this carbon if rutting or creation of large canopy openings are avoided during harvest operations. A modest portion of a forest's carbon is stored in deadwood (snags and logs).

Low impact logging employs the following practices to minimize and control impacts to soils and:

- having a written forest management or stewardship plan
- planning roads and trails before the harvest
- employing directional tree felling
- cutting stumps low to the ground
- constructing roads and trails to minimum widths
- constructing landings to minimum size and spacing
- minimizing ground disturbance
- paying attention to aesthetics or how the site looks after harvest
- minimizing residual stand damage
- following state best management practices (BMPs)
- having a good understanding among landowner, logger, and forester of how the site will be harvested, what will be removed, how it will be removed and measures taken to protect and enhance the remaining stand of trees.

Accepted Management Practices

Practice	GHG Benefit	Co-Benefit	Cost, Payback
Afforestation-Riparian Buffers and Cropland/Pasture Conversion	Long term carbon sequestration, emissions reductions	Increased wildlife habitat, less soil erosion, improved water quality. Can be used as offset	Long term payback. Payback period can be reduced by NRCS program assistance, other programs or by marketing offsets.
Improved Forest Management-meeting all performance standards	Long term carbon sequestration, emissions reductions	Increased wildlife habitat, less soil erosion, improved water quality. Can be used as offset	Moderate to long-term payback, depends on management plan. Payback period can be reduced by NRCS program assistance, other programs, and managed harvest and/or by marketing offsets.
30 year Conservation Easement with carbon sequestration requirements	Long term carbon sequestration, emissions reductions	Increased wildlife habitat, less soil erosion, improved water quality	Payback depends on $, if any, received in return for the conservation easement.
In Perpetuity Conservation Easement -Avoided Development	Long term carbon sequestration, emissions reductions	Increased wildlife habitat, less soil erosion, improved water quality.	Payback depends on $, if any, received in return for the conservation easement.
Conservation Easement in Perpetuity with carbon sequestration requirements.	Long term carbon sequestration, emissions reductions	increased wildlife habitat, less soil erosion, improved water quality.	Payback depends on $, if any, received in return for the conservation easement.

Offset protocols require conservation easements, length depending on the protocol, as a way to insure lasting benefits. Typically, easements of a longer duration are more valuable as offsets.

Maine Earth Smart

“Farming for the Future”

Energy Management

“Agricultural production consumes large amounts of energy, either directly through combustion of fossil fuels, or indirectly through use of energy-intensive inputs, especially fertilizer. Over 2005-08, expenses from direct energy use averaged about 6.7 percent of total production expenses in the U.S. farm sector, while fertilizer expenses represented another 6.6 percent. However, these sector averages mask much greater energy intensities for major field crops. Agricultural production is therefore sensitive to changes in energy prices, whether the changes are caused by world oil markets, policies to achieve environmental goals, or policies to enhance energy security.”
(Impacts of Higher Energy Prices on Agriculture and Rural Economies / ERR-123Economic Research Service / USDA, Aug 2011)

This module deals only with direct reduction of on-site energy use of fossil fuels and electricity and includes energy conservation, energy efficiency, and renewable energy. Energy management is crucial for long-term agricultural economic sustainability and reduction of energy use will yield a reduction in GHG emissions while reducing production expenses immediately, given no investment in new equipment.

Accepted Management Practices

Practice	GHG Benefit	Co-Benefit	Cost, Payback
Fossil Fuel Reduction	Reduction of carbon dioxide, reduced upstream emissions reductions.	Reduced environmental impact, reduced expenses	Immediate payback, reduced expenses
Fuel Switching (exp. Fossil fuel to biofuel, diesel to propane)	Reduction of carbon dioxide based on equivalent fossil fuel use	Decreased fossil fuel consumption, decreased environmental impact.	Payback depends on modifications needed and fuel switch. Must eliminate any possibility of engine damage if switching fuel in vehicles or tractors.
Electricity reduction via conservation and efficiency	Reduction of carbon dioxide based on equivalent fossil fuel use	Reduced environmental impact, decreased expense	May require equipment or lighting upgrade. Payback related to equipment cost and overall reduction of energy use.
Renewable energy sources-solar, wind, biofuel etc.	Reduction of carbon dioxide based on equivalent fossil fuel use	Reduces dependence on fossil fuels and off farm electricity, direct emissions reduction. Can be used as offset.	Can be several years or longer pay- back period, needs careful analysis and assessment prior to investment. Excess energy production can be credited and used when production is reduced-for up to a year after it is made.