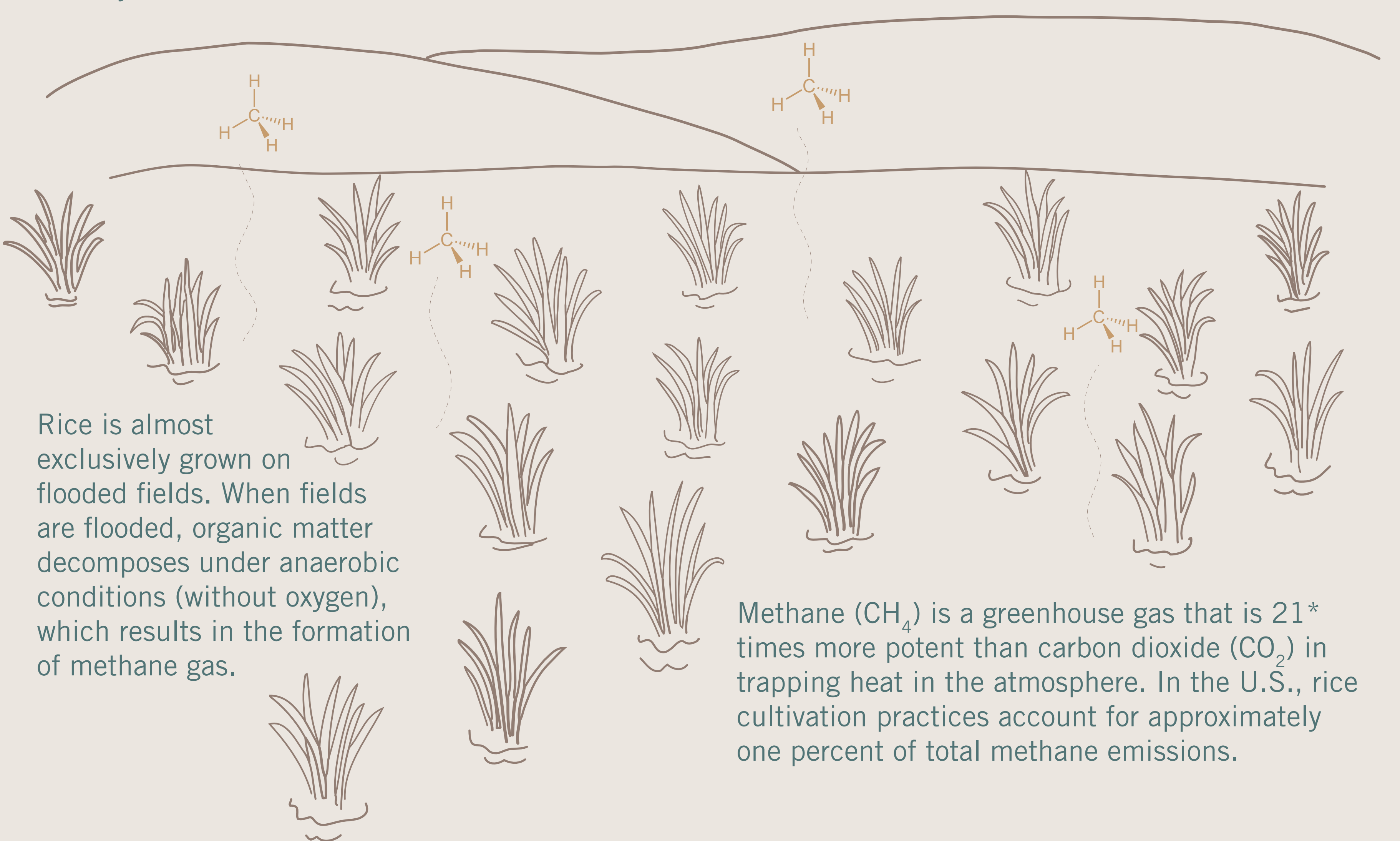
RICE CULTIVATION

IN CALIFORNIA'S CAP-AND-TRADE PROGRAM

BASELINE

In the United States, rice is cultivated in three geographic areas: Mid-South (Arkansas, Louisiana, Mississippi, and Missouri), Gulf Coast (Florida, Louisiana, and Texas), and California's Sacramento Valley.



Rice is almost exclusively grown on flooded fields. When fields are flooded, organic matter decomposes under anaerobic conditions (without oxygen), which results in the formation of methane gas.

Methane (CH_4) is a greenhouse gas that is 21* times more potent than carbon dioxide (CO_2) in trapping heat in the atmosphere. In the U.S., rice cultivation practices account for approximately one percent of total methane emissions.

REDUCE EMISSIONS

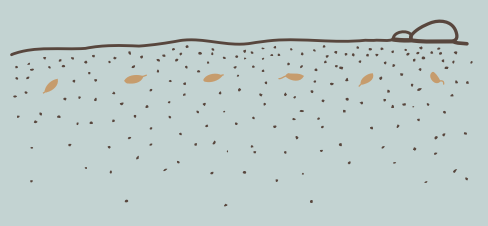
Opportunity exists to reduce the methane generated by rice cultivation practices. Rice farmers can change cultivation practices to decrease the amount of time a field is flooded, resulting in reduced greenhouse gas (GHG) emissions compared to baseline management practices.

The California Air Resources Board (ARB) adopted the Rice Cultivation Projects Compliance Offset Protocol for use in its cap-and-trade program to support emissions reductions from rice cultivation practices. The protocol provides offset project eligibility rules, methods to calculate GHG emissions reductions, and approaches for project monitoring, reporting and verification. Offsets earned under this protocol may be used as compliance instruments.

ELIGIBLE PROJECT ACTIVITIES

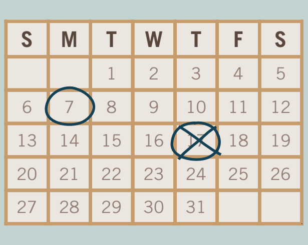
DRY SEEDING

Rice cultivation projects that sow seeds into a dry or moist seedbed, resulting in the reduction of methane that would otherwise be released into the atmosphere if the seeds were wet-seeded; project must be located in the California Rice Growing Region.



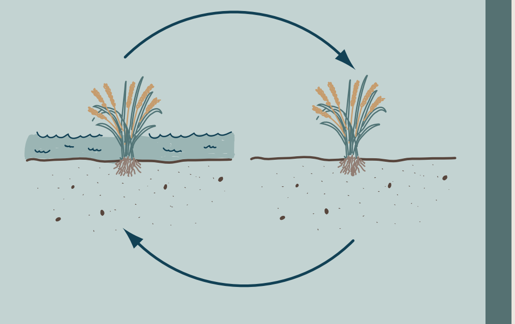
EARLY DRAINAGE

Rice cultivation projects that drain standing water from fields earlier during the rice growing season, resulting in the reduction of methane that would otherwise be released into the atmosphere if the rice fields were drained on the customary date; project may be located in both the California and Mid-South Rice Growing Regions.



ALTERNATE WETTING AND DRYING

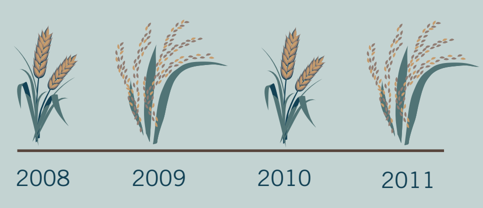
Rice cultivation projects that cyclically wet and dry the rice fields during the growing season to reduce methane emissions that would otherwise be released into the atmosphere if the project employed continuous flooding; project must be located in the Mid-South Rice Growing Region.



KEY ELIGIBILITY REQUIREMENTS

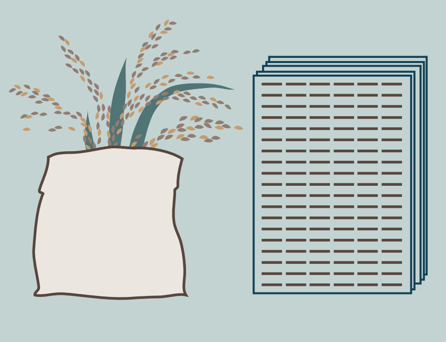
BASELINE

Project must have planted rice for at least two rice cultivation years in the baseline period before the project commencement.



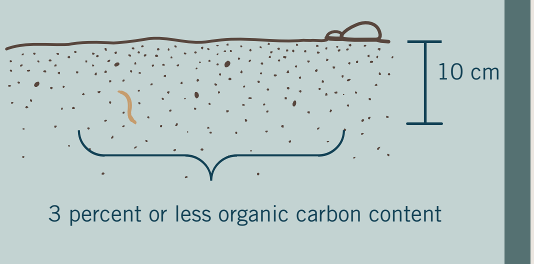
RECORDS

Project must have historical information, such as rice yield and management records, for the baseline period.



SOIL ORGANIC CARBON CONTENT

Project must have soil with three percent or less organic carbon content in the top 10 centimeters of soil in each eligible field.



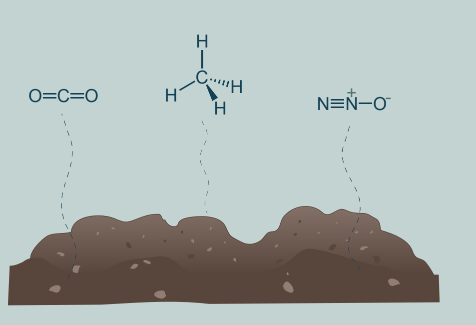
QUANTIFY EMISSIONS

Soil, climate, and farm management records collected throughout a growing season are used to quantify the amount of methane emissions reduced by the eligible project activities (dry seeding, early drainage, and/or alternate wetting and drying).

WHAT GETS QUANTIFIED

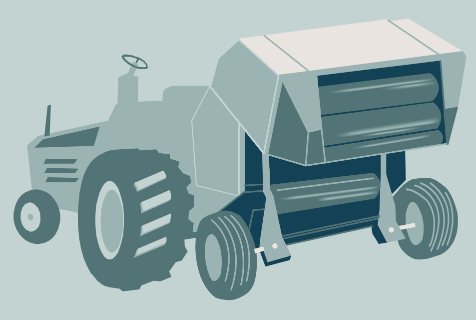
EMISSIONS FROM SOIL DYNAMICS

The biogeochemical interactions occurring in the soil that produce emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and changes in soil carbon stocks.



EMISSIONS FROM EQUIPMENT

Carbon dioxide emissions increase as a result of equipment use for rice cultivation activities and rice straw management activities, i.e. collecting and removing rice and rice straw from fields.



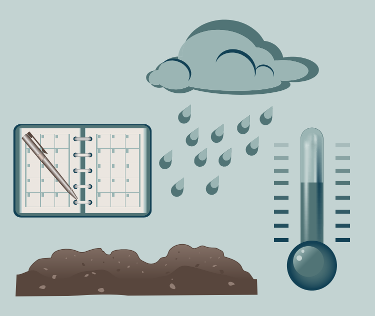
EMISSIONS FROM RICE CROP RESIDUE MANAGEMENT

Carbon dioxide and methane emissions from on-site rice crop residue management, i.e. rice straw burning or anaerobic decomposition.

HOW TO QUANTIFY EMISSIONS

DNDC MODEL

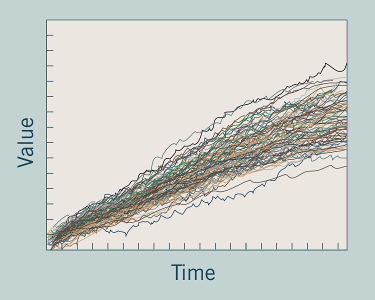
The DeNitrification-DeComposition (DNDC) computer model simulates the biogeochemical processes that drive carbon and nitrogen cycling in agricultural soils. It has been used to quantify greenhouse gas emissions from agricultural soils for over 20 years. Upon inputting accurate data on climate, soil, and management practices, the model can be used to predict crop yield, carbon sequestration, nitrate leaching loss, and emissions of trace gases, including methane and nitrous oxide.



DATA INPUTS

Data inputs into the DNDC model include:

1. Soil data: clay content, bulk density, soil pH, soil organic carbon (SOC) at surface soil, soil texture
2. Daily climate data: including precipitation, maximum temperature, minimum temperature
3. Farming management practices: crop, tillage, fertilization, manure management, irrigation, flooding, plastic film use, and grazing or cutting information



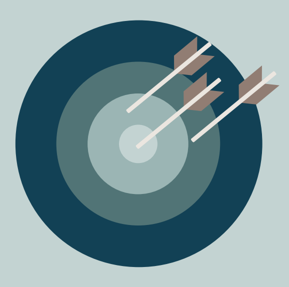
MONTE CARLO SIMULATIONS

The algorithm relies on repeated random sampling within a set range of input values to compute results. The Rice Cultivation Projects Compliance Offset Protocol provides specific equations designed for either 16 or 1000 Monte Carlo runs.

1. 16 runs: the 16 runs must comprise of every possible combination of the minimum and maximum uncertainty values for each of the soil parameters (bulk density, clay content, soil organic content, pH)
2. 1000 runs: varies input parameters randomly

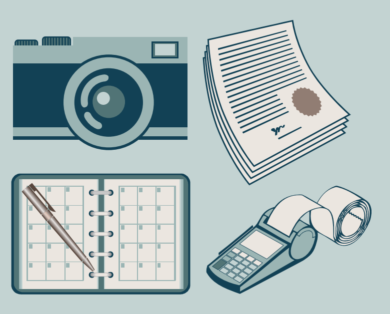
ENSURE ACCURACY AND TRANSPARENCY

KEY MECHANISMS TO ENSURE ACCURACY AND TRANSPARENCY



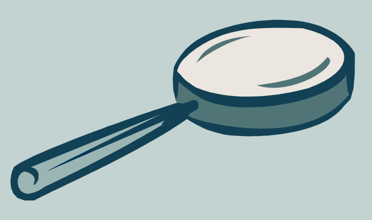
ACCOUNT FOR MODEL STRUCTURAL UNCERTAINTY AND SOIL INPUT UNCERTAINTY

Inherent in biogeochemical models like DNDC are uncertainties due to imperfect science in the models. Model structural uncertainty roughly quantifies how well the model represents reality. Because physical and chemical properties of soil have a significant impact on methane and nitrous oxide production, consumption, and emissions, further uncertainty is also introduced to the model in the sampling of soil data. This is known as soil input uncertainty. The protocol requires that project developers account for both soil input uncertainty and model structural uncertainty by applying an Uncertainty Deduction to the emission reductions calculated by DNDC to ensure that credited GHG reductions remain conservative.



RECORDS MANAGEMENT GUIDELINES

The protocol includes comprehensive document retention and records management guidelines, which may be followed in order to support verification that project activities actually occurred. Guidelines include purchase/rental records, seeding service contracts/receipts, and digital photograph(s) per field taken from various vantage points and geotagged to include date and geocoordinates in the metadata in order to clearly establish project activities.



VERIFICATION REQUIREMENTS

The protocol contains strict verification requirements, including having an agronomic expert on the verification team to evaluate certain requirements.

CO-BENEFITS OF RICE CULTIVATION PROJECTS

POSITIVE ENVIRONMENTAL AND COMMUNITY CO-BENEFITS

WATER SAVINGS

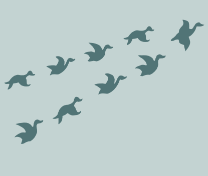
Dry seeding may result in less diversion of water from rivers, which can be beneficial to fish and riparian habitat, and may reduce irrigation fees for farmers. With early drainage, there may be water savings attributed to less evaporative loss from the field under drained conditions.

REDUCED THREAT OF VECTOR BORNE ILLNESSES

A reduction in the duration of flooded rice fields may result in less conducive conditions for the breeding of mosquitoes and the transmission of vector borne illnesses.

GREATER, HEALTHIER RICE PLANTS

Compared to continuous flooding of rice paddies, reducing the amount of time that a field is flooded allows more oxygen to go to the roots, which increases the density and number of roots and may help achieve greater yield.



HABITATS FOR MIGRATORY BIRDS

Rice fields provide habitat and nourishment for millions of ducks, geese, and shorebirds during their annual migrations. By preserving winter flooded rice fields, the protocol protects important habitats for migratory birds, and strikes a balance between climate, environment, wildlife, and social benefits.

*This value is set by the Compliance Offset Protocol Rice Cultivation Projects Chapter 5(d) and ARB regulation 95102(a) and may be subject to revision in the future.

For more information, please visit:

California Air Resources Board Rice Cultivation Projects Compliance Offsets Protocol webpage
http://www.arb.ca.gov/cc/capandtrade/protocols/riceprotocol.htm

University of New Hamspshire DNDC Model webpage
http://www.dndc.sr.unh.edu/

Climate Action Reserve Rice Cultivation Project Protocol webpage
http://www.climateactionreserve.org/how/protocols/rice-cultivation/

CLIMATE ACTION RESERVE