California Air Resources Board

Quantification Methodology

California Department of Food and Agriculture
Healthy Soils Program

California Climate Investments

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List of Acronyms and Abbreviations

Acronym	Term
C	carbon
CARB	California Air Resources Board
CDFA	California Department of Food and Agriculture
CO	carbon monoxide
COMET	carbon and greenhouse gas evaluation tool suite
CPS	Conservation Practice Standard
DayCent	a biogeochemical model
DNDC	denitrification-decomposition, a biogeochemical model
GGRF	Greenhouse Gas Reduction Fund
GHG	greenhouse gas
HSP	Healthy Soils Program
IPCC	International Panel on Climate Change
lb	pound
$MTCO_2e$	metric tons of carbon dioxide equivalent
N	nitrogen
NH_3	ammonia
NO_x	nitrous oxide
NRCS	Natural Resources Conservation Service
O_3	ozone
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometers
ROG	reactive organic gases
SO_2	sulfur dioxide
USDA	United States Department of Agriculture
WOR	whole orchard recycling

Section A. Introduction

California Climate Investments is a statewide initiative that puts billions of Cap-and-Trade dollars to work facilitating greenhouse gas (GHG) emission reductions; strengthening the economy; improving public health and the environment; and providing benefits to residents of disadvantaged communities, low-income communities, and low-income households, collectively referred to as "priority populations." Where applicable and to the extent feasible, California Climate Investments must maximize economic, environmental, and public health co-benefits to the State.

The California Air Resources Board (CARB) is responsible for providing guidance on estimating the net GHG benefit and co-benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). This guidance includes quantification methodologies, co-benefit assessment methodologies, and benefits calculator tools. CARB develops these methodologies and tools based on the projects eligible for funding by each administering agency, as reflected in the program expenditure records available at: www.arb.ca.gov/cci-expenditurerecords.

For the California Department of Food and Agriculture (CDFA) Healthy Soils Program (HSP), CARB staff developed this HSP Quantification Methodology to provide guidance for estimating the net GHG benefit and selected co-benefits of each proposed project type. This methodology uses calculations to estimate soil carbon sequestration, nitrous oxide emission reductions and methane emission reductions associated with the implementation of HSP projects.

The COMET-Planner CDFA HSP Calculator Tool automates methods described in this document, and provides a link to a step-by-step introductory video with a project example. Projects will report the total project GHG benefit estimated using the COMET-Planner CDFA HSP Calculator Tool. The COMET-Planner CDFA HSP Calculator Tool is available at: http://comet-planner-cdfahsp.com/.

Using the same inputs required to estimate net GHG benefit, the HSP Quantification Methodology estimates the following co-benefits from certain HSP project types: $PM_{2.5}$ (in lbs), NO_x (in lbs), NH_3 (in lbs), ROG (in lbs), SO_2 (in lbs), and CO (in lbs). CDFA will also report for each project the land restored/treated (in acres), soil benefit (in acres) and pollinator habitat established (in acres). Additional co-benefits for which CARB assessment methodologies were not incorporated into the CDFA Benefits Calculator Tool may also be applicable to the project. Applicants should consult the CDFA guidelines, solicitation materials, and agreements to ensure they are meeting CDFA requirements. All CARB co-benefit assessment methodologies are available at: www.arb.ca.gov/cci-cobenefits.

Methodology Development

CARB and CDFA developed this Quantification Methodology consistent with the guiding principles of California Climate Investments, including ensuring transparency and accountability.[1] CARB and CDFA developed this HSP Quantification Methodology to be used 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 net GHG benefit estimates that are conservative and supported by empirical literature.

CARB assessed peer-reviewed literature and tools and consulted with experts, as needed, to determine methods appropriate for the HSP project types. 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.

In addition, the University of California, Berkeley, in collaboration with CARB, developed assessment methodologies for a variety of co-benefits such as providing cost savings, lessening the impacts and effects of climate change, and strengthening community engagement. Co-benefit assessment methodologies are posted at: www.arb.ca.gov/cci-cobenefits.

Tools

Applicants must use the COMET-Planner CDFA HSP Calculator Tool to estimate the net GHG benefit of the proposed project. The COMET-Planner CDFA HSP Calculator Tool is available at: http://comet-planner-cdfahsp.com/. The tool relies on project-specific outputs from the following tools:

COMET-Planner, developed by the United State Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is largely derived using a sample-based approach and model runs in COMET-Farm, which utilizes USDA entity-scale greenhouse gas inventory methods. Coefficients were generalized by multi-county regions defined by USDA Major Land Resource Areas. Emissions estimates represent field emissions only, including those associated with soils and woody biomass as appropriate, and do not include off-site emissions, such as those from transportation, manufacturing, processing, etc. COMET Farm is a web-based, whole farm, GHG

[1] California Air Resources Board. www.arb.ca.gov/cci-fundingguidelines

accounting system that employs methods outlined in the USDA Methods for Entity-Scale Inventory guidance. Estimation methods used for most GHG sources in COMET-Planner rely on advanced methods (commonly referred to as "Tier 3" methodologies in International Panel on Climate Change (IPCC) quantification methods), such as process-based modeling in DayCent and regionally-specific empirical calculations. COMET-Planner is available at: http://www.comet-planner.com/.

The Denitrification-Decomposition (DNDC) model is a process-based computer simulation model of carbon (C) and nitrogen (N) biogeochemistry and was developed for quantifying carbon sequestration and emissions of GHGs in agroecosystems. The core of DNDC modeling consists of microbe-mediated biochemical processes commonly occurring in terrestrial soils. The processes simulated include decomposition, nitrification, denitrification, fermentation, and methanogenesis. A full description of the DNDC scientific basis and processes, including all equations involved, is available at http://www.dndc.sr.unh.edu/.

The US Forest Service (USFS) i-Tree Planting web based tool provides quantitative data for an individual or population of trees to be planted as part of the project, including the amount of particulate matter ($PM_{2.5}$), nitrogen oxide (NO_x), ozone (O_3), and sulfur dioxide (SO_2) adsorbed by the tree based on project characteristics such as the climate zone, tree species, and tree age and lifetime. i-Tree Planting is available at: https://planting.itreetools.org/. A description about the tool is available at: https://planting.itreetools.org/help/.

COMET-Planner, DNDC and i-Tree are used statewide, subject to regular updates to incorporate new information, free of charge, and publicly available online.

CDFA staff will use the CDFA HSP Co-Benefits Calculator Tool to estimate the co-benefits of the proposed project. The CDFA HSP Co-Benefits Calculator Tool is available at: http://www.arb.ca.gov/cci-resources. The tool relies on project-specific outputs from the DNDC model.

In addition to the tools above, the HSP Quantification Methodology relies on CARB developed emission factors. CARB has established a single repository for emission factors, referred to as the California Climate Investments Quantification Methodology Emission Factor Database (Database), available at: http://www.arb.ca.gov/cci-resources. The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

Updates

CARB staff periodically review each quantification methodology and benefits calculator tool to evaluate their effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified.

CARB updated the CDFA Quantification Methodology from the previous version[2] to enhance the analysis and provide additional clarity. The changes include:

- Addition of new co benefits associated with planting trees for the following practices:
  - Alley Cropping
  - Multistory Cropping
  - Hedgerow Planting
  - Riparian Forest Buffer
  - Tree/Shrub Establishment
  - Windbreak/Shelterbelt Establishment
  - Silvopasture

Section B. Methods

The following section provides details on the methods supporting emission reductions in the HSP Benefits Calculator Tool.

Project Practice Implementations

CDFA selected 84 practice implementations that meet the objectives of the HSP and for which there are methods to quantify a net GHG benefit.[3] Other project features may be eligible for funding under the HSP; however, each project quantified using the COMET-Planner CDFA HSP Calculator Tool must include at least one of the following Practice Implementations, as defined by NRCS Conservation Practice Standards[4] (CPS; each practice is uniquely numbered), CDFA Compost Application Rates for California Croplands and Rangelands,[5] or CDFA Whole Orchard Recycling:[6]

[2] https://ww2.arb.ca.gov/sites/default/files/classic//cc/capandtrade/auctionproceeds/cdfa_hsp_final_qm_2020-02-27.pdf
[3] CDFA Healthy Soils Program Guidelines at https://www.cdfa.ca.gov/oefi/healthysoils/.
[4] Details about specific NRCS California Conservation Practices can be found at https://efotg.sc.egov.usda.gov/; California; Section IV; Old Section IV; Conservation Practices – CA Approved.
[5] Details about CDFA Compost Application Practices can be found at https://www.cdfa.ca.gov/oefi/healthysoils/docs/CompostApplicationRate_WhitePaper.pdf.
[6] Details about CDFA Whole Orchard Recycling can be found at https://www.cdfa.ca.gov/oefi/healthysoils/docs/CDFA_WOR_Report.pdf.

Cropland Agricultural System Practice Implementations

- Alley Cropping (CPS 311)
  - Replace 20% of Annual Cropland with Woody Plants
- Compost Application[7]
  - Compost (C/N < or = 11) Application to Annual Crops
  - Compost (C/N > 11) Application to Annual Crops
- Conservation Cover (CPS 327)
  - Convert Irrigated Cropland to Permanent Unfertilized Grass Cover
  - Convert Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover
  - Convert Non-Irrigated Cropland to Permanent Unfertilized Grass Cover
  - Convert Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover
- Conservation Crop Rotation (CPS 328)
  - Decrease Fallow Frequency or Add Perennial Crops to Rotations
- 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
- 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
- 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
- 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
- Forage and Biomass Planting (CPS 512)
  - Conversion of Annual Cropland to Irrigated Grass/Legume Forage/Biomass Crops
  - Conversion of Annual Cropland to Non-Irrigated Grass/Legume Forage/Biomass Crops

[7] These practice implementations are in Compost Purchased from a Certified Facility and On-Farm Compost. Some project sites may be ineligible for Compost Application as the quantifications of the implementations are no applicable due to high soil organic matter. Refer to the CDFA Request for Grant Applications and the Compost Ineligibility Map at http://replan-tool.org/.

Cropland Agricultural System Practice Implementations (cont'd)

- Grassed Waterway (CPS 412)
  - Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover
  - Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover
  - Convert Strips of Non-Irrigated Cropland to Permanent Unfertilized Grass Cover
  - Convert Strips of Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover
- Hedgerow Planting (CPS 422)
  - Replace a Strip of Cropland with 1 Row of Woody Plants
- Herbaceous Wind Barriers (CPS 603)
  - Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover
  - Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover
  - Convert Strips of Non-Irrigated Cropland to Permanent Unfertilized Grass Cover
  - Convert Strips of Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover
- Mulching (CPS 484)
  - Add Mulch to Croplands
- Multi-story Cropping (CPS 379)
  - Replace 20% of Annual Cropland with Woody Plants
- Nutrient Management (CPS 590)
  - Improved N Fertilizer Management on Irrigated Croplands – Reduce Fertilizer Application Rate by 15%
  - Improved N Fertilizer Management on Non-Irrigated Croplands – Reduce Fertilizer Application Rate by 15%
- 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
- Riparian Forest Buffer (CPS 391)
  - Replace a Strip of Cropland Near Watercourses or Water Bodies with Woody Plants

Cropland Agricultural System Practice Implementations (cont'd)

- 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
  - Convert Strips of Non-Irrigated Cropland to Permanent Unfertilized Grass Cover Near Aquatic Habitats
  - Convert Strips of Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover Near Aquatic Habitats
- Strip-cropping (CPS 585)
  - Add Perennial Cover Grown in Strips with Irrigated Annual Crops
  - Add Perennial Cover Grown in Strips with Non-Irrigated Annual Crops
- Tree/Shrub Establishment (CPS 612)
  - Conversion of Annual Cropland to a Farm Woodlot
- Vegetative Barriers (CPS 601)
  - Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover
  - Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover
  - Convert Strips of Non-Irrigated Cropland to Permanent Unfertilized Grass Cover
  - Convert Strips of Non-Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover
- Windbreak/Shelterbelt Establishment (CPS 380)
  - Replace a Strip of Cropland with 1 Row of Woody Plants

Orchard or Vineyards Agricultural System Practice Implementations

- Compost Application[7]
  - Compost (C/N < or = 11) Application to Perennials, Orchards and Vineyards
  - Compost (C/N > 11) Application to Perennials, Orchards and Vineyards
- Conservation Cover (CPS 327)
  - Convert Idle Land near Orchards/Vineyards to Permanent Unfertilized Grass Cover
  - Convert Idle Land near Orchards/Vineyards to Permanent Unfertilized Grass/Legume Cover
  - Plant Permanent Grass Cover in Orchard/Vineyard Alleys
  - Plant Permanent Grass/Legume Cover in Orchard/Vineyard Alleys
- Cover Crop (CPS 340)
  - Add Legume/Legume Mix Cover Crop to Orchard/Vineyard Alleys
  - Add Non-Legume Cover Crop to Orchard/Vineyard Alleys

Orchard or Vineyards Agricultural System Practice Implementations (cont'd)

- Filter Strip (CPS 393)
  - Convert Idle Land near Orchards/Vineyards to Permanent Unfertilized Grass Cover
  - Convert Idle Land near Orchards/Vineyards to Permanent Unfertilized Grass/Legume Cover
- Hedgerow Planting (CPS 422)
  - Plant 1 Row of Woody Plants on Border of Orchard or Vineyard
- Mulching (CPS 484)
  - Add Mulch to Orchard/Vineyards
- Nutrient Management (CPS 590)
  - Improved N Fertilizer Management on Orchard/Vineyards – Reduce Fertilizer Application Rate by 15%
- Residue and Tillage Management – No Till (CPS 329)
  - Conventional Till to No Till on Orchard/Vineyard Alleys
- Residue and Tillage Management – Reduced Till (CPS 345)
  - Conventional Till to Reduced Till in Orchard/Vineyard Alleys
- Whole Orchard Recycling
  - Whole Orchard Recycling followed by Orchard Replant within 3 Years
- Windbreak/Shelterbelt Establishment (CPS 380)
  - Plant 1 Row of Woody Plants on Border of Orchard or Vineyard

Grazing Land Agricultural System Practice Implementations

- Compost Application[7]
  - Compost (C/N > 11) Application to Grazed Grassland
  - Compost (C/N > 11) Application to Grazed, Irrigated Pasture
- Hedgerow Planting (CPS 422)
  - Replace a Strip of Grassland with 1 Row of Woody Plants
- Prescribed Grazing (CPS 528)
  - Grazing Management to Improve Irrigated Pasture Condition
  - Grazing Management to Improve Rangeland or Non-Irrigated Pasture Condition
- Range Planting (CPS 550)
  - Seeding Forages to Improve Rangeland Condition
- Riparian Forest Buffer (CPS 391)
  - Replace a Strip of Grassland Near Watercourses or Water Bodies with Woody Plants
- Silvopasture (CPS 381)
  - Tree/Shrub Planting on Grazed Grasslands

Grazing Land Agricultural System Practice Implementations (cont'd)

- Tree/Shrub Establishment (CPS 612)
  - Conversion of Grasslands to a Farm Woodlot
- Windbreak/Shelterbelt Establishment (CPS 380)
  - Replace a Strip of Grassland with 1 Row of Woody Plants

General Approach

Methods used in the COMET-Planner CDFA HSP Calculator Tool and CDFA HSP Benefits Calculator Tool for estimating the net GHG benefit and air pollutant emission co-benefits by activity type are provided in this section. GHG emission reduction coefficients were largely derived using a sample-based approach and model runs in COMET-Farm, which utilizes USDA entity-scale greenhouse gas inventory methods. Coefficients were generalized by multi-county regions defined by USDA Major Land Resource Areas. More information on quantification methods is available in the USDA/Colorado State University COMET-Planner report;[8] CARB's white paper on CDFA's compost application rates;[9] and CDFA's report on the Whole Orchard Recycling practice.[10] The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

These methods account for field emissions only, including those associated with soils and woody biomass as appropriate, and do not include off-site emissions, such as those from transportation, manufacturing, processing, etc. In general, the COMET-Planner CDFA HSP Calculator Tool calculates changes in above ground biomass, soil carbon decomposition, and methane and nitrous oxide production from the soil microbiome to estimate the net GHG benefit. The HSP Co-Benefit Quantification Methodology also estimates air pollutant emission co-benefits (NO_x, $PM_{2.5}$, O_3, ROG, SO_2, NH_3, and CO) using the same inputs used to estimate the net GHG benefit.

A. Emission Reductions from Practice Implementations

Both the GHG benefit and air pollutant emission reductions from project implementations are estimated using Equations 1-3.

Equation 1: Emission Reductions from Project Practice Implementation

$$Emission\ Reduction = QA_{pim} \times ERC_{pol,pim,c}$$

Where,			Units
Emission Reduction	=	GHG and air pollutant emissions reductions from project implementation.	$MTCO_2e$/yr or lbs/yr
QA	=	Quantified area of project site for a practice implementation (*pim*)	acres
ERC	=	Emission Reduction Coefficient for a given pollutant (*pol*) for a practice implementation (*pim*) implemented in a county (*c*).	$MTCO_2e$/acre-yr or lbs/acre-yr

[8] http://bfuels.nrel.colostate.edu/health/COMET-Planner_Report_Final.pdf
[9] https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/dndc_calculations.pdf
[10] https://www.cdfa.ca.gov/oefi/efasap/docs/WORforPublicCommentReport.pdf

Equation 2: Quantified Area of Project Practice Implementation

$$QA_{pim} = PA_{pim} - CA_{pim}$$

Where,			Units
QA	=	Quantified area: The area project site where the practice implementation (*pim*) is estimated for Benefits	acres
PA	=	Project area: The area where the practice is implemented (*pim*) in the project.	acres
CA	=	Continuing area: The area in the project where any practice implementation (*pim*) was implemented in the previous year. CA has a value of zero for new practices to the Project area.	acres

Equation 3: Area Calculation for Linear Practice Implementations

$$A_{pim} = \frac{1}{43{,}560} \times L_{pim} \times W_{pim}$$

Where,			Units
A	=	Area of a practice implementation (*pim*)	acres
1/43,560	=	Conversion factor	acres/feet^2
L	=	The center-line length of a linear practice implementation (*pim*).	feet
W	=	The width of a practice implementation (*pim*), determined by applicant, Conservation Practice Standard, Conservation Practice Specification, or Conservation Management Plan. Refer to Healthy Soils Program Guidelines.	feet

Section C. References

The following references were used in the development of this Quantification Methodology, the COMET-Planner CDFA HSP Calculator Tool, and the CDFA HSP Co-Benefits Calculator Tool.

California Air Resources Board. (2017). Quantification of Greenhouse Gas Emissions for Compost Application in California Croplands. Retrieved from https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/dndc_calculations.pdf.

California Air Resources Board. (2016). ARB Miscellaneous Process Methodology Section 7.4: Agricultural Land Preparation Operations. Sacramento, CA: Janet Spencer. https://www.arb.ca.gov/ei/areasrc/fullpdf/full7-4_2016.pdf.

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 Air Resources Board. (2003). Computing Agricultural PM_{10} Fugitive Dust Emissions Using Process Specific Emission Rates and GIS. Sacramento, CA: Patrick Gaffney and Hong You. https://www3.epa.gov/ttnchie1/conference/ei12/fugdust/yu.pdf.

California Department of Food and Agriculture (2020). Whole Orchard Recycling: Inclusion in the CDFA Healthy Soils Incentive Program. Sacramento, CA: Wolff, Michael and Gou, Lei. https://www.cdfa.ca.gov/oefi/healthysoils/docs/CDFA_WOR_Report.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. https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html.

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/.

National Resource Conservation Service. (2008). Soil Tillage Intensity Rating (STIR). Retrieved from https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1119754.pdf.

University of California, Division of Agriculture and Natural Resources. (2009). Classification of Conservation Tillage Practices in California Irrigated Row Crop Systems. Publication 8364. https://anrcatalog.ucanr.edu/pdf/8364.pdf.

University of California, Crocker Nuclear Laboratory. (2001). Sources and Sinks of PM_{10} in the San Joaquin Valley. U.S. Department of Agriculture Special Research Grants Program, Contract Nos. 94-33825-0383 and 98-38825-6063. Davis, CA: Robert G. Flocchini. https://www.arb.ca.gov/research/apr/reports/l2022.pdf.

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.

U.S. Forest Service. (2018). Forest Inventory & Analysis. Retrieved from https://www.fia.fs.fed.us/.

U.S. Forest Service. (2020). i-Tree Planting Tool. Retrieved from https://planting.itreetools.org/.