California Air Resources Board

Greenhouse Gas Quantification Methodology for the California Department of Food and Agriculture Healthy Soils Program

Greenhouse Gas Reduction Fund
Fiscal Year 2016-17

August 8, 2017

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Section A. Introduction

The goal of California Climate Investments is to reduce greenhouse gas (GHG) emissions and further the purposes of the Global Warming Solutions Act of 2006, known as Assembly Bill (AB) 32. The California Air Resources Board (CARB) is responsible for providing the quantification methodology to estimate the net GHG benefits and other benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). CARB develops these methodologies based on the project types eligible for funding by each administering agency as reflected in the program Expenditure Records available at: https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/expenditurerecords.htm. CARB staff periodically review each quantification methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified.

For the California Department of Food and Agriculture (CDFA) Healthy Soils Program[1] (Healthy Soils), CARB staff developed this quantification methodology to provide methods for estimating net GHG benefits of each proposed project (Section B), provide instructions for documenting and supporting the estimate (Section C), and outline the process for tracking and reporting GHG and other benefits once a project is funded (Section D).

This methodology estimates the net GHG benefits from increases in carbon sequestration and changes in nitrous oxide and methane emissions from the implementation of agricultural practices that are part of Healthy Soils Program projects. Projects will report the total project GHG benefit estimated using this methodology as well as the total project GHG benefit per dollar of GGRF funds requested.

Healthy Soils Practices and Organization

CDFA adopted 17 practices to be incentivized over a 3 year period that meet the objectives of the Healthy Soils Program and for which there are methods to quantify net GHG benefits. Fourteen of the practices follow conservation practice standards (CPS) developed by the U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS). All CPS can be found in Section IV of the USDA-NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov/), but only the 14 CPS listed in Figure 1 are in the Healthy Soils Program. Three of the practices follow standards developed by CDFA, and can be found in “Compost Application Rates for California Croplands and Rangelands for a CDFA Healthy Soils Incentives Program” (https://www.cdfa.ca.gov/oefi/efasap/docs/CompostApplicationRate_WhitePaper.pdf). Other project features may be eligible for funding under the Healthy Soils Program; however, GHG benefits will be quantified only for specific implementations within these practices for FY 2016-17.

[1] Healthy Soils Program Guidelines available at https://www.cdfa.ca.gov/oefi/healthysoils/.

Practices are organized into Classes to align with USDA-NRCS CPS organization, and the Classes are organized into Groups to align with the CDFA Guidelines structure for the Healthy Soils Program. This organization is shown in Figure 1.

Figure 1. Organization of Healthy Soils Practices

Soil Management Group

Cropland Management Class (USDA-NRCS)

- Cover Crops (CPS 340)
- Mulching (CPS 484)
- Residue and Tillage Management, No Till (CPS 329)
- Residue and Tillage Management, Reduced Till (CPS 345)

Compost Application Class (CDFA)

- Compost Application to Annual Crops
- Compost Application to Perennials, Orchards and Vineyards
- Compost Application to Grasslands

Cropland to Herbaceous Cover Group

Cropland to Herbaceous Cover Class (USDA-NRCS)

- Contour Buffer Strips (CPS 332)
- Field Border (CPS 386)
- Filter Strip (CPS 393)
- Herbaceous Wind Barriers (CPS 603)
- Riparian Herbaceous Cover (CPS 390)
- Vegetative Barrier (CPS 601)

Establishment of Woody Cover Group

Woody Plantings Class (USDA-NRCS)

- Hedgerow Planting (CPS 422)
- Riparian Forest Buffer Establishment (CPS 391)
- Windbreak/Shelterbelt Establishment (CPS 380)

Grazing Lands Class (USDA-NRCS)

- Silvopasture Establishment on Grazed Grasslands (CPS 381)

Section B of this quantification methodology details the practice implementations to use and methods to quantify based on the project practice(s) proposed.

Methodology Development

CARB and CDFA developed this quantification methodology consistent with the guiding implementation principles of California Climate Investments, including ensuring transparency and accountability.[2] CARB and CDFA developed this quantification methodology to estimate the outcomes of proposed projects, inform project selection, and track results of funded projects. The implementing principles ensure that the methodology would:

- Apply at the project-level;
- Provide uniform methods to be applied statewide, and be accessible by all applicants;
- Use existing and proven tools and methods;
- Use project-level data, where available and appropriate; and
- Result in GHG emission-reduction estimates that are conservative and supported by empirical literature.

CARB reviewed peer-reviewed literature and tools and consulted with experts, as needed, to determine methods appropriate for the Healthy Soils Program practices. CARB also consulted with CDFA to determine project-level inputs available. The methods were developed to provide estimates that are as accurate as possible with data readily available at the project level. CARB released a draft FY 2016-17 quantification methodology for public comment in June 2017.

Tools

Applicants must use this quantification methodology to estimate the net GHG benefit of the proposed project. Annual changes in GHG are quantified in metric tonnes of carbon dioxide equivalent per year (MT-CO_2e/yr). GHG benefits have positive values, and GHG disbenefits have negative values. This quantification methodology relies on project-specific outputs from the following tools:

COMET-Planner is a tool developed by USDA-NRCS to provide estimates of GHG impacts of conservation practices. The tool uses an ensemble approach consistent with Comet-Farm, a web-based, whole farm, GHG accounting system. Estimation methods used for most GHG sources in COMET-Planner rely on advanced methods, such as process-based modeling in DAYCENT, DNDC and California-specific empirical calculations to determine the long-term impacts of conservation practices on carbon sequestration, nitrous oxide emissions, and methane emissions.

USDA-NRCS has developed a Healthy Soils Program version of COMET-Planner that quantifies the GHG benefits of the 14 Healthy Soils practices with Conservation Practice Standards described by the USDA-NRCS. The tool, COMET-Planner CDFA HSP, is

[2] As described in Volume 1 of the California Air Resources Board. Funding Guidelines for Agencies Administering California Climate Investments (December 21, 2015) (Funding Guidelines). www.arb.ca.gov/cci-fundingguidelines

used statewide, publicly available, subject to regular updates to incorporate new information, is free of charge, and available to anyone with internet access. COMET-Planner CDFA HSP can be accessed at: http://comet-planner-cdfahsp.com/. COMET-Planner CDFA HSP can also be reached by navigating from the national COMET-Planner website, which can be accessed at: www.comet-planner.com.

Compost-Planner is a methodology developed by CARB, with an interface developed by USDA-NRCS, to provide estimates of GHG impacts of compost application. The tool is based on calculations made by the DeNitrification-DeComposition model (DNDC), a biogeochemical model used to simulate the impacts of compost application on carbon sequestration, nitrous oxide emissions, and methane emissions.

Compost-Planner is used to quantify carbon sequestration benefits and changes in nitrous oxide and methane emission of the three compost application practices developed by CDFA. The tool is publicly available, subject to regular updates to incorporate new information, is free of charge, and available to anyone with internet access. Compost-Planner can be accessed at: www.compost-planner.com.

DNDC modeling and scenarios used by Compost-Planner to create estimates for determining the net GHG benefit by activity type are provided in Appendix B, "Quantification of Greenhouse Gas Emissions from CDFA Compost Practices."

Program Assistance

CARB and CDFA staff will review the quantification portions of the Healthy Soils project applications to ensure that the methods described in this document were properly applied to estimate the net GHG benefit for the proposed project. Applicants should use the following resources for additional questions and comments:

- Questions on this document should be sent to GGRFProgram@arb.ca.gov.
- For more information on CARB's efforts to support implementation of GGRF investments, see: https://www.arb.ca.gov/auctionproceeds.
- Questions pertaining to the Healthy Soils Program should be sent to cdfa.oefi@cdfa.ca.gov.

Section B. GHG Quantification Methodology

Overview

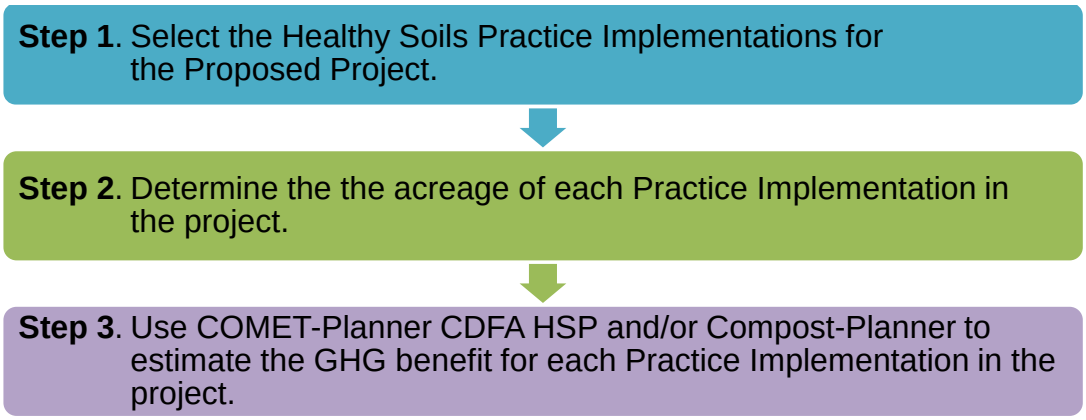
This quantification methodology accounts for the effects of project implementation on increases in carbon stocks in soil and woody biomass, as well as changes in nitrous oxide and methane emissions. The biogeochemical models that inform COMET-Planner CDFA HSP and Compost-Planner include complicated biological and chemical systems, but each group of practices are predominately affected a few types of GHG reduction:

- **Soil Management** practices increase soil organic carbon by sequestering CO_2 in soils.
- **Cropland to Herbaceous Cover** practices sequester CO_2 in herbaceous perennial cover and in soils, and decrease N_2O emissions where fertilizer use is decreased.
- **Establishment of Woody Cover** practices sequester CO_2 in trees and in soils, and decrease N_2O emissions where fertilizer use is decreased.

To quantify GHG reductions, applicants must determine how each practice in the project is implemented, and the area of each implementation. Each of the 17 Healthy Soils practices can be implemented in one to four different ways. Practice implementations differences include whether cropland in the project area is irrigated or non-irrigated, whether plants are legumes or non-legumes, and whether the ratio of carbon to nitrogen in compost is low or high.

Applicants will follow the steps outlined in Figure 2 to estimate the net GHG benefit from the proposed project. Detailed instructions for each step are provided on subsequent pages.

Figure 2. Steps to Estimating Net GHG Benefit



Step 1: Select the Healthy Soils Practice Implementations for the Proposed Project.

Applicants must identify the project practice implementations from Table 1 that will be used in the project.

Only practices and implementations listed in Table 1 will be considered for quantification in the FY 2016-17 Healthy Soils Program. Other USDA-NRCS conservation practices and implementations will not be quantified.

Eligible practices can be implemented alone or in combinations. Single or combined agricultural management practices can be implemented on one APN or on a grouping of several APNs. A project must contain a new or existing Soil Management Practice. Applicants should refer to the "Program Requirements" section of the Healthy Soils Program *Request for Applications* for additional guidance, available at https://www.cdfa.ca.gov/oefi/healthysoils/IncentivesProgram.html for the Incentives Program and https://www.cdfa.ca.gov/oefi/healthysoils/DemonstrationProjects.html for Demonstration Projects.

Some practice implementations have additional requirements listed in Table 1 that may not be listed by the USDA-NRCS as a requirement in the Conservation Practice Standard. The implementations of the Compost Application Class are quantified only for specific application rates, and are not quantified on soils having organic matter content of 20% dry weight or above. Applicants should refer to the "Baseline Data" section of the Healthy Soils Program *Request for Grant Applications* to determine soil organic matter content. The Compost (C:N > 11) Application to Grazed Grassland Implementation is ineligible on certain sites. Some of the practices of the Cropland to Herbaceous Cover Group have minimum width requirements. The practices of the Establishment of Woody Cover Group have minimum tree density requirements. Some of the practices of the Woody Plantings Class have minimum width requirements. The project practice implementations selected by the applicant will determine which quantification methodology tools must be used in order to estimate the net GHG benefit.

The Healthy Soils Practice Implementations are available for selection in the COMET-Planner CDFA HSP and Compost-Planner quantification tools.

Table 1. Healthy Soils Practice Implementations and Practice Requirements to Ensure Alignment with GHG Estimation Methods.

Soil Management Group		
Cropland Management Class Practices[3]	**Practice Implementations in COMET-Planner CDFA HSP**	**Requirements for Alignment**
Cover Crop (CPS 340)	Add Legume Seasonal Cover Crop to Irrigated Cropland	
	Add Legume Seasonal Cover Crop to Non-Irrigated Cropland	
	Add Non-Legume Seasonal Cover Crop to Irrigated Cropland	
	Add Non-Legume Seasonal Cover Crop to Non-Irrigated Cropland	
Mulching (CPS 484)	Add High Carbon Mulch to Croplands	
Residue and Tillage Management – No-Till (CPS 329)	Intensive Till to No Till or Strip Till on Irrigated Cropland	
	Intensive Till to No Till or Strip Till on Non-Irrigated Cropland	
Residue and Tillage Management – Reduced Till (CPS 345)	Intensive Till to Reduced Till on Irrigated Cropland	
	Intensive Till to Reduced Till on Non-Irrigated Cropland	
Compost Application Class Practices[4,5]	**Practice Implementations in Compost-Planner**	**Requirements for Alignment**
Compost Application to Annual Crops (CDFA)	Compost (C:N ≤ 11) Application to Annual Crops	Application rate must[6] be between 2.2-3.6 dry tons/acre[7]
	Compost (C:N > 11) Application to Annual Crops	Application rate must[6] be between 4.0-5.3 dry tons/acre[8]
Compost Application to Perennials, Orchards and Vineyards (CDFA)	Compost (C:N ≤ 11) Application to Perennials, Orchards and Vineyards	Application rate must[6] be between 1.5-2.9 dry tons/acre[7]
	Compost (C:N > 11) Application to Perennials, Trees and Vineyards	Application rate must[6] be between 4.0-5.3 dry tons/acre[8]
Compost Application to Grassland (CDFA)	Compost (C:N > 11) Application to Grazed, Irrigated Pasture	Application rate must[6] be between 4.0-5.3 dry tons/acre[8]
	Compost (C:N > 11) Application to Grazed Grassland[9]	Application rate must[6] be between 4.0-5.3 dry tons/acre[8]

Table 1 (cont'd). Healthy Soils Practice Implementations and Practice Requirements to Ensure Alignment with GHG Estimation Methods.

Cropland to Herbaceous Cover Group		
Cropland to Herbaceous Cover Class Practices[3]	**Practice Implementations in COMET-Planner CDFA HSP**	**Requirements for Alignment**[10]
Contour Buffer Strips (CPS 332)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	
Field Border (CPS 386)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	
Riparian Herbaceous Cover (CPS 390)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover Near Aquatic Habitats	
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover Near Aquatic Habitats	
Filter Strip (CPS 393)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	
Vegetative Barriers (CPS 601)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	Width of the Vegetative Barrier must be at least 3 feet.
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	
Herbaceous Wind Barrier (CPS 603)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	Width of the Herbaceous Wind Barrier must be at least 2 feet.
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	

Table 1 (cont'd). Healthy Soils Practice Implementations and Practice Requirements to Ensure Alignment with GHG Estimation Methods.

Establishment of Woody Cover Group		
Woody Plantings Class Practices[3]	**Practice Implementations in COMET-Planner CDFA HSP**	**Requirements for Alignment**[10]
Hedgerow Planting (CPS 422)	Replace a Strip of Cropland with 1 Row of Woody Plants	There must be at least 200 tree and shrub plantings per acre.[11] Width of each Hedgerow must be at least 8 feet.
	Replace a Strip of Grassland with 1 Row of Woody Plants	
Riparian Forest Buffer (CPS 391)	Replace a Strip of Cropland Near Watercourses or Water Bodies with Woody Plants	There must be at least 35 tree and shrub plantings per acre.[11]
	Replace a Strip of Grassland Near Watercourses or Water Bodies with Woody Plants	
Windbreak/Shelterbelt Establishment (CPS 380)	Replace a Strip of Cropland with 1 Row of Woody Plants	There must be at least 200 tree plantings per acre.[11] Width of each Windbreak must be at least 8 feet.
	Replace a Strip of Grassland with 1 Row of Woody Plants	
Grazing Lands Class Practices[3]	**Practice Implementations in COMET-Planner CDFA HSP**	**Requirements for Alignment**
Silvopasture (CPS 381)	Tree/Shrub Planting on Grazed Grassland	There must be at least 20 tree and shrub plantings per acre.[11]

[3] All NRCS Practices must be implemented per applicable Conservation Practice Standard (CPS) and Specification. (National Resource Conservation Service, 2017b)

[4] All CDFA Practices must be implemented per CDFA paper "Compost Application Rates for California Croplands and Rangelands for a CDFA Healthy Soils Incentives Program." (California Department of Food and Agriculture, 2016)

[5] Soils with organic matter content greater than 20% by weight when mixed to depth of 20 cm are not quantified for Compost practices in the Healthy Soils Program. Organic carbon content is defined by a simplification of the IPCC definition of Organic Soils.

[6] Applicants may apply a higher rate of compost, but only rates in this range will be quantified and funded by the Healthy Soils Program.

[7] If compost (C:N ≤ 11) is received in wet tons, multiply wet tons by 0.7289 to calculate weight of compost in dry tons. (California Department of Food and Agriculture, 2016)

[8] If compost (C:N > 11) is received in wet tons, multiply wet tons by 0.6586 to calculate weight of compost in dry tons. (California Department of Food and Agriculture, 2016)

[9] Some rangeland sites are ineligible for compost application. See https://www.cdfa.ca.gov/oefi/efasap/docs/CompostApplicationRate_WhitePaper.pdf.

[10] Some Cropland to Herbaceous Cover and Woody Plantings Practice Standard and Specification minimum width requirements are included to assist with Step 2.

[11] This is the minimum number of plantings per acre required for quantification. The conservation plan for a selected practice may require a number greater than this minimum.

Step 2: Determine the new acreage of each Practice Implementation in the project.

To quantify the GHG reduction for each practice implementation selected from Step 1, applicants must determine the acreage of each practice implementation to be quantified in the project. The quantification methodology only considers acreage where practice implementations were not applied the previous year. Applicants should refer to the "Program Requirements" section of the Healthy Soils Program *Request for Applications* for additional guidance, and Appendix A, "Example Projects" for examples of how multiple practices are implemented on a project site. Applicants should refer to their Work Plan (part of the Healthy Soils Program *Request for Grant Applications* Application Process) to determine the number of acres for each practice implementation for quantification.

If applicants are expanding a continuing practices from the previous year, or have selected Conversion to Herbaceous Cover or Woody Plantings practices that are characterized primarily by length, the applicant should observe the following conditions:

Continuing Practices

Practices that were implemented in the previous year on a farm are considered "continuing", and are already reducing GHG on the area where they were implemented. GHG reductions associated with the continuing practice on the previously implemented area are not quantified in Healthy Soils project. However, applicants that are expanding the continuing practice to additional acres, fields or APNs as part of the Healthy Soils project, can include the additional area in the quantification.

The acreage that will be quantified for GHG reduction for each practice is calculated as:

$$Quantified\ Area_{Practice} = Project\ Area_{Practice} - Continuing\ Area_{Practice}$$

Where

Variable	Units	Description
$Quantified\ Area_{Practice}$	Acres	The area in the project that will be quantified using the methodology for the practice.
$Project\ Area_{Practice}$	Acres	The area where the practice is implemented in the project.
$Continuing\ Area_{Practice}$	Acres	The area in the project where any implementation of the practice was implemented in the previous year. A new practice has a value of zero.

If one implementation of a practice was implemented on acreage last year, and a different implementation of the same practice is proposed in a Healthy Soils application on that same acreage, the practice is still considered continuing.

As an example, a project involves three 50-acre plots with annual cropland. Last year, non-legume cover crops were added to the first plot, but not the second or third. No compost was applied to any plot last year. The farmer applies for a project that will add legume cover crops to all three plots.

The project includes 150 acres of the Cover Crops. The Cover Crops practice is continuing on 50 acres in the project area. The acreage that is quantified in the project is:

$$Quantified\ Area_{Cover\ Crops} = 150\ acres - 50\ acres = 100\ acres$$

This project has a quantified area of 100 acres for the Cover Crops practice.

Conservation Practices characterized by Length

For Conversion to Herbaceous Cover and Woody Plantings practices that are typically characterized by their length, refer to Table 1 and the Conservation Practice Standards and Specifications in the USDA-NRCS Field Office Technical Guide for conservation practice width requirements and guidance. Areas of these length-based practices can be calculated by:

$$Area_{Practice} = \frac{1}{43{,}560} \times Length_{Practice} \times Width_{Practice}$$

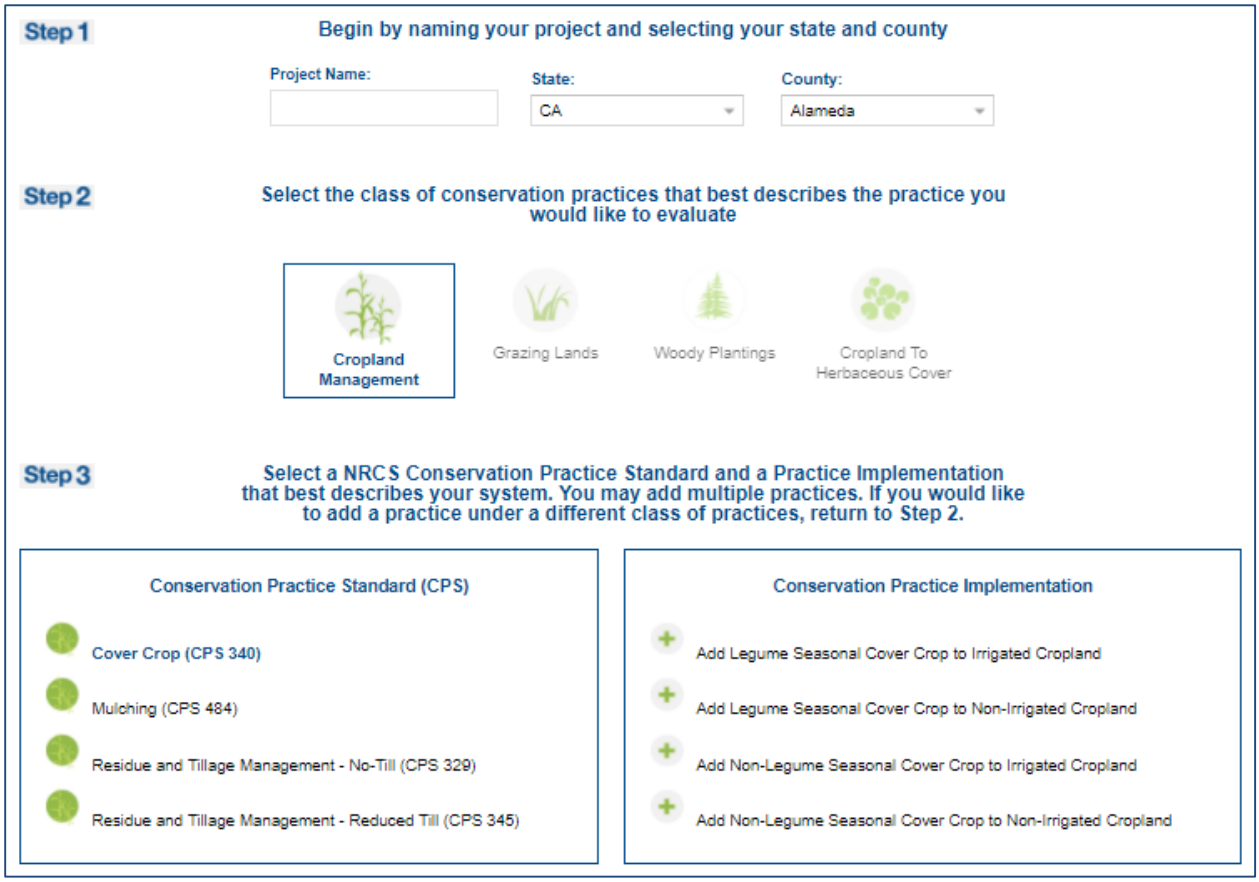
Where

Variable	Units	Description
$Area_{Practice}$	Acres	The area of a practice.
$\frac{1}{43{,}560}$	$\frac{\text{Acres}}{\text{Feet}^2}$	Conversion factor.
$Length_{Practice}$	Feet	The center-line length of a practice, determined by applicant or Conservation Management Plan.
$Width_{Practice}$	Feet	The width of a practice, determined by applicant, Conservation Practice Standard, Conservation Practice Specification, or Conservation Management Plan. Refer to Table 2.

Step 3: Use COMET-Planner CDFA HSP and/or Compost-Planner to estimate the GHG benefit for each Practice in the project.

Applicants must use the USDA-NRCS COMET-Planner CDFA HSP and/or the CARB Compost-Planner Evaluation Tool to complete this step. COMET-Planner CDFA HSP can be accessed by visiting http://comet-planner-cdfahsp.com/. Compost-Planner can be accessed by visiting www.compost-planner.com. These tools are maintained by USDA-NRCS and their interfaces may differ from the images in this document.

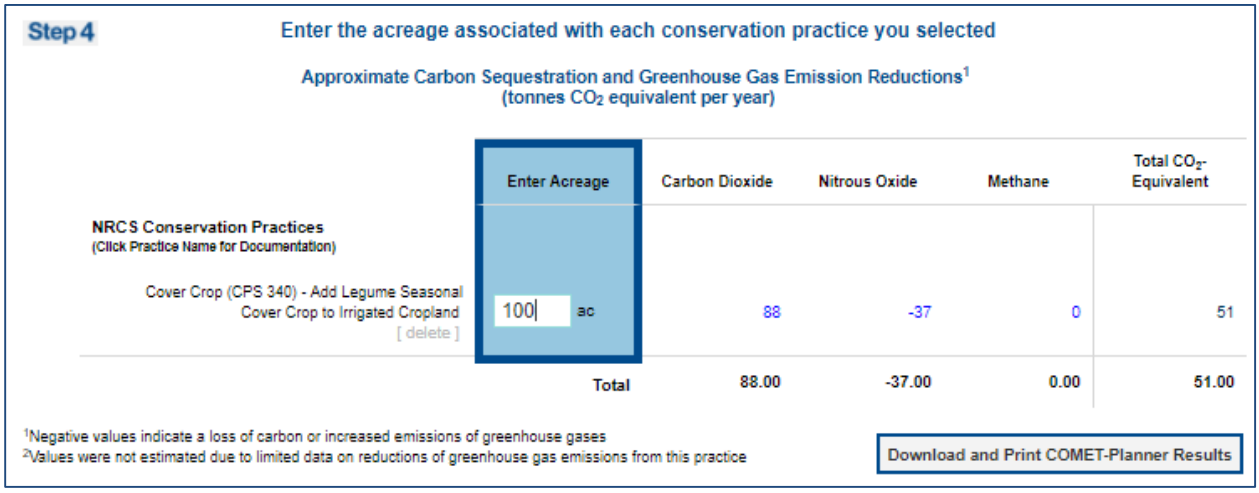
Figure 3. COMET-Planner User Interface for selecting Project Class, Conservation Practice, and Implementation.



The user interface for COMET-Planner CDFA HSP is shown in Figure 3. Use COMET-Planner CDFA HSP by first inputting the Project Name and State, and the County where the project will be implemented. For each USDA-NRCS Conservation Practice that will be implemented in the project, select the conservation practice class, then the conservation practice standard (CPS), then the type of implementation the project will use. In COMET-Planner CDFA HSP, practices and implementations are restricted to those listed in Table 1. In Figure 3, the Cover Crop Conservation Practice from the

Cropland Management Class has been selected, and will be implemented by Adding a Legume Seasonal Cover Crop to Irrigated Cropland. Repeat for all USDA-NRCS conservation practices to be implemented in the project; there will be as many inputs as there were practice implementations selected. Then enter the quantified area from Step 2 on which each of the practices will be implemented, as shown in Figure 4, where the legume seasonal cover crop on irrigated cropland will be implemented on 100 acres of land. COMET-Planner CDFA HSP will calculate the annual greenhouse gas reduction estimates for each practice implementation and sum them. The resulting table can be downloaded to a .pdf file. This file is submitted as part of the Healthy Soils Program application.

Figure 4. COMET-Planner CDFA HSP User Interface for entering the quantified area where a conservation practice will be implemented.



Details of the USDA-NRCS estimation methods for COMET-Planner CDFA HSP can be found online at the http://comet-planner-cdfahsp.com/ website by scrolling to the "COMET-Planner Report" link at the bottom of the webpage.

The user interface for Compost-Planner is shown in Figure 5. Use Compost-Planner by first entering the Project Name and State, and the County where the project will be implemented into the Compost-Planner website. For each Compost Practice that will be implemented in the project, select the type of implementation the project will use. In Figure 4, the Compost Application to Cropland Practice has been selected, and will be implemented by Compost (C:N ≤ 11) Application to Annual Crops. Repeat for all CDFA Compost practices to be implemented in the project. Then enter the quantifiable area on which each of the practices will be implemented, as shown in Figure 5, where the Compost (C:N ≤ 11) will be applied to 100 acres of Annual Cropland. The webpage will calculate the annual greenhouse gas reduction estimates for each practice implementation and sum them. Details of CDFA Compost calculation methods are provided in Appendix B. The resulting table can be downloaded to a .pdf file. This file is submitted as part of the Healthy Soils Program application.

Figure 5. Compost-Planner User Interface for selecting Project Practice and Implementation.

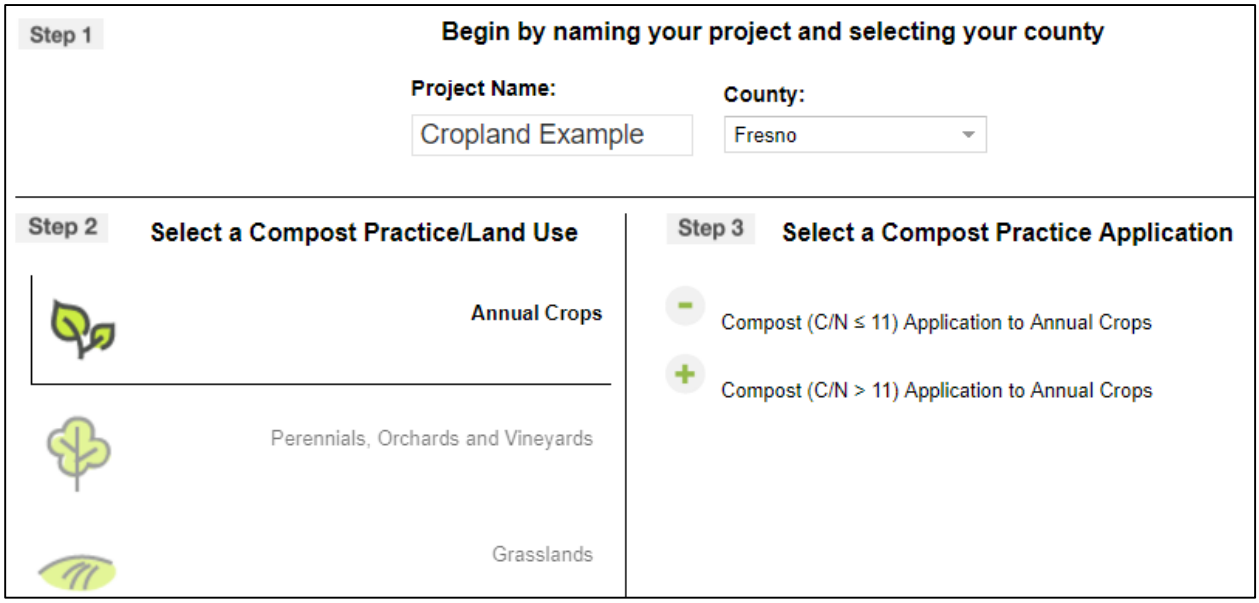
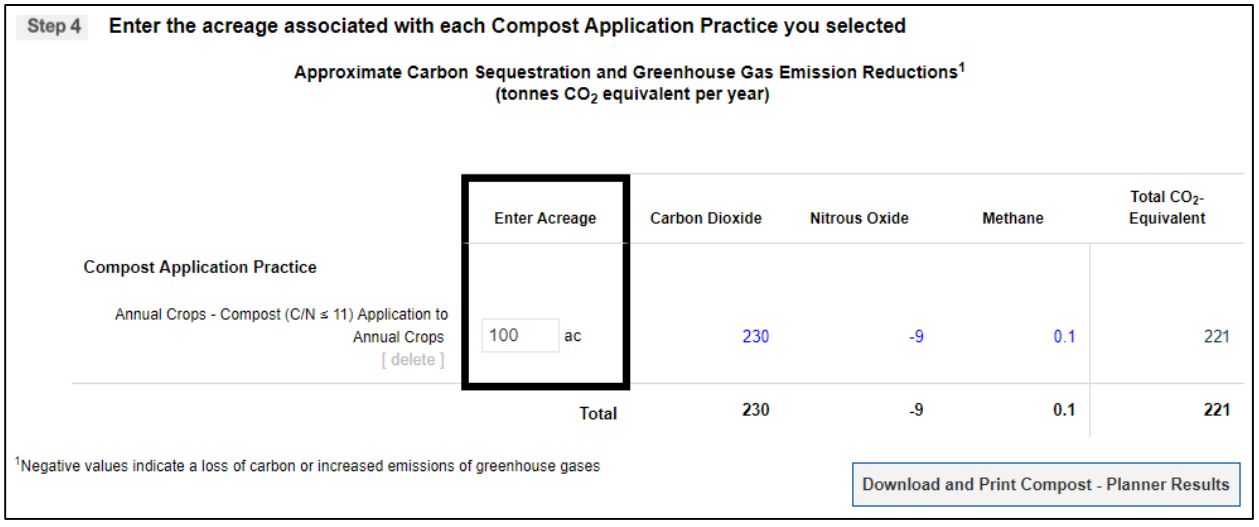


Figure 6. Compost-Planner User Interface for entering the quantified area where a practice will be implemented.



The COMET-Planner CDFA HSP and/or Compost-Planner .pdf files listing the annual GHG reduction for each practice completes the applicant's required calculations for GHG quantification. Refer to Section C for additional required documentation.

CDFA Assessment of Project GHG Quantification

The COMET-Planner CDFA HSP and/or Compost-Planner .pdf files submitted by applicants will be used by CDFA to aggregate and determine the annual and total project GHG benefits as well as the estimated total project GHG benefits per Healthy Soils Program GGRF dollar and per total GGRF dollar requested, as described below.

- **Total Project GHG Benefit** is equal to the sum of the project's GHG benefits and emissions reductions for each practice implementation calculated by COMET-Planner CDFA HSP and Compost-Planner, multiplied by the number of years each practice is quantified. Practices in the Establishment of Woody Cover Group are quantified for 10 years; all other practices are quantified for 3 years. Total Project GHG Benefit is calculated as:

$$\sum Annual\ GHG\ Benefit_{Practice} \times Credited\ Years_{Practice}$$

- **Total Project GHG Benefit per Dollar of Healthy Soils Program GGRF Funds Requested** is calculated as:

$$\frac{Total\ Project\ GHG\ Benefit\ in\ Metric\ Tons\ of\ CO_2e}{Healthy\ Soils\ Program\ GGRF\ Funds\ Requested\ (\$)}$$

  The Healthy Soils Program GGRF Funds Requested ($) is equal to the amount of GGRF dollars the applicant is requesting from CDFA's Healthy Soils Program.

- **Total Project GHG Benefit per Dollar of GGRF Funds Requested** is calculated as:

$$\frac{Total\ Project\ GHG\ Benefit\ in\ Metric\ Tons\ of\ CO_2e}{Total\ GGRF\ Funds\ Requested\ (\$)}$$

  The Total GGRF Funds Requested ($) is equal to the amount of GGRF dollars the applicant is requesting from CDFA's Healthy Soils Program, plus all GGRF dollars from CDFA or other agencies that have previously been awarded to the same project and any GGRF dollars from agencies other than CDFA that the project has or plans to apply for. For a list of GGRF funded programs, go to: www.arb.ca.gov/cci-events. If no other GGRF funds are requested, this will be the same amount as the Healthy Soils Program GGRF Funds Requested.

Section C. Documentation

As part of the Healthy Soils application requirements and GHG quantification methodology, applicants for GGRF funding are required to document results from the use of this quantification methodology, including supporting materials to verify the accuracy of project-specific inputs.

Applicants are required to provide electronic documentation that is complete and sufficient to allow the calculations to be reviewed and replicated. Paper copies of supporting materials must be available upon request by agency staff.

A complete application as described in the Healthy Soil Program *Request for Applications* will contain this documentation. The following checklist is provided as a guide to applicants; additional data and/or information may be necessary to support project-specific input assumptions.

	Documentation Description	Completed
1.	Contact information for the person who can answer project specific questions from staff reviewers on the quantification calculations.	
2.	Project Description, including excerpts or specific references to the location in the main Healthy Soils application of the project information necessary to complete the applicable portions of the quantification methodology.	
3.	The Healthy Soil GGRF Funds Requested, and Total GGRF Funds Requested. If the Total GGRF Funds Requested are different than the Healthy Soils GGRF Funds Requested, identify the other GGRF program(s) where funding is sought, including the fiscal year of the application(s).	
4.	Completed COMET-Planner CDFA HSP and/or Compost-Planner Carbon Sequestration and Greenhouse Gas Estimation Report file(s) (in .pdf).	
5.	IF Compost Application Practice(s) is/are selected: • One soil organic matter test taken within the last five years from each APN OR • Soil organic matter content data sourced from the Web Soil Survey at https://casoilresource.lawr.ucdavis.edu/gmap for the specific APNs where project implementations will occur. to confirm that soil organic matter content of APNs in the project site do not exceed 20% by dry weight.	

Section D. Reporting after Funding Award

Accountability and transparency are essential elements for all GGRF California Climate Investment projects. As described in CARB's Funding Guidelines for Agencies that Administer California Climate Investments (Funding Guidelines) and Funding Guidelines supplement, each administering agency is required to track and report on the benefits of the California Climate Investments funded under their program(s). Each project funded by the GGRF is expected to provide a real and quantifiable net GHG benefit. The previous sections of this document provide the methods and tools to estimate the net GHG benefit of a proposed project based on project characteristics and assumptions of expected conditions and activity levels. This section explains the minimum reporting requirements for administering agencies and funding recipients during project implementation, termed Phase 1, and after a project is completed, termed Phase 2. Table 4 below shows the project phases and when reporting is required.

Table 2. Quantification and Reporting By Project Phase

	Timeframe & Reporting Frequency	Quantification Methods
Project Selection	Period from solicitation to funding awards. Applicant submits application to CDFA by due date in solicitation materials.	All applicants use methods in CARB's quantification methodology to estimate the net annual GHG benefit of practices in the project. CDFA uses methods in CARB's quantification methodology to estimate the net GHG benefit of each project.
Phase 1	Period from project award date through project completion date. CDFA reports to CARB on an annual basis.	All awarded projects use methods in CARB's quantification methodology to update initial estimate of net annual GHG benefit for practice in the project, as needed, based on project changes. CDFA uses methods in CARB's quantification methodology to estimate the net GHG benefit of each awarded project.
Phase 2	Starts after Phase 1 is complete and a project becomes operational. CDFA reports to CARB consistent with the Funding Guidelines.	GHG reduction estimates are updated and reported for a subset of awarded projects.

Funding recipients have the obligation to provide, or provide access to, data and information on project outcomes to CDFA. Applicants should familiarize themselves with the requirements below as well as those within the Healthy Soils solicitation materials (e.g., guidelines, applications, etc.), and grant agreement.

It is the responsibility of administering agencies to collect and compile project data from funding recipients, including the net annual GHG benefits for practice implementations and information on benefits to disadvantaged communities.

Phase 1 reporting is required for all CDFA projects. CDFA will collect and submit data to CARB to satisfy Phase 1 reporting requirements. Projects must report any changes that impact net GHG benefit (i.e., assumptions or quantities) to CDFA prior to project completion.

Phase 2 reporting is required for only a subset of CDFA projects and is intended to document actual project benefits achieved after the project becomes operational. Phase 2 data collection and reporting will not be required for every project. CDFA will be responsible for identifying the subset of individual projects that must complete Phase 2 reporting, identifying who will be responsible for collecting Phase 2 data, and for reporting the required information to CARB. CARB will work with CDFA to address Phase 2 procedures, including but not limited to:

- The **timelines** for Phase 2 reporting, i.e., when does Phase 2 reporting begin, how long will Phase 2 reporting be needed.
- As applicable, **approaches for determining the subset of projects** that need Phase 2 reporting (i.e., how many **X** projects out of **Y** total projects are required to have Phase 2 reporting).
- **Methods for monitoring or measuring** the necessary data to quantify and document achieved GHG reductions and other select project benefits.
- **Data to be collected**, including data fields needed to support quantification of GHG emission benefits.
- Reporting requirements for transmitting the data to CARB or CDFA for program transparency and use in reports.

Once the Phase 2 quantification method and data needs are determined, CARB will develop and post the final CARB approved Phase 2 methodology for use in Phase 2 reporting.

Section E. References

The following references were used in the development of this quantification methodology and the accompanying Healthy Soils GHG Calculator Tool.

California Air Resources Board. (2013). *Calibrating, Validating, and Implementing Process Models for California Agriculture Greenhouse Gas Emissions.* Sacramento, CA: Li, Changsheng. https://www.arb.ca.gov/research/rsc/1-31-14/item11dfr10-309.pdf

California Department of Food and Agriculture. (2016). *Compost Application Rates for California Croplands and Grasslands for a CDFA Healthy Soils Incentives Program.* Davis, CA: Grauver, Kelly. https://www.cdfa.ca.gov/oefi/efasap/docs/CompostApplicationRate_WhitePaper.pdf

Intergovernmental Panel on Climate Change. (2006). *Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use.* Hayama, Japan: Bickel, K., G. Richard, M. Köhl and R.L.V. Rodrigues.

National Resource Conservation Service. (2017a) *COMET-Planner: Carbon and greenhouse gas evaluation for NRCS conservation practice planning.* Ft. Collins, CO: Swan, Amy. http://comet-planner.nrel.colostate.edu/COMET-Planner_Report_Final.pdf

National Resource Conservation Service. (2017b) *Field Office Technical Guide*. Retrieved from https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/

National Resource Conservation Service. (2016) *COMET-Farm Tool.* Retrieved from http://cometfarm.nrel.colostate.edu/

University of New Hampshire, Institute for the Study of Earth, Oceans, and Space. (2012). *DeNitrification DeComposition Model*. Retrieved from http://www.dndc.sr.unh.edu/

U.S. Department of Agriculture. (2014). *Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory.* Washington, D.C.: Eve, M. http://www.usda.gov/oce/climate_change/estimation.htm

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Appendix A. Example Projects

A. Cropland Example Project

Introduction

The following is a hypothetical project[11] to demonstrate how the FY 2016-17 Healthy Soils Program Quantification Methodology would be applied to a cropland project. This example does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the proposed project

The proposed project the following three management practices:

- Windbreaks
- Intensive Till to Reduced Till
- Compost Application to Cropland

The proposed project is located in the County of Fresno with the following project features:

- 200 acres of irrigated annual cropland with a fallow winter season
- Plan to convert 3 acres to 1-row windbreaks along windward sides of project area, with 8 foot spacing on each side of the windbreak.
- Plan to change the tilling practice from intensive till to reduced till on the remaining 197 acres
- Plan to apply compost with a carbon to nitrogen ratio of ten (C:N = 10) to remaining 197 acres at a rate of 3 dry tons per acre. Project site SOM = 1.5%.
- These practices will be implemented and maintained for 3 years

Methods to apply

Step 1: Identify the Project Components and Appropriate Implementations for the Proposed Project.

Refer to Table 1 to match the conservation practices with the steps required to quantify the GHG benefit.

The 3 acres of windbreaks are part of the “Windbreak/Shelterbelt Establishment (CPS 380)” USDA-NRCS Practice, and the “Replace a Strip of Cropland with 1 Row of Woody Plants” implementation. The total width of the windbreak (16 feet) meets the minimum width requirement of the practice (8 feet). The 197 acres that went intensive tillage to reduced tillage are part of the “Residue and Tillage Management – Reduced Till (CPS 345)” USDA-NRCS Practice, and the “Intensive Till to Reduced Till on Irrigated

[11] The hypothetical project has not undergone verification of any Healthy Soils Program requirements; all assumptions about location type and features are for quantification methodology demonstration purposes only.

Cropland" implementation. The 197 acres of compost (C:N = 10) application to the annual cropland are part of the "Cropland Compost Application (CDFA)" Practice, and the "Compost (C:N ≤ 11) Application to Annual Crops" implementation. The Cropland Compost Application practice is eligible for quantification because project site soil organic matter content is less than 20%.

Step 2: Determine the acreage upon which the selected practices will be quantified.

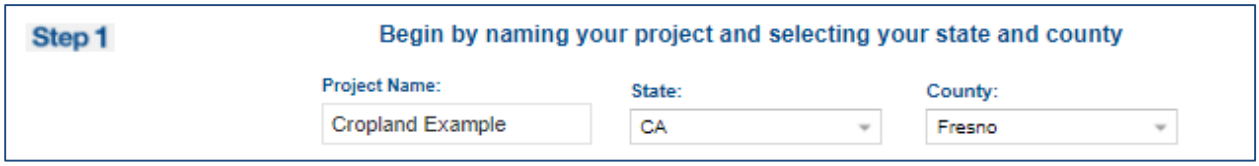
No conservation practices are continuing on this project site. All acreage associated with each practice implementation will be quantified for GHG reductions.

Step 3: Use COMET-Planner CDFA HSP and/or Compost-Planner to estimate the GHG benefit for each practice in the project.

USDA-NRCS Conservation Practice Estimates

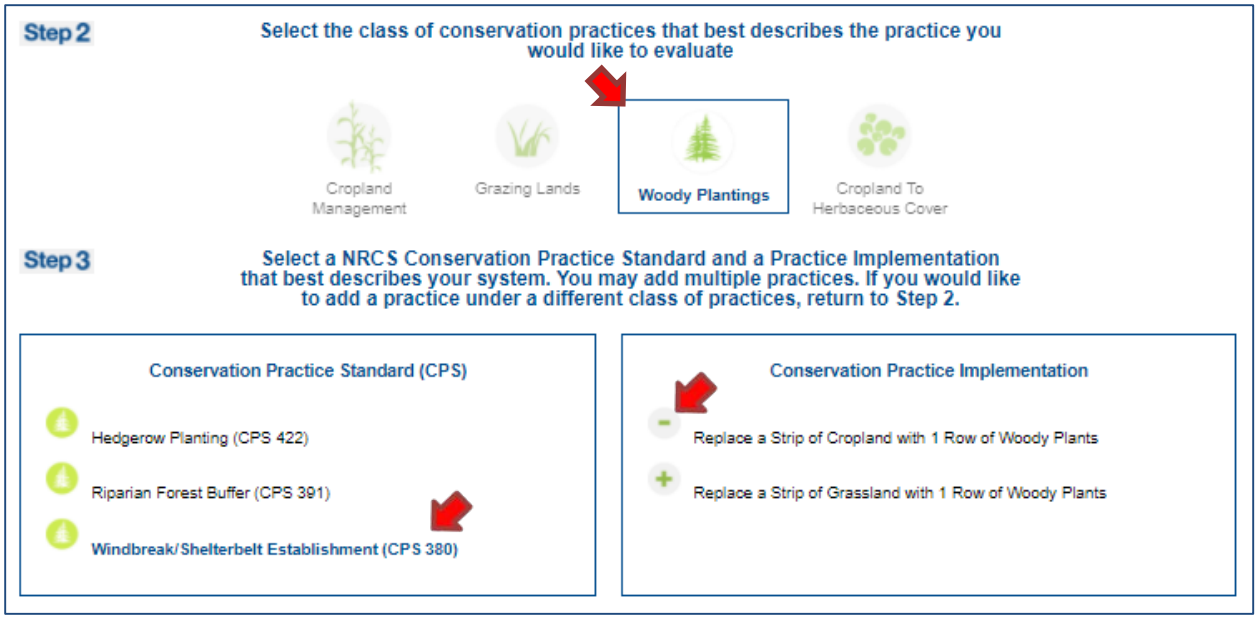
The USDA-NRCS Conservation Practices are estimated using COMET-Planner CDFA HSP. COMET-Planner CDFA HSP is accessed at http://comet-planner-cdfahsp.com/. Alternatively, the website can be reached by going to http://www.comet-planner.com/, selecting "CA" from the State drop-down menu, and selecting the link at the bottom of the dialogue box.

Input a project name and location information first:

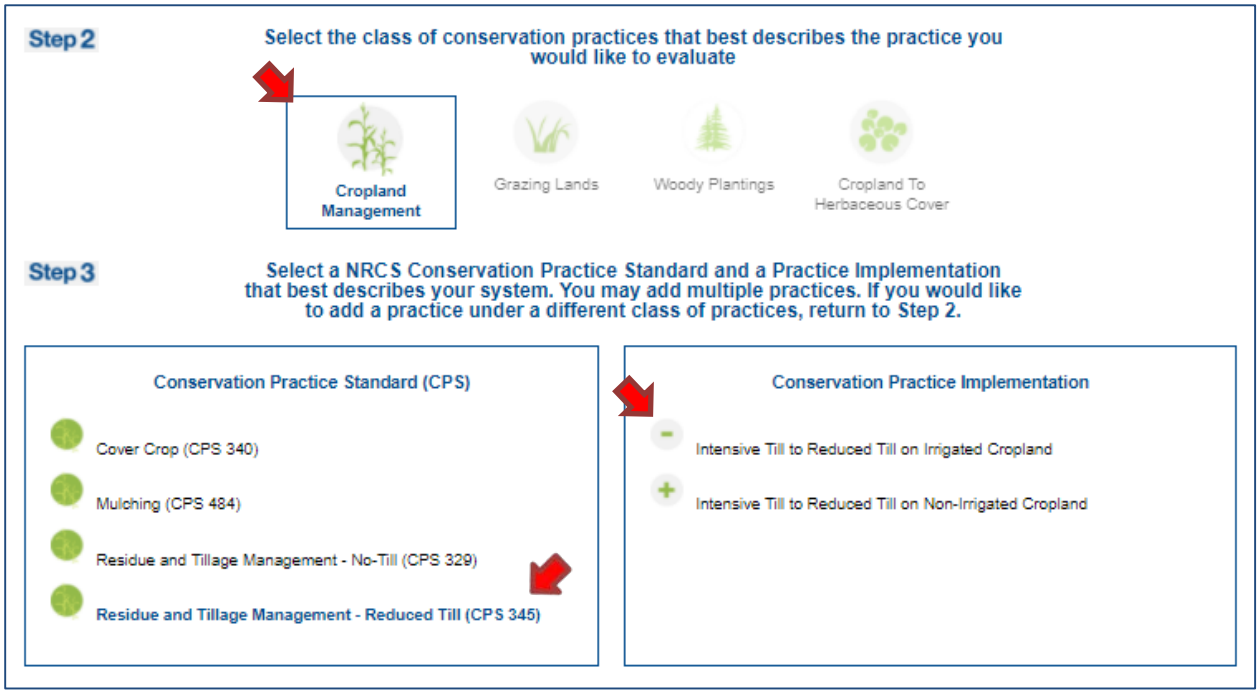


Then, for each USDA-NRCS Practice, select the practice class, the practice standard, and the practice implementation. Practice classes are identified on page 1 of this document.

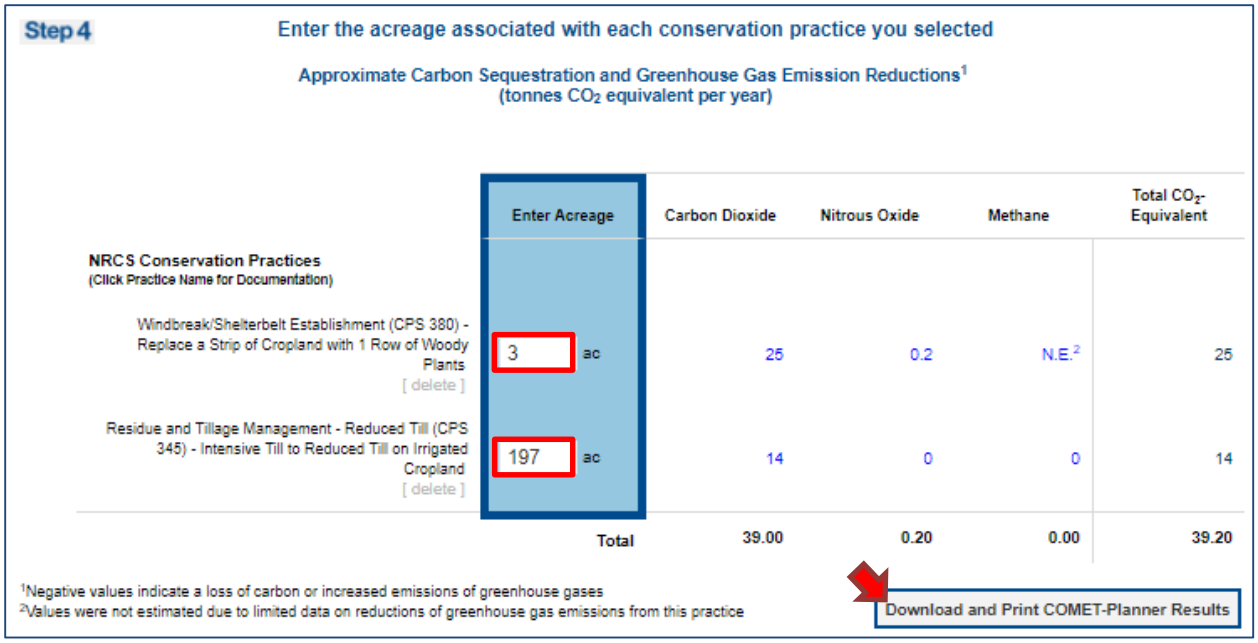
Planting a 1-row windbreak on cropland has this input:



Converting from Intensive to Till to Reduced Till on irrigated cropland has this input:



Each time an implementation is selected, a new entry is created at the bottom of the webpage. Enter the quantified area, in acres, upon which each practice will be implemented in each practice's respective line. Reductions in greenhouse gases will auto-calculate. The total GHG benefit is for these two Practice Implementations is 39.20 metric tonnes CO_2 equivalent per year (MT-CO_2eq/yr).



Step 4 Enter the acreage associated with each conservation practice you selected

Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions[1]
(tonnes CO_2 equivalent per year)

NRCS Conservation Practices (Click Practice Name for Documentation)	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
Windbreak/Shelterbelt Establishment (CPS 380) - Replace a Strip of Cropland with 1 Row of Woody Plants [delete]	3 ac	25	0.2	N.E.[2]	25
Residue and Tillage Management - Reduced Till (CPS 345) - Intensive Till to Reduced Till on Irrigated Cropland [delete]	197 ac	14	0	0	14
	Total	39.00	0.20	0.00	39.20

[1]Negative values indicate a loss of carbon or increased emissions of greenhouse gases
[2]Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

Download and Print COMET-Planner Results

Click on the "Download and Print COMET-Planner Results" button and follow any instructions from your internet browser to create a .pdf file. The .pdf file will look like the below table and will contain the project name, county, practice implementations, and GHG reductions. (Depending on computer and browser type, the file may show up at the bottom of the browser or in the computer's "Downloads" folder.) This file is one of the documents to be included in the application and used by CDFA to calculate Total Project GHG Benefit, Total Project GHG Benefit per Dollar of Healthy Soils Program GGRF Funds Requested, and Total Project GHG Benefit per Dollar of GGRF Funds Requested.

COMET-Planner Carbon Sequestration and Greenhouse Gas Estimation Report

Project Name: Cropland Example
State: CA
County: Fresno
Date Created: 8/4/2017 5:09:21 PM

NRCS Conservation Practices	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
Windbreak/Shelterbelt Establishment (CPS 380) - Replace a Strip of Cropland with 1 Row of Woody Plants	3	25	0.2	N.E.2	25
Residue and Tillage Management - Reduced Till (CPS 345) - Intensive Till to Reduced Till on Irrigated Cropland	197	14	0	0	14
	Total	39.00	0.20	0.00	39.20

1Negative values indicate a loss of carbon or increased emissions of greenhouse gases
2Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

For more information on how these estimates were generated, please visit www.comet-planner.com.

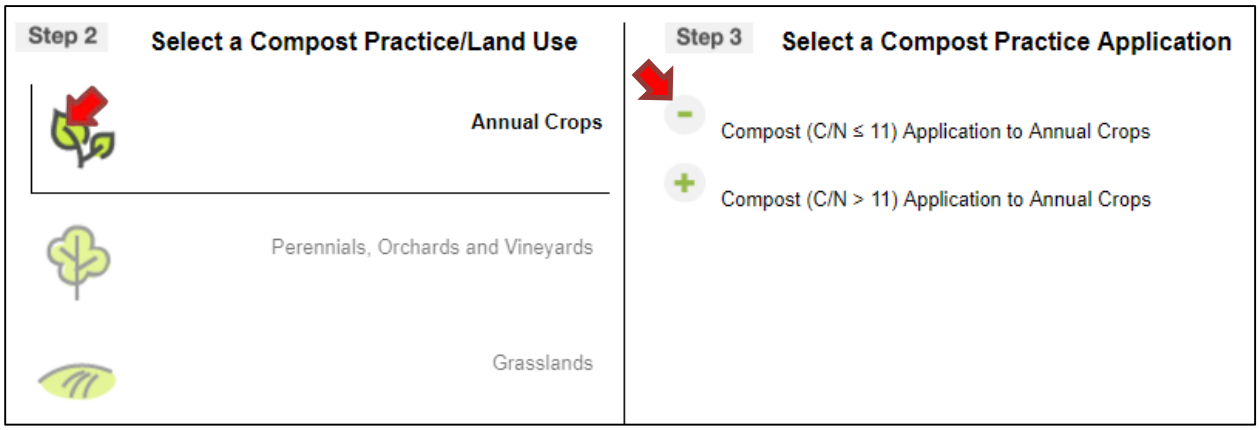
CDFA Compost Practice Estimates

The CDFA Compost Practices are estimated using Compost-Planner. Compost-Planner is accessed at www.compost-planner.com.

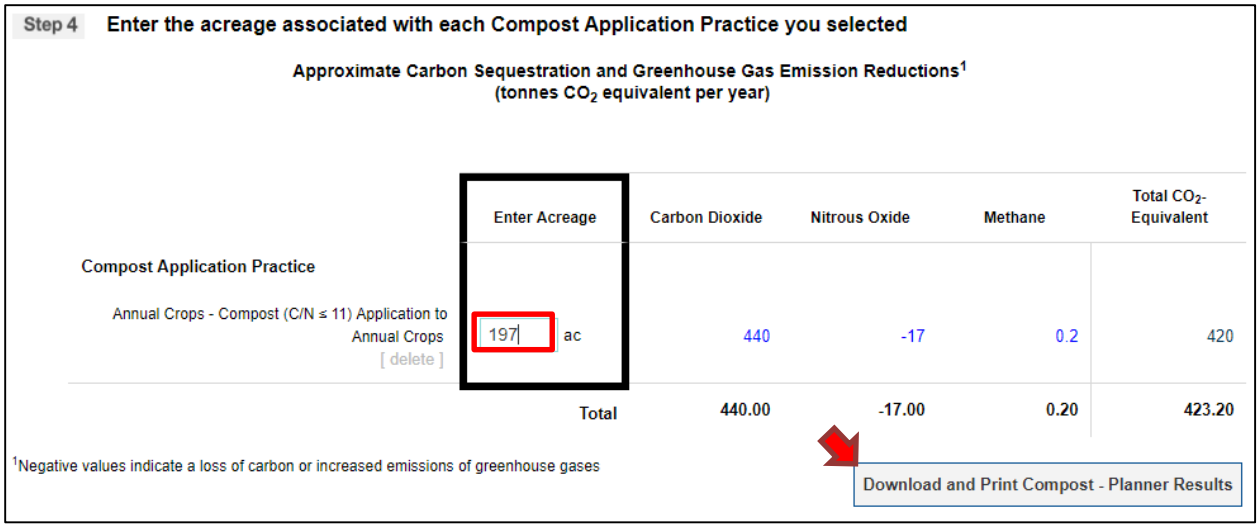
The Compost-Planner website appears. Input a project name and location information first:

Then, for each Compost Practice, select the practice standard and the practice implementation.

Applying compost with a C:N ratio less than 11 to cropland where annuals are grown has this input:



Each time an implementation is selected, a new entry is created at the bottom of the webpage. Enter the quantified area, in acres, upon which each practice will be implemented in each practice's respective line. Reductions in greenhouse gases will auto-calculate. The total GHG benefit is for this Practice Implementation is 423.20 metric tonnes CO_2 equivalent per year (MT-CO_2eq/yr).



Step 4 **Enter the acreage associated with each Compost Application Practice you selected**

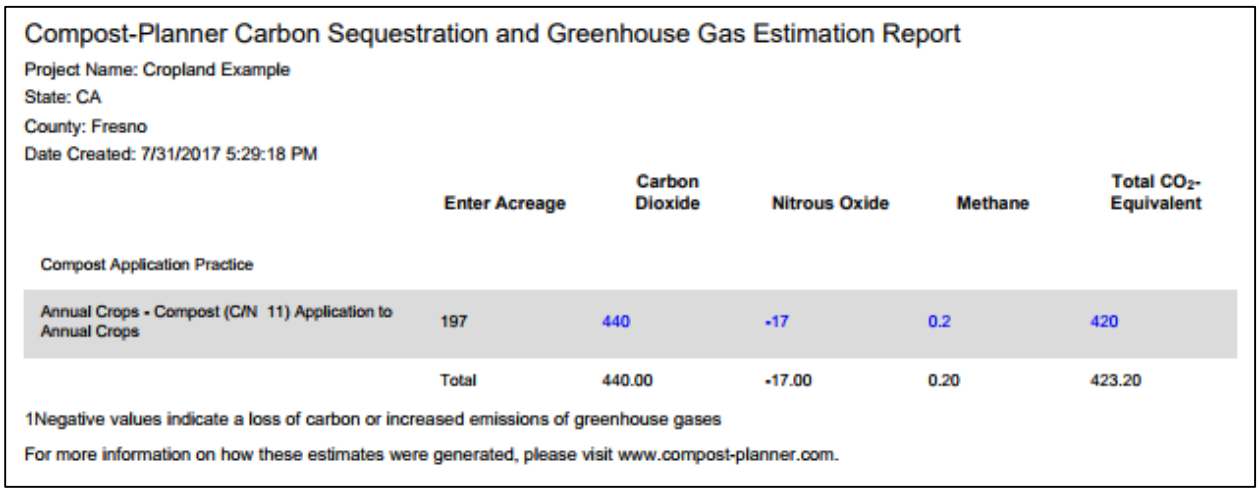
Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions[1]
(tonnes CO_2 equivalent per year)

Compost Application Practice	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
Annual Crops - Compost (C/N ≤ 11) Application to Annual Crops [delete]	197 ac	440	-17	0.2	420
	Total	440.00	-17.00	0.20	423.20

[1]Negative values indicate a loss of carbon or increased emissions of greenhouse gases

Download and Print Compost - Planner Results

Click on the "Download and Print Compost-Planner Results" button and follow any instructions from your internet browser to create a .pdf file. The .pdf file will look like the below table and will contain the project name, county, practice implementations, and GHG reductions. (Depending on computer and browser type, the file may show up at the bottom of the browser or in the computer's "Downloads" folder.) This file is one of the documents to be included in the application and used by CDFA to calculate Total Project GHG Benefit, Total Project GHG Benefit per Dollar of Healthy Soils Program GGRF Funds Requested, and Total Project GHG Benefit per Dollar of GGRF Funds Requested.



Compost-Planner Carbon Sequestration and Greenhouse Gas Estimation Report

Project Name: Cropland Example
State: CA
County: Fresno
Date Created: 7/31/2017 5:29:18 PM

Compost Application Practice	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
Annual Crops - Compost (C/N 11) Application to Annual Crops	197	440	-17	0.2	420
	Total	440.00	-17.00	0.20	423.20

1Negative values indicate a loss of carbon or increased emissions of greenhouse gases

For more information on how these estimates were generated, please visit www.compost-planner.com.

The Total Project GHG Benefit for this Cropland Example is 39.20 + 423.20 = 462.40 metric tonnes CO_2 equivalent per year (MT-CO_2eq/yr).

B. Grassland Example Project

Introduction

The following is a hypothetical project[12] to demonstrate how the FY 2016-17 Healthy Soils Program Quantification Methodology would be applied to a grassland project. This example does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the proposed project

The proposed project is a Healthy Soils proposing the following components:

- Silvopasture
- Compost Application to Grassland

The proposed project is located in the County of Modoc with the following project features:

- 1,000 acres of grazed grassland.
- Plan to plant trees on Grazed Grasslands to 50 acres (Trees had been planted on 20 acres elsewhere on the grassland last year.)
- Plan to apply compost (C:N = 25) to 150 acres. Project site SOM = 3%.

Methods to apply

Step 1: Identify the Project Components and Appropriate Quantification Methods for the Proposed Project

Refer to Table 2 to match the conservation practices with the steps required to quantify the GHG benefit.

The 50 acres of trees are part of the “Silvopasture (CPS 380)” USDA-NRCS Practice, and the “Tree/Shrub Planting on Grazed Grassland” implementation.

The 150 acres of low nitrogen compost application to the grazed grassland are part of the “Compost Application to Grassland (CDFA)” Practice, and the “Compost (C:N > 11) Application to Grazed Grassland” implementation. The Grassland Compost Application practice is eligible for quantification because project site soil organic matter content is less than 20%.

[12] The hypothetical project has not undergone verification of any Healthy Soils Program requirements; all assumptions about location type and features are for quantification methodology demonstration purposes only.

Step 2: Determine the acreage upon which the selected practices will be quantified.

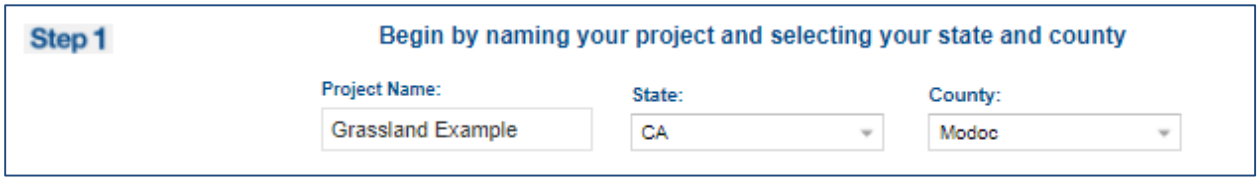
While the "Silvopasture (CPS 380)" USDA-NRCS Practice was implemented last year on 20 acres, the project practice is being implemented on 50 acres of new acreage. All acreage associated with each practice implementation will be quantified for GHG reductions.

Step 3: Use COMET-Planner CDFA HSP and/or Compost-Planner to estimate the GHG benefit for each practice in the project.

NRCS Conservation Practice Estimates

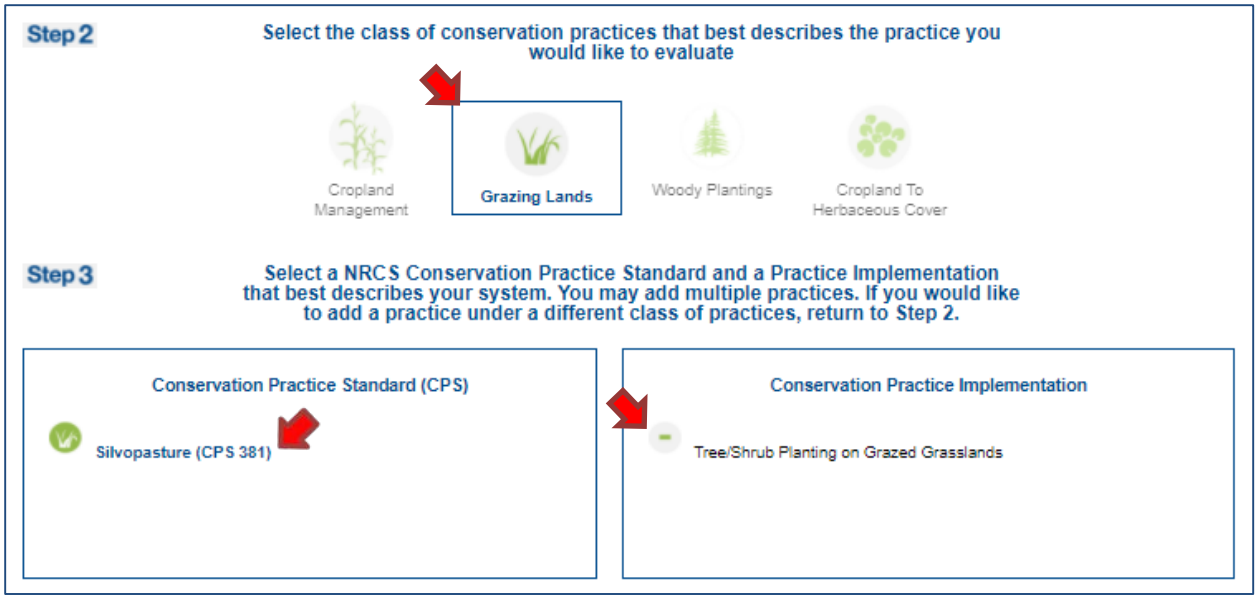
The USDA-NRCS Conservation Practices are estimated using COMET-Planner CDFA HSP. COMET-Planner CDFA HSP is accessed at http://comet-planner-cdfahsp.com/. Alternatively, the website can be reached by going to http://www.comet-planner.com/, selecting "CA" from the State drop-down menu, and selecting the link at the bottom of the dialogue box.

Input a project name and location information first:

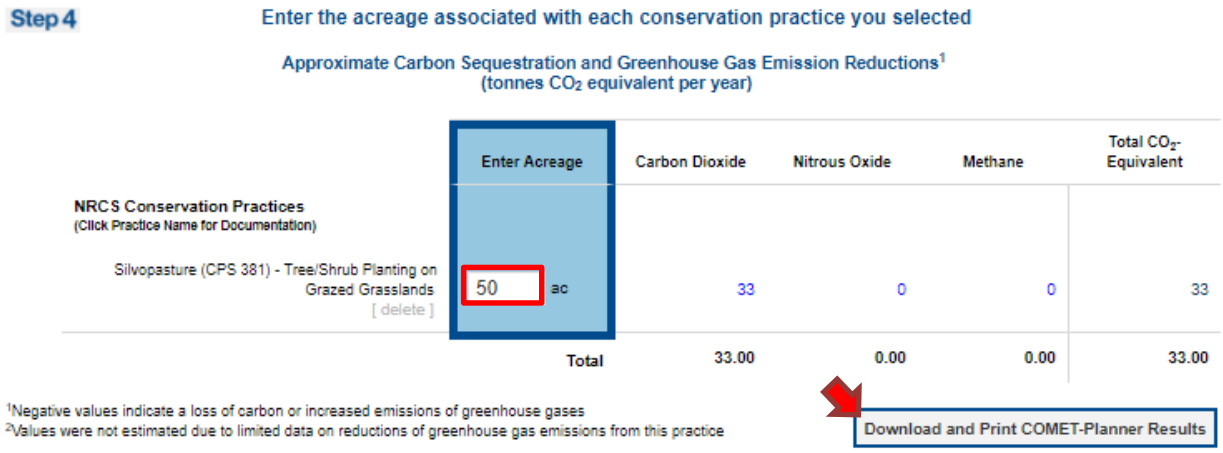


Then, for each NRCS Practice, select the practice class, the practice standard, and the practice implementation. Practice classes are identified on page 1 of this document.

Planting trees as silvopasture on grazed grassland has this input:



Each time an implementation is selected, a new entry is created at the bottom of the webpage. Enter the quantified area, in acres, upon which each practice will be implemented in each practice's respective line. Reductions in greenhouse gases will auto-calculate. The total GHG benefit is for this Practice Implementation is 33.00 metric tonnes CO_2 equivalent per year (MT-CO_2eq/yr).



Click on the "Download and Print COMET-Planner Results" button and follow any instructions from your internet browser to create a .pdf file. The .pdf file will look like the below table and will contain the project name, county, practice implementations, and GHG reductions. (Depending on computer and browser type, the file may show up at the bottom of the browser or in the computer's "Downloads" folder.) This file is one the documents to be included in the application and used by CDFA to calculate Total Project GHG Benefit, Total Project GHG Benefit per Dollar of Healthy Soils Program GGRF Funds Requested, and Total Project GHG Benefit per Dollar of GGRF Funds Requested.

COMET-Planner Carbon Sequestration and Greenhouse Gas Estimation Report

Project Name: Grassland Example
State: CA
County: Modoc
Date Created: 8/4/2017 5:25:13 PM

	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
NRCS Conservation Practices					
Silvopasture (CPS 381) - Tree/Shrub Planting on Grazed Grasslands	50	33	0	0	33
	Total	33.00	0.00	0.00	33.00

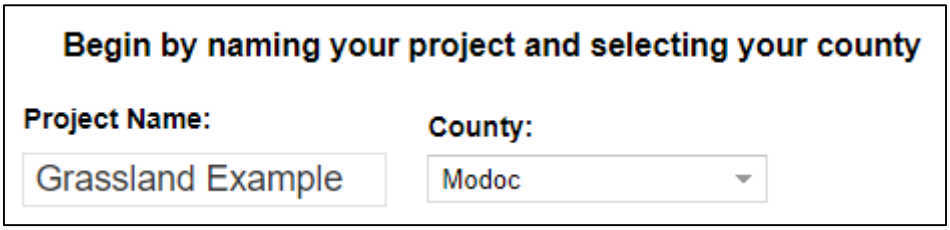
1Negative values indicate a loss of carbon or increased emissions of greenhouse gases
2Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

For more information on how these estimates were generated, please visit www.comet-planner.com.

CDFA Compost Practice Estimates

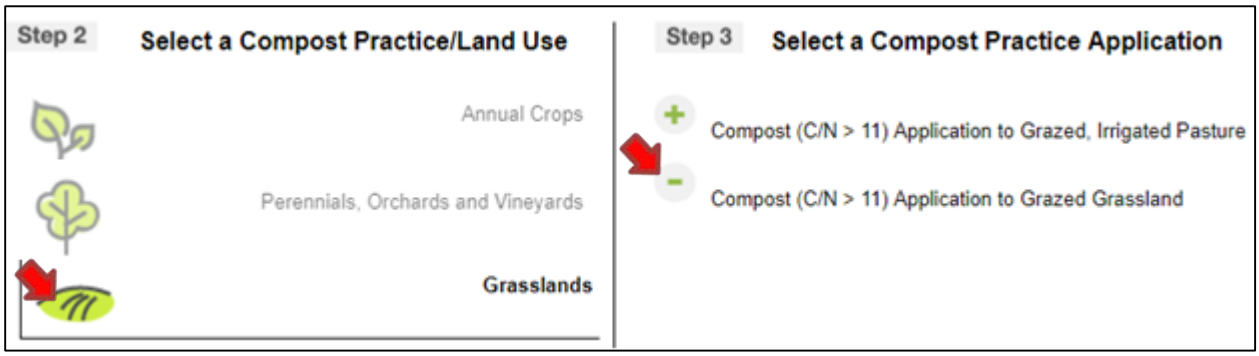
The CDFA Compost Practices are estimated using Compost-Planner. Compost-Planner is accessed by visiting http://www.compost-planner.com/.

The Compost-Planner website appears. Input a project name and location information first:



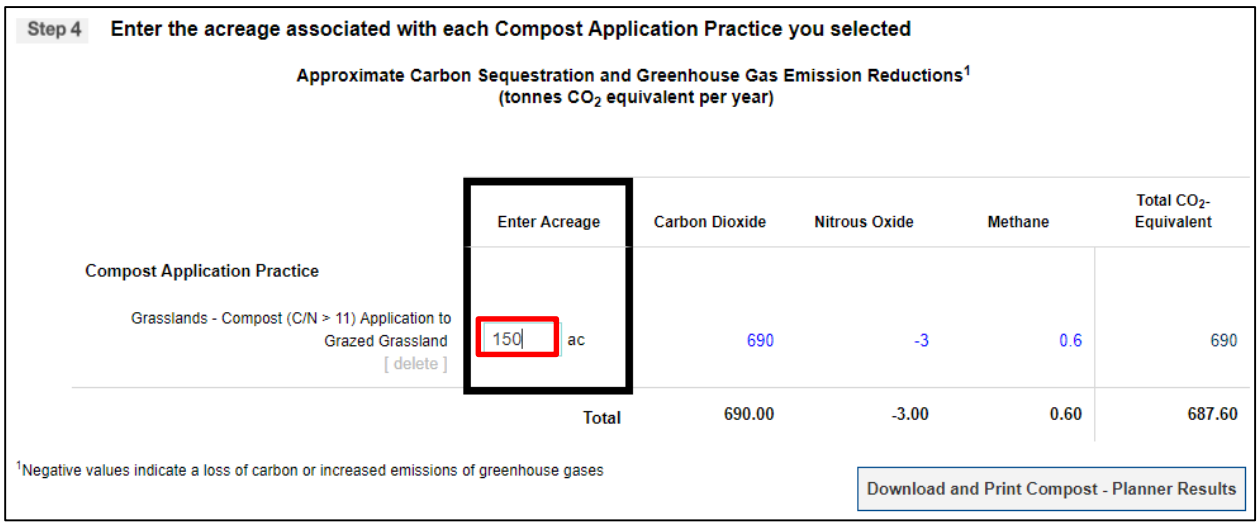
Then, for each Compost Practice, select the practice standard and the practice implementation.

Applying compost with a C:N ratio greater than 11 to grazed grassland has this input:



Each time an implementation is selected, a new entry is created at the bottom of the webpage. Enter the quantified area, in acres, upon which each practice will be

implemented in each practice's respective line. Reductions in greenhouse gases will auto-calculate. The total GHG benefit is for this Practice Implementation is 687.60 metric tonnes CO_2 equivalent per year (MT-CO_2eq/yr).



Step 4 **Enter the acreage associated with each Compost Application Practice you selected**

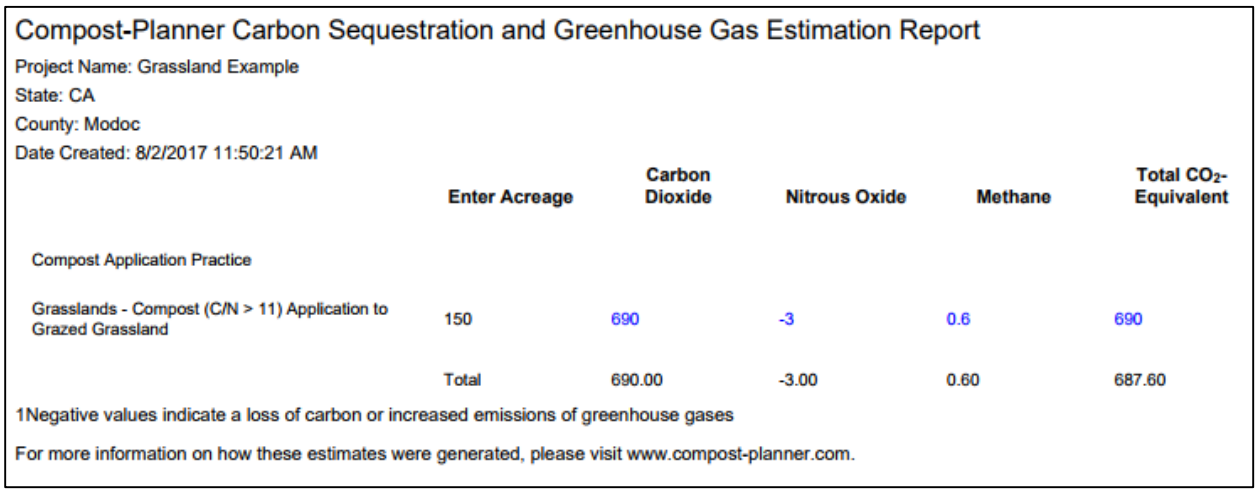
Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions[1]
(tonnes CO_2 equivalent per year)

Compost Application Practice	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
Grasslands - Compost (C/N > 11) Application to Grazed Grassland [delete]	150 ac	690	-3	0.6	690
	Total	690.00	-3.00	0.60	687.60

[1]Negative values indicate a loss of carbon or increased emissions of greenhouse gases

Download and Print Compost - Planner Results

Click on the "Download and Print Compost-Planner Results" button and follow any instructions from your internet browser to create a .pdf file. The .pdf file will look like the below table and will contain the project name, county, practice implementations, and GHG reductions. (Depending on computer and browser type, the file may show up at the bottom of the browser or in the computer's "Downloads" folder.) This file is one the documents to be included in the application and used by CDFA to calculate Total Project GHG Benefit, Total Project GHG Benefit per Dollar of Healthy Soils Initiative GGRF Funds Requested, and Total Project GHG Benefit per Dollar of GGRF Funds Requested.



Compost-Planner Carbon Sequestration and Greenhouse Gas Estimation Report

Project Name: Grassland Example
State: CA
County: Modoc
Date Created: 8/2/2017 11:50:21 AM

Compost Application Practice	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
Grasslands - Compost (C/N > 11) Application to Grazed Grassland	150	690	-3	0.6	690
	Total	690.00	-3.00	0.60	687.60

1Negative values indicate a loss of carbon or increased emissions of greenhouse gases

For more information on how these estimates were generated, please visit www.compost-planner.com.

The Total Project GHG Benefit for this Grassland Example is 33.00 + 687.60 = 720.60 metric tonnes CO_2 equivalent per year (MT-CO_2eq/yr).

Appendix B. Quantification of Greenhouse Gas Emissions from CDFA Compost Practices

The GHG benefit from CDFA Compost Practices are calculated by Compost-Planner, a modeling tool that uses the DNDC biogeochemical model to determine the change in carbon sequestration, nitrous oxide emissions, and methane emissions when compost is applied in different regions in California. A report on the DNDC calculations used to model compost practices can be found at this link: https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/dndc_calculations.pdf.