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 4.0*)

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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 and ranches. 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, NRCS conservation practices may also support regenerative agriculture and atmospheric/climate benefits, through carbon sequestration and/or reduction of greenhouse gas (GHG) emissions. If conservation planners wish to incorporate these benefits into their planning process, agricultural producers will need access to quick, easy-to-use tools to assess carbon and 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, site-specific analyses of an individual farm's or ranch's carbon and greenhouse gas dynamics 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. Since the first version of COMET-Planner was published in January 2015, several changes and updates were incorporated and published through documented versioning:

- Version 1 (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).
- Version 2 (April 2019): The team 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.

- Version 3 (September 2022): This version followed the same general modeling approach as was used in Version 2, however an updated version of the DayCent model was used that simulates a soil depth of 30 cm for soil organic carbon and soil nitrous oxide (prior DayCent version simulated to 20 cm). An update to this version was published in December 2023 with revised agroforestry biomass carbon methodology and estimates (see Estimation Methods – Woody Biomass Carbon).
- Version 4: The current version of COMET-Planner aligns with the second edition of the USDA Quantifying Greenhouse Gas Fluxes: Methods for Entity-Scale Inventory released in April 2024 (Hanson et al. 2024). The second edition of the methods guidance prescribes a revised DayCent model version and includes methodology for evaluating Enhanced Efficiency Fertilizers, among other changes.

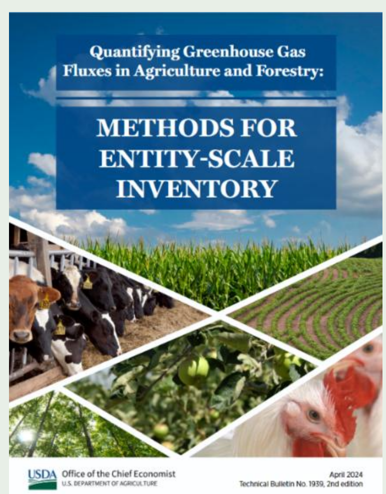
Conservation Scenarios

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. However, in the current version additional no-till baselines were added to conservation scenarios. 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 21).

Estimation Methods

Since 2015, the COMET-Farm tool has been fully aligned with the first edition of the USDA Methods for Entity-Scale Inventory (Eve et al. 2014) (Box 1).

Box 1: **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 first edition was released in 2014 and was the methodological basis for COMET-Planner Versions 2 & 3 (2019-2025). The second edition was released in 2024 and is the methodological basis for COMET-Planner Version 4 (2025).

A major version change to COMET-Farm was released in September 2024 that aligned the tool with the second edition of the USDA Methods for Entity-Scale Inventory (Hanson et al 2024). COMET-Planner was first aligned with the USDA Methods for Entity-Scale Inventory in 2019 and the current version aligns with the second edition, released in 2024. COMET-Planner estimates carbon fluxes and GHG emissions changes from the following source categories: soil carbon, direct and indirect N_2O emissions, and woody biomass carbon. Methods provided by the USDA Methods for Entity-Scale Inventory for those source categories are described in Table 1.

Estimation Methods descriptions in this report are separated into sections for Soil Carbon and Soil Nitrous Oxide, Woody Biomass Carbon, and Hawaii Quantification Methods (relying on IPCC Tier 1 & 2 approaches).

Table 1. Overview of Sources and Selected GHG Estimation Methods for Cropland and Grazing Land Systems (adapted from Table 3-2 in Hanson et al. (2024)).

Source	Method
Biomass carbon stock changes	Woody plant growth and losses in agroforestry or perennial tree crops are estimated with an IPCC Tier 3 method, using a measurement-based approach with entity input. Other woody perennial crops are estimated with the IPCC Tier 1 method (Ogle et al., 2019b).
Soil organic carbon (SOC) stocks for mineral soils	An IPCC Tier 3 method is used to estimate the SOC stock changes to a 30 cm depth for most crops and mineral soils using the DayCent process-based model (See U.S. EPA, 2020 for information about the Tier 3 model). SOC stock changes for other crops and mineral soil types are estimated with an IPCC Tier 2 method to a 30 cm depth (Ogle et al., 2003). Biochar soil amendments impacts on SOC are estimated with a Tier 2 method (Ogle et al., 2019a; Woolf et al., 2021).
Direct N_2O emissions from mineral soils	The direct N_2O emissions are estimated with an IPCC Tier 3 method using the DayCent process-based model for most crops and grazing lands (U.S. EPA, 2020). Other crops are estimated with an adapted IPCC Tier 1 method (Hergoualc'h et al., 2019) that includes some scaling of emissions for select practices, including nitrification inhibitors, biochar or slow-release fertilizers, and no-till adoption.
Indirect N_2O emissions	Indirect soil N_2O emissions are estimated with the IPCC Tier 1 method (Hergoualc'h et al., 2019).

The USDA Methods for Entity-Scale Inventory (Hanson et al. 2024) also provided methodologies for estimating the following source categories in croplands and grasslands:

- CO_2 emissions from biomass burning, liming, urea fertilization, and drained organic soils
- CO emissions from biomass burning
- N_2O emissions from biomass burning, and drained organic soils
- CH_4 emissions from soil, wetland rice cultivation and biomass burning

Those source categories were not estimated in COMET-Planner because practices leading to those emissions were not simulated (e.g. residue burning, liming, or wetland rice cultivation) and organic soils were excluded from the analysis. Dynamics of carbon and nitrogen cycles in organic soils, and the impact of management practices on those cycles, differs from agriculture on non-flooded, mineral soils. Users interested in evaluating effects of burning, liming, or flooded rice should use COMET-Farm.

Soil Carbon and Soil Nitrous Oxide

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 utilizing DayCent and the USDA methods employed in COMET-Farm.

The spatial units of the analysis to derive estimates for COMET-Planner were county-rectified Major Land Resource Areas (Figure 1), using 2024 county boundaries. 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 2022). Prior versions of COMET-Planner utilized the 2006 MLRA layer. In the conterminous (48-state) US, there are 212 individual county-rectified MLRAs.

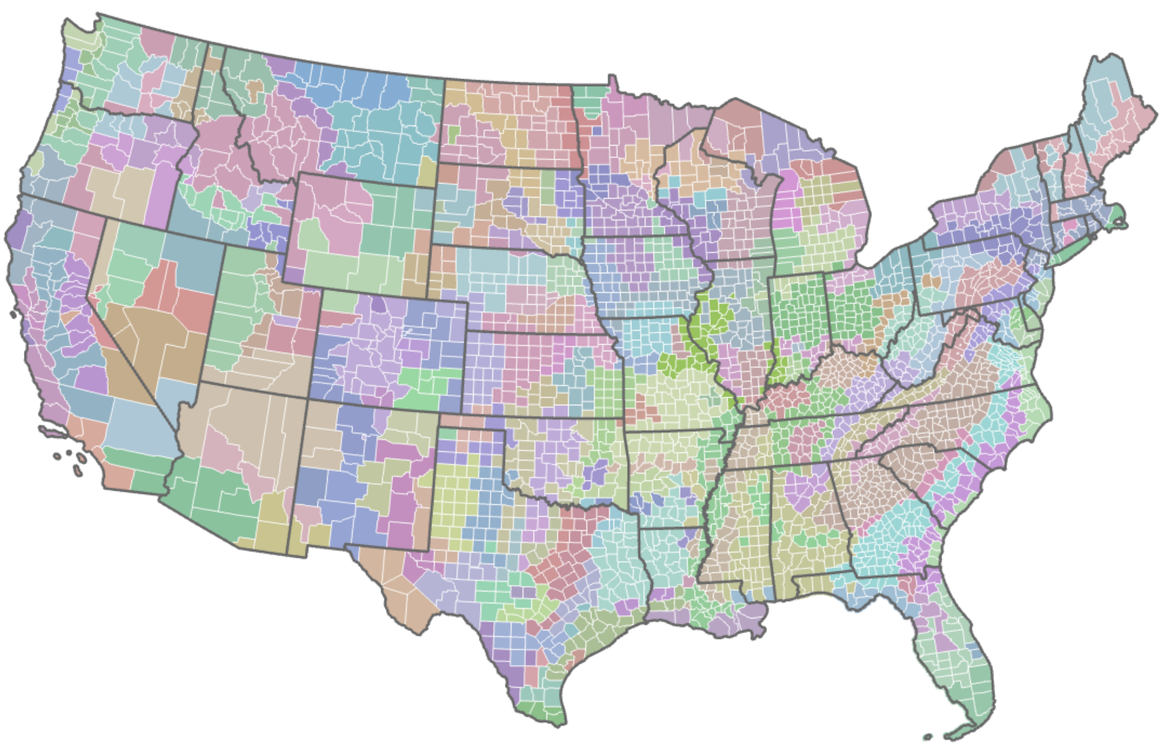


Figure 1. U.S. counties in the conterminous U.S., grouped by Major Land Resource Areas.

Within each county-rectified MLRA, the COMET-Planner team developed a unique random point sample targeting approximately 300 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 51,817 cropland points and 39,709 grassland points, which represented a doubling of sample sizes over prior versions of COMET-Planner.

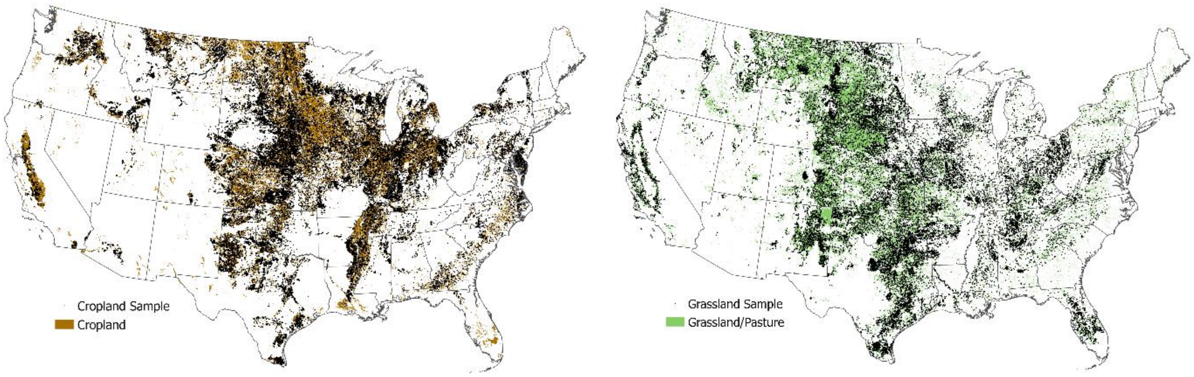


Figure 2. Random point samples used in the modeling for croplands (left) and grasslands (right).

For each point, recent land use was determined by extracting land cover from Cropland Data Layers (CDL) for 2009-2024 (USDA-NASS 1990-2024). Analysis was restricted to crops that can be modeled in DayCent, as defined in Hanson et al. (2024), which includes most common grain and row crops and excludes most specialty crops and orchard/vineyard crops. For cropland land uses, crop rotations were constructed from the cropping sequence provided in CDL. 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 DayCent (version Rev491) (Figure 3). The future baseline and conservation scenarios were modeled for 10 years and conservation practices were implemented every year unless the practice description states otherwise. The DayCent version utilized in this version of COMET-Planner is the same as that currently deployed in the COMET-Farm tool, as advised in Hanson et al (2024).

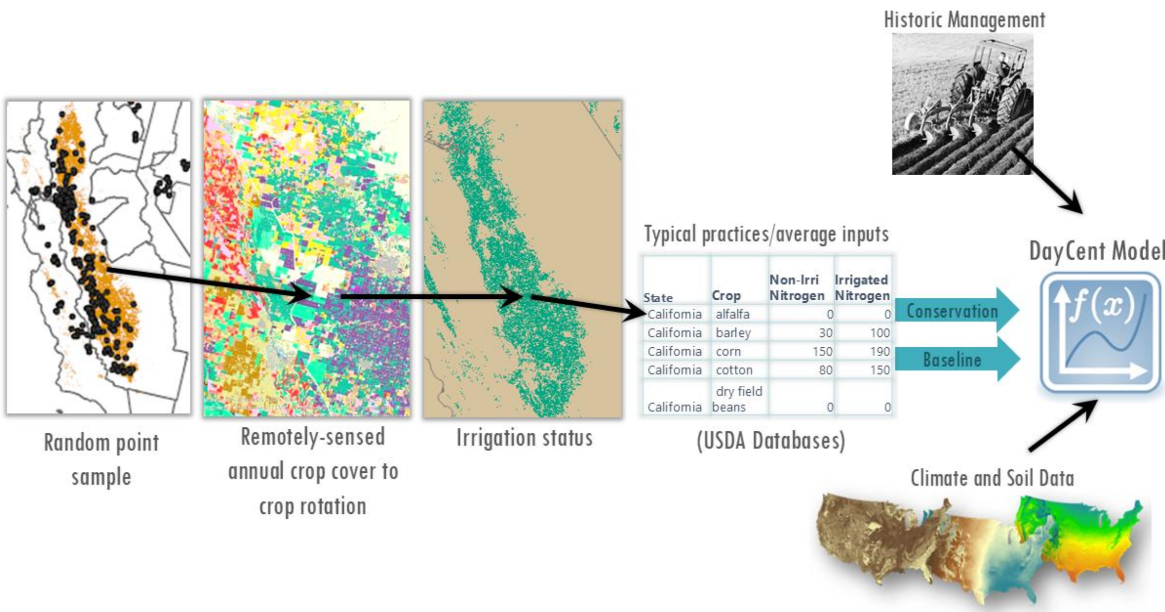


Figure 3. An overview of the process of building the model runs conducted in DayCent.

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 terminology), such as process-based modeling in DayCent and regionally-specific empirical calculations (Table 1). Methods for N_2O from leaching and runoff (part of indirect soil N_2O soil emissions) deviate from the USDA Methods for Entity-Scale Inventory guidance and instead follow methodology used in the U.S. National Greenhouse Gas Inventory (EPA 2024). Under this method, the amount of leached nitrogen was estimated from the DayCent model and then an emission factor was applied to estimate the fraction of nitrogen leached that was converted to N_2O. This method was selected over the Hanson et al. (2024) empirical method for leaching and runoff, due to limitations in the method to account for the effects of permanent grassland and application of enhanced efficiency fertilizer products.

Outputs from COMET-Farm were processed by averaging all samples to generate a mean emission at the county-rectified MLRA scale for the baseline and conservation scenario and calculating a difference in emissions between the conservation scenario and baseline for each conservation practice. There are a small number of annual cropland and grassland practices for which the Tier 3 DayCent modeling approach could not be used and instead relied on meta-analyses or Tier 2 methods. Brief descriptions of quantification methods are noted in each practice one-page summary. In addition to the mean estimate, the COMET-Planner downloadable dataset 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 and standard errors that similarly represent the range of modeling conditions. Neither set of estimates represents uncertainty of the modeled estimates relative to observations.

Woody Biomass Carbon

Agroforestry biomass carbon estimates were updated in COMET-Planner Version 3.1 (Build 1) to align with the newly released 2nd edition of “Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory” (Hanson et al. 2024). These estimates were not updated in Version 4 and therefore woody biomass carbon estimates remain the same as in the prior version. The updated methods guidance provides an approach to estimate biomass C from diameter at breast height (DBH), following an allometric modeling method derived from Chojnacky et al. (2014). Woodland species diameters are given at root collar, though throughout the methods discussion, the term DBH will generally be used. The biomass models are provided by taxon groups, which are at the family or genus level (Appendix IV, Tables 1-3). Guidance in Hanson et al. (2024) describes a method to determine DBH from a plot survey and DBH measurements, assuming the agroforestry system already exists. However, for the purposes of COMET-Planner, DBH must be estimated without plot measurements. Hanson et al. (2024) does not provide a specific method for predictive modeling of DBH but does recommend using the U.S. Forest Service Forest Inventory Analysis (FIA) database to develop growth increment models.

For use in the COMET tools, the team developed simple DBH over age linear regression models, aggregated for USDA Land Resource Regions (LRR) (USDA-NRCS 2006) and utilizing USFS FIA Database Version 1.9.0.02 (USDA-USFS 2023). Models were developed for the same taxon groups given in Hanson et al. (2024) (Appendix IV, Tables 1-3), for LRRs where those taxon groups exist in FIA and where taxa are present in agroforestry prescriptions. The COMET team discussed alternative approaches, such as selecting trees from FIA tables based on plot site conditions, but ultimately decided there was not sufficient measurement data from actual agroforestry systems to draw analogies between forested site conditions and trees planted in agricultural landscapes. The analysis was also limited in covariates since there is limited site-specific information available in COMET-Planner to drive models.

FIA provides data on age and DBH in two tables; the TREE and SITE_TREE tables. Observations from the SITE_TREE table were used, as that data represents dominant trees on a FIA survey plot. Planted agroforestry systems are open-grown, meaning that trees are planted so that each tree has sufficient light and generally do not have understory trees. Therefore, in most agroforestry systems, all trees are ‘dominant’ trees. However, for a few woodland taxon groups (Cupressaceae, Fagaceae deciduous and evergreen), there were not sufficient observations in the SITE_TREE table, so data was used from the TREE table. In the dataset, DBH was filtered to include trees with diameters between 1 and 100 inches, and age was filtered to include trees between 1 and 200 years old. The species available in FIA and used in the models for each LRR/taxon group are listed in Appendix IV, Table 4. Taxon group/LRR models were developed according to the presence of taxon groups within USDA NRCS agroforestry prescriptions by region. The team did not develop models for all taxon groups, in all regions. This work resulted in 108 unique growth models across taxa and LRRs. See Equation 1 for the linear model used to predict DBH from age and Appendix IV, Table 5 for all model parameter values. Most taxon groups were log-transformed for DBH and age prior to model fitting, however a few taxon groups were not log-transformed for DBH. See Appendix IV, Table 5 for notation on which taxon groups were not log-transformed. As can be seen in Appendix IV, Table 5, the sample size for some taxon groups/LRRs was very small, so only models with 20 or more observations were used. If a taxon group was needed for prescriptions in an LRR but there was not a sufficient sample in the FIA, a model from a neighboring LRR was used.

Equation 1: Tree DBH predicted from tree age

$$ln(\text{DBH}) = \beta_0 + \beta_1(\ln(\text{age}))$$

Where:

DBH = diameter at breast height for each stem (inches)

β_0 and β_1 = model parameters for each stem (see Appendix X, Table X)

Age = the age of the stem in (years)

ln = natural log base "e" (2.718282)

The team applied the DBH model to predict tree DBH for taxon groups up to age 50. These DBH values were combined with the Hanson et al. (2024) methods to predict aboveground and belowground biomass. All biomass carbon methods for cropland and grazing lands (i.e. trees outside of forests) are located in Hanson et al. (2024) Chapter 3 (see Equations 3-4, 3-5, and 3-6). The final result was a total carbon stock per stem for a given age. To produce an annual increment, the stock in year 50, minus the stock in year 1 or the first year to have a minimum DBH of 1 inch (2.5 centimeters) were used, and divided by the number of years between those values. It should be noted that woody biomass carbon estimates in COMET-Planner only account for standing tree components and do not account for dead or downed wood, or surface litter at this time.

Agroforestry Systems and Prescriptions

COMET-Planner data should be viewed as a continuum, growing upon previous findings and improving conservation prescriptions over time. With consultation from national and regional foresters over the past decade, NRCS has developed conservation practice standards and standardized prescriptions (by region) for the following agroforestry systems: alley cropping (CPS 311), forest farming (CPS 379), hedgerow planting (CPS 422), riparian forest buffers (CPS 391), silvopasture (CPS 381), tree/shrub establishment (CPS 612) and windbreak/shelterbelt establishment/renovation (380). In order to predict biomass accumulation of agroforestry systems over time and by region, NRCS and Colorado State University compiled common tree types and planting configurations (planting density or number of rows and between/within row spacing) via telephone interviews with NRCS foresters and literature reviews (Merwin et al. 2009, and personal discussions 2015-present). The results are referred to in this report as the "agroforestry prescriptions" and are meant to provide generic systems for the purposes of conservation planning and approximating the impact of these conservation practices on woody biomass carbon sequestration (Appendix IV, Table 6). As with other conservation practice standards examined in COMET-Planner, actual NRCS conservation prescriptions will vary locally and be designed to meet site-level conservation planning objectives. Agroforestry prescriptions developed by Merwin et al. (2009), consultation from Craig Ziegler (2013), and personal discussions 2013-present, have varied by LRR in both their presence/absence, planting configuration, and tree species. NRCS conservation practice prescriptions and narrative information was not available for all conservation practice standards in all regions, either because they were not suitable or not used in a region at the time of the survey or information on implementation was not available. If users note a system that is common in their region, but is not available in COMET-Planner, they may recommend practice data (conservation practice standard, system of conservation practice implementation, planting configuration, tree spacing, tree types, and other conservation practice data) by sending this information to appnrel@colostate.edu for potential addition to the COMET-Planner tool in future versions. Users may also design and assess their own agroforestry systems in COMET-Farm (www.comet-farm.com) by specifying tree type(s), planting densities and ages or DBH.

The tree-level woody biomass accumulation models were combined with the agroforestry prescriptions to estimate system level woody biomass carbon accumulation on a per acre per year basis. Figure 4 illustrates how tree-level biomass carbon estimates are combined with agroforestry prescriptions to estimate agroforestry system biomass carbon per acre. In COMET-Planner, total acres of the agroforestry system are provided by users. COMET-Planner includes 93 unique agroforestry systems over the 26 Land Resource Regions (LRRs) within the conterminous U.S.

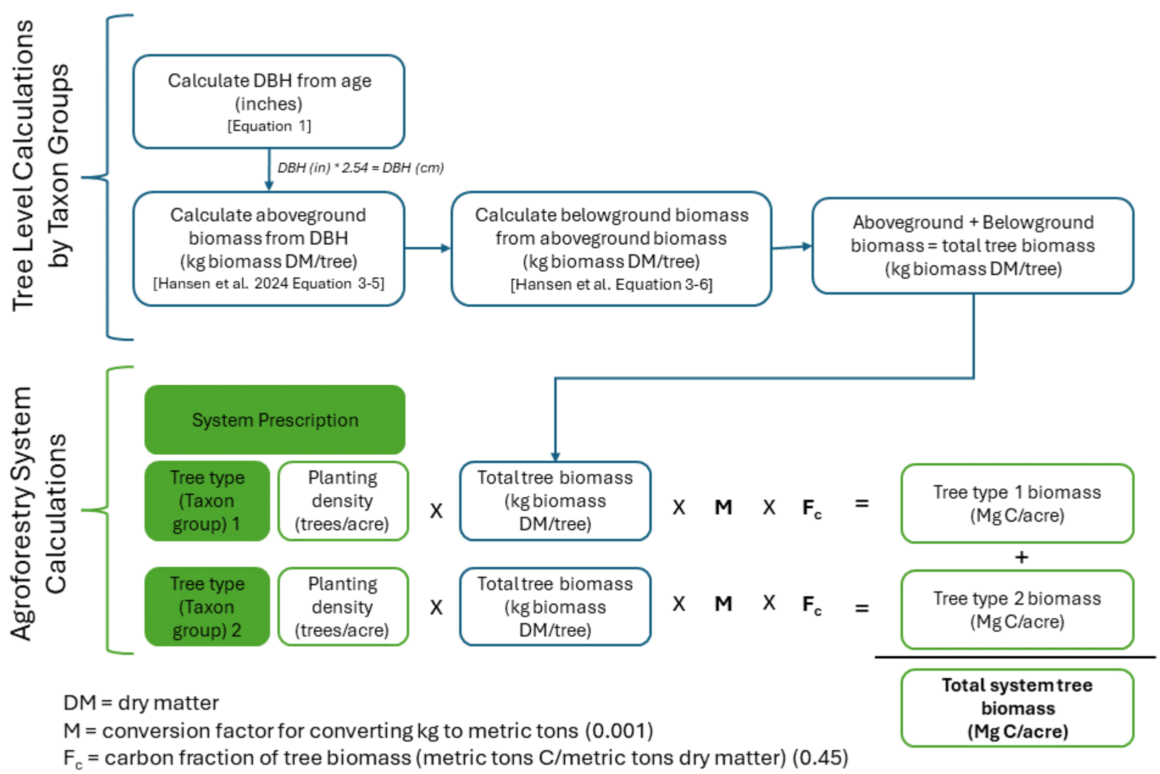


Figure 4. An overview of how woody biomass carbon stocks were estimated for agroforestry systems in COMET-Planner.

Hawaii Quantification Methods

COMET-Farm and the COMET-Farm API were not available for Hawaii at the time of the COMET-Planner analysis, therefore the team 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, the 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) were deployed. 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, the team 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 5). Analyses were limited to annual cropland and pasture land uses.

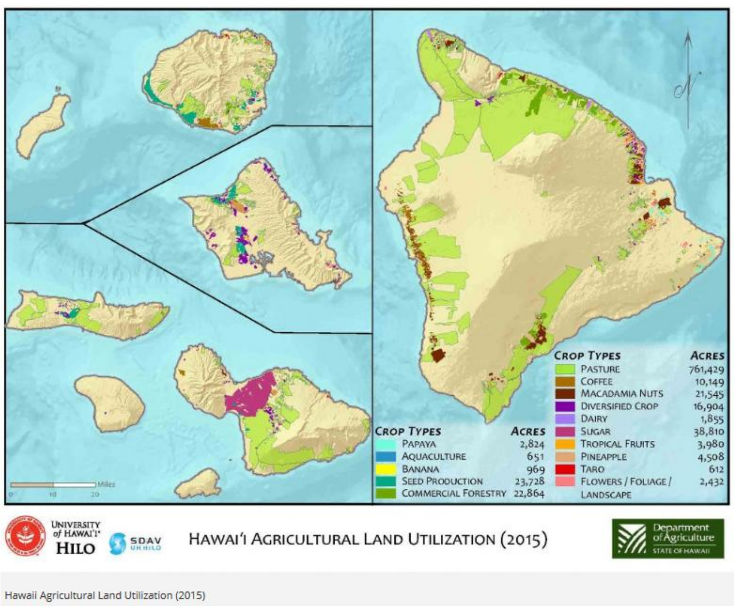


Figure 5. Hawai'I Agricultural Land Use Baseline, 2015.

Broad climate zones were classified according to the classification scheme provided in the IPCC 2006 Guidance (IPCC 2006) from global weather datasets (Figure 6). 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 6).

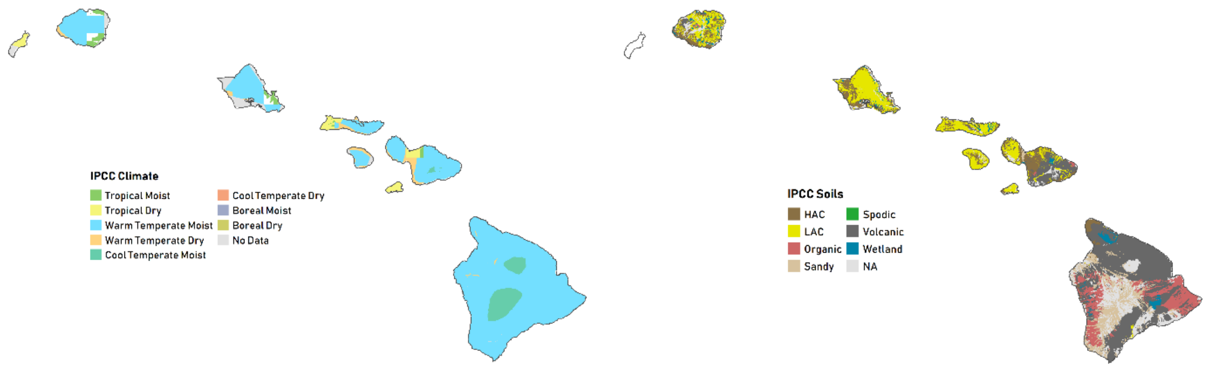


Figure 6. IPCC climate zones (left) and IPCC soil types (right) for Hawaii (HAC = High activity clay; LAC = Low activity clay).

Once unique intersections of land use, climate and soil were complete, reference carbon stocks were assigned to each polygon. To the extent possible, the team 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). Consistent with the IPCC guidelines, SOC stock changes are assumed to occur over 20 years with this method; therefore annual change was estimated 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, the team was 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. A generalized baseline application rate of 178 lbs N/ac/yr (200 kg N/ha/yr) was assumed, 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 or carbon removal 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. IMPORTANT: The COMET-Planner carbon sequestration and GHG reductions reported in the tool should be viewed as average annual values over a 10-year duration. The conservation practices are considered to be fully implemented during this timeframe, and reversals (human or natural disruptions) are not considered. The COMET-Planner results are intended to help conservation planners, and actual results for an individual parcel may vary based on soil, weather, etc.

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 (1 Megagram (Mg) = 1 Metric Tonnes)
Megagrams or Metric Tonnes are equivalent to 1000 kilograms. An English (or 'short') tons equals 2,000 pounds; 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 Hanson et al. (2024), which utilized the IPCC Fifth Assessment Report (IPCC 2013) (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)	28
Nitrous oxide (N_2O)	265

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)
SOIL CARBON AMENDMENT (CPS 336)
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 health 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 disturbance operation during strip tillage, the planting operation, and a seed row/furrow closing device. There is no full-width soil disturbance performed from the time immediately following harvest or termination of one cash crop through harvest or termination of the next cash crop in the rotation regardless of the depth of the tillage operation. The soil tillage intensity rating (STIR) value shall include all field operations that are performed during the crop interval between harvest and termination of the previous cash crop and harvest or termination of the current cash crop (includes fallow periods). The crop interval STIR value shall be no greater than 20.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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


Photo by USDA NRCS

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 health 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 disturbance operation during strip tillage, the planting operation, and a seed row/furrow closing device. There is no full-width soil disturbance performed from the time immediately following harvest or termination of one cash crop through harvest or termination of the next cash crop in the rotation regardless of the depth of the tillage operation. The soil tillage intensity rating (STIR) value shall include all field operations that are performed during the crop interval between harvest and termination of the previous cash crop and harvest or termination of the current cash crop (includes fallow periods). The crop interval STIR value shall be no greater than 20.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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


Photo by CSU

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 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 and excessive sediment in surface waters (soil erosion)
- Reduce tillage-induced particulate emissions (air quality impact)
- Improve soil health and maintain or increase organic matter content (soil quality degradation)
- Reduce energy use (inefficient energy use)

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Intensive Till Irrigated/Non-Irrigated Croplands - Reduce Fertilizer Application Rate by 15%

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:
- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of an improved nitrogen management in an intensive till system 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 No-Till Irrigated/Non-Irrigated Croplands - Reduce Fertilizer Application Rate by 15%

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:

- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of an improved nitrogen management in a no-till system 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Intensive Till Irrigated/Non-Irrigated Croplands - Use of Nitrification Inhibitors

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:
- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of an improved nitrogen management by implementing a nutrient management plan in an intensive till system in which nitrification inhibitors are applied. 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 and soil carbon. Emission changes result from lower rates of nitrification of ammonium to nitrate.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Intensive Till Irrigated/Non-Irrigated Croplands - Use of Nitrification Inhibitors with 15% Rate Reduction

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:
- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of an improved nitrogen management by implementing a nutrient management plan in an intensive till system in which nitrification inhibitors are applied and nitrogen fertilizer rates are reduced 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 and soil carbon. Emission changes result from lower rates of nitrification of ammonium to nitrate and lower rates of N application.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 No-Till Irrigated/Non-Irrigated Croplands - Use of Nitrification Inhibitors

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:

- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nitrogen management by implementing a nutrient management plan in a no-till system in which nitrification inhibitors are applied. 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. The greenhouse gas impacts of these practices are estimated for soil nitrous oxide emissions and soil carbon. Emission changes result from lower rates of nitrification of ammonium to nitrate.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 No-Till Irrigated/Non-Irrigated Croplands - Use of Nitrification Inhibitors with 15% Rate Reduction

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:
- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nitrogen management by implementing a nutrient management plan in a no-till system in which nitrification inhibitors are applied and nitrogen fertilizer rates are reduced 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 and soil carbon. Emission changes result from lower rates of nitrification of ammonium to nitrate and lower rates of N application.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Intensive Till Irrigated/Non-Irrigated Croplands - Use of Slow Release Fertilizers

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:

- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nitrogen management by implementing a nutrient management plan in an intensive till system in which slow release nitrogen fertilizers are applied. 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 and soil carbon. Emission changes result from use of slow release fertilizers, to reduce losses of N that may be converted to N_2O.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Intensive Till Irrigated/Non-Irrigated Croplands - Use of Slow Release Fertilizers with 15% Rate Reduction

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:
- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nitrogen management by implementing a nutrient management plan in an intensive till system in which slow release nitrogen fertilizers are applied and N rates are reduced by 15%. 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 and soil carbon. Emission changes result from use of slow release fertilizers, to reduce losses of N that may be converted to N_2O and reduced application rate.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 No-Till Irrigated/Non-Irrigated Croplands - Use of Slow Release Fertilizers

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:
- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nitrogen management by implementing a nutrient management plan in a no-till system in which slow release nitrogen fertilizers are applied. 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 and soil carbon. Emission changes result from use of slow release fertilizers, to reduce losses of N that may be converted to N_2O.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 No-Till Irrigated/Non-Irrigated Croplands - Use of Slow Release Fertilizers with 15% Rate Reduction

NRCS Conservation Practice Standard Summary

DEFINITION: Manage rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE:

- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water.
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES: All fields where plant nutrients and soil amendments are applied. Does not apply to one-time nutrient applications at establishment of permanent vegetation.

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume adoption of improved nitrogen management by implementing a nutrient management plan in a no-till system in which slow release nitrogen fertilizers are applied and N rates are reduced by 15%. 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 and soil carbon. Emission changes result from use of slow release fertilizers, to reduce losses of N that may be converted to N_2O and reduced application rate.

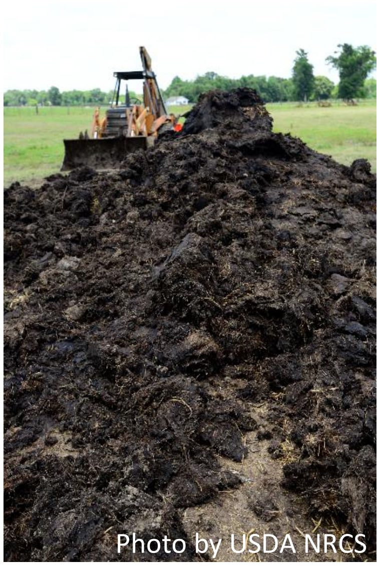
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 5^{th} year and remaining constant at that level in the years that follow. Manure is added annually 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.

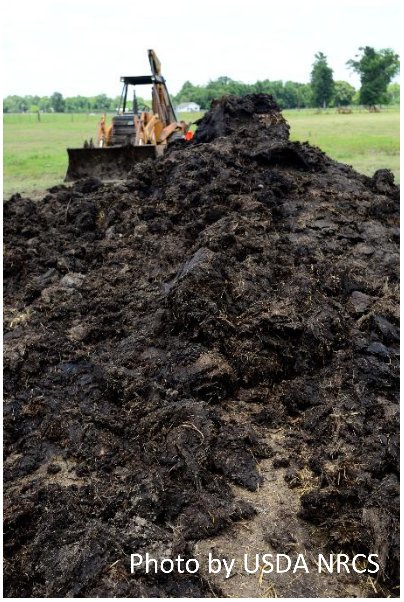
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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.

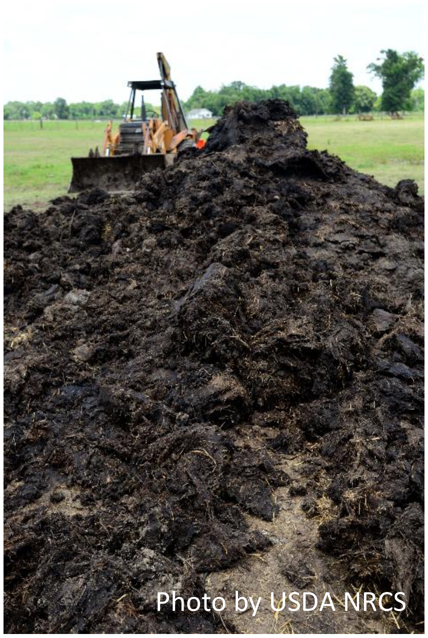
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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.

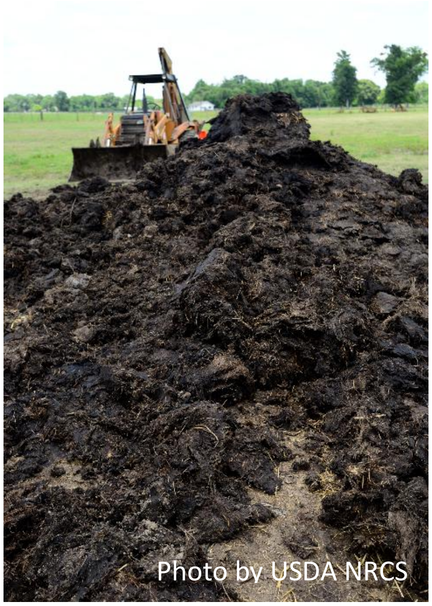
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

Photo by USDA NRCS

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 in moist climates adding perennial crops to rotations (Eagle et al. 2012). Nitrous oxide emissions from these scenarios were not estimated, but were assumed to 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 20% Fertilizer N Reduction) to Intensive Till Irrigated/Non-Irrigated Cropland


Photo bv 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 in intensive till systems that supply partial (20%) commodity crop fertilizer demand. Nitrogen fertilizer applied to the commodity crop is subsequently reduced by 20 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 20% 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 leguminous cover crops that supply partial (20%) commodity crop fertilizer demands for croplands under no-till management. Nitrogen fertilizer applied to the commodity crop is subsequently reduced by 20 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 10% Fertilizer N Reduction) to Intensive 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 in intensive till systems that supply partial (10%) commodity crop fertilizer demand. Nitrogen fertilizer applied to the following commodity crop is subsequently reduced by 10 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 10% 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 leguminous cover crops that supply partial (10%) commodity crop fertilizer demand on croplands under no-till management. Nitrogen fertilizer applied to the following commodity crop is subsequently reduced by 10 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 to Intensive 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, leguminous cover crops in intensive till systems without any adjustment of N fertilizer rates. 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 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, leguminous cover crops under no-till management without any adjustment of N fertilizer rates. 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 to Intensive 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 in intensive till systems without any adjustment of N fertilizer rates. 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 to No-Till Irrigated/Non-Irrigated Cropland


Photo bv 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 under no-till management without any adjustment of N fertilizer rates. 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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.

Soil Carbon Amendment (CPS 336)

Add 3 tons/ac of Compost (C:N 20) Annually to Intensive Till Irrigated/Non-Irrigated Cropland

NRCS Conservation Practice Standard Summary

DEFINITION: Application of carbon-based amendments derived from plant materials or treated animal byproducts.

PURPOSE:
- Improve or maintain soil organic matter
- Sequester carbon and enhance soil carbon (C) stocks
- Improve soil aggregate stability
- Improve habitat for soil organisms

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent an annual application of 3 tons/ac of compost (C:N = 20) on intensive till croplands, without any adjustment to N fertilizer rates. 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 compost and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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.

Soil Carbon Amendment (CPS 336)

Add 3 tons/ac of Compost (C:N 20) Every 3 Years to Intensive Till Irrigated/Non-Irrigated Cropland

NRCS Conservation Practice Standard Summary

DEFINITION: Application of carbon-based amendments derived from plant materials or treated animal byproducts.

PURPOSE:
- Improve or maintain soil organic matter
- Sequester carbon and enhance soil carbon (C) stocks
- Improve soil aggregate stability
- Improve habitat for soil organisms

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent an application of 3 tons/ac of compost (C:N = 20) every 3 years (Years 1, 4, 7, 10) on intensive till croplands, without any adjustment to N fertilizer rates. 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 compost and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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).

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Soil Carbon Amendment (CPS 336)

Add 3 tons/ac of Compost (C:N 20) Once to Intensive Till Irrigated/Non-Irrigated Cropland


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Application of carbon-based amendments derived from plant materials or treated animal byproducts.

PURPOSE:
- Improve or maintain soil organic matter
- Sequester carbon and enhance soil carbon (C) stocks
- Improve soil aggregate stability
- Improve habitat for soil organisms

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent a one-time application (in year 1) of 3 tons/ac of compost (C:N = 20) on intensive till croplands, without any adjustment to N fertilizer rates. 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 compost and small changes in soil nitrous oxide emissions.

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Soil Carbon Amendment (CPS 336)

Add 6 tons/ac of Compost (C:N 20) Annually to Intensive Till Irrigated/Non-Irrigated Cropland

NRCS Conservation Practice Standard Summary

DEFINITION: Application of carbon-based amendments derived from plant materials or treated animal byproducts.

PURPOSE:
• Improve or maintain soil organic matter
• Sequester carbon and enhance soil carbon (C) stocks
• Improve soil aggregate stability
• Improve habitat for soil organisms

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent an annual application of 6 tons/ac of compost (C:N = 20) on intensive till croplands, without any adjustment to N fertilizer rates. 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 compost and small changes in soil nitrous oxide emissions.

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• Improve soil aggregate stability
• Improve habitat for soil organisms

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent an application of 6 tons/ac of compost (C:N = 20) every 3 years (Years 1, 4, 7, 10) on intensive till croplands, without any adjustment to N fertilizer rates. 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 compost and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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.

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• Improve soil aggregate stability
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CONDITIONS WHERE PRACTICE APPLIES: This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent a one-time application (in year 1) of 6 tons/ac of compost (C:N = 20) on intensive till croplands, without any adjustment to N fertilizer rates. 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 compost and small changes in soil nitrous oxide emissions.

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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.

Soil Carbon Amendment (CPS 336)

Add 10 tons/ac of Compost (C:N 20) Annually to Intensive Till Irrigated/Non-Irrigated Cropland

NRCS Conservation Practice Standard Summary

DEFINITION: Application of carbon-based amendments derived from plant materials or treated animal byproducts.

PURPOSE:
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• Improve habitat for soil organisms

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions

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COMET-Planner estimates represent an annual application of 10 tons/ac of compost (C:N = 20) on intensive till croplands, without any adjustment to N fertilizer rates. 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 compost and small changes in soil nitrous oxide emissions.

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Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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.

Soil Carbon Amendment (CPS 336)

Add 10 tons/ac of Compost (C:N 20) Every 3 Years to Intensive Till Irrigated/Non-Irrigated Cropland


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Application of carbon-based amendments derived from plant materials or treated animal byproducts.

PURPOSE:
- Improve or maintain soil organic matter
- Sequester carbon and enhance soil carbon (C) stocks
- Improve soil aggregate stability
- Improve habitat for soil organisms

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions

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COMET-Planner estimates represent an application of 10 tons/ac of compost (C:N = 20) every 3 years (Years 1, 4, 7, 10) on intensive till croplands, without any adjustment to N fertilizer rates. 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 compost and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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.

Soil Carbon Amendment (CPS 336)

Add 10 tons/ac of Compost (C:N 20) Once to Intensive Till Irrigated/Non-Irrigated Cropland

NRCS Conservation Practice Standard Summary

DEFINITION: Application of carbon-based amendments derived from plant materials or treated animal byproducts.

PURPOSE:
• Improve or maintain soil organic matter
• Sequester carbon and enhance soil carbon (C) stocks
• Improve soil aggregate stability
• Improve habitat for soil organisms

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions

COMET-Planner Practice Implementation Information

COMET-Planner estimates represent a one-time application (in year 1) of 10 tons/ac of compost (C:N = 20) on intensive till croplands, without any adjustment to N fertilizer rates. 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 compost and small changes in soil nitrous oxide emissions.

GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 to the land surface.

PURPOSE:
- Improve the efficiency of moisture management
- Reduce irrigation energy used in farming/ranching practices and field operations
- Improve the efficient use of irrigation water
- Prevent excessive bank erosion from water conveyance channels
- Reduce concentrated flow erosion
- Reduce sheet, rill, & wind erosion
- Improve plant productivity and health
- Maintain or increase organic matter content
- Reduce emissions of particulate matter

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where mulches are needed.

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 at least once every 3 years. 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

NRCS Conservation Practice Standard Summary

DEFINITION: Growing planned rotations of erosion-resistant and erosion-susceptible crops or fallow in a systematic arrangement of strips across a field

PURPOSE:
- Reduce sheet and rill erosion
- Reduce wind erosion
- Reduce excess nutrients in surface waters
- Reduce sediment transport to surface waters
- Reduce pesticide transport to surface waters
- Improve plant productivity and health

CONDITIONS WHERE PRACTICE APPLIES: This practice applies on cropland.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

NRCS Conservation Practice Standard Summary

DEFINITION: Replace, repower, or retrofit an agricultural combustion system and related components or devices

PURPOSE:

- Improve air quality by reducing emissions of oxides of nitrogen (NOx)
- Improve air quality by reducing emissions of particulate matter (PM)
- Reduce energy use by increasing the efficiency of the combustion system

CONDITIONS WHERE PRACTICE APPLIES: For a combustion system associated with a pumping plant (e.g., pumping plant power unit), when the only change to the pumping plant is the replacement, repowering, or retrofit of the power unit for an air quality or energy purpose, use this conservation practice standard (CPS). For all other scenarios involving a pumping plant combustion system, use CPS Pumping Plant (Code 533)

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

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing and maintaining permanent vegetative cover

PURPOSE:
• Reduce sheet, rill, and wind erosion
• Reduce sediment transport to surface water
• Reduce ground and surface water quality degradation by nutrients
• Reduce emissions of particulate matter.
• Provide wildlife, pollinator, and other beneficial organism habitat
• Improve soil health by maintaining or increasing soil organic matter quantity
• Improve soil health by increasing soil aggregate stability
• Improve soil health by enhancing habitat for soil organisms
• Improve soil health by reducing compaction

CONDITION WHERE PRACTICE APPLIES: This practice applies on most lands needing permanent vegetative cover. This practice may be used to conserve and stabilize archeological and historic sites. This practice does not apply to plantings for forage production or to critical area plantings that require special measures to ensure successful establishment.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 sheet, rill, and wind erosion
- Reduce sediment transport to surface water
- Reduce ground and surface water quality degradation by nutrients
- Reduce emissions of particulate matter.
- Provide wildlife, pollinator, and other beneficial organism habitat
- Improve soil health by maintaining or increasing soil organic matter quantity
- Improve soil health by increasing soil aggregate stability
- Improve soil health by enhancing habitat for soil organisms
- Improve soil health by reducing compaction

CONDITION WHERE PRACTICE APPLIES: This practice applies on most lands needing permanent vegetative cover. This practice may be used to conserve and stabilize archeological and historic sites. This practice does not apply to plantings for forage production or to critical area plantings that require special measures to ensure successful establishment.

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.

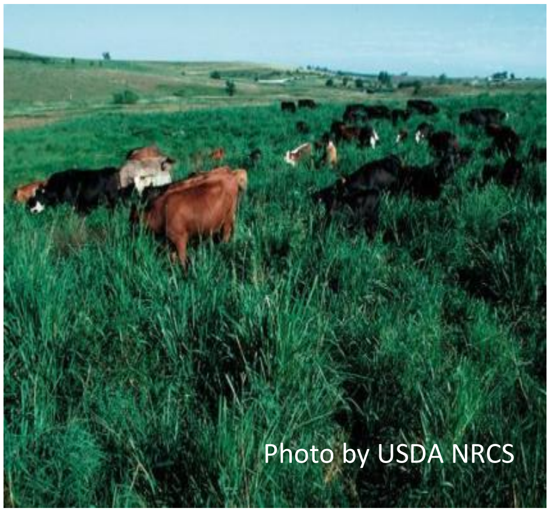
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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.

Pasture and Hay Planting (CPS 512)

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



NRCS Conservation Practice Standard Summary

DEFINITION: Establishing adapted and compatible species, varieties, or cultivars of perennial herbaceous plants suitable for pasture or hay 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 water quality
- Improve air quality
- Improve soil and health

CONDITIONS WHERE PRACTICE APPLIES: This practice applies on all lands suitable for the one-time establishment of perennial species for forage production that will likely persist for 5 years. This practice does not apply to the establishment of annually planted and mechanically harvested food, fiber, or oilseed crops planted on designated cropland

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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).

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Herbaceous Wind Barriers (CPS 603)

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

NRCS Conservation Practice Standard Summary

DEFINITION: Herbaceous vegetation established in narrow strips within the field to reduce wind speed and wind erosion

PURPOSE:
- Reduce wind erosion (creep, saltation, suspension)
- Reduce particulate matter emissions and airborne dust
- Improve plant productivity and health

CONDITIONS WHERE PRACTICE APPLIES: Cropland where wind erosion is a resource concern.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 narrow strips within the field to reduce wind speed and wind erosion

PURPOSE:
- Reduce wind erosion (creep, saltation, suspension)
- Reduce particulate matter emissions and airborne dust
- Improve plant productivity and health

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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


Photo by USDA NRCS

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
- Reduce sediment transport to surface waters

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all land uses where sheet and rill erosion or ephemeral gully erosion are resource concerns

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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
- Reduce sediment transport to surface waters

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all land uses where sheet and rill erosion or ephemeral gully erosion are resource concerns

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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: Grasses, sedges, rushes, ferns, legumes, and forbs tolerant of intermittent flooding or saturated soils, established or managed as the dominant vegetation in the transitional zone between upland and aquatic habitats

PURPOSE:

- Provide or improve food and cover for fish, wildlife and livestock
- Improve and maintain water quality
- Establish and maintain habitat corridors
- Increase water storage on floodplains
- Reduce erosion and improve stability to stream banks and shorelines
- Increase net carbon storage in the biomass and soil
- Enhance pollen, nectar, and nesting habitat for pollinators
- Restore, improve or maintain the desired plant communities
- Dissipate stream energy and trap sediment
- 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. For seasonal or ephemeral watercourses and water bodies, this zone extends to the center of the channel or basin
- 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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


Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

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PURPOSE:

- Provide or improve food and cover for fish, wildlife and livestock
- Improve and maintain water quality
- Establish and maintain habitat corridors
- Increase water storage on floodplains
- Reduce erosion and improve stability to stream banks and shorelines
- Increase net carbon storage in the biomass and soil
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- Dissipate stream energy and trap sediment
- 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. For seasonal or ephemeral watercourses and water bodies, this zone extends to the center of the channel or basin
- 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

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 water quality degradation from the transport of sediment and other waterborne contaminants downslope
• Improve soil moisture management through increased water infiltration
• Reduce water quality degradation from the transport of nutrients downslope

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

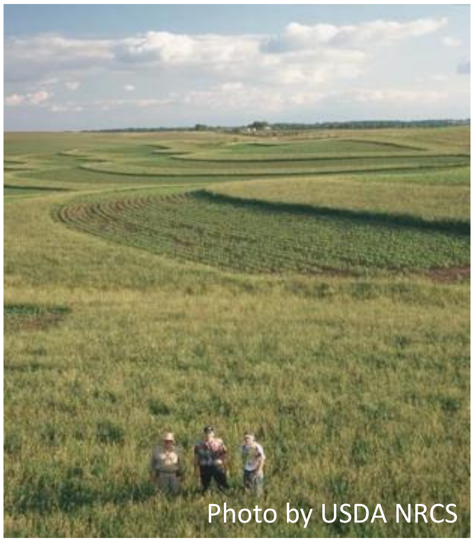

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

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 water quality degradation from the transport of sediment and other waterborne contaminants downslope
- Improve soil moisture management through increased water infiltration
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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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 and reduce excessive sediment to surface waters (soil erosion)
- Reduce sedimentation offsite and protect water quality and nutrients in surface and ground waters (water quality degradation)
- Provide food and cover for wildlife and pollinators or other beneficial organisms (inadequate habitat for fish and wildlife).
- Reduce greenhouse gases and increase carbon storage (air quality impact)
- Reduce emissions of particulate matter (air quality impact)

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 pasture fields.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 and reduce excessive sediment to surface waters (soil erosion)
- Reduce sedimentation offsite and protect water quality and nutrients in surface and ground waters (water quality degradation)
- Provide food and cover for wildlife and pollinators or other beneficial organisms (inadequate habitat for fish and wildlife).
- Reduce greenhouse gases and increase carbon storage (air quality impact)
- Reduce emissions of particulate matter (air quality impact)

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 pasture fields.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

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 and excessive sediment in surface waters
- Reduce dissolved contaminant loadings in runoff
- Reduce suspended solids and associated contaminants in irrigation tailwater and excessive sediment in surface waters

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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)

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Photo by USDA NRCS

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PURPOSE:

- Reduce suspended solids and associated contaminants in runoff and excessive sediment in surface waters
- Reduce dissolved contaminant loadings in runoff
- Reduce suspended solids and associated contaminants in irrigation tailwater and excessive sediment in surface waters

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

NRCS Conservation Practice Standard Summary

DEFINITION: A shaped or graded channel that is established with suitable vegetation to convey surface water at a nonerosive velocity using a broad and shallow cross section to a stable outlet

PURPOSE:

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

CONDITIONS WHERE PRACTICE APPLIES: This practice is applied in areas where added water conveyance capacity and vegetative protection are needed to prevent erosion and improve runoff water quality resulting from concentrated surface flow.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

NRCS Conservation Practice Standard Summary

DEFINITION: A shaped or graded channel that is established with suitable vegetation to convey surface water at a nonerosive velocity using a broad and shallow cross section to a stable outlet

PURPOSE:

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

CONDITIONS WHERE PRACTICE APPLIES: This practice is applied in areas where added water conveyance capacity and vegetative protection are needed to prevent erosion and improve runoff water quality resulting from concentrated surface flow.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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)
FOREST FARMING (CPS 379)
RIPARIAN FOREST BUFFER (CP 391)
TREE/SHRUB ESTABLISHMENT (CP 612)
WINDBREAK/SHELTERBELT ESTABLISHMENT AND RENOVATION (CP 380)

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, direct seeding, or through natural regeneration.

PURPOSE:

- Maintain or improve desirable plant diversity, productivity, and health by establishing woody plants
- Improve water quality by reducing excess nutrients and other pollutants in runoff and ground water
- Restore or maintain native plant communities
- Control erosion
- Create or improve habitat for target wildlife species, beneficial organisms, or pollinator species compatible with ecological characteristics of the site
- Sequester and store carbon
- Conserve energy
- Provide livestock shelter

CONDITIONS WHERE PRACTICE APPLIES: Tree-shrub establishment can be applied on any site capable of growing woody plants

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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, direct seeding, or through natural regeneration.

PURPOSE:
- Maintain or improve desirable plant diversity, productivity, and health by establishing woody plants
- Improve water quality by reducing excess nutrients and other pollutants in runoff and ground water
- Restore or maintain native plant communities
- Control erosion
- Create or improve habitat for target wildlife species, beneficial organisms, or pollinator species compatible with ecological characteristics of the site
- Sequester and store carbon
- Conserve energy
- Provide livestock shelter

CONDITIONS WHERE PRACTICE APPLIES: Tree-shrub establishment can be applied on any site capable of growing woody plants

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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 and Renovation (CPS 380)

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

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing, enhancing, or renovating windbreaks, also known as shelterbelts, which are single or multiple rows of trees and/or shrubs in linear or curvilinear configurations

PURPOSE:

- Reduce soil erosion from wind
- Enhance plant health and productivity by protecting plants from wind related damage
- Manage snow distribution to improve moisture utilization by plants
- Manage snow distribution to reduce obstacles, ponding, and flooding that impacts other resources, animals, structures, and humans
- Improve moisture management by reducing transpiration and evaporation losses and improving irrigation efficiency
- Provide shelter from wind, snow, and excessive heat, to protect animals, structures, and humans
- Improve air quality by intercepting airborne particulate matter, chemicals, and odors, and/or by reducing airflow across contaminant or dust sources
- Reduce energy use in heating and cooling buildings, and in relocating snow
- Increase carbon storage in biomass and soils

CONDITIONS WHERE PRACTICE APPLIES: On all lands except forest land, apply this practice to establish, enhance, or renovate windbreaks where rows of woody plants are desired and suited for the intended purposes. Apply this practice to any existing windbreaks that are no longer functioning properly for the intended purpose, or where renovation can extend the functional life of a windbreak.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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 and Renovation (CPS 380)

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

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing, enhancing, or renovating windbreaks, also known as shelterbelts, which are single or multiple rows of trees and/or shrubs in linear or curvilinear configurations

PURPOSE:

- Reduce soil erosion from wind
- Enhance plant health and productivity by protecting plants from wind related damage
- Manage snow distribution to improve moisture utilization by plants
- Manage snow distribution to reduce obstacles, ponding, and flooding that impacts other resources, animals, structures, and humans
- Improve moisture management by reducing transpiration and evaporation losses and improving irrigation efficiency
- Provide shelter from wind, snow, and excessive heat, to protect animals, structures, and humans
- Improve air quality by intercepting airborne particulate matter, chemicals, and odors, and/or by reducing airflow across contaminant or dust sources
- Reduce energy use in heating and cooling buildings, and in relocating snow
- Increase carbon storage in biomass and soils

CONDITIONS WHERE PRACTICE APPLIES: On all lands except forest land, apply this practice to establish, enhance, or renovate windbreaks where rows of woody plants are desired and suited for the intended purposes. Apply this practice to any existing windbreaks that are no longer functioning properly for the intended purpose, or where renovation can extend the functional life of a windbreak.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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 and Renovation (CPS 380)

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

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing, enhancing, or renovating windbreaks, also known as shelterbelts, which are single or multiple rows of trees and/or shrubs in linear or curvilinear configurations

PURPOSE:

- Reduce soil erosion from wind
- Enhance plant health and productivity by protecting plants from wind related damage
- Manage snow distribution to improve moisture utilization by plants
- Manage snow distribution to reduce obstacles, ponding, and flooding that impacts other resources, animals, structures, and humans
- Improve moisture management by reducing transpiration and evaporation losses and improving irrigation efficiency
- Provide shelter from wind, snow, and excessive heat, to protect animals, structures, and humans
- Improve air quality by intercepting airborne particulate matter, chemicals, and odors, and/or by reducing airflow across contaminant or dust sources
- Reduce energy use in heating and cooling buildings, and in relocating snow
- Increase carbon storage in biomass and soils

CONDITIONS WHERE PRACTICE APPLIES: On all lands except forest land, apply this practice to establish, enhance, or renovate windbreaks where rows of woody plants are desired and suited for the intended purposes. Apply this practice to any existing windbreaks that are no longer functioning properly for the intended purpose, or where renovation can extend the functional life of a windbreak.

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.

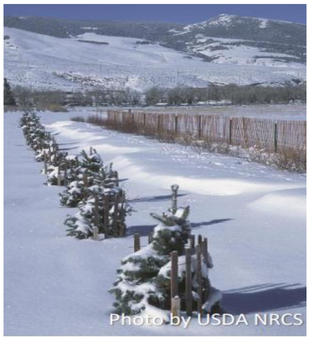
GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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 and Renovation (CPS 380)

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



NRCS Conservation Practice Standard Summary

DEFINITION: Establishing, enhancing, or renovating windbreaks, also known as shelterbelts, which are single or multiple rows of trees and/or shrubs in linear or curvilinear configurations

PURPOSE:

- Reduce soil erosion from wind
- Enhance plant health and productivity by protecting plants from wind related damage
- Manage snow distribution to improve moisture utilization by plants
- Manage snow distribution to reduce obstacles, ponding, and flooding that impacts other resources, animals, structures, and humans
- Improve moisture management by reducing transpiration and evaporation losses and improving irrigation efficiency
- Provide shelter from wind, snow, and excessive heat, to protect animals, structures, and humans
- Improve air quality by intercepting airborne particulate matter, chemicals, and odors, and/or by reducing airflow across contaminant or dust sources
- Reduce energy use in heating and cooling buildings, and in relocating snow
- Increase carbon storage in biomass and soils

CONDITIONS WHERE PRACTICE APPLIES: On all lands except forest land, apply this practice to establish, enhance, or renovate windbreaks where rows of woody plants are desired and suited for the intended purposes. Apply this practice to any existing windbreaks that are no longer functioning properly for the intended purpose, or where renovation can extend the functional life of a windbreak.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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 and Renovation (CPS 380)

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

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing, enhancing, or renovating windbreaks, also known as shelterbelts, which are single or multiple rows of trees and/or shrubs in linear or curvilinear configurations

PURPOSE:

- Reduce soil erosion from wind
- Enhance plant health and productivity by protecting plants from wind related damage
- Manage snow distribution to improve moisture utilization by plants
- Manage snow distribution to reduce obstacles, ponding, and flooding that impacts other resources, animals, structures, and humans
- Improve moisture management by reducing transpiration and evaporation losses and improving irrigation efficiency
- Provide shelter from wind, snow, and excessive heat, to protect animals, structures, and humans
- Improve air quality by intercepting airborne particulate matter, chemicals, and odors, and/or by reducing airflow across contaminant or dust sources
- Reduce energy use in heating and cooling buildings, and in relocating snow
- Increase carbon storage in biomass and soils

CONDITIONS WHERE PRACTICE APPLIES: On all lands except forest land, apply this practice to establish, enhance, or renovate windbreaks where rows of woody plants are desired and suited for the intended purposes. Apply this practice to any existing windbreaks that are no longer functioning properly for the intended purpose, or where renovation can extend the functional life of a windbreak.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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 and Renovation (CPS 380)

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

NRCS Conservation Practice Standard Summary

DEFINITION: Establishing, enhancing, or renovating windbreaks, also known as shelterbelts, which are single or multiple rows of trees and/or shrubs in linear or curvilinear configurations

PURPOSE:

- Reduce soil erosion from wind
- Enhance plant health and productivity by protecting plants from wind related damage
- Manage snow distribution to improve moisture utilization by plants
- Manage snow distribution to reduce obstacles, ponding, and flooding that impacts other resources, animals, structures, and humans
- Improve moisture management by reducing transpiration and evaporation losses and improving irrigation efficiency
- Provide shelter from wind, snow, and excessive heat, to protect animals, structures, and humans
- Improve air quality by intercepting airborne particulate matter, chemicals, and odors, and/or by reducing airflow across contaminant or dust sources
- Reduce energy use in heating and cooling buildings, and in relocating snow
- Increase carbon storage in biomass and soils

CONDITIONS WHERE PRACTICE APPLIES: On all lands except forest land, apply this practice to establish, enhance, or renovate windbreaks where rows of woody plants are desired and suited for the intended purposes. Apply this practice to any existing windbreaks that are no longer functioning properly for the intended purpose, or where renovation can extend the functional life of a windbreak.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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)

NRCS Conservation Practice Standard Summary

DEFINITION: An area predominantly trees and/or shrubs located adjacent to and up-gradient from a watercourse or water body.

PURPOSE:
- Reduce transport of sediment to surface water, and reduce transport of pathogens, chemicals, pesticides, and nutrients to surface and ground water
- Improve the quantity and quality of terrestrial and aquatic habitat for wildlife, invertebrate species, fish, and other organisms
- Maintain or increase total carbon stored in soils and/or perennial biomass to reduce atmospheric concentrations of greenhouse gasses
- Lower elevated stream water temperatures
- Restore diversity, structure, and composition of riparian plant communities

CONDITIONS WHERE PRACTICE APPLIES: Apply riparian forest buffers on areas adjacent to permanent or intermittent streams, lakes, ponds, and wetlands where channels and streambanks are sufficiently stable

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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)

NRCS Conservation Practice Standard Summary

DEFINITION: An area predominantly trees and/or shrubs located adjacent to and up-gradient from a watercourse or water body.

PURPOSE:
- Reduce transport of sediment to surface water, and reduce transport of pathogens, chemicals, pesticides, and nutrients to surface and ground water
- Improve the quantity and quality of terrestrial and aquatic habitat for wildlife, invertebrate species, fish, and other organisms
- Maintain or increase total carbon stored in soils and/or perennial biomass to reduce atmospheric concentrations of greenhouse gasses
- Lower elevated stream water temperatures
- Restore diversity, structure, and composition of riparian plant communities

CONDITIONS WHERE PRACTICE APPLIES: Apply riparian forest buffers on areas adjacent to permanent or intermittent streams, lakes, ponds, and wetlands where channels and streambanks are sufficiently stable

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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 conservation purpose.

PURPOSE:
- Provide habitat including food, cover, shelter or habitat connectivity for terrestrial or aquatic wildlife
- Provide food or cover for beneficial organisms as a component of pest management
- Filter, intercept, or adsorb airborne particulate matter, chemical drift, or odors
- Provide visual or physical screens and barriers
- Increase carbon storage in biomass and soils

CONDITIONS WHERE PRACTICE APPLIES: This practice applies wherever it will accomplish at least one of the purposes stated above. Linear plantings to treat erosion, to reduce nutrient transport, or to reduce sediment transport should use Conservation Practice Standard (CPS) Windbreak/Shelterbelt Establishment (Code 380), CPS Riparian Forest Buffer (Code 391), CPS Filter Strip (Code 393), CPS Vegetative Barrier (Code 601), CPS Cross Wind Trap Strips (Code 589C), or CPS Alley Cropping (Code 311)

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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 conservation purpose.

PURPOSE:
- Provide habitat including food, cover, shelter or habitat connectivity for terrestrial or aquatic wildlife
- Provide food or cover for beneficial organisms as a component of pest management
- Filter, intercept, or adsorb airborne particulate matter, chemical drift, or odors
- Provide visual or physical screens and barriers
- Increase carbon storage in biomass and soils

CONDITIONS WHERE PRACTICE APPLIES: This practice applies wherever it will accomplish at least one of the purposes stated above. Linear plantings to treat erosion, to reduce nutrient transport, or to reduce sediment transport should use Conservation Practice Standard (CPS) Windbreak/Shelterbelt Establishment (Code 380), CPS Riparian Forest Buffer (Code 391), CPS Filter Strip (Code 393), CPS Vegetative Barrier (Code 601), CPS Cross Wind Trap Strips (Code 589C), or CPS Alley Cropping (Code 311)

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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)

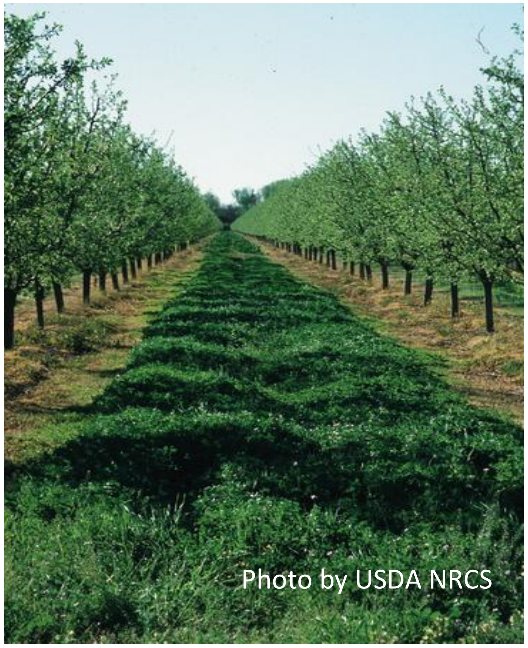


Photo by USDA NRCS

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:

- Enhance microclimate conditions to improve crop or forage quality and quantity
- 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
- Increase crop diversity
- Decrease offsite movement of nutrients or chemicals
- Increase carbon storage in plant biomass and soils
- Develop renewable energy systems
- Improve air quality

CONDITIONS WHERE PRACTICE APPLIES: On all cropland and hayland where trees, shrubs, crops and 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.

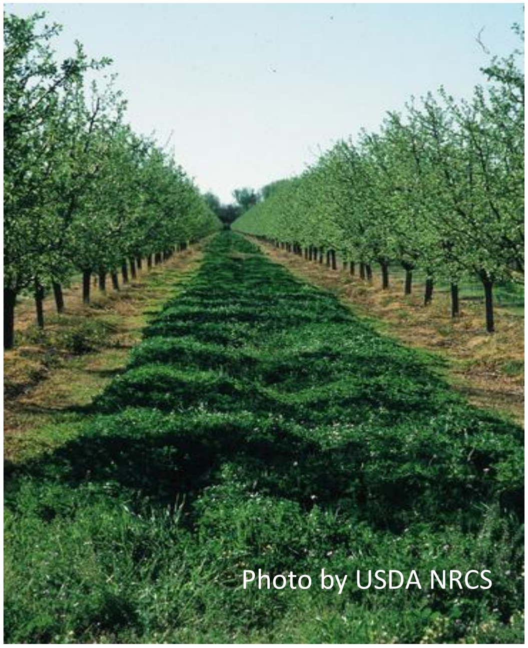
GHG Estimation Methods

Greenhouse gas emissions from soils were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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:
- Enhance microclimate conditions to improve crop or forage quality and quantity
- 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
- Increase crop diversity
- Decrease offsite movement of nutrients or chemicals
- Increase carbon storage in plant biomass and soils
- Develop renewable energy systems
- Improve air quality

CONDITIONS WHERE PRACTICE APPLIES: On all cropland and hayland where trees, shrubs, crops and 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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.

Forest Farming (CPS 379)

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

NRCS Conservation Practice Standard Summary

DEFINITION: Managing or establishing stands of trees or shrubs in coordination with the management and/or cultivation of understory plants or nontimber forest products

PURPOSE:
- Increase plant/tree community diversity—including native species—as well as their compatibility with each other and the site
- Improve crop diversity by growing mixed but compatible crops having different heights on the same area
- Improve soil health by maintaining or increasing soil organic matter
- Improve terrestrial habitat

CONDITIONS WHERE PRACTICE APPLIES: On all lands where trees, shrubs, and woody or nonwoody crops can be grown in combination.

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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

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.

NRCS CONSERVATION PRACTICES

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

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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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


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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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


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 5^{th} year and remaining constant at that level in the years that follow. Manure is added annually 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.

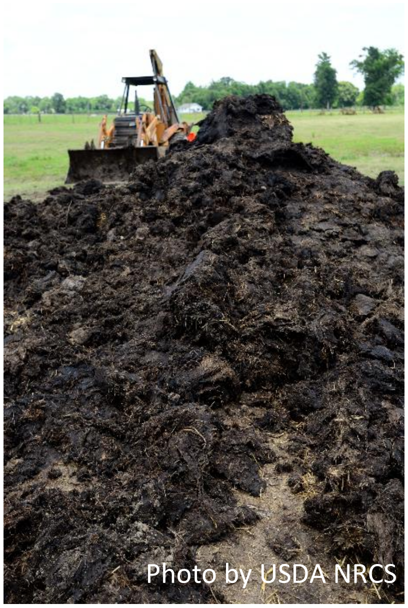
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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.

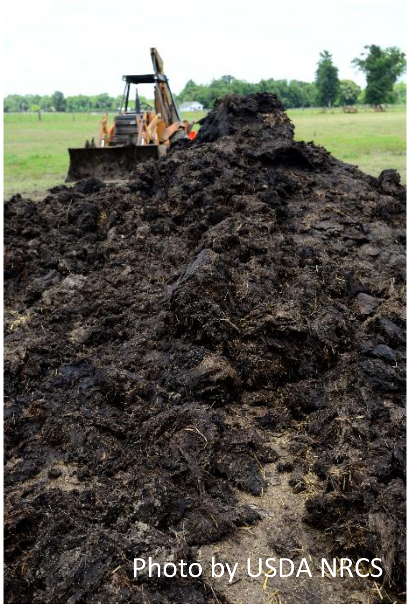
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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.

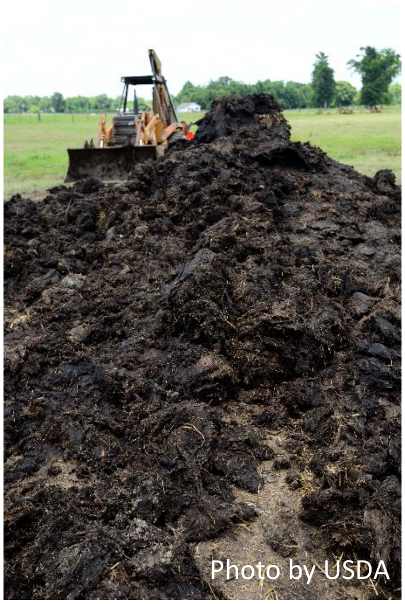
GHG Estimation Methods

Greenhouse gas emissions were estimated using a sample-based, metamodeling approach with the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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

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 annually 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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: The seeding and establishment of herbaceous and woody species for the improvement of vegetation composition and productivity of the plant community to meet management goals

PURPOSE:
- Restore a plant community similar to the Ecological Site Description reference state for the site or the desired plant community
- Provide or improve forages for livestock
- Provide or improve forage, browse, or cover for wildlife
- Reduce erosion by wind and water
- Improve water quality and quantity
- Increase and/or stabilize carbon balance and sequestration

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to land where the principle goals and method of vegetation management are or will be based on ecological processes and interactions. This practice will 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 management of herbivory 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: Establishment and/or management of desired trees and forages on the same land unit

PURPOSE:
- Provide forage, shade, and/or shelter for livestock
- Improve the productivity and health of trees/shrubs and forages
- Improve water quality
- Reduce erosion
- Enhance wildlife habitat
- Improve biological diversity
- Improve soil quality
- Increase carbon sequestration and storage
- Provide for beneficial organisms and pollinators

CONDITIONS WHERE PRACTICE APPLIES: This practice may be applied on any area that is suitable for the desired forages, trees, and livestock

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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 Hanson et al. 2024. Details of the modeling approach are described in the Estimation Methods section of this report.

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 vegetation with grazing and browsing animals to achieve specific ecological, economic, and management objectives

PURPOSE:

- Improve or maintain desirable species composition, structure, productivity, health and/or vigor of plants and plant communities
- Improve or maintain the quantity, quality, and/or balance of forages to meet the nutritional needs and ensure the health and performance of grazing and browsing animals
- Reduce or eliminate the transportation of sediment, nutrients, pathogens, or chemicals to surface and groundwater
- Improve or maintain upland hydrology, riparian dynamics, or watershed function to reduce surface or groundwater depletion and improve naturally available moisture
- Reduce runoff and compaction and enhance or maintain key soil health components, such as soil organic matter, aggregate stability, habitat for soil organisms, water infiltration, and water holding capacity
- Prevent or reduce sheet, rill, classic gully, ephemeral gully, bank, or wind erosion
- Improve or maintain terrestrial or aquatic habitat for wildlife, fish, invertebrates, or other organisms
- Manage biomass accumulation for the desired fuel load to reduce wildfire risk or to facilitate prescribed burning
- Reduce plant pest pressure from invasive and/or undesirable plants and other pests as part of an integrated plan

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

COMET-Planner Practice Implementation Information

COMET-Planner estimates assume improvement of degraded grazing lands by replacing extensive continuous grazing over the grazing season at a lower offtake rate, with extensive rotational grazing for 1 month of the grazing season with a higher daily offtake rate. 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 the DayCent model, which is based on methodology in the USDA entity-scale inventory methods (Hanson et al. 2024). 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 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.

NRCS CONSERVATION PRACTICES

CRITICAL AREA PLANTING (CPS 342)
LAND RECLAMATION – ABANDONED MINED LAND (CPS 543)
LAND RECLAMATION – LANDSLIDE TREATMENT (CPS 453)

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 topsoil cause unusually large N transformations and movements with substantial loss. Management of topsoil 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 seeding/planting methods.

PURPOSE:

- Stabilize areas with existing or expected high rates of soil erosion by wind or water
- Stabilize stream and channel banks, pond and other shorelines, earthen features of structural conservation practices
- Stabilize 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.

Land Reclamation: Abandoned Mined Land (CPS 543)

Restoring Abandoned Mine Lands by Planting Permanent Vegetative Cover

Photo by USDA NRCS

NRCS Conservation Practice Standard Summary

DEFINITION: Reclamation of land and water areas adversely affected by past mining activities

PURPOSE:
- Decrease erosion and sedimentation
- Improve offsite water quality
- Protect public health and safety

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to abandoned mined land with one or more problems that degrade the quality of the environment; prevent or interfere with the beneficial uses of soil, water, air, plant, or animal resources; or endanger human health and safety. This practice also applies to nearby nonmined areas adversely affected by the past mining activities. Treat the source of the problem before or in conjunction with treatment of the nonmined areas.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for land reclamation of abandoned mined lands 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) substituting 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.

Land Reclamation: Landslide Treatment (CPS 453)

Restoring Land Slide Areas by Planting Permanent Vegetative Cover

NRCS Conservation Practice Standard Summary

DEFINITION: Reclamation of land and water areas adversely affected by past mining activities

PURPOSE:

- Repair unstable natural or altered slopes to prevent slope failure
- Protect public health and safety
- Decrease erosion and sedimentation
- Improve offsite water quality, including downstream drinking water and landscape resource quality
- Create a condition conducive to establishing surface protection and beneficial land use

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to abandoned mined land that degrades the quality of the environment and prevents or interferes with the beneficial uses of soil, water, air, plant or animal resources, or endangers human health and safety.

COMET-Planner Practice Implementation Information

COMET-Planner estimates for land reclamation of landslides 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) substituting 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.

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

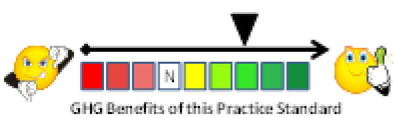
Information about each NRCS Practice Standard can be found here:

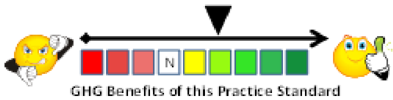
Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
 **Practices with the highest greenhouse gas benefit**	**327**	Conservation Cover	Establishing perennial vegetation on land retired from agriculture production increases soil carbon and 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.
Continuation…	**512**	Forage and Biomass Planting	Deep-rooted perennial biomass sequesters carbon and may have slight soil carbon benefits.

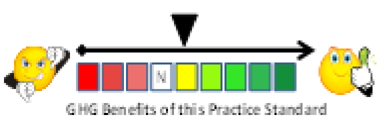
Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
			Harvested biomass can serve as a renewable fuel and feedstock.
	590	Nutrient Management	Precisely managing the amount, source, timing, placement, and form of nutrient and soil amendments 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.

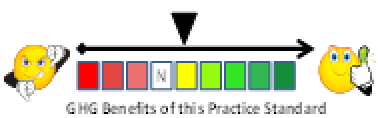
Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
	**332**	Contour Buffer Strips	Permanent herbaceous vegetative cover increases biomass carbon sequestration and increases soil carbon stocks.
	391	Riparian Forest Buffer	Planting trees and shrubs for riparian benefits also increases

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
Practices with high greenhouse gas benefits			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, increasing soil organic matter and minimizing soil disturbance.

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
	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.
Continuation… 	**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 is increased by incorporating

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
			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 IV: Tables for Woody Plantings Methods

Table 1: Thirteen Taxon Groupings for 45 Conifer Species (or Species Groups)

(Copied from Hanson et al. 2024 Table 3-A-1; Appendix 3-A from Chapter 3)

Taxon	Genus and Species	Common Name
Abies < 0.35 spg[a]	Abies balsamea	Fir, balsam
Abies < 0.35 spg[a]	A. fraseri	Fir, Fraser
Abies < 0.35 spg[a]	A. lasiocarpa	Fir, subalpine
Abies ≥ 0.35 spg	A. amabilis	Fir, Pacific silver
Abies ≥ 0.35 spg	A. concolor	Fir, white
Abies ≥ 0.35 spg	A. grandis	Fir, grand
Abies ≥ 0.35 spg	A. magnifica	Fir, California red
Abies ≥ 0.35 spg	A. procera	Fir, noble
Abies ≥ 0.35 spg	Abies spp.	Fir, Pacific silver/noble/other
Cupressaceae < 0.30 spg	Thuja occidentalis	Cedar, northern white
Cupressaceae 0.30-0.39 spg	Calocedrus decurrens	Incense cedar
Cupressaceae 0.30-0.39 spg	Sequoiadendron giganteum	Sequoia, giant
Cupressaceae 0.30-0.39 spg	T. plicata	Cedar, western red
Cupressaceae ≥ 0.40 spg	Chamaecyparis nootkatensis	Cedar, Alaska
Cupressaceae ≥ 0.40 spg	Juniperus virginiana	Juniper, eastern redcedar
Larix	Larix laricina	Tamarack
Larix	L. occidentalis	Tamarack, western larch
Larix	Larix spp.	Tamarack, larch (introduced)
Picea < 0.35 spg	Picea engelmannii	Spruce, Engelmann
Picea < 0.35 spg	P. sitchensis	Spruce, Sitka
Picea ≥ 0.35 spg	P. abies	Spruce, Norway
Picea ≥ 0.35 spg	P. glauca	Spruce, white
Picea ≥ 0.35 spg	P. mariana	Spruce, black
Picea ≥ 0.35 spg	P. rubens	Spruce, red
Pinus < 0.45 spg	Pinus albicaulis	Pine, whitebark
Pinus < 0.45 spg	P. arizonica	Pine, Arizona
Pinus < 0.45 spg	P. banksiana	Pine, jack
Pinus < 0.45 spg	P. contorta	Pine, lodgepole
Pinus < 0.45 spg	P. jeffreyi	Pine, Jeffrey
Pinus < 0.45 spg	P. lambertiana	Pine, sugar
Pinus < 0.45 spg	P. leiophylla	Pine, Chihuahua
Pinus < 0.45 spg	P. monticola	Pine, western white
Pinus < 0.45 spg	P. ponderosa	Pine, ponderosa
Pinus < 0.45 spg	P. resinosa	Pine, red
Pinus < 0.45 spg	Pinus spp.	Pine, ponderosa/lodgepole/sugar
Pinus < 0.45 spg	P. strobus	Pine, eastern white
Pinus ≥ 0.45 spg	P. echinata	Pine, shortleaf

Pinus ≥ 0.45 spg	P. elliottii	Pine, slash
Pinus ≥ 0.45 spg	P. palustris	Pine, longleaf
Pinus ≥ 0.45 spg	P. rigida	Pine, pitch
Pinus ≥ 0.45 spg	P. taeda	Pine, loblolly
Pseudotsuga	Pseudotsuga menziesii	Douglas fir
Tsuga < 0.40 spg	Tsuga canadensis	Hemlock, eastern
Tsuga ≥ 0.40 spg	T. heterophylla	Hemlock, western
Tsuga ≥ 0.40 spg	T. mertensiana	Hemlock, mountain

Source: Chojnacky et al., 2014.

[a] spg = specific gravity of wood on a green volume to dry-weight basis.

Table 2: Eighteen Taxon Groupings for 70 Hardwood Species (or Species Groups)

(Copied from Hanson et al. 2024 Table 3-A-2; Appendix 3-A from Chapter 3)

Taxon	Family	Genus and Species	Common Name
Aceraceae < 0.50 spg[a]	Aceraceae	Acer macrophyllum	Maple, bigleaf
Aceraceae < 0.50 spg[a]	Aceraceae	A. pensylvanicum	Maple, striped
Aceraceae < 0.50 spg[a]	Aceraceae	A. rubrum	Maple, red
Aceraceae < 0.50 spg[a]	Aceraceae	A. saccharinum	Maple, silver
Aceraceae < 0.50 spg[a]	Aceraceae	A. spicatum	Maple, mountain
Aceraceae ≥ 0G50 spg	Aceraceae	A. saccharum	Maple, sugar
Betulaceae < 0.40 spg	Betulaceae	Alnus rubra	Alder, red
Betulaceae < 0.40 spg	Betulaceae	Alnus spp.	Alder, Sitka
Betulaceae 0.40-0.49 spg	Betulaceae	Betula papyrifera	Birch, paper
Betulaceae 0.40-0.49 spg	Betulaceae	B. populifolia	Birch, gray
Betulaceae 0.50-0.59 spg	Betulaceae	B. alleghaniensis	Birch, yellow
Betulaceae ≥ 0.60 spg	Betulaceae	B. lenta	Birch, sweet
Betulaceae ≥ 0.60 spg	Betulaceae	Ostrya virginiana	Hophornbeam
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Cornaceae	Cornus florida	Dogwood
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Cornaceae	Nyssa aquatica	Tupelo, water
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Cornaceae	N. sylvatica	Tupelo, blackgum
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Ericaceae	Arbutus menziesii	Madrone, Pacific
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Ericaceae	Oxydendrum arboreum	Sourwood
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Ericaceae	Umbellularia californica	California bay laurel
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Lauraceae	Sassafras albidum	Sassafras
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Platanaceae	Platanus occidentalis	Sycamore
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Rosaceae	Amelanchier spp.	Serviceberry

Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Rosaceae	Prunus pensylvanica	Cherry, pin
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Rosaceae	P. serotina	Cherry, black
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Rosaceae	P. virginiana	Cherry, chokecherry
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Rosaceae	Sorbus americana	Sorbus, mountain ash
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Ulmaceae	Ulmus americana	Elm
Cornaceae/Ericaceae/Lauraceae/Platanaceae/ Rosaceae/Ulmaceae	Ulmaceae	Ulmus spp.	Elm
Fabaceae/Juglandaceae,Carya	Juglandaceae	Carya illinoinensis	Pecan
Fabaceae/Juglandaceae,Carya	Juglandaceae	C. ovata	Hickory, shagbark
Fabaceae/Juglandaceae,Carya	Juglandaceae	Carya spp.	Hickory
Fabaceae/Juglandaceae,Other	Fabaceae	Robinia pseudoacacia	Locust, black
Fagaceae, deciduous	Fagaceae	Castanea dentata	Chestnut, American
Fagaceae, deciduous	Fagaceae	Fagus grandifolia	Beech
Fagaceae, deciduous	Fagaceae	Quercus alba	Oak, white
Fagaceae, deciduous	Fagaceae	Q. coccinea	Oak, scarlet
Fagaceae, deciduous	Fagaceae	Q. ellipsoidalis	Oak, pin
Fagaceae, deciduous	Fagaceae	Q. falcata	Oak, red southern
Fagaceae, deciduous	Fagaceae	Q. macrocarpa	Oak, bur
Fagaceae, deciduous	Fagaceae	Q. nigra	Oak, water
Fagaceae, deciduous	Fagaceae	Q. prinus	Oak, chestnut
Fagaceae, deciduous	Fagaceae	Q. rubra	Oak, red northern
Fagaceae, deciduous	Fagaceae	Quercus spp.	Oaks
Fagaceae, deciduous	Fagaceae	Q. stellata	Oak, post
Fagaceae, deciduous	Fagaceae	Q. velutina	Oak, black
Fagaceae, evergreen	Fagaceae	Chrysolepis chrysophylla	Chinkapin, golden
Fagaceae, evergreen	Fagaceae	Lithocarpus densiflorus	Tanoak
Fagaceae, evergreen	Fagaceae	Q. douglasii	Oak, blue
Fagaceae, evergreen	Fagaceae	Q. laurifolia	Oak, laurel
Fagaceae, evergreen	Fagaceae	Q. minima	Oak, dwarf live
Hamamelidaceae	Hamamelidaceae	Liquidambar styraciflua	Sweetgum
Hippocastanaceae/Tiliaceae	Hippocastanaceae	Aesculus flava	Aesculus, yellow buckeye
Hippocastanaceae/Tiliaceae	Tiliaceae	Tilia americana	Basswood
Hippocastanaceae/Tiliaceae	Tiliaceae	T. americana. var. heterophylla	Basswood, white
Magnoliaceae	Magnoliaceae	Liriodendron tulipifera	Tulip poplar
Magnoliaceae	Magnoliaceae	Magnolia fraseri	Magnolia, Fraser
Magnoliaceae	Magnoliaceae	M. virginiana	Magnolia, sweetbay

Oleaceae < 0.55 spg	Oleaceae	Fraxinus nigra	Ash, black
Oleaceae < 0.55 spg	Oleaceae	F. pennsylvanica	Ash, green
Oleaceae < 0.55 spg	Oleaceae	Fraxinus spp.	Ash
Oleaceae ≥ 0.55 spg	Oleaceae	F. americana	Ash, white
Salicaceae < 0.35 spg	Salicaceae	Populus balsamifera	Populus, balasm poplar
Salicaceae < 0.35 spg	Salicaceae	P. balsamifera. ssp. trichocarpa	Populus, black Cottonwood
Salicaceae < 0.35 spg	Salicaceae	P. balsamifera. ssp. trichocarpa	
Salicaceae < 0.35 spg	Salicaceae	Populus spp.	Populus, cottonwood
Salicaceae ≥ 0.35 spg	Salicaceae	P. deltoides	Populus, cottonwood eastern
Salicaceae ≥ 0.35 spg	Salicaceae	P. grandidentata	Populus, aspen bigtooth
Salicaceae ≥ 0.35 spg	Salicaceae	Populus spp.	Populus, cottonwood
Salicaceae ≥ 0.35 spg	Salicaceae	P. tremuloides	Populus, aspen quaking
Salicaceae ≥ 0.35 spg	Salicaceae	Salix alba	Willow, white
Salicaceae ≥ 0.35 spg	Salicaceae	Salix spp.	Willow

Source: Chojnacky et al., 2014.

[a] spg = specific gravity of wood on a green volume to dry-weight basis.

Table 3: Four Taxon Groupings for 15 Woodland Species (or Species Groups)

(Copied from Hanson et al. 2024 Table 3-A-3; Appendix 3-A from Chapter 3)

Taxon	Family	Genus and Species	Common Name
Cupressaceae	Cupressaceae	Cupressus spp.	Cypress, pygmy
Cupressaceae	Cupressaceae	Juniperus monosperma	Juniper, oneseed
Cupressaceae	Cupressaceae	J. occidentalis	Juniper, western
Cupressaceae	Cupressaceae	J. osteosperma	Juniper, Utah
Fabaceae/Rosaceae	Fabaceae	Cercidium microphyllum	Paloverde, yellow
Fabaceae/Rosaceae	Fabaceae	Prosopis spp.	Mesquite
Fabaceae/Rosaceae	Rosaceae	Cercocarpus ledifolius	Mountain mahogany
Fabaceae/Rosaceae	Rosaceae	C. montanus. var. pauciden	Mountain mahogany
Fagaceae	Fagaceae	Quercus douglasii	Oak, blue
Fagaceae	Fagaceae	Q. gambelii	Oak, Gambel
Fagaceae	Fagaceae	Q. hypoleucoides	Oak, silverleaf
Fagaceae	Fagaceae	Quercus (live) spp.	Oak, evergreen spp.
Pinaceae	Pinaceae	Pinus cembroides	Pine, pinyon
Pinaceae	Pinaceae	P. edulis	Pine, pinyon
Pinaceae	Pinaceae	P. monophylla	Pine, pinyon singleleaf

Table 4: FIA Species Occurrence by LRR and Taxon group

Taxon Group	LRR	Common Species Name
Aceraceae < 0.50 spg	F	Red Maple, Boxelder
	K	Red Maple
	L	Red Maple
	M	Red Maple
	R	Red Maple
	S	Red Maple
Betulaceae < 0.40 spg	A	Red Alder
	C	Red Alder
Betulaceae 0.40-0.49 spg	K	Paper Birch
	L	Paper Birch
	R	Paper Birch, Gray Birch
	S	Paper Birch
Cornaceae, other	F	American Elm, Hackberry
	G	American Elm, Hackberry
	HN	Hackberry, American Elm
	HS	American Elm, Hackberry
	K	American Elm, Black Cherry, Hackberry
	L	Hackberry, American Elm, Black Cherry
	M	Hackberry, American Elm, Black Cherry
	N	Hackberry, American Elm, Black Cherry, American Sycamore, Blackgum
	O	Hackberry, American Elm
	PW	American Elm
	R	American Elm, Black Cherry
	S	Black Cherry, Hackberry, Blackgum, American Sycamore
	TE	Black Cherry
Cupressaceae	DN	Arizona Cypress, Western Juniper
	DS	Arizona Cypress, Western Juniper
	E	Western Juniper
Cupressaceae 0.30-0.39 spg	A	Redwood, Incense-Cedar, Western Red Cedar
	B	Western Red Cedar
	C	Redwood, Incense-Cedar
	DS	Incense-Cedar
Cupressaceae > 0.40 spg	HN	Eastern Red Cedar
	HS	Eastern Red Cedar
	M	Eastern Red Cedar
Fabaceae, Juglandaceae, Carya	L	Shagbark Hickory, Black Walnut
	M	Shagbark Hickory, Black Walnut, Pecan
	N	Pecan, Shagbark Hickory, Black Walnut, Hickory spp.
Fagaceae	DN	Gambel Oak
	DS	Gambel Oak

	E	Gambel Oak
Fagaceae, deciduous	C	California Black Oak
	DN	California Black Oak
	F	Bur Oak, Northern Red Oak, White Oak
	G	Bur Oak
	J	Post Oak, Black Oak, Bur Oak, Northern Red Oak, Pin Oak, Water Oak, Southern Red Oak, White Oak
	K	Pin Oak, Bur Oak, White Oak, Black Oak, Northern Red Oak, American Beech
	L	Northern Red Oak, White Oak, Pin Oak, Black Oak, Bur Oak, American Beech, Chestnut Oak, Scarlet Oak
	M	Northern Red Oak, Bur Oak, Black Oak, White Oak, Pin Oak, Post Oak, Scarlet Oak, American Beech, Chestnut Oak, Water Oak
	N	White Oak, Southern Red Oak, Scarlet Oak, Chestnut Oak, Northern Red Oak, Black Oak, Post Oak, Water Oak, Pin Oak, American Beech, Bur Oak
	O	Southern Red Oak, Post Oak, White Oak, Water Oak, Northern Red Oak, Black Oak, Scarlet Oak, Pin Oak, Bur Oak
	R	Black Oak, Northern Red Oak, White Oak, Scarlet Oak, Chestnut Oak, American Beech, Pin Oak, Southern Red Oak
	S	Scarlet Oak, Black Oak, Pin Oak, White Oak, Post Oak, Northern Red Oak, Southern Red Oak, Chestnut Oak, American Beech
	U	Water Oak
Fagaceae, evergreen	C	Canyon Live Oak
Hamamelidaceae	N	Sweetgum
	O	Sweetgum
	PW	Sweetgum
	TE	Sweetgum
	TW	Sweetgum
Larix	K	Tamarack
Magnoliaceae	O	Yellow Poplar
	PE	Yellow Poplar
	PW	Yellow Poplar
	S	Yellow Poplar
	TE	Yellow Poplar
Oleaceae < 0.55 spg	F	Green Ash
	G	Green Ash
	J	Green Ash
	K	Green Ash
	L	Green Ash
	M	Green Ash
	O	Green Ash
	PW	Green Ash

	S	Green Ash
Picea	A	Engelmann Spruce, Sitka Spruce
Picea	B	Engelmann Spruce, Sitka Spruce
	E	Engelmann Spruce
Pinus < 0.45 spg	A	Ponderosa Pine, Jeffrey Pine, Western White Pine, Lodgepole Pine, Sugar Pine
	B	Ponderosa Pine, Lodgepole Pine, Whitebark Pine, Western White Pine, Sugar Pine
	C	Ponderosa Pine, Jeffrey Pine, Sugar Pine, Lodgepole Pine, Western White Pine, Whitebark Pine
	DN	Ponderosa Pine, Chihuahuan Pine, Sugar Pine, Jeffrey Pine, Lodgepole Pine, Western White Pine, Whitebark Pine
	DS	Chihuahuan Pine, Ponderosa Pine, Arizona Pine, Lodgepole Pine, Jeffrey Pine, Sugar Pine, Western White Pine, Whitebark Pine
	E	Ponderosa Pine, Lodgepole Pine, Whitebark Pine, Western White Pine
	G	Ponderosa Pine, Lodgepole Pine, Whitebark Pine, Jack Pine
	K	Eastern White Pine, Red Pine, Jack Pine, Scotch Pine, Ponderosa Pine
	M	Ponderosa Pine, Scotch Pine, Red Pine, Eastern White Pine, Jack Pine
	N	Eastern White Pine, Red Pine, Scotch Pine
	R	Eastern White Pine, Red Pine, Scotch Pine, Jack Pine
	S	Eastern White Pine, Scotch Pine, Red Pine
Pinus > 0.45 spg	N	Loblolly Pine, Shortleaf Pine, Longleaf Pine, Slash Pine, Pitch Pine
	PE	Loblolly Pine, Longleaf Pine, Shortleaf Pine, Slash Pine
	PW	Loblolly Pine, Longleaf Pine, Shortleaf Pine, Slash Pine
	TE	Loblolly Pine, Slash Pine, Longleaf Pine, Shortleaf Pine
	TW	Slash Pine, Loblolly Pine, Longleaf Pine, Shortleaf Pine
	U	Loblolly Pine, Longleaf Pine, Slash Pine
Pseudotsuga	A	Douglas-Fir
	B	Douglas-Fir
	C	Douglas-Fir
SalicaceaeGTE0.35spg	B	Quaking Aspen
	DN	Quaking Aspen, Plains Cottonwood
	E	Quaking Aspen, Plains Cottonwood, Eastern Cottonwood
	F	Quaking Aspen, Eastern Cottonwood, Plains Cottonwood
	G	Plains Cottonwood, Quaking Aspen, Eastern Cottonwood
	HN	Eastern Cottonwood
	HS	Plains Cottonwood, Eastern Cottonwood
	L	Bigtooth Aspen, Eastern Cottonwood, Quaking Aspen
	M	Eastern Cottonwood, Quaking Aspen, Bigtooth Aspen

Table 5: Linear regression models used to predict DBH (inches) from age by Taxon Group and LRR.

Taxon Group	LRR	Model Parameters	Estimate	SE	p	CI (lower)	CI (upper)	R^2	Observations
Aceraceae < 0.50 spg	F	β_0	-3.18	6.67	0.72	-87.92	81.55	0.39	3
		β_1	1.34	1.68	0.57	-19.98	22.66		
	K	β_0	0.33	0.05	0	0.24	0.42	0.34	3593
		β_1	0.48	0.01	0	0.45	0.50		
	L	β_0	0.37	0.09	0	0.20	0.54	0.43	686
		β_1	0.51	0.02	0	0.47	0.56		
	M	β_0	0.29	0.19	0.13	-0.08	0.66	0.39	195
		β_1	0.55	0.05	0	0.45	0.65		
	R	β_0	0.08	0.06	0.18	-0.04	0.19	0.53	1341
		β_1	0.56	0.02	0	0.53	0.59		
	S	β_0	0.64	0.16	0	0.32	0.97	0.34	207
		β_1	0.43	0.04	0	0.35	0.51		
Betulaceae < 0.40 spg	A	β_0	0.56	0.07	0	0.42	0.71	0.48	732
		β_1	0.55	0.02	0	0.51	0.59		
	C	β_0	1.05	0.21	0.02	0.39	1.70	0.95	5
		β_1	0.44	0.06	0.01	0.26	0.63		
Betulaceae 0.40 - 0.49 spg	K	β_0	0.17	0.05	0	0.07	0.27	0.43	2063
		β_1	0.50	0.01	0	0.47	0.52		
	L	β_0	-0.03	0.17	0.85	-0.37	0.31	0.71	67
		β_1	0.57	0.05	0	0.48	0.66		
	R	β_0	0.38	0.11	0	0.16	0.60	0.48	247
		β_1	0.44	0.03	0	0.38	0.50		
Cornaceae, other	F	β_0	1.35	0.65	0.04	0.04	2.66	0.05	40
		β_1	0.24	0.17	0.16	-0.10	0.58		
	G	β_0	0.27	0.38	0.47	-0.50	1.05	0.59	24
		β_1	0.56	0.1	0	0.35	0.76		
	HN	β_0	0.34	0.13	0.01	0.08	0.60	0.47	281
		β_1	0.59	0.04	0	0.51	0.66		
	HS	β_0	-0.59	0.77	0.45	-2.17	1.00	0.35	30
		β_1	0.85	0.22	0	0.40	1.29		
	K	β_0	1.17	0.07	0	1.04	1.31	0.19	967
		β_1	0.29	0.02	0	0.25	0.33		
	L	β_0	0.33	0.08	0	0.16	0.49	0.41	840
		β_1	0.55	0.02	0	0.50	0.59		
	M	β_0	0.69	0.04	0	0.60	0.77	0.35	2706
		β_1	0.47	0.01	0	0.44	0.49		
	N	β_0	0.51	0.09	0	0.33	0.69	0.47	466
		β_1	0.50	0.03	0	0.45	0.55		

	O	β_0	1.85	1.44	0.42	-16.45	20.15	0.24	3
		β_1	0.21	0.38	0.67	-4.58	5.00		
	PW	β_0	0.71	0.26	0.22	-2.54	3.96	0.98	3
		β_1	0.43	0.07	0.1	-0.41	1.27		
	R	β_0	0.45	0.16	0.01	0.14	0.76	0.53	121
		β_1	0.51	0.04	0	0.42	0.60		
	S	β_0	0.19	0.42	0.65	-0.68	1.06	0.58	22
		β_1	0.61	0.12	0	0.37	0.85		
Cupressaceae	DS	β_0	-1.47	0.05	0	-1.56	-1.39	0.5	5545
		β_1	0.81	0.01	0	0.79	0.83		
	E	β_0	-1.30	0.04	0	-1.38	-1.22	0.5	7020
		β_1	0.78	0.01	0	0.76	0.80		
Cupressaceae 0.30-0.39 spg[a]	A	β_0	-14.63	1.83	0	-18.22	-11.03	0.35	781
		β_1	9.43	0.46	0	8.53	10.33		
	B	β_0	-17.58	6.42	0.01	-30.42	-4.74	0.33	61
		β_1	8.17	1.52	0	5.12	11.22		
	C	β_0	-22.49	5.74	0	-33.86	-11.12	0.36	123
		β_1	11.00	1.34	0	8.35	13.66		
	DS	β_0	9.71	27	0.78	-333.08	352.51	0.04	3
		β_1	1.15	5.83	0.88	-72.96	75.26		
Cupressaceae > 0.40 spg	HN	β_0	0.20	0.21	0.36	-0.22	0.61	0.42	113
		β_1	0.54	0.06	0	0.42	0.66		
	HS	β_0	0.60	0.45	0.2	-0.33	1.53	0.41	21
		β_1	0.45	0.12	0	0.19	0.71		
	M	β_0	0.68	0.11	0	0.46	0.89	0.28	423
		β_1	0.39	0.03	0	0.33	0.45		
Fabaceae, Juglandaceae, Carya	L	β_0	1.09	0.22	0	0.65	1.53	0.28	99
		β_1	0.35	0.06	0	0.23	0.46		
	M	β_0	1.23	0.06	0	1.12	1.34	0.24	1285
		β_1	0.29	0.01	0	0.26	0.32		
	N	β_0	0.81	0.11	0	0.59	1.03	0.38	334
		β_1	0.39	0.03	0	0.34	0.45		
Fagaceae	DN	β_0	-2.16	0.04	0	-2.23	-2.09	0.74	3594
		β_1	0.89	0.01	0	0.87	0.91		
	DS	β_0	-1.90	0.1	0	-2.10	-1.69	0.70	457
		β_1	0.83	0.03	0	0.78	0.88		
	E	β_0	-2.14	0.04	0	-2.21	-2.07	0.73	3155
		β_1	0.86	0.01	0	0.84	0.88		
Fagaceae, deciduous	F	β_0	-1.05	0.27	0	-1.58	-0.52	0.48	171
		β_1	0.80	0.06	0	0.67	0.92		
	G	β_0	0.22	0.42	0.61	-0.62	1.05	0.31	59
		β_1	0.50	0.1	0	0.30	0.69		
	J	β_0	1.14	0.15	0	0.84	1.43	0.11	460
		β_1	0.28	0.04	0	0.20	0.35		

	K	β_0	0.50	0.04	0	0.42	0.58	0.35	4176
		β_1	0.47	0.01	0	0.45	0.49		
	L	β_0	1.08	0.05	0	0.99	1.18	0.31	2059
		β_1	0.36	0.01	0	0.33	0.38		
	M	β_0	1.10	0.03	0	1.04	1.17	0.29	4536
		β_1	0.34	0.01	0	0.32	0.35		
	N	β_0	0.69	0.02	0	0.65	0.72	0.31	20044
		β_1	0.43	0.01	0	0.43	0.44		
	O	β_0	1.45	0.14	0	1.17	1.73	0.14	349
		β_1	0.27	0.04	0	0.20	0.34		
	R	β_0	0.67	0.06	0	0.56	0.79	0.35	1766
		β_1	0.44	0.01	0	0.41	0.47		
	S	β_0	0.90	0.06	0	0.78	1.02	0.29	1827
		β_1	0.39	0.01	0	0.36	0.42		
	U	β_0	-1.50	1.92	0.49	-7.61	4.60	0.55	5
		β_1	0.98	0.51	0.15	-0.65	2.61		
Fagaceae, deciduous	C	β_0	-2.55	0.15	0	-2.86	-2.25	0.7	398
		β_1	1.18	0.04	0	1.11	1.25		
	DN	β_0	-3.43	0.1	0	-3.63	-3.24	0.8	1011
		β_1	1.32	0.02	0	1.28	1.37		
Fagaceae, evergreen	C	β_0	-3.80	0.17	0	-4.13	-3.48	0.7	419
		β_1	1.40	0.04	0	1.32	1.48		
Hamamelidaceae	N	β_0	0.71	0.06	0	0.59	0.84	0.48	822
		β_1	0.47	0.02	0	0.44	0.51		
	O	β_0	0.63	0.14	0	0.36	0.90	0.46	235
		β_1	0.52	0.04	0	0.45	0.60		
	PW	β_0	0.68	0.04	0	0.61	0.76	0.51	2039
		β_1	0.49	0.01	0	0.47	0.52		
	TE	β_0	0.79	0.07	0	0.66	0.92	0.55	536
		β_1	0.46	0.02	0	0.42	0.49		
	TW	β_0	1.04	0.23	0	0.58	1.49	0.36	82
		β_1	0.43	0.06	0	0.30	0.55		
Larix	K	β_0	1.24	0.05	0	1.13	1.34	0.06	3019
		β_1	0.18	0.01	0	0.15	0.20		
Magnoliaceae[a]	O	β_0	-1.87	5.91	0.76	-14.34	10.60	0.30	19
		β_1	4.54	1.7	0.02	0.95	8.12		
	PE	β_0	-7.89	0.54	0	-8.95	-6.84	0.41	2313
		β_1	5.74	0.15	0	5.46	6.02		
	PW	β_0	-7.93	0.66	0	-9.23	-6.63	0.42	1431
		β_1	5.99	0.19	0	5.63	6.36		
	S	β_0	-7.03	1.41	0	-9.80	-4.26	0.40	366
		β_1	5.72	0.36	0	5.00	6.44		
	TE	β_0	-7.92	1.75	0	-11.37	-4.48	0.45	189
		β_1	5.97	0.48	0	5.02	6.93		

Oleaceae < 0.55 spg	F	β_0	0.22	0.2	0.28	-0.17	0.60	0.27	266
		β_1	0.49	0.05	0	0.39	0.59		
	G	β_0	0.83	0.36	0.02	0.11	1.55	0.13	102
		β_1	0.36	0.09	0	0.18	0.54		
	J	β_0	1.27	2.45	0.66	-9.26	11.80	0.06	4
		β_1	0.24	0.68	0.76	-2.70	3.19		
	K	β_0	0.92	0.07	0	0.79	1.05	0.24	1337
		β_1	0.35	0.02	0	0.31	0.38		
	L	β_0	0.90	0.07	0	0.77	1.03	0.30	1204
		β_1	0.39	0.02	0	0.36	0.43		
	M	β_0	0.71	0.07	0	0.59	0.84	0.37	1177
		β_1	0.46	0.02	0	0.42	0.49		
	O	β_0	0.40	0.25	0.14	-0.16	0.97	0.89	11
		β_1	0.54	0.06	0	0.40	0.68		
	PW	β_0	-0.11	0.72	0.89	-1.71	1.50	0.52	12
		β_1	0.70	0.21	0.01	0.23	1.17		
	S	β_0	1.11	0.42	0.02	0.21	2.02	0.47	17
		β_1	0.40	0.11	0	0.17	0.62		
Picea	A	β_0	1.03	0.13	0	0.77	1.29	0.325	460
		β_1	0.52	0.04	0	0.45	0.59		
Picea	B	β_0	0.69	0.19	0	0.32	1.06	0.22	431
		β_1	0.46	0.04	0	0.38	0.54		
	E	β_0	0.72	0.04	0	0.65	0.80	0.19	8929
		β_1	0.38	0.01	0	0.37	0.40		
Pinus > 0.45 spg	N	β_0	1.49	0.02	0	1.45	1.53	0.27	6857
		β_1	0.26	0.01	0	0.25	0.27		
	PE	β_0	1.12	0.02	0	1.09	1.15	0.45	8853
		β_1	0.38	0	0	0.37	0.38		
	PW	β_0	1.06	0.01	0	1.04	1.08	0.49	25739
		β_1	0.41	0	0	0.41	0.42		
	TE	β_0	1.14	0.02	0	1.11	1.18	0.46	5524
		β_1	0.38	0.01	0	0.37	0.40		
	TW	β_0	1.27	0.04	0	1.18	1.35	0.32	1730
		β_1	0.34	0.01	0	0.32	0.36		
	U	β_0	1.12	0.07	0	0.99	1.25	0.33	723
		β_1	0.36	0.02	0	0.32	0.40		
Pinus < 0.45 spg (All Species)	A	β_0	0.92	0.06	0	0.80	1.03	0.32	2029
		β_1	0.43	0.01	0	0.40	0.46		
	B	β_0	0.70	0.03	0	0.64	0.76	0.37	6114
		β_1	0.46	0.01	0	0.44	0.47		
	C	β_0	1.29	0.1	0	1.10	1.48	0.23	963
		β_1	0.38	0.02	0	0.34	0.43		
	DN	β_0	0.62	0.02	0	0.58	0.67	0.29	17620
		β_1	0.47	0.01	0	0.46	0.48		

	DS	β_0	-0.05	0.15	0.73	-0.34	0.24	0.31	734
		β_1	0.61	0.03	0	0.54	0.67		
	E	β_0	1.42	0.03	0	1.37	1.47	0.07	17171
		β_1	0.22	0.01	0	0.21	0.24		
	G	β_0	0.83	0.05	0	0.74	0.92	0.22	4493
		β_1	0.38	0.01	0	0.36	0.40		
	K	β_0	0.42	0.02	0	0.38	0.47	0.50	7441
		β_1	0.51	0.01	0	0.50	0.52		
	M	β_0	0.39	0.11	0	0.18	0.61	0.49	337
		β_1	0.55	0.03	0	0.49	0.61		
	N	β_0	0.92	0.06	0	0.79	1.04	0.42	931
		β_1	0.45	0.02	0	0.41	0.48		
	R	β_0	0.48	0.06	0	0.37	0.59	0.48	1405
		β_1	0.52	0.01	0	0.49	0.54		
	S	β_0	0.90	0.17	0	0.57	1.24	0.37	151
		β_1	0.41	0.04	0	0.32	0.50		
Pinus < 0.45 spg (Non-Alpine Species)	A	β_0	0.97	0.06	0	0.85	1.09	0.33	1731
		β_1	0.43	0.02	0	0.40	0.46		
	B	β_0	0.72	0.03	0	0.65	0.78	0.46	4693
		β_1	0.48	0.01	0	0.46	0.49		
	C	β_0	1.11	0.09	0	0.93	1.29	0.33	836
		β_1	0.44	0.02	0	0.40	0.48		
	DN	β_0	0.74	0.03	0	0.69	0.79	0.30	14987
		β_1	0.46	0.01	0	0.45	0.47		
	DS	β_0	-0.09	0.15	0.57	-0.39	0.21	0.30	706
		β_1	0.61	0.04	0	0.55	0.68		
	E	β_0	1.23	0.04	0	1.16	1.30	0.14	7934
		β_1	0.31	0.01	0	0.30	0.33		
	G	β_0	0.75	0.05	0	0.66	0.84	0.26	4177
		β_1	0.40	0.01	0	0.38	0.42		
	K	β_0	0.42	0.02	0	0.38	0.47	0.50	7441
		β_1	0.51	0.01	0	0.50	0.52		
	M	β_0	0.39	0.11	0	0.18	0.61	0.49	337
		β_1	0.55	0.03	0	0.49	0.61		
	N	β_0	0.92	0.06	0	0.79	1.04	0.42	931
		β_1	0.45	0.02	0	0.41	0.48		
	R	β_0	0.48	0.06	0	0.37	0.59	0.48	1405
		β_1	0.52	0.01	0	0.49	0.54		
	S	β_0	0.90	0.17	0	0.57	1.24	0.37	151
		β_1	0.41	0.04	0	0.32	0.50		
Pseudotsuga	A	β_0	0.84	0.01	0	0.82	0.86	0.55	39710
		β_1	0.52	0	0	0.51	0.52		
	B	β_0	0.58	0.04	0	0.50	0.65	0.36	5595
		β_1	0.51	0.01	0	0.49	0.52		

	C	β_0	0.54	0.09	0	0.36	0.72	0.45	862
		β_1	0.59	0.02	0	0.54	0.63		
Salicacea > 0.35 spg	B	β_0	0.63	0.19	0	0.26	1.00	0.22	211
		β_1	0.35	0.05	0	0.26	0.44		
	DN	β_0	0.06	0.09	0.5	-0.12	0.25	0.28	1329
		β_1	0.49	0.02	0	0.45	0.54		
	E	β_0	0.40	0.05	0	0.29	0.50	0.22	4010
		β_1	0.41	0.01	0	0.38	0.43		
	F	β_0	-0.93	0.11	0	-1.14	-0.72	0.62	521
		β_1	0.82	0.03	0	0.77	0.88		
	G	β_0	-0.25	0.28	0.37	-0.79	0.30	0.23	299
		β_1	0.62	0.07	0	0.49	0.75		
	HN	β_0	0.44	0.31	0.17	-0.19	1.07	0.52	52
		β_1	0.61	0.08	0	0.45	0.78		
	HS	β_0	1.00	0.61	0.12	-0.27	2.27	0.25	21
		β_1	0.42	0.16	0.02	0.07	0.76		
	L	β_0	0.36	0.1	0	0.16	0.56	0.37	586
		β_1	0.53	0.03	0	0.47	0.58		
	M	β_0	0.57	0.11	0	0.36	0.78	0.38	553
		β_1	0.54	0.03	0	0.48	0.59		

[a] The models for these taxon groups were estimated on DBH, not ln(DBH) as for other taxon groups.

Table 6: NRCS agroforestry systems, tree types and planting densities. If a taxon group was reported for an agroforestry system, but there was not sufficient data in FIA to estimate a DBH model, a model was chosen for either a neighboring LRR or another taxon group in the same LRR. Gap-filled taxon groups are noted in the last 2 columns.

LRR	**Agroforestry System**	**Tree Type**		**Trees/ acre**	**Gap-fill**	
		Taxon Group Common Name(s)	Taxon Group		LRR	Taxon Group
A	1-row windbreak (Conifer)	Douglas Fir	Pseudotsuga	360		
	3-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	100		
		Douglas Fir	Pseudotsuga	210		
	Farm woodlot (Conifer)	Douglas Fir	Pseudotsuga	400		
	Riparian buffer (Mixed Hardwoods/ Conifer)	Alder	Betulaceae < 0.40 spg	220		
		Birch	Betulaceae 0.40-0.49 spg	110	A	Betulaceae < 0.40 spg
		Spruce	Picea < 0.35 spg	110		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	220	B	Salicaceae >= 0.35 spg
B	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	350		
	2-row windbreak (Mixed Conifers)	Pine	Pinus < 0.45 spg	280		
		Douglas Fir	Pseudotsuga	280		
	3-row windbreak	Pine	Pinus < 0.45 spg	210		

	(Hardwood/ Conifer)	Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	100		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	300		
	Riparian buffer (Hardwood/Conifer)	Spruce	Picea < 0.35 spg	240		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	120		
C	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	440		
	2-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	360		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	300		
	Riparian buffer (Mixed Hardwoods/ Conifer)	Pine	Pinus < 0.45 spg	100		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	100		
		Evergreen Oak	Fagaceae, evergreen	100		
DN	1-row windbreak (Conifer)	Woodland Cypress/ Juniper	Cupressaceae	440		
	3-row windbreak (Hardwood/ Conifer)	Woodland Cypress/ Juniper	Cupressaceae	90		
		Pine	Pinus < 0.45 spg	90		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	90		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	200		
	Riparian buffer (Mixed Hardwoods)	Woodland Oak	Fagaceae	30		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	30		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	30		
DS	1-row windbreak (Conifer)	Woodland Cypress/ Juniper	Cupressaceae	440		
	3-row windbreak (Mixed Conifers)	Woodland Cypress/ Juniper	Cupressaceae	90		
		Cedar	Cupressaceae 0.30-0.39 spg	90	C	Cupressaceae 0.30-0.39 spg
		Pine	Pinus < 0.45 spg	90		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	200		
	Riparian buffer (Mixed Hardwoods)	Woodland Oak	Fagaceae	50		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	50	C	Fagaceae, deciduous
E	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	350		
	4-row windbreak (Hardwood/ Conifer)	Woodland Cypress/ Juniper	Cupressaceae	60		
		Spruce	Picea < 0.35 spg	60		

		Pine	Pinus < 0.45 spg	60		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	60		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	440		
	Riparian buffer (Mixed Hardwoods)	Woodland Oak	Fagaceae	220		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	220		
F	1-row windbreak (Hardwood)	Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	220		
	5-row windbreak (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	40	M	Aceraceae < 0.50 spg
		Woodland Legume/ Rose	Fabaceae/Rosaceae	40	F	Cornaceae/ Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	70		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	40		
	Farm woodlot (Hardwood)	Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	200		
	Riparian buffer (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	40	M	Aceraceae < 0.50 spg
		Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	80		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	40		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	40		
G	1-row windbreak (Conifer)	Woodland Cypress/ Juniper	Cupressaceae	440	E	Cupressaceae
	1-row windbreak (Hardwood)	Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	220		
	3-row windbreak (Hardwood/ Conifer)	Woodland Cypress/ Juniper	Cupressaceae	70	E	Cupressaceae
		Pine	Pinus < 0.45 spg	70		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	70		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	200		
	Riparian buffer (Mixed Hardwoods)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	70		

		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	70		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	70		
HN	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	440	G	Pinus < 0.45 spg
	1-row windbreak (Hardwood)	Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	220		
	3-row windbreak (Hardwood/ Conifer)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	50		
		Pine	Pinus < 0.45 spg	140	G	Pinus < 0.45 spg
HS	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	440	G	Pinus < 0.45 spg
	1-row windbreak (Hardwood)	Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	220		
	3-row windbreak (Hardwood/ Conifer)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	50		
		Pine	Pinus < 0.45 spg	140	G	Pinus < 0.45 spg
IN[a]	1-row windbreak (Conifer)	Woodland Cypress/ Juniper	Cupressaceae	440	DS	Cupressaceae
	3-row windbreak (Mixed Conifers)	Woodland Cypress/Juniper	Cupressaceae	90	DS	Cupressaceae
		Cedar	Cupressaceae 0.30-0.39 spg	90	C	Cupressaceae 0.30-0.39 spg
		Pine	Pinus < 0.45 spg	90	DS	Pinus < 0.45 spg
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	200	DS	Pinus < 0.45 spg
	Riparian buffer (Mixed Hardwoods)	Woodland Oak	Fagaceae	50	DS	Fagaceae
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	50	C	Fagaceae, deciduous
IS[a]	1-row windbreak (Conifer)	Woodland Cypress/ Juniper	Cupressaceae	440	DS	Cupressaceae
	3-row windbreak (Mixed Conifers)	Woodland Cypress/ Juniper	Cupressaceae	90	DS	Cupressaceae
		Cedar	Cupressaceae 0.30-0.39 spg	90	C	Cupressaceae 0.30-0.39 spg
		Pine	Pinus < 0.45 spg	90	DS	Pinus < 0.45 spg
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	200	DS	Pinus < 0.45 spg
	Riparian buffer (Mixed Hardwoods)	Woodland Oak	Fagaceae	50	DS	Fagaceae
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	50	C	Fagaceae, deciduous
J	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	350	PW	Pinus >= 0.45 spg

	Riparian buffer (Hardwood)	Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	100		
K	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	350		
	3-row windbreak (Hardwood/ Conifer)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	90		
		Pine	Pinus < 0.45 spg	180		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	440		
	Riparian buffer (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	140		
		Birch	Betulaceae 0.40-0.49 spg	140		
		Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	140		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	140		
		Larch	Larix	140		
L	1-row windbreak (Hardwood)	Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	440		
	2-row windbreak (Mixed Hardwoods)	Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	140		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	140		
	Farm woodlot (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	140		
		Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	140		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	270		
	Riparian buffer (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	110		
		Birch	Betulaceae 0.40-0.49 spg	110		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	110		
		Ash	Oleaceae < 0.55 spg	110		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	110		
M	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	350		
	3-row windbreak (Hardwood/ Conifer)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	70		

		Cedar	Cupressaceae >= 0.40 spg	70		
		Pine	Pinus < 0.45 spg	70		
	5-row windbreak (Hardwood/ Conifer)	Maple	Aceraceae < 0.50 spg	70		
		Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	70		
		Cedar	Cupressaceae >= 0.40 spg	70		
		Pine	Pinus < 0.45 spg	130		
	Alley cropping (Hardwood)	Hickory/Pecan/Walnut	Fabaceae/ Juglandaceae, Carya	70		
	Farm woodlot (Mixed Hardwoods)	Hickory/Pecan/Walnut	Fabaceae/ Juglandaceae, Carya	150		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	290		
	Riparian buffer (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	90		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	260		
		Cottonwood/Willow/ Aspen	Salicaceae >= 0.35 spg	90		
N	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	350		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	680		
	Farm woodlot (Hardwood)	Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	440		
	Riparian buffer (Mixed Hardwoods)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	170		
		Hickory/Pecan/Walnut	Fabaceae/ Juglandaceae, Carya	90		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	90		
		Sweetgum	Hamamelidaceae	90		
	Silvopasture (Conifer)	Pine	Pinus >= 0.45 spg	190		
	Silvopasture (Hardwood)	Hickory/Pecan/Walnut	Fabaceae/ Juglandaceae, Carya	70		
O	1-row windbreak (Conifer)	Pine	Pinus >= 0.45 spg	350	PE	Pinus >= 0.45 spg
	Farm woodlot (Mixed Hardwoods)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	150	N	Cornaceae/ Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae

		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	150		
		Sweetgum	Hamamelidaceae	150		
	Riparian buffer (Mixed Hardwoods/ Conifer)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	60	N	Cornaceae/ Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae
		Cedar	Cupressaceae >= 0.40 spg	60	M	Cupressaceae >= 0.40 spg
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	60		
		Sweetgum	Hamamelidaceae	60		
		Magnolia/Tulip Tree	Magnoliaceae	60	PW	Magnoliaceae
PE	1-row windbreak (Conifer)	Pine	Pinus >= 0.45 spg	350		
	Farm woodlot (Conifer)	Pine	Pinus >= 0.45 spg	680		
	Farm woodlot (Mixed Hardwoods)	Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	230	N	Fagaceae, deciduous
		Magnolia/Tulip Tree	Magnoliaceae	80		
	Riparian buffer (Hardwood/ Conifer)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	170	N	Cornaceae/ Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	170	N	Fagaceae, deciduous
		Pine	Pinus >= 0.45 spg	90		
	Silvopasture (Conifer)	Pine	Pinus >= 0.45 spg	250		
PW	1-row windbreak (Conifer)	Pine	Pinus >= 0.45 spg	350		
	Farm woodlot (Conifer)	Pine	Pinus >= 0.45 spg	680		
	Farm woodlot (Mixed Hardwoods)	Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	230	N	Fagaceae, deciduous
		Magnolia/Tulip Tree	Magnoliaceae	80		
	Riparian buffer (Mixed Hardwoods/ Conifer)	Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	90	N	Cornaceae/ Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	170	N	Fagaceae, deciduous
		Sweetgum	Hamamelidaceae	90		

		Pine	Pinus >= 0.45 spg	90		
	Silvopasture (Conifer)	Pine	Pinus >= 0.45 spg	320		
R	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	350		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	440		
	Farm woodlot (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	150		
		Birch	Betulaceae 0.40-0.49 spg	150		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	150		
	Riparian buffer (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	90		
		Birch	Betulaceae 0.40-0.49 spg	90		
		Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	90		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	170		
S	1-row windbreak (Conifer)	Pine	Pinus < 0.45 spg	350		
	Farm woodlot (Conifer)	Pine	Pinus < 0.45 spg	440		
	Farm woodlot (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	150		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	150		
		Magnolia/Tulip Tree	Magnoliaceae	150		
	Riparian buffer (Mixed Hardwoods)	Maple	Aceraceae < 0.50 spg	90		
		Birch	Betulaceae 0.40-0.49 spg	90	R	Betulaceae 0.40-0.49 spg
		Other Hardwood	Cornaceae/Ericaceae/ Lauraceae/ Platanaceae/ Rosaceae/ Ulmaceae	90		
		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	170		
TE	1-row windbreak (Conifer)	Pine	Pinus >= 0.45 spg	350		
	3-row windbreak (Hardwood/ Conifer)	Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	90	S	Fagaceae, deciduous
		Pine	Pinus >= 0.45 spg	180		
	Farm woodlot (Conifer)	Pine	Pinus >= 0.45 spg	680		
	Riparian buffer (Mixed Hardwoods/ Conifer)	Sweetgum	Hamamelidaceae	150		
		Magnolia/Tulip Tree	Magnoliaceae	150		
		Pine	Pinus >= 0.45 spg	150		

	Silvopasture (Conifer)	Pine	Pinus >= 0.45 spg	250		
TW	1-row windbreak (Conifer)	Pine	Pinus >= 0.45 spg	350		
	Farm woodlot (Conifer)	Pine	Pinus >= 0.45 spg	680		
	Riparian buffer (Mixed Hardwoods/ Conifer)	Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	150	J	Fagaceae, deciduous
		Sweetgum	Hamamelidaceae	150		
		Pine	Pinus >= 0.45 spg	150		
	Silvopasture (Conifer)	Pine	Pinus >= 0.45 spg	320		
U	1-row windbreak (Conifer)	Pine	Pinus >= 0.45 spg	450		
U	Farm woodlot (Conifer)	Pine	Pinus >= 0.45 spg	440		
U	Riparian buffer (Mixed Hardwoods/ Conifer)	Cedar	Cupressaceae >= 0.40 spg	150	U	Pinus >= 0.45 spg
U		Deciduous Oak/Beech/Chesnut	Fagaceae, deciduous	150	TE	Hamamelidaceae
U		Magnolia/Tulip Tree	Magnoliaceae	150	TE	Magnoliaceae
U	Silvopasture (Conifer)	Pine	Pinus >= 0.45 spg	250		

[a] Note LRR I had no observations in FIA for any of the taxon groups reported for agroforestry systems, so prescriptions from LRR D were applied.