COMET Planner

Carbon and greenhouse gas evaluation for NRCS conservation practice planning

A companion report to
www.comet-planner.com

USDA United States Department of Agriculture
Natural Resources Conservation Service

Colorado State University

COMET-Planner

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A companion report to www.comet-planner.com
(*Version 3.1*)

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Introduction

The following report serves as a companion to www.comet-planner.com, an evaluation tool designed to provide approximate greenhouse gas mitigation and carbon sequestration potentials for NRCS conservation practices. This report provides the rationale, approach, and documentation of methods for COMET-Planner.

Purpose and Rationale

Conservation planners must assess a range of environmental, agronomic and economic impacts of implementing conservation practices on farms. While environmental impacts such as soil erosion control, improved soil quality, reduced nonpoint source pollution and a number of other site-specific benefits are currently considered, conservation practices may also have significant atmospheric and climate benefits, through carbon sequestration and/or reduction of greenhouse gas (GHG) emissions. If conservation planners wish to incorporate greenhouse gas impacts into their planning process, they will need access to quick, easy-to-use tools to assess greenhouse gas impacts of conservation practices on farms. NRCS has developed a qualitative ranking of conservation practices for carbon sequestration and GHG emission reduction (Appendix I). The qualitative ranking table provided the starting point for COMET-Planner, which was expanded to provide more quantitative information, in a web-based platform.

Carbon sequestration and greenhouse gas emission reduction values provided in this report and generated in www.comet-planner.com are intended to provide generalized estimates of the greenhouse gas impacts of conservation practices for conservation planning purposes. Those interested in conducting more detailed analyses of on-farm greenhouse gas emissions are encouraged to visit www.comet-farm.com.

COMET-Planner Approach

Numerous meta-analyses and literature reviews have examined the impacts of a range of land use changes, agricultural management practices and mitigation strategies on carbon sequestration and greenhouse gas emission reductions (Denef et al. 2011). From these field-based studies, land use and management activities were compared to, and aligned with, NRCS Conservation Practice Standards (CPS) to estimate the greenhouse gas and carbon sequestration impacts of implementing NRCS conservation practices on farms. In the first version of COMET-Planner (published January 2015), emission reduction coefficients were derived from meta-analyses and literature reviews and were generalized at the national-scale and differentiated by broad climate zones as defined by the Intergovernmental Panel on Climate Change (IPCC). In Version 2 of COMET-Planner, we revised the emissions estimation approach to: 1) align GHG reduction estimates with COMET-Farm and the USDA entity-scale GHG inventory methods (Eve et al. 2014), 2) improve the spatial resolution of estimates from the sub-national scale to multi-county regions, and 3) add options for implementing more regionally-specific variations of Conservation Practice Standards and well as implementation of some common combined practices. In Version 3, the same modeling approach was used as in Version 2, however we used an updated version of the DayCent model that simulates soil depth of 30 cm for soil organic carbon and soil nitrous oxide. A few other changes were incorporated and detailed in the methods section.

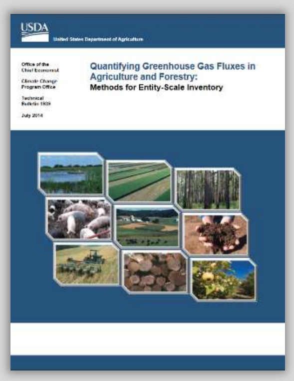
Conservation Scenarios

To determine the ex-ante impacts of adopting Conservation Practice Standards on carbon sequestration and GHG emissions, the COMET tools must define a baseline – or "business-as-usual" – scenario and a conservation implementation scenario. Baseline scenarios generally represent current management practices that are typical of the region but in which there is minimal use of conservation-focused management practices. In constructing the conservation scenarios, NRCS Conservation Practices Standards were carefully reviewed and implementations of the practices were designed to conform to the definitions and criteria in the Conservation Practice Standards. Detailed descriptions of practice implementation assumptions are provided within this report, in the one-page practice summaries (starting on page 14).

Estimation Methods

Cropland Management, Grazing Lands and Cropland to Herbaceous Cover

GHG reduction estimates of implemented Conservation Practice Standards on croplands, grasslands, and croplands converted to herbaceous cover were developed using a sample-based metamodeling approach with the USDA methods employed in COMET-Farm. Since 2015, COMET-Farm has been fully aligned with the USDA Methods for Entity-Scale Inventory (Eve et al. 2014).



Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory

The USDA was tasked in the 2008 Farm Bill with developing technical guidance and the science-based methods for estimating greenhouse gas (GHG) emissions and removals from land management and livestock management practices. Expert working groups, including leading scientists from academia, government and industry, developed a comprehensive set of consensus-based methods to account for greenhouse gas emissions associated with agriculture, forestry and land use change activities at the entity scale. The methods employ several approaches and models that were designed to be consistent with other inventory approaches (e.g. for national and international GHG accounting), but specific to US conditions.

The spatial units of the analysis to derive estimates for COMET-Planner were county-rectified Major Land Resource Areas (Figure 1). Major Land Resource Areas (MLRA) are geographically associated land resource units, defined by the USDA, that have similarities in physiography, climate, soils, biological resources, and land use (USDA-NRCS 2006). In the conterminous (48-state) US, there are 227 individual MLRAs. Within each county-rectified MLRA, the COMET-Planner team developed a unique random point sample of approximately 100 points per broad land use category, with some variation in sample size depending on the size of the MLRA and the density of agricultural land use within the MLRA (Figure

2). In total, we modeled 23,429 cropland points and 16,474 grassland points. For each point, recent land use was determined by extracting land cover from Cropland Data Layers (CDL) for 2009-2020 (USDA-NASS 1990-2020).

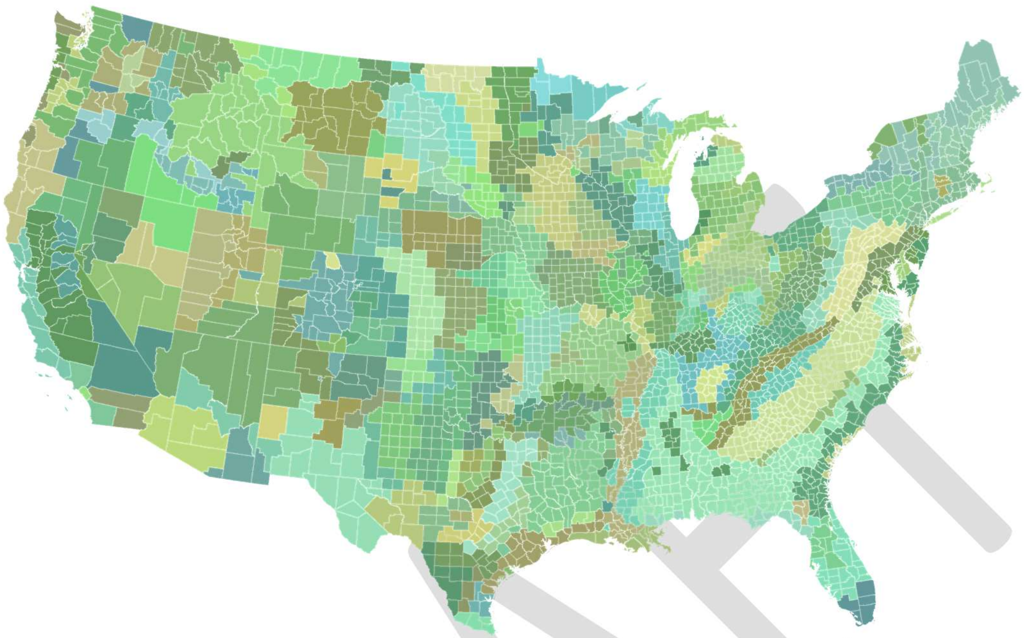


Figure 1. U.S. counties in the conterminous U.S., grouped by Major Land Resource Areas.

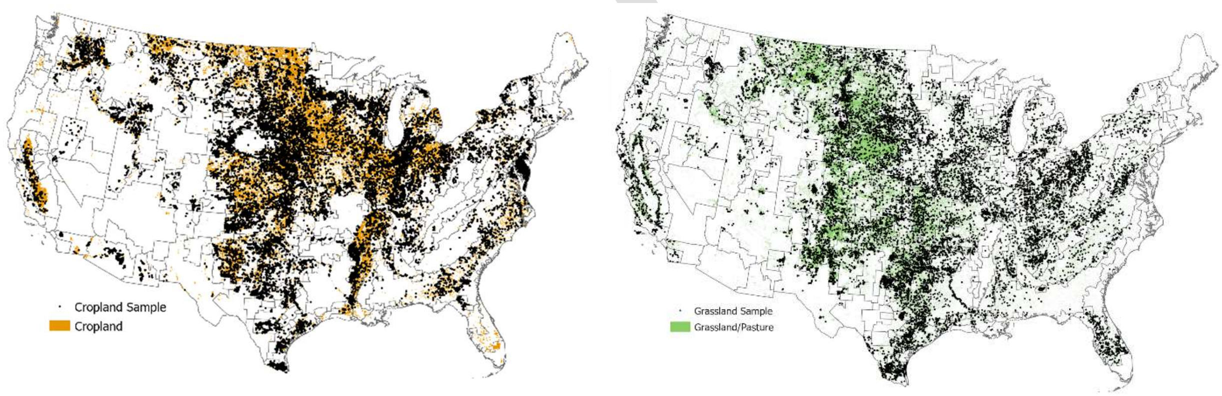


Figure 2. Random point samples used in the modeling for croplands (left) and grasslands (right).

For cropland land uses, crop rotations were constructed from the cropping sequence provided in CDL. Because cropping data was only available starting in 2009 and COMET-Farm requires management data back to the year 2000 to calculate soil carbon, crop rotations were repeated backwards to the year 2000, which serves as the start of the baseline period. In Version 3, irrigation status of each point was determined from a Landsat-based 30 m irrigation dataset (Xie et al. 2021). If the majority of years available in the dataset (1997-2017) were irrigated, then the point was deemed irrigated. Otherwise, the point was classified as non-irrigated. The majority of points had either all years irrigated or no years irrigated. The USDA Economic Research Service (USDA-ERS 2014) provides average nitrogen fertilizer rates for major crops and were used in this analysis. Other practices typical of the crops grown and the region, such as planting and harvest dates (USDA-NASS 2010), tillage and residue management were applied. Similarly, baseline practices for rangelands and managed pasture assume typical management by region. Once baseline and conservation scenarios were constructed, the COMET-Planner team modeled scenarios in the COMET-Farm system through an Application Programming Interface (API) (Figure 3). The COMET-Farm API is essentially a side door into the tool that allows for multiple runs and modeling sets of fields or points without utilizing the graphical user interface (GUI). An example of a COMET-Farm API input file is included in Appendix III. Within COMET-Farm, point locations are used to access site-specific soil and weather model inputs, and typical historic land management.

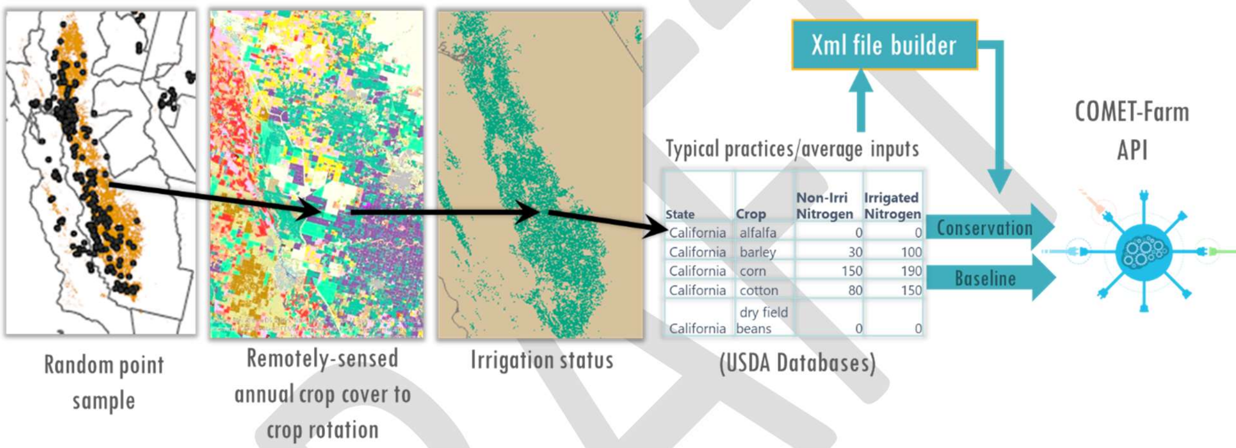


Figure 3. An overview of the process of building the model runs conducted in the COMET-Farm API.

COMET-Farm is a web-based, whole farm, GHG accounting systems that employs methods outlined in the USDA Methods for Entity-Scale Inventory guidance (see Box on page 2). Estimation methods used for most GHG sources in COMET-Planner rely on advanced methods (commonly referred to as “Tier 3” methodologies in IPCC quantification methods), such as process-based modeling in DayCent and regionally-specific empirical calculations (Table 1). In version 3.0 of COMET-Planner, modeling for SOC and soil N_2O utilize a newer version of DayCent, that models soil depth to 30 cm, whereas the prior model simulated a depth of 20 cm. Moving to the 30 cm version of DayCent aligns COMET-Planner with the current U.S. National Greenhouse Gas Inventory methods (EPA 2022). Methods for direct and indirect soil N_2O deviate from the USDA Methods for Entity-Scale Inventory guidance, and instead follow methodology used in the U.S. National Greenhouse Gas Inventory (EPA 2022). Under this method, direct soil N_2O emissions are estimated with the process-based model, DayCent (Parton et al. 1987, Parton 1998), resembling that described for soil organic carbon in Eve et al. 2014 (Section 3.5.3). Indirect soil N_2O includes emissions from leached and volatilized N. The amounts of leached and volatilized nitrogen are estimated from the DayCent model and then emission factors from Eve et al. 2014 (Table 3-11) are applied to estimate the fractions of nitrogen leached or volatilized that are converted to N_2O.

Table 1. Estimation approaches by emission source for croplands and grazing lands adapted from the USDA Methods for Entity-Scale Inventory (Eve et al. 2014).

Source	Basic Estimated Equation (cf., IPCC Tier 1)	Inference (cf., IPCC Tier 2)	Modified IPCC or Empirical Model (cf., IPCC Tier 2 or IPCC Tier 3)	Processed-Based Model (cf., IPCC Tier 3)
Croplands/ Grazing Lands	▪ Direct N_2O Emissions from Drainage of Organic Soils ▪ CH_4 Emissions from Rice Cultivation ▪ CO_2 from Urea Fertilizer Application	▪ Soil Organic Carbon Stocks for Organic Soils ▪ CO_2 from Liming ▪ N_2O Emissions from Rice Cultivation ▪ Non-CO_2 Emissions from Biomass Burning ▪ Indirect N_2O Emissions	▪ Biomass Carbon Stock Changes ▪ CH_4 Uptake by Soils ▪ Direct N_2O Emissions from Mineral Soils	▪ Soil Organic Carbon Stocks for Mineral Soils

COMET-Farm generates emission and sequestration estimates for the following GHG source categories, though not all sources are relevant for all conservation practice implementation activities:

- soil carbon
- woody biomass carbon
- CO_2 emissions from biomass burning, liming, urea fertilization, and drained organic soils
- CO emissions from biomass burning
- N_2O emissions from soils (including fertilizers), biomass burning, and drained organic soils
- CH_4 emissions from soil, wetland rice cultivation and biomass burning

Though COMET-Farm generates estimates for all of the above source categories, COMET-Planner does not currently include emissions or sequestration from drained organic soils or wetland rice cultivation. Dynamics of carbon and nitrogen cycles in these systems, and the impact of management practices on those cycles, differs from agriculture on non-flooded, mineral soils. Users interested in evaluating these systems may so do in COMET-Farm.

Outputs from COMET-Farm were processed by calculating the differences between conservation and baseline scenarios for each GHG source category and then averaging all samples to generate a mean emission reduction coefficient for each conservation practice and county-rectified MLRA. There are a small number of annual cropland and grassland practices for which we were not able to use the COMET-Farm API modeling approach. A brief description of quantification methods are noted in each practice one-page summary (starting on page 16). In addition to the mean estimate, COMET-Planner provides maximum and minimum values for net GHG emissions that demonstrate how emission estimates vary over a range of soil, weather and agricultural management conditions within each MLRA.

Woody Plantings

Models for woody biomass accumulation in agroforestry systems (windbreaks, shelterbelts, farm woodlots, silvopasture, riparian buffers and alley cropping) were built from the USDA Forest Service Forest Inventory Analysis (FIA) database, using simple dbh over age regression models, aggregated for US Land Resource Regions (LRR). The forthcoming update to Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory (Eve et al 2014), is scheduled for release by the end of 2023 and contains an updated method for estimating biomass C from dbh (diameter at breast height), following an allometric modeling approach derived from Chojnacky et al. (2014). The models are provided by taxon groups, which are at the family or genus level. The method determines dbh from a plot survey and measurements, assuming the agroforestry system already exists. However, for the purposes of COMET-Planner, dbh must be estimated without plot measurements. The Blue Book does not provide a specific method for determining dbh, but does recommend using USFS FIA data to develop growth increment models. We developed simple age/dbh regression models from USFS FIA data for the taxon groups given in the 2023 entity-scale methods, for LRRs where those taxon groups exist and where taxa are present in agroforestry prescriptions. This work resulted in 108 unique taxon/LRR growth (age/dbh) models. Further description of the methods and final models will be provided in a methods white paper that is currently under development. The biomass accumulation models were combined with USDA/NRCS practice recommendations for the dominant agroforestry systems and projections of biomass accumulation rates for these major agroforestry installations at the LRR level were developed. COMET-Planner includes 93 unique agroforestry systems over the 26 Land Resource Regions within the conterminous U.S.

Hawaii Quantification Methods

COMET-Farm and the COMET-Farm API were not available for Hawaii at the time of the COMET-Planner analysis, therefore we had to deploy alternative assessment methods. Improvements to COMET-Farm and underlying models are currently underway to extend the tool to Hawaii, which will allow modeling for COMET-Planner similar to methods described in this report for the 48 contiguous US states. Given that there are limited observational data from Hawaii for meta-analyses, we used Intergovernmental Panel on Climate Change (IPCC) Tier 2 methods for soil organic carbon (SOC) outlined in Eve et al. (2014) and IPCC Tier 1 methods for soil nitrous oxide (IPCC 2006). These methods have also been applied for Hawaii soil GHG emissions in the U.S. EPA National Greenhouse Gas Inventory (EPA 2019).

The SOC method uses reference SOC stocks, determined by soil and climate classification, and then adjusts those stocks by land use and management emission factors. Reference stocks and emission factors are given in Eve et al. (2014). To apply these methods in Hawaii, we overlaid spatial datasets for land use, IPCC climate zone, and IPCC soil types. Land use was derived from the Hawaii Agricultural Land Use Baseline 2015 (Melrose et al. 2016) (Figure 4). Analyses were limited to annual cropland and pasture land uses.

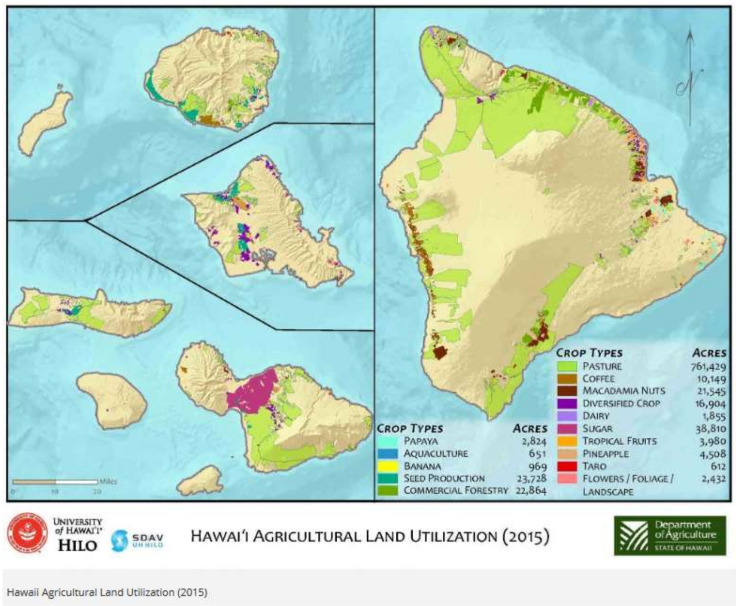


Figure 4. Hawai'I Agricultural Land Use Baseline, 2015.

Broad climate zones were classified according to the classification scheme provided in the IPCC 2006 Guidance (IPCC 2006) from global weather datasets (Figure 5). Soil types were classified according to the classification scheme for USDA taxonomy provided in the IPCC 2006 Guidance (IPCC 2006) from USDA SSURGO soil mapunits (Figure 4).

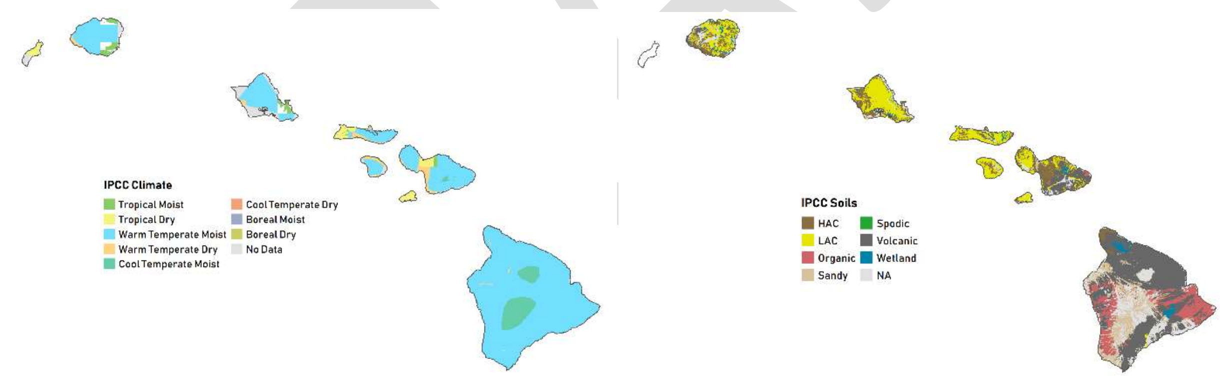


Figure 5. IPCC climate zones (left) and IPCC soil types (right) for Hawaii (HAC = High activity clay; LAC = Low activity clay).

Once unique intersections of land use, climate and soil were complete, we assigned reference carbon stocks to each polygon. To the extent possible, we assessed SOC stock changes due to NRCS conservation practice adoption using the emission factors for land use (e.g. converting cropland to permanent herbaceous cover), tillage (reduced or no tillage), or increasing carbon inputs (e.g. conservation crop rotation, mulching). SOC stock changes are assumed to occur over 20 years with this method, therefore we estimated an annual change by dividing the total model-estimated stock change by 20. County-level estimates represent an area-weighted average of emission changes from each landuse/climate/soil polygon. Due to limitations in the methods and data available for Hawaii, we were not able to estimate emission changes for a number of conservation practices, including woody plantings.

Soil nitrous oxide emissions changes were only estimated for improved nitrogen fertilizer management under CPS 590 (Nutrient Management), which was assessed as a 15% rate reduction. We assumed a generalized baseline application rate of 178 lbs N/ac/yr (200 kg N/ha/yr), which was reduced by 15% following adoption of CPS 590. IPCC Tier 1 direct soil N_2O emission quantification methods were applied to estimate a soil N_2O emission reduction (IPCC 2006). While a number of other conservation practices may affect soil N_2O emissions, data and method limitations prevented broader analysis.

Emissions Benefits and Carbon Sequestration Estimates

All estimates are presented as emission reductions relative to baseline management, thus positive values denote a decrease in GHG emissions and negative values denote an increase in GHG emissions due to the implementation of a conservation practice. It should be noted that soil and biomass carbon stock increases in response to these conservation practices are often limited in duration – eventually carbon stocks approach a new equilibrium condition and thus carbon dioxide removals do not continue indefinitely. The carbon dioxide reductions reported should be viewed as average annual values over a 10-year duration.

Units

Model-simulated carbon sequestration and greenhouse gas emission reduction estimates are given in ***Mg CO_2 eq per acre per year***, where:

Mg = Megagrams (same as Metric Tonnes)
Megagrams or Metric Tonnes are similar to English (or 'short') tons; 1 Megagram (Metric Ton) = 1.1 English (short) tons

CO_2 eq = Carbon Dioxide Equivalents
Carbon dioxide equivalent is a common measure used to compare the emissions/sequestration from various greenhouse gases, based upon their ***global warming potential****. Carbon dioxide equivalents are used in COMET-Planner to allow users to compare emissions of carbon dioxide, nitrous oxide and methane in standardized units.*

Global Warming Potential
A Global Warming Potential (GWP) is assigned to each greenhouse gas and reflects the climate forcing of emissions of one kilogram of a GHG, relative to one kilogram of carbon dioxide (CO_2), over a defined period of time. The Intergovernmental Panel on Climate Change (IPCC) defines GWPs for GHGs in their assessment reports, which have changed slightly across assessments. COMET-Planner relies on GWPs cited in the IPCC Fourth Assessment Report (IPCC 2006) (Table 2).

Table 2. Global Warming Potential (GWP) of greenhouse gases (GHG) reported in COMET-Planner.

	Global Warming Potential (GWP) over 100 years
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298

Organization

NRCS conservation practices are grouped into five broad categories: cropland management, grazing lands, cropland to herbaceous cover, woody plantings, and restoration of disturbed lands. Following each overview of the broad categories, are informational sheets for each practice that provide a description of the practice and how the practice was analyzed for COMET-Planner.

Cropland Management

Conservation Benefits

NRCS conservation practices for cropland management have multiple objectives that may include reducing soil erosion, maintaining or increasing soil quality and organic matter content, improving air quality, minimizing nonpoint source pollution from agricultural nutrients and chemicals, enhancing soil moisture efficiency and a number of other agronomic and environmental benefits. Cropland management practices are generally applied to annual cropping systems, although benefits may be similar for perennial cropland systems or other lands where these practices may be applied. While NRCS promotes these cropland management practices for conservation benefits, there may be additional greenhouse gas benefits of implementing these practices on farms.

NRCS Conservation Practices

Combustion System Improvement (CPS 372)
Conservation Crop Rotation (CPS 328)
Cover Crops (CPS 340)
Mulching (CPS 484)
Nutrient Management (CPS 590)
Residue and Tillage Management - No-Till (CPS 329)
Residue and Tillage Management - Reduced Till (CPS 345)
Stripcropping (CPS 585)

Greenhouse Gas Emissions

The main sources of greenhouse gas emissions in cropland agriculture (excluding rice) are carbon dioxide from soils and nitrous oxide from use of nitrogen fertilizers (CAST 2011). Practices that cause soil disturbance, such as tillage, may increase emissions of carbon dioxide from soil, whereas practices that reduce soil disturbance or increase organic matter carbon inputs may sequester carbon in the soil (Ogle et al. 2005). Adoption of **no-till** or **reduced tillage** has been shown in previous research to enhance soil carbon storage in soils, as compared to conventional (full-width) tillage (Denef et al. 2011). Organic matter carbon inputs may be increased through higher plant residue inputs from more productive annual crops, intensified cropping frequency or inclusion of perennial crops in rotation. As such, practices such as **conservation crop rotations** that include perennial crops or higher cropping frequency, use of seasonal **cover crops**, or **stripcropping** with perennial crops may enhance soil carbon sequestration. Organic matter inputs may also be increased through addition of organic matter amendments, such as **mulching** with straw or crop residues (high C:N ratios), or amendments that may fully or partially replace nitrogen fertilizer, such as manure or other organic amendments and by-products. Agricultural soil nitrous oxide emissions account for approximately 4.5 percent of total U.S. greenhouse gas emissions (EPA 2014); however there are a number of strategies that farmers may use to reduce nitrous oxide emissions. The most dominant source of nitrous oxide emissions from management of soils is from the use of nitrogen fertilizers (EPA 2014). **Nutrient management** strategies may include reducing the rate of nitrogen fertilizer applied or using nitrification inhibitors (ICF International 2013). Nitrogen rate reductions, especially when additions exceed plant demand, have significant potential to reduce nitrous oxide emissions. Nitrification inhibitors inhibit microbial activity that produce emissions and may enhance availability of nitrogen to plants (Akiyama et al. 2010). Partial substitution of mineral nitrogen fertilizer with organic amendments, such as manure or compost, has a small impact on nitrous oxide emissions, but may significantly increase soil carbon (Maillard and Angers 2014). In addition to soil processes, carbon dioxide emissions from fossil fuel use can be a major source of on-farm greenhouse gas emissions (CAST 2011). **Improved fuel-efficiency of farm equipment** will reduce carbon dioxide emissions from cultivation, harvest, and management activities.

Residue and Tillage Management - No-Till (CPS 329)

Intensive Till to No Till or Strip Till on Irrigated/Non-Irrigated Cropland

NRCS Conservation Practice Standard Summary

DEFINITION: Limiting soil disturbance to manage the amount, orientation and distribution of crop and plant residue on the soil surface year around.

PURPOSE:
- Reduce sheet, rill and wind erosion
- Reduce tillage-induced particulate emissions
- Maintain or increase soil quality and organic matter content
- Reduce energy use
- Increase plant-available moisture
- Provide food and escape cover for wildlife

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all cropland. This practice only involves an in-row soil tillage operation during the planting operation and a seed row/furrow closing device. There is no full-width tillage performed from the time of harvest or termination of one cash crop to the time of harvest or termination of the next cash crop in the rotation regardless of the depth of the tillage operation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume a conversion from spring conventional (full-width) tillage to no-till/strip till, as defined by the NRCS practice standard. Other cropland management practices remain the same with adoption of this conservation practice. Impacts on greenhouse gases include a soil carbon change from decreased soil disturbance, and changes in nitrous oxide emissions due to changes in the soil environment (does not include changes in nitrogen fertilizer that may accompany tillage changes).

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Residue and Tillage Management - No-Till (CPS 329)

Reduced Till to No Till or Strip Till on Irrigated/Non-Irrigated Cropland

NRCS Conservation Practice Standard Summary

DEFINITION: Limiting soil disturbance to manage the amount, orientation and distribution of crop and plant residue on the soil surface year around.

PURPOSE:
- Reduce sheet, rill and wind erosion
- Reduce tillage-induced particulate emissions
- Maintain or increase soil quality and organic matter content
- Reduce energy use
- Increase plant-available moisture
- Provide food and escape cover for wildlife

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all cropland. This practice only involves an in-row soil tillage operation during the planting operation and a seed row/furrow closing device. There is no full-width tillage performed from the time of harvest or termination of one cash crop to the time of harvest or termination of the next cash crop in the rotation regardless of the depth of the tillage operation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume a conversion from spring reduced tillage to no-till/strip till, as defined by the NRCS practice standard. Other cropland management practices remain the same with adoption of the conservation practice. Impacts on greenhouse gases include soil carbon change from decreased soil disturbance, and changes in nitrous oxide emissions due to changes in the soil environment (does not include changes in nitrogen fertilizer that may accompany tillage changes).

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Residue and Tillage Management – Reduced Till (CPS 345)

Intensive Till to Reduced Till on Irrigated/Non-Irrigated Cropland

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting the soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting.

PURPOSE:
• Reduce sheet, rill and wind erosion
• Reduce tillage-induced particulate emissions
• Maintain or increase soil quality and organic matter content
• Reduce energy use
• Increase plant-available moisture

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all cropland. This practice includes tillage methods commonly referred to as mulch tillage or conservation tillage where the entire soil surface is disturbed by tillage operations such as chisel plowing, field cultivating, tandem disking, or vertical tillage. It also includes tillage/planting systems with few tillage operations (e.g. ridge till) but which do not meet the Soil Tillage Intensity Rating (STIR) criteria for Residue and Tillage Management - No Till (code 329)

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume a conversion from spring conventional (full-width) tillage to any type of reduced tillage (excluding no-till/strip till), as defined by the NRCS practice standard. Other cropland management practices remain the same with adoption of the conservation practice. Impacts on greenhouse gases include soil carbon change from decreased soil disturbance, and changes in nitrous oxide emissions due to changes in the soil environment (does not include changes in nitrogen fertilizer that may accompany tillage changes).

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Improved N Fertilizer Management on Irrigated/Non-Irrigated Croplands - Reduce Fertilizer Application Rate by 15%

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nitrogen management by implementing a nutrient management plan and reducing nitrogen fertilizer rates by 15 percent. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. Other cropland management practices remain the same with adoption of the conservation practice. The greenhouse gas impacts of these practices are estimated for soil nitrous oxide emissions. Emission changes result from reduced use of nitrogen fertilizers. Under this practice, it is assumed that reduced N rates do not decrease crop productivity and therefore we did not assess changes in soil organic carbon.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Beef Feedlot Manure on Irrigated/Non-Irrigated Croplands

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of beef feedlot manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Chicken Broiler Manure on Irrigated/Non-Irrigated Croplands


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of chicken broiler manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Chicken Layer Manure on Irrigated/Non-Irrigated Croplands

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of chicken layer manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

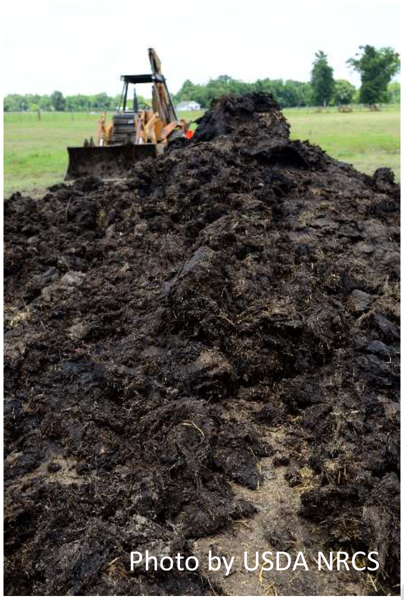
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Dairy Manure on Irrigated/Non-Irrigated Croplands



NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:
- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of dairy manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

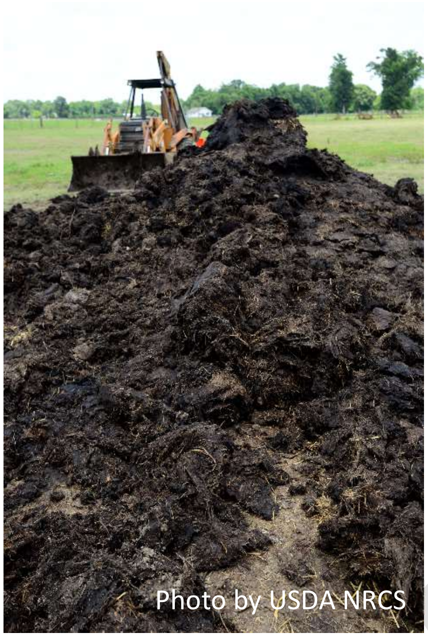
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Other Manure on Irrigated/Non-Irrigated Croplands



NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of dairy manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Sheep Manure on Irrigated/Non-Irrigated Croplands

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of sheep manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Swine Manure on Irrigated/Non-Irrigated Croplands

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of swine manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Compost (C:N 10) on Irrigated/Non-Irrigated Croplands

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of compost (C:N ratio of 10; N%=3.6) for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Compost is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Compost (C:N 15) on Irrigated/Non-Irrigated Croplands

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:
- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of compost (C:N ratio of 15; N%=2.4) for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5^{th} year and remaining constant at that level in the years that follow. Compost is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Compost (C:N 20) on Irrigated/Non-Irrigated Croplands

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:
- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of compost (C:N ratio of 20; N%=1.8) for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Compost is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Compost (C:N 25) on Irrigated/Non-Irrigated Croplands


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:
- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of compost (C:N ratio of 25; N%=1.4) for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Compost is added at a rate that supplies 20% of the total nitrogen applied to the system. Other cropland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Conservation Crop Rotation (CPS 328)

Decrease Fallow Frequency or Add Perennial Crops to Rotations

NRCS Conservation Practice Standard Summary

DEFINITION: A planned sequence of crops grown on the same ground over a period of time (i.e. the rotation cycle).

PURPOSE:
- Reduce sheet, rill and wind erosion
- Maintain or increase soil health and organic matter content
- Reduce water quality degradation due to excess nutrients
- Improve soil moisture efficiency
- Reduce the concentration of salts and other chemicals from saline seeps
- Reduce plant pest pressures
- Provide feed and forage for domestic livestock
- Provide food and cover habitat for wildlife, including pollinator forage, and nesting

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all cropland where at least one annually-planted crop is included in the crop rotation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume scenarios of decreasing fallow frequencies and/or adding perennial crops to rotations. Other cropland management practices remain the same with adoption of the conservation practice. The greenhouse gas impacts of this practice include an increase in soil carbon from higher carbon inputs from plant residue.

GHG Estimation Methods

Values for dry climates were averaged from soil carbon sequestration rates from eliminating summer fallow (Eagle et al. 2012, Sherrod et al. 2003) and adding perennial crops to rotations (Eagle et al. 2012). Nitrous oxide emissions from these scenarios average to essentially zero, since increased cropping intensity may lead to an increase in nitrogen application, whereas perennial crops in rotation likely result in a decrease in nitrogen fertilization.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Cover Crops (CPS 340)

Add Legume Seasonal Cover Crop (with 50% Fertilizer N Reduction) to Irrigated/Non-Irrigated Cropland

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Grasses, legumes, and forbs planted for seasonal vegetative cover.

PURPOSE:
• Reduce erosion from wind and water
• Maintain or increase soil health and organic matter content
• Reduce water quality degradation by utilizing excessive soil nutrients
• Suppress excessive weed pressures and break pest cycles
• Improve soil moisture use efficiency
• Minimize soil compaction

CONDITIONS WHERE PRACTICE APPLIES: All lands requiring seasonal vegetative cover for natural resource protection or improvement.

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent planting of seasonal leguminous cover crops that supply partial (50%) commodity crop fertilizer demand. Nitrogen fertilizer applied to the commodity crop is subsequently reduced by 50 percent. Other cropland management practices remain the same with adoption of the conservation practice. The greenhouse gas impacts of this practice include an increase in soil carbon from higher carbon inputs from plant residue and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Cover Crops (CPS 340)

Add Non-Legume Seasonal Cover Crop (with 25% Fertilizer N Reduction) to Irrigated/Non-Irrigated Cropland

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Grasses, legumes, and forbs planted for seasonal vegetative cover.

PURPOSE:

- Reduce erosion from wind and water
- Maintain or increase soil health and organic matter content
- Reduce water quality degradation by utilizing excessive soil nutrients
- Suppress excessive weed pressures and break pest cycles
- Improve soil moisture use efficiency
- Minimize soil compaction

CONDITIONS WHERE PRACTICE APPLIES: All lands requiring seasonal vegetative cover for natural resource protection or improvement.

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent planting of seasonal non-leguminous cover crops that supply partial (25%) commodity crop fertilizer demand. Nitrogen fertilizer applied to the following commodity crop is subsequently reduced by 25 percent. Other cropland management practices remain the same with adoption of the conservation practice. The greenhouse gas impacts of this practice include an increase in soil carbon from higher carbon inputs from plant residue and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Cover Crops (CPS 340)

Add Legume Seasonal Cover Crop (with 50% Fertilizer N Reduction) to No-Till Irrigated/Non-Irrigated Cropland


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Grasses, legumes, and forbs planted for seasonal vegetative cover.

PURPOSE:
- Reduce erosion from wind and water
- Maintain or increase soil health and organic matter content
- Reduce water quality degradation by utilizing excessive soil nutrients
- Suppress excessive weed pressures and break pest cycles
- Improve soil moisture use efficiency
- Minimize soil compaction

CONDITIONS WHERE PRACTICE APPLIES: All lands requiring seasonal vegetative cover for natural resource protection or improvement.

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent planting of seasonal, leguminous cover crops that supply partial (50%) commodity crop fertilizer demand on croplands under no-till management. Nitrogen fertilizer applied to the commodity crop is subsequently reduced by 50 percent. Other cropland management practices remain the same with adoption of the conservation practice. The greenhouse gas impacts of this practice include an increase in soil carbon from higher carbon inputs from plant residue and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Cover Crops (CPS 340)

Add Non-Legume Seasonal Cover Crop (with 25% Fertilizer N Reduction) to No-Till Irrigated/Non-Irrigated Cropland

NRCS Conservation Practice Standard Summary

DEFINITION: Grasses, legumes, and forbs planted for seasonal vegetative cover.

PURPOSE:
- Reduce erosion from wind and water
- Maintain or increase soil health and organic matter content
- Reduce water quality degradation by utilizing excessive soil nutrients
- Suppress excessive weed pressures and break pest cycles
- Improve soil moisture use efficiency
- Minimize soil compaction

CONDITIONS WHERE PRACTICE APPLIES: All lands requiring seasonal vegetative cover for natural resource protection or improvement.

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent planting of seasonal, non-leguminous cover crops that supply partial (25%) commodity crop fertilizer demand on croplands under no-till management. Nitrogen fertilizer applied to the following commodity crop is subsequently reduced by 25 percent. Other cropland management practices remain the same with adoption of the conservation practice. The greenhouse gas impacts of this practice include an increase in soil carbon from higher carbon inputs from plant residue and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Mulching (CPS 484)
Add Mulch to Croplands

NRCS Conservation Practice Standard Summary

DEFINITION: Applying plant residues or other suitable materials produced off site, to the land surface.

PURPOSE:
- Conserve soil moisture
- Reduce energy use associated with irrigation
- Provide erosion control
- Improve soil health
- Reduce airborne particulates

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where mulches are needed. This practice may be used alone or in combination with other practices.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for mulching represent the addition of high carbon (low nitrogen) organic matter amendments, such as straw or crop residues, to croplands. Other cropland management practices remain the same with adoption of the conservation practice. The greenhouse gas impacts of this practice include an increase in soil carbon from higher carbon inputs.

GHG Estimation Methods

Emissions reductions for soil carbon were estimated using the Intergovernmental Panel on Climate Change (IPCC) inventory method for annual cropland, using the emission factors for high input without amendment (dry = 1.07, humid = 1.07) from Eve et al. (2014). Reference soil carbon stocks were from Eve et al. (2014) and estimated stock changes were area-weighted using total IPCC soil areas classified from SSURGO soils data, by IPCC climate regions (IPCC 2006, Soil Survey Staff 2011).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Stripcropping (CPS 585)

Add Perennial Cover Grown in Strips with Irrigated/Non-Irrigated Annual Crops


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Growing planned rotations of row crops, forages, small grains, or fallow in a systematic arrangement of equal width strips across a field.

PURPOSE:
- Reduce soil erosion from water and transport of sediment and other water-borne contaminants
- Reduce soil erosion from wind
- Protect growing crops from damage by wind-borne soil particles

CONDITIONS WHERE PRACTICE APPLIES: This practice applies on cropland or other land where crops are grown.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for stripcropping represent the addition of dense grasses or legumes, hay crops or other perennial cover, grown in strips with annual crops. Cropland management practices on annual crop strips remain the same with adoption of the conservation practice. Strips of perennial cover are estimated to increase soil carbon stocks through increased carbon inputs from plant residues and reduced soil disturbance. Nitrous oxide emission reductions are based the assumption that perennial strips are not fertilized.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Combustion System Improvement (CPS 372)

Improved Farm Equipment Fuel Efficiency

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Installing, replacing, or retrofitting agricultural combustion systems and/or related components or devices for air quality and energy efficiency improvement.

PURPOSE:

- To improve air quality by addressing the air quality resource concerns for particulate matter and ozone precursors by mitigating actual or potential emissions of oxides of nitrogen and/or fine particulate matter
- To improve the energy efficiency of agricultural combustion systems

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to any agricultural operation that operates an agricultural combustion system, including stationary, portable, mobile, and self-propelled equipment. The combustion system must be used primarily for agricultural and/or forestry activities.

COMET-Planner Practice Implementation Information

COMET-Planner estimates focus only on improved fuel efficiency of farm equipment commonly used in cropland management. Carbon dioxide emission reductions were estimated from a 15 percent improvement in fuel efficiency of farm equipment.

GHG Estimation Methods

Total emissions from common tillage operations, as reported in West and Marland (2002), were area-weighted by total area of tillage systems in the U.S. (CTIC 2008). Emissions estimates were then reduced by 15% to represent a 15% improvement in fuel efficiency.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Cropland to Herbaceous Cover

Conservation Benefits

NRCS conservation practices for conversion of annual cropland to perennial herbaceous cover have multiple objectives that may include reducing soil erosion, improving water and air quality, enhancing wildlife habitat, protecting crops from wind damage, stabilizing steep slopes, and/or reducing sediment and contaminant loadings in runoff. Converting all or part of cropland fields to perennial herbaceous cover may also have significant greenhouse gas benefits.

NRCS CONSERVATION PRACTICES

CONSERVATION COVER (CPS 327)
CONTOUR BUFFER STRIPS (CPS 332)
FIELD BORDER (CPS 386)
FILTER STRIP (CPS 393)
FORAGE AND BIOMASS PLANTING (CPS 512)
GRASSED WATERWAYS (CPS 412)
HERBACEOUS WIND BARRIERS (CPS 603)
RIPARIAN HERBACEOUS COVER (CPS 390)
VEGETATIVE BARRIERS (CPS 601)

Greenhouse Gas Emissions

While the main sources of emissions from cropland agriculture (excluding rice) are carbon dioxide emissions from soils and nitrous oxide emissions from nitrogen fertilizers (CAST 2011), conversion to perennial herbaceous cover has significant potential to reduce emissions and sequester atmospheric carbon. Lands that have been previously retired from cropland agriculture and converted to perennial cover, such as those under the Conservation Reserve Program (CRP), are predicted to be significant agricultural soil carbon sinks in the U.S. (EPA 2014). Cropland soils are often subject to soil disturbance from tillage, and cessation of tillage under permanent cover may reduce carbon dioxide emissions from soils. Perennial vegetation also contributes increased carbon inputs from roots and plant residues, further enhancing soil carbon sequestration potential (Denef et al. 2011). However, it is worth noting that soil carbon recovery following conversion to permanent cover can be slow, especially in lower precipitation climates. Conservation Reserve Program lands in semiarid Colorado achieved only half of the plant basal cover and approximately 60% of soil carbon stocks of native grasslands after 18 years (Munson et al. 2012). Further, site level differences, such as soil texture can play a significant role. Restored grasslands in eastern Nebraska showed a clear trend of soil carbon recovery over time on finer textured soils, whereas the trend on sandy soils was less clear (Baer et al. 2010). Even on the finer textured soils, full recovery to native soil carbon stocks was predicted to take over 100 years (Baer et al. 2010). Nitrogen fertilizer can be a major source of nitrous oxide emissions from cropland soils as described under Cropland Management; fertilizer is not generally applied to herbaceous cover, however, thus reducing emissions.

Conservation Cover (CPS 327)

Convert Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass Cover


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing and maintaining permanent vegetative cover

PURPOSE:
- Reduce soil erosion and sedimentation
- Improve water quality
- Improve air quality
- Enhance wildlife habitat and pollinator habitat.
- Improve soil quality
- Manage plant pests

CONDITION WHERE PRACTICE APPLIES: This practice applies on all lands needing permanent vegetative cover. This practice does not apply to plantings for forage production or to critical area plantings.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for conservation cover planting are constructed from the scenario of converting conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions due to no longer applying synthetic nitrogen fertilizer.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Conservation Cover (CPS 327)

Convert Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing and maintaining permanent vegetative cover

PURPOSE:
- Reduce soil erosion and sedimentation
- Improve water quality
- Improve air quality
- Enhance wildlife habitat and pollinator habitat.
- Improve soil quality
- Manage plant pests

CONDITION WHERE PRACTICE APPLIES: This practice applies on all lands needing permanent vegetative cover. This practice does not apply to plantings for forage production or to critical area plantings.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for conservation cover planting are constructed from the scenario of converting conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass/legume cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions due to no longer applying synthetic nitrogen fertilizer.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Forage and Biomass Planting (CPS 512)

Conversion of Irrigated/Non-Irrigated Cropland to Grass/Legume Forage/Biomass Crops

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay, or biomass production.

PURPOSE:

- Improve or maintain livestock nutrition and/or health.
- Provide or increase forage supply during periods of low forage production
- Reduce soil erosion
- Improve soil and water quality
- Produce feedstock for biofuel or energy production

CONDITIONS WHERE PRACTICE APPLIES: This practice applies all lands suitable to the establishment of annual, biennial or perennial species for forage or biomass production.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for forage and biomass planting assume full conversion, replacing all crops in a conventionally managed, irrigated or non-irrigated, annual crop rotation with continuous unfertilized grass/legume forage/biomass crops. Impacts on greenhouse gases include changes in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions due to ceasing or reducing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Herbaceous Wind Barriers (CPS 603)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass Cover

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Herbaceous vegetation established in rows or narrow strips in the field across the prevailing wind direction.

PURPOSE:
- Reduce soil erosion from wind
- Reduce soil particulate emissions to the air
- Protect growing crops from damage by wind or wind-borne soil particles
- Enhance snow deposition to increase plant-available moisture

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to lands where crops or forages are grown.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for herbaceous wind barriers assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing or reducing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Herbaceous Wind Barriers (CPS 603)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover

NRCS Conservation Practice Standard Summary

DEFINITION: Herbaceous vegetation established in rows or narrow strips in the field across the prevailing wind direction.

PURPOSE:
• Reduce soil erosion from wind
• Reduce soil particulate emissions to the air
• Protect growing crops from damage by wind or wind-borne soil particles
• Enhance snow deposition to increase plant-available moisture

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to lands where crops or forages are grown.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for herbaceous wind barriers assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass/legume cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing or reducing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Vegetative Barriers (CPS 601)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass Cover

NRCS Conservation Practice Standard Summary

DEFINITION: Permanent strips of stiff, dense vegetation established along the general contour of slopes or across concentrated flow areas.

PURPOSE:
- Reduce sheet and rill erosion
- Reduce ephemeral gully erosion
- Manage water flow
- Stabilize steep slopes
- Trap sediment

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all land uses where sheet and rill and/or concentrated flow erosion are resource concerns. This practice is not well-suited to soils that are shallow to rock or other restrictive layers and where tillage is used on the cropped strips. The “benching” process that occurs on slopes where barriers are installed can expose soil material unfavorable for crop growth.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for vegetative barriers assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing or reducing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Vegetative Barriers (CPS 601)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover

NRCS Conservation Practice Standard Summary

DEFINITION: Permanent strips of stiff, dense vegetation established along the general contour of slopes or across concentrated flow areas.

PURPOSE:
- Reduce sheet and rill erosion
- Reduce ephemeral gully erosion
- Manage water flow
- Stabilize steep slopes
- Trap sediment

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all land uses where sheet and rill and/or concentrated flow erosion are resource concerns. This practice is not well-suited to soils that are shallow to rock or other restrictive layers and where tillage is used on the cropped strips. The “benching” process that occurs on slopes where barriers are installed can expose soil material unfavorable for crop growth.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for vegetative barriers assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass/legume cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing or reducing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Riparian Herbaceous Cover (CPS 390)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass Cover Near Aquatic Habitats

NRCS Conservation Practice Standard Summary

DEFINITION: Herbaceous plants tolerant of intermittent flooding or saturated soils established or managed as the dominant vegetation in the transitional zone habitats.

PURPOSE:
- Provide or improve food and cover for fish, wildlife and livestock
- Improve and maintain water quality
- Reduce erosion and improve stability to stream banks and shorelines
- Increase net carbon storage in the biomass and soil
- Restore, improve or maintain the desired plant communities
- Enhance stream bank protection as part of stream bank soil bioengineering practices.

CONDITIONS WHERE PRACTICE APPLIES:
- Areas adjacent to perennial and intermittent watercourses or water bodies where the natural plant community is dominated by herbaceous vegetation that is tolerant of periodic flooding or saturated soils
- Where channel and stream bank stability is adequate to support this practice
- Where the riparian area has been altered and the potential natural plant community has changed

COMET-Planner Practice Implementation Information

COMET-Planner estimates for riparian herbaceous cover assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland near streams to permanent unfertilized grass cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing or reducing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Riparian Herbaceous Cover (CPS 390)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover Near Aquatic Habitats

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Herbaceous plants tolerant of intermittent flooding or saturated soils established or managed as the dominant vegetation in the transitional zone habitats.

PURPOSE:

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- Enhance stream bank protection as part of stream bank soil bioengineering practices.

CONDITIONS WHERE PRACTICE APPLIES:

- Areas adjacent to perennial and intermittent watercourses or water bodies where the natural plant community is dominated by herbaceous vegetation that is tolerant of periodic flooding or saturated soils
- Where channel and stream bank stability is adequate to support this practice
- Where the riparian area has been altered and the potential natural plant community has changed

COMET-Planner Practice Implementation Information

COMET-Planner estimates for riparian herbaceous cover assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland near streams to permanent unfertilized grass/legume cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing or reducing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Contour Buffer Strips (CPS 332)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass Cover

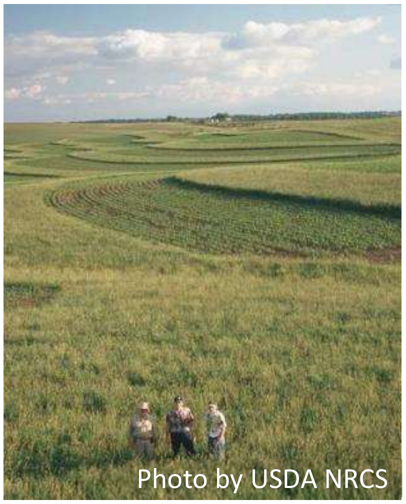
Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Narrow strips of permanent, herbaceous vegetative cover established around the hill slope, and alternated down the slope with wider cropped strips that are farmed on the contour.

PURPOSE:
- Reduce sheet and rill erosion
- Reduce transport of sediment and other water-borne contaminants downslope
- Increase water infiltration

CONDITIONS WHERE PRACTICE APPLIES: This practice applies on all sloping cropland, including orchards, vineyards and nut crops. Where the width of the buffer strips will be equal to or exceed the width of the adjoining crop strips, the practice Stripcropping (Conservation Practice Standard 585) applies.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for contour buffer strips assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing or reducing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Contour Buffer Strips (CPS 332)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover

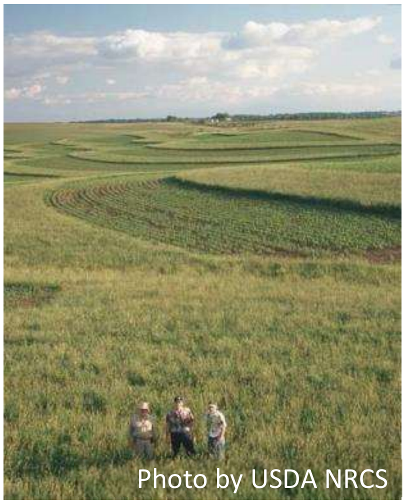
Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

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- Increase water infiltration

CONDITIONS WHERE PRACTICE APPLIES: This practice applies on all sloping cropland, including orchards, vineyards and nut crops. Where the width of the buffer strips will be equal to or exceed the width of the adjoining crop strips, the practice Stripcropping (Conservation Practice Standard 585) applies.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for contour buffer strips assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass/legume cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Field Border (CPS 386)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass Cover


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: A strip of permanent vegetation established at the edge or around the perimeter of a field.

PURPOSE:
- Reduce erosion from wind and water
- Protect soil and water
- Provide wildlife food and cover and pollinator or other beneficial organism
- Increase soil carbon
- Improve air quality

CONDITIONS WHERE PRACTICE APPLIES: This practice is applied around the inside perimeter of fields. Its use can support or connect other buffer practices within and between fields. This practice applies to cropland and grazing lands.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for field borders assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Field Border (CPS 386)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover

NRCS Conservation Practice Standard Summary

DEFINITION: A strip of permanent vegetation established at the edge or around the perimeter of a field.

PURPOSE:

- Reduce erosion from wind and water
- Protect soil and water
- Provide wildlife food and cover and pollinator or other beneficial organism
- Increase soil carbon
- Improve air quality

CONDITIONS WHERE PRACTICE APPLIES: This practice is applied around the inside perimeter of fields. Its use can support or connect other buffer practices within and between fields. This practice applies to cropland and grazing lands.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for field borders assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass/legume cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Filter Strip (CPS 393)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass Cover

NRCS Conservation Practice Standard Summary

DEFINITION: A strip or area of herbaceous vegetation that removes contaminants from overland flow.

PURPOSE:

- Reduce suspended solids and associated contaminants in runoff
- Reduce dissolved contaminant loadings in runoff
- Reduce suspended solids and associated contaminants in irrigation tailwater

CONDITIONS WHERE PRACTICE APPLIES: Filter strips are established where environmentally-sensitive areas need to be protected from sediment; other suspended solids and dissolved contaminants in runoff.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for filter strip assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Filter Strip (CPS 393)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: A strip or area of herbaceous vegetation that removes contaminants from overland flow.

PURPOSE:
- Reduce suspended solids and associated contaminants in runoff
- Reduce dissolved contaminant loadings in runoff
- Reduce suspended solids and associated contaminants in irrigation tailwater

CONDITIONS WHERE PRACTICE APPLIES: Filter strips are established where environmentally-sensitive areas need to be protected from sediment; other suspended solids and dissolved contaminants in runoff.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for filter strip assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass/legume cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Grassed Waterway (CPS 412)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass Cover

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: A shaped or graded channel that is established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet.

PURPOSE:

- To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding
- To reduce gully erosion
- To protect/improve water quality

CONDITIONS WHERE PRACTICE APPLIES: In areas where added water conveyance capacity and vegetative protection are needed to control erosion resulting from concentrated runoff.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for grassed waterway assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Grassed Waterway (CPS 412)

Convert Strips of Irrigated/Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: A shaped or graded channel that is established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet.

PURPOSE:

- To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding
- To reduce gully erosion
- To protect/improve water quality

CONDITIONS WHERE PRACTICE APPLIES: In areas where added water conveyance capacity and vegetative protection are needed to control erosion resulting from concentrated runoff.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for grassed waterway assume conversion of strips of conventionally managed, irrigated or non-irrigated, annual cropland to permanent unfertilized grass/legume cover. Impacts on greenhouse gases include changes in soil organic matter carbon due to ceasing tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from ceasing synthetic nitrogen fertilizer applications.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Cropland to Woody Cover

Conservation Benefits

NRCS CONSERVATION PRACTICES

- ALLEY CROPPING (CPS 311)
- HEDGEROW PLANTING (CP 422)
- MULTI-STORY CROPPING (CPS 379)
- RIPARIAN FOREST BUFFER (CP 391)
- TREE/SHRUB ESTABLISHMENT (CP 612)
- WINDBREAK/SHELTERBELT ESTABLISHMENT (CP 380)
- WINDBREAK/SHELTERBELT RENOVATION (CP 650)

NRCS Conservation Practices that involve the conversion of conventionally tilled and fertilized annual cropland to woody systems are implemented for a number of purposes that may include the creation of wood products or renewable energy sources, the control of erosion by wind or water, the reduction of chemical runoff and leaching, storage of carbon in biomass and soils, provide or improve wildlife/insect habitat, and to provide living structures that can screen air borne pollution, shelter crops, and manage snow deposition. Additionally, perennial woody cover may have significant potential for carbon storage in woody biomass and soils.

Greenhouse Gas Emissions

Carbon sequestration rates in conservation cover with trees and shrubs are estimated to be much greater than many other greenhouse gas mitigation options on farms, largely due to the high potential for carbon storage in woody biomass (Shoeneberger 2008, Udawatta and Jose 2014). All of the conservation practices presented involve the long-term carbon dioxide uptake from the atmosphere and resultant storage of carbon as woody biomass. Soil carbon is expected to usually increase with addition of trees or shrub vegetation due to increased plant residue inputs and the cessation of conventional tillage. As described under Cropland Management, nitrous oxide emissions from nitrogen fertilizer applications are a major source of greenhouse gas emissions in the U.S. (EPA 2014). Practices that involve full conversion of previously fertilized croplands to perennial woody cover generally receive little or no nitrogen fertilizer and therefore have greatly reduced emissions of nitrous oxide (CAST 2011). Practices with partial conversion to woody cover, such as alley cropping and multi-story cropping, are assumed to have lower fertilizer inputs than the areas planted to crops, thus reducing nitrous oxide emissions, though not to the extent of those practices with full conversion. Agroforestry systems used as buffers near agricultural fields may also slow runoff and filter nitrate in runoff, reducing nitrate pollution to surface and ground water (Dosskey 2001).

Tree/Shrub Establishment (CPS 612)

Conversion of Annual Cropland to a Farm Woodlot (Conifer, Mixed Hardwoods)

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration.

PURPOSE:
- Forest products such as timber, pulpwood, etc.
- Wildlife habitat
- Long-term erosion control and improvement of water quality
- Treat waste
- Store carbon in biomass
- Reduce energy use
- Develop renewable energy systems
- Improve or restore natural diversity
- Enhance aesthetics

CONDITIONS WHERE PRACTICE APPLIES: Tree/shrub establishment can be applied on any appropriately prepared site where woody plants can be grown.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for tree/shrub establishment assume replacing conventionally managed and fertilized annual cropland with unfertilized, woody plants (conifer, mixed hardwoods). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from decreased synthetic fertilizer application.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Tree/Shrub Establishment (CPS 612)

Conversion of Grasslands to a Farm Woodlot (Conifer, Mixed Hardwoods)

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration.

PURPOSE:
- Forest products such as timber, pulpwood, etc.
- Wildlife habitat
- Long-term erosion control and improvement of water quality
- Treat waste
- Store carbon in biomass
- Reduce energy use
- Develop renewable energy systems
- Improve or restore natural diversity
- Enhance aesthetics

CONDITIONS WHERE PRACTICE APPLIES: Tree/shrub establishment can be applied on any appropriately prepared site where woody plants can be grown.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for tree/shrub establishment assume replacing rangeland or managed pasture with unfertilized, woody plants (conifer, mixed hardwoods). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Windbreak/Shelterbelt Establishment (CPS 380)

Replace a Strip of Cropland with 1 Row of Woody Plants (Conifer, Hardwood)

NRCS Conservation Practice Standard Summary

DEFINITION: Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSE:

- Increase carbon storage in biomass and soils
- Reduce soil erosion from wind
- Protect plants from wind related damage
- Alter the microenvironment for enhancing plant growth
- Manage snow deposition
- Provide shelter
- Enhance wildlife habitat
- Provide noise and visual screens
- Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors
- Improve irrigation efficiency

CONDITIONS WHERE PRACTICE APPLIES: Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for windbreak/shelterbelt establishment assume replacing conventionally managed and fertilized annual cropland with one row of unfertilized, woody plants (conifer, hardwood). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from decreased synthetic fertilizer application. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Windbreak/Shelterbelt Establishment (CPS 380)
Replace a Strip of Cropland with 2 Rows of Woody Plants (Conifer, Mixed Conifers)


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSE:
- Increase carbon storage in biomass and soils
- Reduce soil erosion from wind
- Protect plants from wind related damage
- Alter the microenvironment for enhancing plant growth
- Manage snow deposition
- Provide shelter
- Enhance wildlife habitat
- Provide noise and visual screens
- Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors
- Improve irrigation efficiency

CONDITIONS WHERE PRACTICE APPLIES: Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for windbreak/shelterbelt establishment assume replacing conventionally managed and fertilized annual cropland with two rows of unfertilized, woody plants (conifer, mixed conifers). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from decreased synthetic fertilizer application. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Windbreak/Shelterbelt Establishment (CPS 380)
Replace a Strip of Cropland with 3 or More Rows of Woody Plants (Hardwood/Conifer)


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSE:
- Increase carbon storage in biomass and soils
- Reduce soil erosion from wind
- Protect plants from wind related damage
- Alter the microenvironment for enhancing plant growth
- Manage snow deposition
- Provide shelter
- Enhance wildlife habitat
- Provide noise and visual screens
- Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors
- Improve irrigation efficiency

CONDITIONS WHERE PRACTICE APPLIES: Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for windbreak/shelterbelt establishment assume replacing conventionally managed and fertilized annual cropland with three or more rows of unfertilized, woody plants (hardwood/conifer). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from decreased synthetic fertilizer application. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Windbreak/Shelterbelt Establishment (CPS 380)

Replace a Strip of Grassland with 1 Row of Woody Plants (Conifer, Hardwood)

NRCS Conservation Practice Standard Summary

DEFINITION: Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSE:
- Increase carbon storage in biomass and soils
- Reduce soil erosion from wind
- Protect plants from wind related damage
- Alter the microenvironment for enhancing plant growth
- Manage snow deposition
- Provide shelter
- Enhance wildlife habitat
- Provide noise and visual screens
- Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors
- Improve irrigation efficiency

CONDITIONS WHERE PRACTICE APPLIES: Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for windbreak/shelterbelt establishment assume replacing rangeland or managed pasture with one row of unfertilized, woody plants (conifer, hardwood). Impacts on greenhouse gases include woody biomass carbon accumulation, and change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Windbreak/Shelterbelt Establishment (CPS 380)

Replace a Strip of Grassland with 2 Rows of Woody Plants (Conifer, Mixed Conifers)

NRCS Conservation Practice Standard Summary

DEFINITION: Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSE:
- Increase carbon storage in biomass and soils
- Reduce soil erosion from wind
- Protect plants from wind related damage
- Alter the microenvironment for enhancing plant growth
- Manage snow deposition
- Provide shelter
- Enhance wildlife habitat
- Provide noise and visual screens
- Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors
- Improve irrigation efficiency

CONDITIONS WHERE PRACTICE APPLIES: Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for windbreak/shelterbelt establishment assume replacing rangeland or managed pasture with two rows of unfertilized, woody plants (conifer, mixed conifers). Impacts on greenhouse gases include woody biomass carbon accumulation, and change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Windbreak/Shelterbelt Establishment (CPS 380)

Replace a Strip of Grassland with 3 or More Rows of Woody Plants (Hardwood/Conifer)


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSE:
• Increase carbon storage in biomass and soils
• Reduce soil erosion from wind
• Protect plants from wind related damage
• Alter the microenvironment for enhancing plant growth
• Manage snow deposition
• Provide shelter
• Enhance wildlife habitat
• Provide noise and visual screens
• Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors
• Improve irrigation efficiency

CONDITIONS WHERE PRACTICE APPLIES: Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for windbreak/shelterbelt establishment assume replacing rangeland or managed pasture with three or more rows of unfertilized, woody plants (hardwood/conifer). Impacts on greenhouse gases include woody biomass carbon accumulation, and change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Windbreak/Shelterbelt Renovation (CPS 650)

Replace Woody Plants in an existing Windbreak/Shelterbelt


Photo by USDA

NRCS Conservation Practice Standard Summary

DEFINITION: Replacing, releasing and/or removing selected trees and shrubs or rows within an existing windbreak or shelterbelt, adding rows to the windbreak or shelterbelt or removing selected tree and shrub branches.

PURPOSE: Restoring or enhancing the original planned function of existing windbreaks or shelterbelts.

CONDITIONS WHERE PRACTICE APPLIES: In any windbreak or shelterbelt that is no longer functioning properly for the intended purpose.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for windbreak/shelterbelt establishment assume replacing 50 percent of woody plants in an existing unfertilized windbreak. Impacts on greenhouse gases include new woody biomass carbon sequestration. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Riparian Forest Buffer (CPS 391)

Replace a Strip of Cropland Near Watercourses or Water Bodies with Woody Plants (Hardwood/Conifer, Mixed Hardwoods)

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: An area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

PURPOSE:
- Increase carbon storage in plant biomass and soils
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow
- Create or improve riparian habitat and provide a source of detritus and large woody debris
- Reduce pesticide drift entering the water body
- Restore riparian plant communities

CONDITIONS WHERE PRACTICE APPLIES: Riparian forest buffers are applied on areas adjacent to permanent or intermittent streams, lakes, ponds, and wetlands. They are not applied to stabilize stream banks or shorelines.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for riparian forest buffer establishment assume replacing conventionally managed and fertilized annual cropland with unfertilized, woody plants (hardwood/conifer, mixed hardwoods). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from decreased synthetic fertilizer application. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Riparian Forest Buffer (CPS 391)

Replace a Strip of Grassland Near Watercourses or Water Bodies with Woody Plants (Hardwood/Conifer, Mixed Hardwoods)

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: An area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

PURPOSE:

- Increase carbon storage in plant biomass and soils
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow
- Create or improve riparian habitat and provide a source of detritus and large woody debris
- Reduce pesticide drift entering the water body
- Restore riparian plant communities

CONDITIONS WHERE PRACTICE APPLIES: Riparian forest buffers are applied on areas adjacent to permanent or intermittent streams, lakes, ponds, and wetlands. They are not applied to stabilize stream banks or shorelines.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for riparian forest buffer establishment assume replacing rangeland or managed pasture with unfertilized, woody plants (hardwood/conifer, mixed hardwoods). Impacts on greenhouse gases include woody biomass carbon accumulation, and change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Hedgerow Planting (CPS 422)

Replace a Strip of Cropland with 1 Row of Woody Plants (Conifer, Hardwood)

NRCS Conservation Practice Standard Summary

DEFINITION: Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose.

PURPOSE:
- To increase carbon storage in biomass and soils.
- Habitat, including food, cover, and corridors for terrestrial wildlife
- To enhance pollen, nectar, and nesting habitat for pollinators
- To provide substrate for predaceous and beneficial invertebrates as a component of integrated pest management
- To intercept airborne particulate matter
- To reduce chemical drift and odor movement
- Screens and barriers to noise and dust
- Living fences

CONDITIONS WHERE PRACTICE APPLIES: This practice applies wherever it will accomplish at least one of the purposes stated above.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for hedgerow planting assume replacing conventionally managed and fertilized annual cropland with one row of unfertilized, woody plants (conifer, hardwood). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from decreased synthetic fertilizer application. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Hedgerow Planting (CPS 422)

Replace a Strip of Grassland with 1 Row of Woody Plants (Conifer, Hardwood)

NRCS Conservation Practice Standard Summary

DEFINITION: Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose.

PURPOSE:
- To increase carbon storage in biomass and soils.
- Habitat, including food, cover, and corridors for terrestrial wildlife
- To enhance pollen, nectar, and nesting habitat for pollinators
- To provide substrate for predaceous and beneficial invertebrates as a component of integrated pest management
- To intercept airborne particulate matter
- To reduce chemical drift and odor movement
- Screens and barriers to noise and dust
- Living fences

CONDITIONS WHERE PRACTICE APPLIES: This practice applies wherever it will accomplish at least one of the purposes stated above.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for hedgerow planting assume replacing rangeland or managed pasture with one row of unfertilized, woody plants (conifer, hardwood). Impacts on greenhouse gases include woody biomass carbon accumulation, and change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Alley Cropping (CPS 311)

Replace 20% of Annual Cropland with Woody Plants (Hardwood)

NRCS Conservation Practice Standard Summary

DEFINITION: Trees or shrubs are planted in sets of single or multiple rows with agronomic, horticultural crops or forages produced in the alleys between the sets of woody plants that produce additional products.

PURPOSE:

- Increase carbon storage in plant biomass and soils
- Reduce surface water runoff and erosion
- Improve soil health by increasing utilization and cycling of nutrients
- Alter subsurface water quantity or water table depths
- Enhance wildlife and beneficial insect habitat
- Decrease offsite movement of nutrients or chemicals
- Develop renewable energy systems

CONDITIONS WHERE PRACTICE APPLIES: On all cropland and hayland where trees, shrubs, crops and/or forages can be grown in combination.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for alley cropping assume replacing 20% of a conventionally managed and fertilized annual cropland field with unfertilized, woody plants (hardwood). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from decreased synthetic fertilizer application. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Alley Cropping (CPS 311)

Replace 20% of Grass Pasture with Woody Plants (Hardwood)

NRCS Conservation Practice Standard Summary

DEFINITION: Trees or shrubs are planted in sets of single or multiple rows with agronomic, horticultural crops or forages produced in the alleys between the sets of woody plants that produce additional products.

PURPOSE:
- Increase carbon storage in plant biomass and soils
- Reduce surface water runoff and erosion
- Improve soil health by increasing utilization and cycling of nutrients
- Alter subsurface water quantity or water table depths
- Enhance wildlife and beneficial insect habitat
- Decrease offsite movement of nutrients or chemicals
- Develop renewable energy systems

CONDITIONS WHERE PRACTICE APPLIES: On all cropland and hayland where trees, shrubs, crops and/or forages can be grown in combination.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for alley cropping assume replacing 20% of a grass pasture with unfertilized, woody plants (hardwood). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from decreased synthetic fertilizer application. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Multi-story Cropping (CPS 379)

Replace 20% of Annual Cropland with Woody Plants (Hardwood)

NRCS Conservation Practice Standard Summary

DEFINITION: Existing or planted stands of trees or shrubs that are managed as an overstory with an understory of woody and/or non-woody plants that are grown for a variety of products.

PURPOSE:
- Increase net carbon storage in plant biomass and soil
- Improve crop diversity by growing mixed but compatible crops having different heights on the same area
- Improve soil quality by increasing utilization and cycling of nutrients and maintaining or increasing soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: On all lands where trees, shrubs, woody or non-woody crops can be grown in combination. The practice does not apply on land that is grazed.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for multi-story cropping assume replacing 20% of a conventionally managed and fertilized annual cropland field with unfertilized, woody plants (hardwood). Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from decreased synthetic fertilizer application. Estimates apply only to the portion of the field where woody plants are established.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Grazing Lands

Conservation Benefits

NRCS CONSERVATION PRACTICES

NUTRIENT MANAGEMENT (CPS 590)
PRESCRIBED GRAZING (CPS 528)
RANGE PLANTING (CPS 550)
SILVOPASTURE (CPS 381)

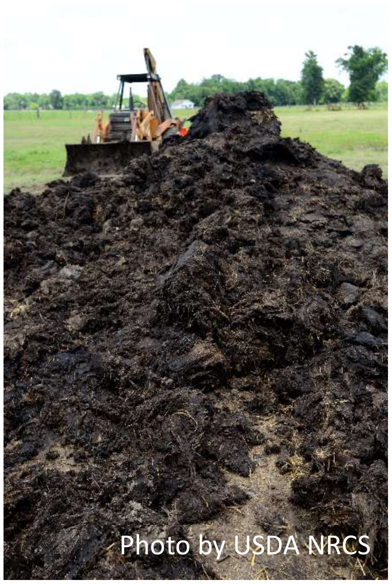
For NRCS conservation practices on grazing lands, conservation objectives include the provision of improved and sustainable forage/browse, improved soil and water quality, reduced erosion, improved shade for livestock and cover for wildlife, reduce fire hazards, and increase carbon sequestration in biomass and soils. Conservation practices on grazing lands that reduce degradation of soils or improve productivity of grasslands also have potential for greenhouse gas benefits.

Greenhouse Gas Emissions

Grazing lands comprise 35 percent of all U.S. land area and about two-thirds of all agricultural land use, thus represent a large potential sink of carbon (CAST 2011). Practices that decrease biomass removal by reducing the number of animals grazing, such as carefully managed **prescribed grazing**, or that increase forage production while holding animal numbers steady, such as **range planting**, will tend to increase carbon sequestration in the soil. Carbon sequestration potential following pasture and grazing management improvements is especially high in grazing lands that have been previously degraded due to long-term overgrazing (Conant and Paustian 2002). The planting of trees or shrubs on grazing land (**silvopasture establishment**) will introduce long-term carbon storage in woody biomass (Schoeneberger et al. 2012). In managed pastures with nitrogen fertilizer applications, changes in **nitrogen management** may lead to a net reduction in GHG emissions from pastures. Substitution of manure or compost for a portion of synthetic nitrogen applied may lead to a net reduction in GHG emissions. In a global meta-analysis, Maillard and Angers (2014) estimated a significant increase in SOC stocks following manure additions, similar to that reported in prior IPCC syntheses (IPCC 2006). Current inventory methods (Eve et al. 2014, IPCC 2006) assume that nitrous oxide emissions would be the same from manure or synthetic nitrogen fertilizer when nitrogen rates remain the same.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Beef Feedlot Manure on Irrigated/Non-Irrigated Managed Pasture



NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of beef feedlot manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Chicken Broiler Manure on Irrigated/Non-Irrigated Managed Pasture

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:
- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of chicken broiler manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5^{th} year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Chicken Layer Manure on Irrigated/Non-Irrigated Managed Pasture

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:
- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of chicken layer manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

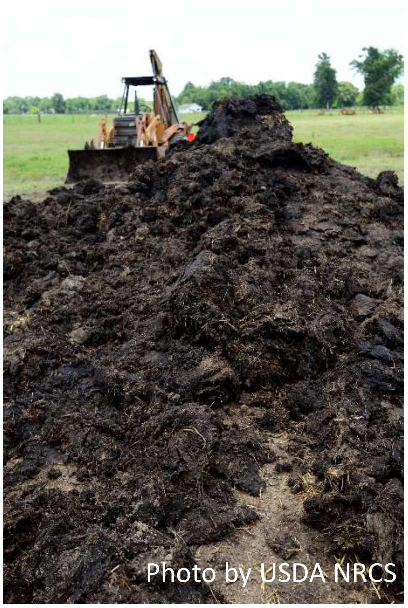
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Dairy Manure on Irrigated/Non-Irrigated Managed Pasture



NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:
- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of dairy manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

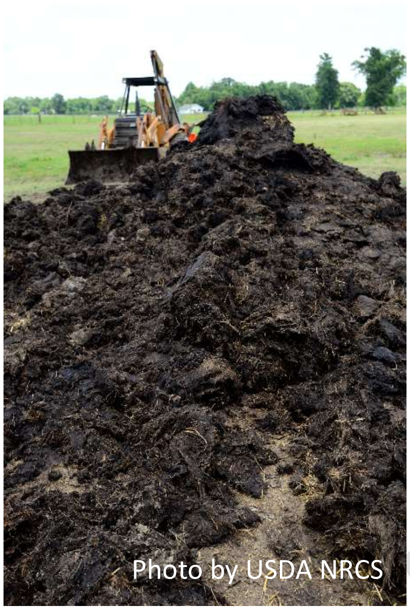
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Other Manure on Irrigated/Non-Irrigated Managed Pasture



NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of other livestock manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

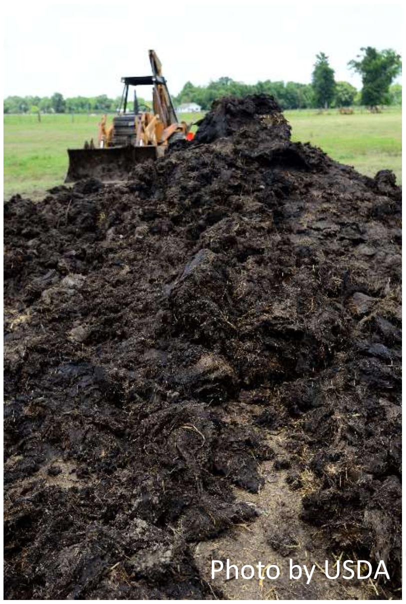
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Sheep Manure on Irrigated/Non-Irrigated Managed Pasture



NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of sheep manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Swine Manure on Irrigated/Non-Irrigated Managed Pasture

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:
- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of swine manure for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Manure is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Compost (C:N 10) on Irrigated/Non-Irrigated Managed Pasture

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of compost (C:N ratio of 10; N%=3.6) for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Compost is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Compost (C:N 15) on Irrigated/Non-Irrigated Managed Pasture

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of compost (C:N ratio of 15; N%=2.4) for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Compost is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Compost (C:N 20) on Irrigated/Non-Irrigated Managed Pasture

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of compost (C:N ratio of 20; N%=1.8) for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Compost is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Nutrient Management (CPS 590)

Replace Synthetic N Fertilizer with Compost (C:N 25) on Irrigated/Non-Irrigated Managed Pasture


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:
- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nutrient management by partial substitution of compost (C:N ratio of 25; N%=1.4) for synthetic nitrogen fertilizer. The management scenario assumes that synthetic nitrogen fertilizer amounts are gradually reduced by approximately 4% per year for 5 years, achieving a 20% reduction in nitrogen fertilizer use after the 5th year and remaining constant at that level in the years that follow. Compost is added at a rate that supplies 20% of the total nitrogen applied to the system. Other grassland management practices remain the same with adoption of the conservation practice, including total N amendment rates. Average regional N fertilization rates by crop used by COMET-Planner are listed in Appendix II. The greenhouse gas impacts of this practice include an increase in soil carbon and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Range Planting (CPS 550)

Seeding Forages to Improve Rangeland Condition

NRCS Conservation Practice Standard Summary

DEFINITION: Establishment of adapted perennial or self-sustaining vegetation such as grasses, forbs, legumes, shrubs and trees.

PURPOSE:
- Restore a plant community similar to the Ecological Site Description reference state for the site or the desired plant community
- To improve the energy efficiency of agricultural combustion systems
- Provide or improve forages for livestock
- Reduce erosion by wind and/or water
- Improve water quality and quantity
- Increase carbon sequestration

CONDITIONS WHERE PRACTICE APPLIES: On rangeland, native or naturalized pasture, grazed forest or other suitable location where the principle goals and method of vegetation management is herbivore based. This practice shall be applied where desirable vegetation is below the acceptable level for natural reseeding to occur, or where the potential for enhancement of the vegetation by grazing management is unsatisfactory.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume that grasslands were restored from degraded to native conditions, or were seeded with improved forages. Enhanced productivity of improved grasslands is expected to increase soil carbon stocks, through higher inputs of carbon from plant residues.

GHG Estimation Methods

Emissions reductions were estimated using the Intergovernmental Panel on Climate Change (IPCC) inventory method (IPCC 2006) for grasslands and evaluated as an average of a change from moderately degraded to nominal condition or from nominal to improved condition, with factors provided in Eve et al. (2014). Reference soil carbon stocks were from Eve et al. (2014) and estimated stock changes were area-weighted using total IPCC soil areas classified from SSURGO soils data, by IPCC climate regions (IPCC 2006, Soil Survey Staff 2011).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Silvopasture (CPS 381)

Tree/Shrub Planting on Grazed Grasslands (Conifer, Hardwood)

NRCS Conservation Practice Standard Summary

DEFINITION: An application establishing a combination of trees or shrubs and compatible forages on the same acreage.

PURPOSE:

- Provide forage for livestock and the production of wood products
- Increase carbon sequestration
- Improve water quality
- Reduce erosion
- Enhance wildlife habitat
- Reduce fire hazard
- Provide shade for livestock
- Develop renewable energy systems

CONDITIONS WHERE PRACTICE APPLIES: Situations where silvopasture establishment applies includes: 1) pasture where trees or shrubs can be added; 2) forest where forages can be added; 3) Land on which neither the desired trees nor forages exist in sufficient quantity to meet the land user's objectives. This practice may be applied on any area that is suitable for the desired plants.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for silvopasture establishment on grazed grassland are constructed from a scenario of tree/shrub planting (conifer, hardwood) on existing unfertilized grazing land. Greenhouse gas impacts include woody biomass carbon accumulation; soil organic carbon is assumed to remain essentially unchanged.

GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006). Woody biomass accumulation rate models were derived for taxon groups (family or genus levels) from the USDA Forest Inventory and Analysis database, and developed to be consistent with a forthcoming update to Eve et al. 2014. Details of the modeling approach will be described in a methods white paper that is currently under development.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Prescribed Grazing (CPS 528)

Grazing Management to Improve Rangeland or Irrigated/Non-Irrigated Pasture Condition

NRCS Conservation Practice Standard Summary

DEFINITION: Managing the harvest of vegetation with grazing and/or browsing animals.

PURPOSE:
- Improve or maintain desired species composition and vigor of plant communities
- Improve or maintain quantity and quality of forage for grazing and browsing animals' health and productivity
- Improve or maintain surface and/or subsurface water quality and quantity
- Improve or maintain riparian and watershed function
- Reduce accelerated soil erosion, and maintain or improve soil condition
- Improve or maintain the quantity and quality of food and/or cover available for wildlife
- Manage fine fuel loads to achieve desired conditions

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where grazing and/or browsing animals are managed.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume improvement of degraded grazing lands by replacing extensive pasture management (60% forage removal) with intensively-managed grazing (40% forage removal) at 21-day intervals. The greenhouse gas impacts of this practice include an increase in soil carbon and variable impacts on soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with COMET-Farm, which employs the USDA entity-scale inventory methods (Eve et al. 2014). GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (USDA-NRCS 2006).

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Restoration of Disturbed Lands

Conservation Benefits

NRCS CONSERVATION PRACTICES

CRITICAL AREA PLANTING (CPS 342)
RIPARIAN RESTORATION

NRCS conservation practices for land restoration have the objectives of reclamation of land adversely affected by natural disaster and by the activities of industry. These practices seek to stabilize disturbed areas to decrease erosion and sedimentation, rehabilitate with desirable vegetation; improve offsite water quality and or quantity, provide safety, and enhance landscape visual and functional quality. Rehabilitation of disturbed lands may have additional benefits of reducing greenhouse gas emissions and sequestering atmospheric carbon.

Greenhouse Gas Emissions

Disturbed lands are lands that have been stripped, partly or entirely, of vegetative cover and where soil disturbance is extreme and/or where soil loss has been excessive. The consequences of physical disturbance to the top soil cause unusually large N transformations and movements with substantial loss. Management of top soil is important for reclamation plan to reduce the N losses and to increase soil nutrients and microbes (Sheoran et al. 2010). Success in the reclamation of disturbed sites, especially when the topsoil has been lost or discarded, depends on the rapid formation of surface soil containing high SOM content (Tate et al. 1987).

Losses of soil organic carbon have been estimated at 80 percent of native levels in mine soils (Ussiri and Lal 2005). Reclamation is an essential part in developing mineral resources in accordance with the principles of ecologically sustainable development (Sheoran et al. 2010). Restoring vegetation to these lands can sequester carbon long-term in biomass if planted to woody systems (EPA-OSRTI 2012) and can sequester carbon in the soil through carbon inputs from plant residues in both woody and herbaceous plantings (Akala and Lal 2000). Successful revegetation and subsequent carbon sequestration in surface mine soils require careful management of soil (physical, chemical, and biological) and vegetation parameters (species selection, seedbed preparation, seeding rates, time of seeding, the appropriate use of amendments in order to assure vegetative establishment) (Brown and Song 2006; Akala and Lal 2000).

Vegetation can protect critical areas such as coastline and stream bank slopes and inhibit landslides by reducing erosion, and strengthening soil. The use of vegetation to manage erosion and protect slopes is relatively inexpensive, does not require heavy machinery on the slope, establishes wildlife habitat, and can improve the aesthetic quality of the property (Myers 1993).

Critical Area Planting (CPS 342)

Restoring Highly Disturbed Areas by Planting Permanent Vegetative Cover

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing permanent vegetation on sites that have, or are expected to have, high erosion rates, and on sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices.

PURPOSE:

- Stabilize stream and channel banks, and shorelines
- Stabilize areas with existing or expected high rates of soil erosion by wind or water
- Rehabilitate and revegetate degraded sites that cannot be stabilized using normal establishment techniques
- Stabilize coastal areas, such as sand dunes and riparian areas

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to highly disturbed areas such as: active or abandoned mined lands; urban conservation sites; road construction areas; conservation practice construction sites; areas needing stabilization before or after natural disasters; eroded banks of natural channels, banks of newly constructed channels, and lake shorelines; other areas degraded by human activities or natural events.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for critical area planting are constructed from two scenarios. For dry/semiarid climates, the assumption is herbaceous planting and soil carbon changes are estimated using cropland set-aside literature. For moist/humid climates, the assumption is woody planting and biomass carbon sequestration and soil carbon changes were estimated using values from tree/shrub establishment.

GHG Estimation Methods

In moist/humid climates, woody biomass carbon estimates were derived from empirical models of woody biomass carbon accumulation in NRCS agroforestry prescriptions that used tree growth increment data from the U.S. Forest Service Forest Inventory and Analysis (FIA) program and allometric equations to allocate biomass carbon to tree components (Paustian et al. 2012, Merwin et al. 2009). Only herbaceous planting was assumed for dry/semiarid climate. Soil organic carbon estimates were based on North America sandy soils (Eve et al. 2014) as a proxy for disturbed soils.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

Riparian Restoration

Restoring Degraded Streambanks by Planting Woody Plants


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

When a riparian system is degraded, heavy runoff moves through the riparian zone directly into river channels. Fine sediments eventually fill up stream pools, altering the shape of the stream channels and covering rocky stream bottoms, thereby impairing important food-producing, shelter, and spawning areas. Runoff can bring seeds of nonnative and nonriparian plant species, reducing habitat for native species, and the water table can be lowered by crowding out more native riparian species. Degradation of the native plant community can create a fire risk by increasing fuel loads. Furthermore, streamsides lose their ability to buffer and protect streams, resulting in damage to aquatic habitat, increased costs for treating drinking water, and loss of aesthetic appeal.
(Machtinger 2007)

COMET-Planner Practice Implementation Information

COMET-Planner estimates for riparian area restoration are constructed from a scenario of woody plantings on degraded streambanks. Impacts on greenhouse gases include woody biomass carbon accumulation and changes in soil organic matter carbon due to increased carbon inputs from plant residues.

GHG Estimation Methods

Woody biomass accumulation rate models were derived at the species and genus level from the USDA Forest Inventory and Analysis database. An example of the model development process is described in Ziegler et al. 2016. Soil carbon estimates were derived from carbon stock values from Eve at al. 2014 (HAC, LAC, and sandy soils) and IPCC 2006 stock change methodology.

Estimates are not meant to apply to any specific site conditions but rather represent the range of expected values to be found over the multi-county region and reflect the assumptions stated.

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APPENDIX I: NRCS Practice Standards for Greenhouse Gas Emission Reduction and Carbon Sequestration

Information about each NRCS Practice Standard can be found here:

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
 **Practices with the highest greenhouse gas benefit**	**327**	Conservation Cover	Establishing perennial vegetation on land retired from agriculture production increases soil carbon and increases biomass carbon stocks.
	329	Residue and Tillage Management, No Till/Strip Till/Direct Seed	Limiting soil-disturbing activities improves soil carbon retention and minimizes carbon emissions from soils.
	366	Anaerobic Digester	Biogas capture reduces CH_4 emissions to the atmosphere and provides a viable gas stream that is used for electricity generation or as a natural gas energy stream.
	367	Roofs and Covers	Capture of biogas from waste management facilities reduces CH_4 emissions to the atmosphere and captures biogas for energy production. CH_4 management reduces direct greenhouse gas emissions.
	372	Combustion System Improvement	Energy efficiency improvements reduce on-farm fossil fuel consumption and directly reduce CO_2 emissions.
	379	Multi-Story Cropping	Establishing trees and shrubs that are managed as an overstory to crops increases net carbon storage in woody biomass and soils. Harvested biomass can serve as a renewable fuel and feedstock.
	380	Windbreak/Shelterbelt Establishment	Establishing linear plantings of woody plants increases biomass carbon stocks and enhances soil carbon.
	381	Silvopasture Establishment	Establishment of trees, shrubs, and compatible forages on the same acreage increases biomass carbon stocks and enhances soil carbon.

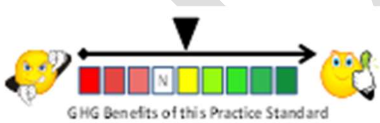
Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
Continuation… 	**512**	Forage and Biomass Planting	Deep-rooted perennial biomass sequesters carbon and may have slight soil carbon benefits. Harvested biomass can serve as a renewable fuel and feedstock.
	590	Nutrient Management	Precisely managing the amount, source, timing, placement, and form of nutrient and soil amendments to ensure ample nitrogen availability and avoid excess nitrogen application reduces N_2O emissions to the atmosphere.
	592	Feed Management	Diets and feed management strategies can be prescribed to minimize enteric CH_4 emissions from ruminants.
	612	Tree/Shrub Establishment	Establishing trees and shrubs on a site where trees/shrubs were not previously established increases biomass carbon and increases soil carbon. Mature biomass can serve as a renewable fuel and feedstock.
	666	Forest Stand Improvement	Proper forest stand management (density, size class, understory species, etc.) improves forest health and increases carbon sequestration potential of the forest stand. Managed forests sequester carbon above and below ground. Harvested biomass can serve as a renewable fuel and feedstock.

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
	332	Contour Buffer Strips	Permanent herbaceous vegetative cover increases biomass carbon

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
 **Practices with high greenhouse gas benefits**			sequestration and increases soil carbon stocks.
	391	Riparian Forest Buffer	Planting trees and shrubs for riparian benefits also increases biomass carbon sequestration and increases soil carbon stocks.
	601	Vegetative Barrier	Permanent strips of dense vegetation increase biomass carbon sequestration and soil carbon.
	650	Windbreak/Shelterbelt Renovation	Restoring trees and shrubs to reduce plant competition and optimize planting density increases carbon sequestration.

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
 **Practices with good greenhouse gas benefits**	**311**	Alley Cropping	Trees and/or shrubs are planted in combination with crops and forages. Increasing biomass density increases carbon sequestration and enhances soil carbon stocks.
	390	Riparian Herbaceous Cover	Perennial herbaceous riparian cover increases biomass carbon and soil carbon stocks.
	550	Range Planting	Establishing deep-rooted perennial and self-sustaining vegetation such as grasses, forbs, legumes, shrubs and trees improves biomass carbon sequestration and enhances soil carbon.
	603	Herbaceous Wind Barriers	Perennial herbaceous vegetation increases biomass carbon sequestration and soil carbon.

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
 **Practices with minimal greenhouse gas benefits**	**346**	Residue and Tillage Management, Ridge Till	Ridge planting promotes organic material accumulation that increases soil carbon. Reconstruction of ridges in the same row year after year will maximize organic matter buildup in the row. Shallow soil disturbance maintains soil carbon in the undisturbed horizons.
	632	Solid/Liquid Waste Separation Facility	Removal of solids from the liquid waste stream improves the efficiency of anaerobic digesters. CH_4 generation is maximized within the digester by separating solids from the liquid feedstock. Proper management of the solid and liquid waste streams increases CH_4 that is available for capture and combustion.

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
 **Practices with minimal greenhouse gas benefits**	**342**	Critical Area Planting	Establishing permanent vegetation on degraded sites enhances soil carbon and increases carbon sequestration by adding vegetative biomass.
	344	Residue Management, Seasonal	Managing residue enhances soil carbon when crop residues are allowed to decompose on a seasonal basis, increasing soil organic matter and reducing soil disturbance.
	345	Residue and Tillage Management, Mulch Till	Soil carbon increases when crop residues are allowed to decompose,

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
			increasing soil organic matter and minimizing soil disturbance.
	384	Forest Slash Treatment	Woody plant residues managed (chipped, scattered, etc.) on-site will increase soil carbon and soil organic matter. Forest slash that is removed can serve as a renewable fuel and feedstock.
	386	Field Border	Permanent vegetative field borders sequester carbon and increase soil carbon content.
	393	Filter Strip	Herbaceous vegetation in filter strips has slight carbon sequestration benefits and enhances soil carbon.
<u>Continuation…</u> 	**412**	Grassed Waterway	Perennial forbs and tall bunch grasses provide slight carbon sequestration benefits, minimize soil disturbance, and increase soil carbon.
	422	Hedgerow Planting	Woody plants and perennial bunch grasses increase biomass carbon stocks and enhance soil carbon.
	543	Land Reclamation Abandoned Mined Land	Establishment of permanent trees, shrubs, and grasses on abandoned and unmanaged lands increases biomass carbon stocks and enhances soil carbon.
	544	Land Reclamation Currently Mined Land	Establishment of permanent trees, shrubs, and grasses increases biomass carbon stocks and enhances soil carbon. Pre-mining baselines are important to establish prior to evaluating any carbon benefits.
	589C	Cross Wind Trap Strips	Perennial vegetative cover increases biomass carbon stocks and enhances soil carbon. Minimized soil disturbance also enhances soil carbon.
	657	Wetland Restoration	Establishment of vegetation, particularly woodland and forest vegetation, increases biomass carbon stocks. Soil organic carbon

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
			is increased by incorporating compost as a physical soil amendment.

APPENDIX II: Average Nitrogen Fertilizer Rates Applied to Crops (USDA-ERS 2014)

State	Crop	Non-Irrigated Rate (lbs N ac^{-1} yr^{-1})	Irrigated Rate (lbs N ac^{-1} yr^{-1})
AL	corn	119	167
AL	cotton	90	96
AL	fallow	0	0
AL	grass (hay or pasture)	96	93
AL	millet	74	100
AL	oats, spring	56	55
AL	peanuts	22	31
AL	potatoes	103	211
AL	rye	120	68
AL	sorghum	74	100
AL	soybeans	20	18
AL	sunflower	96	93
AL	wheat, winter	96	93
AR	alfalfa	0	0
AR	beans, dry field	0	0
AR	corn	119	167
AR	cotton	79	91
AR	fallow	0	0
AR	grass (hay or pasture)	112	93
AR	oats, spring	56	55
AR	peanuts	25	50
AR	potatoes	103	211
AR	rice	112	197
AR	sorghum	74	100
AR	soybeans	29	39
AR	sunflower	112	93
AR	wheat, winter	112	93
AZ	alfalfa	0	0
AZ	barley, spring	38	52
AZ	barley, winter	52	38
AZ	beans, dry field	0	0
AZ	corn	78	157
AZ	cotton	82	136
AZ	fallow	0	0
AZ	grass (hay or pasture)	52	116
AZ	oats, spring	56	55
AZ	oats, winter	55	56
AZ	potatoes	103	228

AZ	rye	119	48
AZ	sorghum	43	100
AZ	wheat, spring	48	119
AZ	wheat, winter	52	116
CA	alfalfa	0	0
CA	barley, spring	28	89
CA	barley, winter	28	89
CA	beans, dry field	0	0
CA	corn	130	167
CA	cotton	83	135
CA	fallow	0	0
CA	grass (hay or pasture)	48	138
CA	millet	74	100
CA	oats, spring	56	55
CA	oats, winter	55	56
CA	potatoes	103	229
CA	rice	48	137
CA	rye	145	72
CA	sorghum	74	100
CA	sunflower	48	138
CA	tomatoes	130	167
CA	wheat, spring	72	145
CA	wheat, winter	48	138
CO	alfalfa	0	0
CO	barley, spring	38	52
CO	barley, winter	52	38
CO	beans, dry field	0	0
CO	corn	78	157
CO	fallow	0	0
CO	grass (hay or pasture)	37	73
CO	millet	43	100
CO	oats, spring	56	55
CO	oats, winter	55	56
CO	potatoes	103	221
CO	rye	119	48
CO	sorghum	43	100
CO	soybeans	20	18
CO	sunflower	37	73
CO	wheat, spring	48	119
CO	wheat, winter	37	73
CT	alfalfa	0	0
CT	corn	82	167
CT	fallow	0	0

CT	grass (hay or pasture)	61	93
CT	potatoes	145	127
DE	alfalfa	0	0
DE	barley, spring	42	54
DE	barley, winter	54	42
DE	beans, dry field	0	0
DE	corn	82	167
DE	fallow	0	0
DE	grass (hay or pasture)	61	93
DE	oats, winter	55	32
DE	potatoes	145	127
DE	rye	120	68
DE	sorghum	74	100
DE	soybeans	19	19
DE	tomatoes	82	167
DE	wheat, winter	61	93
FL	beans, dry field	0	0
FL	corn	119	167
FL	cotton	90	96
FL	fallow	0	0
FL	grass (hay or pasture)	96	93
FL	millet	74	100
FL	oats, spring	56	55
FL	oats, winter	55	56
FL	peanuts	27	31
FL	potatoes	103	211
FL	rye	120	68
FL	sorghum	74	100
FL	soybeans	20	18
FL	wheat, winter	96	93
GA	alfalfa	0	0
GA	beans, dry field	0	0
GA	corn	119	167
GA	cotton	89	95
GA	fallow	0	0
GA	grass (hay or pasture)	96	93
GA	millet	74	100
GA	oats, spring	56	55
GA	oats, winter	55	56
GA	peanuts	20	31
GA	potatoes	103	211
GA	rye	120	68
GA	sorghum	74	100

GA	soybeans	20	18
GA	sunflower	96	93
GA	tomatoes	119	167
GA	wheat, winter	96	93
IA	alfalfa	0	0
IA	barley, spring	45	54
IA	beans, dry field	0	0
IA	corn	130	175
IA	fallow	0	0
IA	grass (hay or pasture)	97	93
IA	oats, spring	30	55
IA	potatoes	103	211
IA	rye	120	68
IA	sorghum	108	122
IA	soybeans	14	14
IA	wheat, spring	68	120
IA	wheat, winter	97	93
ID	alfalfa	0	0
ID	barley, spring	48	59
ID	barley, winter	59	48
ID	beans, dry field	0	0
ID	corn	78	157
ID	fallow	0	0
ID	grass (hay or pasture)	103	137
ID	oats, spring	56	55
ID	potatoes	103	229
ID	rye	130	83
ID	sorghum	43	100
ID	soybeans	20	18
ID	wheat, spring	83	130
ID	wheat, winter	103	137
IL	alfalfa	0	0
IL	barley, spring	45	54
IL	beans, dry field	0	0
IL	corn	157	175
IL	fallow	0	0
IL	grass (hay or pasture)	98	93
IL	millet	108	122
IL	oats, spring	50	55
IL	oats, winter	55	50
IL	potatoes	103	211
IL	rye	120	68
IL	sorghum	108	122

IL	soybeans	17	17
IL	sunflower	98	93
IL	tomatoes	157	175
IL	wheat, spring	68	120
IL	wheat, winter	98	93
IN	alfalfa	0	0
IN	beans, dry field	0	0
IN	corn	150	175
IN	fallow	0	0
IN	grass (hay or pasture)	97	93
IN	oats, spring	34	55
IN	oats, winter	55	34
IN	potatoes	103	211
IN	rye	120	68
IN	sorghum	108	122
IN	soybeans	23	23
IN	sunflower	97	93
IN	tomatoes	150	175
IN	wheat, spring	68	120
IN	wheat, winter	97	93
KS	alfalfa	0	0
KS	barley, spring	54	54
KS	barley, winter	54	54
KS	beans, dry field	0	0
KS	corn	116	199
KS	cotton	82	100
KS	fallow	0	0
KS	grass (hay or pasture)	57	80
KS	millet	71	95
KS	oats, spring	54	54
KS	oats, winter	54	54
KS	potatoes	79	209
KS	rye	120	70
KS	sorghum	71	95
KS	soybeans	17	22
KS	sunflower	57	80
KS	wheat, spring	70	120
KS	wheat, winter	57	80
KY	alfalfa	0	0
KY	barley, spring	45	54
KY	barley, winter	54	45
KY	corn	163	167
KY	cotton	84	100

KY	fallow	0	0
KY	grass (hay or pasture)	109	93
KY	sorghum	74	100
KY	soybeans	33	34
KY	sunflower	109	93
KY	wheat, winter	109	93
LA	alfalfa	0	0
LA	corn	119	167
LA	cotton	81	85
LA	fallow	0	0
LA	grass (hay or pasture)	112	93
LA	millet	74	100
LA	oats, spring	56	55
LA	peanuts	25	50
LA	rice	112	170
LA	rye	120	68
LA	sorghum	74	100
LA	soybeans	15	25
LA	sunflower	112	93
LA	wheat, spring	68	120
LA	wheat, winter	112	93
MA	alfalfa	0	0
MA	corn	82	167
MA	fallow	0	0
MA	grass (hay or pasture)	61	93
MA	potatoes	145	127
MA	rye	120	68
MD	alfalfa	0	0
MD	barley, spring	42	54
MD	barley, winter	54	42
MD	beans, dry field	0	0
MD	corn	82	167
MD	fallow	0	0
MD	grass (hay or pasture)	61	93
MD	oats, spring	32	55
MD	oats, winter	55	32
MD	potatoes	145	127
MD	rye	120	68
MD	sorghum	74	100
MD	soybeans	19	19
MD	tomatoes	82	167
MD	wheat, winter	61	93
ME	barley, spring	42	54

ME	corn	82	167
ME	grass (hay or pasture)	61	93
ME	oats, spring	32	55
ME	potatoes	170	183
ME	rye	120	68
ME	soybeans	19	19
ME	wheat, spring	68	120
MI	alfalfa	0	0
MI	barley, spring	53	54
MI	beans, dry field	0	0
MI	corn	119	136
MI	fallow	0	0
MI	grass (hay or pasture)	95	93
MI	oats, spring	33	33
MI	potatoes	133	187
MI	rye	120	90
MI	sorghum	74	100
MI	soybeans	17	17
MI	sunflower	95	93
MI	tomatoes	119	136
MI	wheat, spring	90	120
MI	wheat, winter	95	93
MN	alfalfa	0	0
MN	barley, spring	62	54
MN	beans, dry field	0	0
MN	corn	116	136
MN	fallow	0	0
MN	grass (hay or pasture)	94	93
MN	millet	74	100
MN	oats, spring	52	52
MN	potatoes	42	186
MN	rye	120	90
MN	sorghum	74	100
MN	soybeans	17	17
MN	sunflower	94	93
MN	wheat, spring	90	120
MN	wheat, winter	94	93
MO	alfalfa	0	0
MO	barley, spring	45	54
MO	barley, winter	54	45
MO	corn	142	185
MO	cotton	99	111
MO	fallow	0	0

MO	grass (hay or pasture)	99	93
MO	millet	108	122
MO	oats, spring	34	55
MO	peanuts	25	50
MO	potatoes	103	211
MO	rice	99	208
MO	rye	120	68
MO	sorghum	108	122
MO	soybeans	18	18
MO	sunflower	99	93
MO	wheat, winter	99	93
MS	corn	119	167
MS	cotton	107	115
MS	fallow	0	0
MS	grass (hay or pasture)	112	93
MS	millet	74	100
MS	oats, spring	56	55
MS	peanuts	25	50
MS	rice	112	189
MS	rye	120	68
MS	sorghum	74	100
MS	soybeans	17	18
MS	sunflower	112	93
MS	wheat, winter	112	93
MT	alfalfa	0	0
MT	barley, spring	29	65
MT	beans, dry field	0	0
MT	corn	78	157
MT	fallow	0	0
MT	grass (hay or pasture)	51	116
MT	millet	43	100
MT	oats, spring	56	55
MT	potatoes	103	228
MT	rye	58	47
MT	sorghum	43	100
MT	soybeans	20	18
MT	sunflower	51	116
MT	wheat, spring	47	58
MT	wheat, winter	51	116
NC	barley, spring	45	54
NC	barley, winter	54	45
NC	beans, dry field	0	0
NC	corn	126	167

NC	cotton	76	100
NC	fallow	0	0
NC	grass (hay or pasture)	109	93
NC	millet	74	100
NC	oats, spring	56	55
NC	peanuts	19	50
NC	potatoes	103	211
NC	rye	120	68
NC	sorghum	74	100
NC	soybeans	27	27
NC	sunflower	109	93
NC	tomatoes	126	167
NC	wheat, winter	109	93
ND	alfalfa	0	0
ND	barley, spring	56	54
ND	beans, dry field	0	0
ND	corn	111	165
ND	fallow	0	0
ND	grass (hay or pasture)	57	80
ND	millet	72	95
ND	oats, spring	48	49
ND	potatoes	79	209
ND	rye	120	70
ND	sorghum	72	95
ND	soybeans	19	17
ND	sunflower	57	80
ND	wheat, spring	70	120
ND	wheat, winter	57	80
NE	alfalfa	0	0
NE	barley, spring	54	54
NE	beans, dry field	0	0
NE	corn	106	158
NE	fallow	0	0
NE	grass (hay or pasture)	48	61
NE	millet	76	95
NE	oats, spring	49	50
NE	oats, winter	50	49
NE	potatoes	79	209
NE	rye	120	70
NE	sorghum	76	95
NE	soybeans	13	17
NE	sunflower	48	61
NE	wheat, spring	70	120

NE	wheat, winter	48	61
NH	grass (hay or pasture)	61	93
NJ	alfalfa	0	0
NJ	barley, spring	42	54
NJ	beans, dry field	0	0
NJ	corn	82	167
NJ	fallow	0	0
NJ	grass (hay or pasture)	61	93
NJ	oats, spring	27	55
NJ	potatoes	145	127
NJ	rye	120	68
NJ	sorghum	74	100
NJ	soybeans	19	19
NJ	tomatoes	82	167
NJ	wheat, winter	61	93
NM	alfalfa	0	0
NM	barley, spring	38	52
NM	barley, winter	52	38
NM	beans, dry field	0	0
NM	corn	78	157
NM	cotton	82	136
NM	fallow	0	0
NM	grass (hay or pasture)	52	116
NM	millet	43	100
NM	oats, spring	56	55
NM	oats, winter	55	56
NM	peanuts	25	50
NM	rye	119	48
NM	sorghum	43	100
NM	sunflower	52	116
NM	wheat, spring	48	119
NM	wheat, winter	52	116
NV	alfalfa	0	0
NV	barley, spring	38	52
NV	corn	78	157
NV	fallow	0	0
NV	grass (hay or pasture)	52	116
NV	oats, spring	56	55
NV	potatoes	103	228
NV	wheat, spring	48	119
NV	wheat, winter	52	116
NY	alfalfa	0	0
NY	barley, spring	42	54

NY	beans, dry field	0	0
NY	corn	76	167
NY	fallow	0	0
NY	grass (hay or pasture)	61	93
NY	oats, spring	32	55
NY	potatoes	122	110
NY	rye	120	68
NY	sorghum	74	100
NY	soybeans	19	19
NY	sunflower	61	93
NY	wheat, spring	68	120
NY	wheat, winter	61	93
OH	alfalfa	0	0
OH	barley, spring	45	54
OH	barley, winter	54	45
OH	beans, dry field	0	0
OH	corn	158	175
OH	fallow	0	0
OH	grass (hay or pasture)	92	93
OH	oats, spring	34	55
OH	potatoes	103	211
OH	rye	120	68
OH	sorghum	108	122
OH	soybeans	13	13
OH	sunflower	92	93
OH	tomatoes	158	175
OH	wheat, spring	68	120
OH	wheat, winter	92	93
OK	alfalfa	0	0
OK	barley, spring	45	54
OK	barley, winter	54	45
OK	beans, dry field	0	0
OK	corn	115	190
OK	cotton	60	82
OK	fallow	0	0
OK	grass (hay or pasture)	62	87
OK	millet	78	99
OK	oats, spring	83	83
OK	peanuts	35	74
OK	potatoes	103	211
OK	rye	120	68
OK	sorghum	78	99
OK	soybeans	20	18

OK	sunflower	62	87
OK	wheat, spring	68	120
OK	wheat, winter	62	87
OR	alfalfa	0	0
OR	barley, spring	63	102
OR	beans, dry field	0	0
OR	corn	130	167
OR	fallow	0	0
OR	grass (hay or pasture)	67	112
OR	oats, spring	56	55
OR	potatoes	103	203
OR	rye	122	59
OR	sorghum	74	100
OR	soybeans	20	18
OR	sunflower	67	112
OR	wheat, spring	59	122
OR	wheat, winter	67	112
PA	alfalfa	0	0
PA	barley, spring	42	54
PA	barley, winter	54	42
PA	beans, dry field	0	0
PA	corn	87	167
PA	fallow	0	0
PA	grass (hay or pasture)	61	93
PA	oats, spring	35	55
PA	oats, winter	55	35
PA	potatoes	106	127
PA	rye	120	68
PA	sorghum	74	100
PA	soybeans	19	19
PA	sunflower	61	93
PA	tomatoes	87	167
PA	wheat, winter	61	93
RI	corn	82	167
RI	grass (hay or pasture)	61	93
SC	barley, spring	45	54
SC	beans, dry field	0	0
SC	corn	119	167
SC	cotton	87	96
SC	fallow	0	0
SC	grass (hay or pasture)	96	93
SC	millet	74	100
SC	oats, spring	56	55

SC	oats, winter	55	56
SC	peanuts	21	31
SC	rye	120	68
SC	sorghum	74	100
SC	soybeans	20	18
SC	sunflower	96	93
SC	wheat, winter	96	93
SD	alfalfa	0	0
SD	barley, spring	54	54
SD	beans, dry field	0	0
SD	corn	98	146
SD	fallow	0	0
SD	grass (hay or pasture)	58	80
SD	millet	63	95
SD	oats, spring	49	47
SD	potatoes	79	209
SD	rye	120	67
SD	sorghum	63	95
SD	soybeans	20	17
SD	sunflower	58	80
SD	wheat, spring	67	120
SD	wheat, winter	58	80
TN	alfalfa	0	0
TN	beans, dry field	0	0
TN	corn	149	167
TN	cotton	91	100
TN	fallow	0	0
TN	grass (hay or pasture)	109	93
TN	oats, winter	55	56
TN	rice	109	182
TN	rye	120	68
TN	sorghum	74	100
TN	soybeans	21	21
TN	sunflower	109	93
TN	wheat, winter	109	93
TX	alfalfa	0	0
TX	barley, spring	45	54
TX	barley, winter	54	45
TX	beans, dry field	0	0
TX	corn	115	190
TX	cotton	60	82
TX	fallow	0	0
TX	grass (hay or pasture)	64	95

TX	millet	79	98
TX	oats, spring	83	83
TX	oats, winter	83	83
TX	peanuts	35	74
TX	potatoes	103	211
TX	rice	64	194
TX	rye	120	68
TX	sorghum	79	98
TX	soybeans	20	18
TX	sunflower	64	95
TX	wheat, spring	68	120
TX	wheat, winter	64	95
US	grass (hay or pasture)	76	98
UT	alfalfa	0	0
UT	barley, spring	38	52
UT	barley, winter	52	38
UT	corn	78	157
UT	fallow	0	0
UT	grass (hay or pasture)	52	116
UT	oats, spring	56	55
UT	potatoes	103	228
UT	rye	119	48
UT	sorghum	43	100
UT	wheat, spring	48	119
UT	wheat, winter	52	116
VA	alfalfa	0	0
VA	barley, spring	45	54
VA	barley, winter	54	45
VA	beans, dry field	0	0
VA	corn	149	167
VA	cotton	84	100
VA	fallow	0	0
VA	grass (hay or pasture)	109	93
VA	millet	74	100
VA	oats, spring	56	55
VA	peanuts	19	50
VA	potatoes	103	211
VA	rye	120	68
VA	sorghum	74	100
VA	soybeans	16	16
VA	sunflower	109	93
VA	tomatoes	149	167
VA	wheat, winter	109	93

VT	alfalfa	0	0
VT	corn	82	167
VT	fallow	0	0
VT	grass (hay or pasture)	61	93
VT	oats, spring	32	55
VT	soybeans	19	19
VT	wheat, spring	68	120
VT	wheat, winter	61	93
WA	alfalfa	0	0
WA	barley, spring	67	102
WA	beans, dry field	0	0
WA	corn	130	167
WA	fallow	0	0
WA	grass (hay or pasture)	67	137
WA	oats, spring	56	55
WA	potatoes	103	259
WA	sorghum	74	100
WA	soybeans	20	18
WA	sunflower	67	137
WA	wheat, spring	74	149
WA	wheat, winter	67	137
WI	alfalfa	0	0
WI	barley, spring	25	54
WI	barley, winter	54	25
WI	beans, dry field	0	0
WI	corn	90	136
WI	fallow	0	0
WI	grass (hay or pasture)	94	93
WI	millet	74	100
WI	oats, spring	22	22
WI	oats, winter	22	22
WI	potatoes	69	193
WI	rye	120	90
WI	sorghum	74	100
WI	soybeans	13	15
WI	sunflower	94	93
WI	wheat, spring	90	120
WI	wheat, winter	94	93
WV	alfalfa	0	0
WV	barley, spring	45	54
WV	barley, winter	54	45
WV	corn	149	167
WV	fallow	0	0

WV	grass (hay or pasture)	109	93
WV	oats, winter	55	56
WV	sorghum	74	100
WV	soybeans	29	29
WV	wheat, winter	109	93
WY	alfalfa	0	0
WY	barley, spring	38	52
WY	beans, dry field	0	0
WY	corn	78	157
WY	fallow	0	0
WY	grass (hay or pasture)	53	116
WY	millet	43	100
WY	oats, spring	56	55
WY	potatoes	103	228
WY	rye	119	48
WY	sorghum	43	100
WY	soybeans	20	18
WY	sunflower	53	116
WY	wheat, spring	48	119
WY	wheat, winter	53	116

APPENDIX III: Sample COMET-Farm API Input File

Below is an example of a COMET-Farm API (application programming interface) xml input file. This example represents a single point and conservation scenario.


```
<Day cometEmailId="mark.easter@colostate.edu">
    Cropland name="module:cropland|id:1012097|irrigated:N|mlra:17|practice:Intensive Tillage to No Tillage or Strip
    Tillage|crop2009:cotton|crop2010:alfalfa|crop2011:cotton|crop2012:cotton|crop2013:alfalfa|crop2014:alfalfa|crop2015:alfalfa">
        <GEOM SRID="4326" AREA="10">POINT(-119.559 35.4519)</GEOM>
        <Pre-1980>Upland Non-Irrigated (Pre 1980s)</Pre-1980>
        <CRP>None</CRP>
        <CRPStartYear></CRPStartYear>
        <CRPEndYear></CRPEndYear>
        <CRPType>None</CRPType>
        <Year1980-2000>Non-Irrigated: Spring Wheat-Mechanical Fallow</Year1980-2000>
        <Year1980-2000_Tillage>Intensive Tillage</Year1980-2000_Tillage>
        <CropScenario Name="Current">
            <CropYear Year="2000">
                <Crop CropNumber="1">
                    <CropName>alfalfa</CropName>
                    <PlantingDate>01/03/2000</PlantingDate>
                    <ContinueFromPreviousYear>Y</ContinueFromPreviousYear>
                    <HarvestList>
                        <HarvestEvent>
                            <HarvestDate>02/15/2000</HarvestDate>
                            <Grain>No</Grain>
                            <yield>6.9</yield>
                            <StrawStoverHayRemoval>50</StrawStoverHayRemoval>
                        </HarvestEvent>
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                        </HarvestEvent>
                        <HarvestEvent>
                            <HarvestDate>11/11/2000</HarvestDate>
```

```
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                        <StrawStoverHayRemoval>50</StrawStoverHayRemoval>
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                    <HarvestEvent>
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                        <Grain>No</Grain>
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                    </HarvestEvent>
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                    </TillageEvent>
                </TillageList>
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                        <NApplicationMethod>Surface Band /Sidedress</NApplicationMethod>
                        <EEP>None</EEP>
                    </NApplicationEvent>
                </NApplicationList>
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                </IrrigationList>
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        </CropYear>
        <CropYear Year="2001">
            <Crop CropNumber="1">
                <CropName>alfalfa</CropName>
                <PlantingDate>01/03/2001</PlantingDate>
                <ContinueFromPreviousYear>Y</ContinueFromPreviousYear>
                <HarvestList>
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                        <yield>6.9</yield>
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