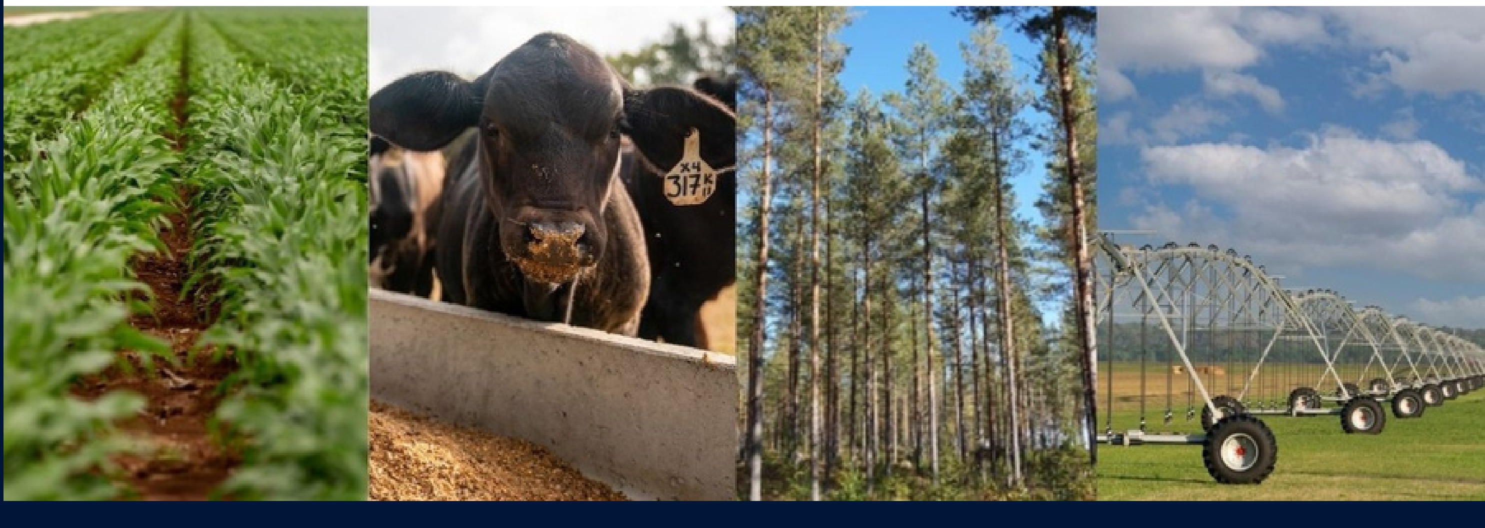
TEXAS

CLIMATE-SMART **INITIATIVE**

CROPS · FORESTRY · LIVESTOCK

MMRV PLAN



MEASUREMENT
Quantification of the greenhouse gas (GHG) benefits (reduction or capture) using mathematical models and/or direct physical measurements in the field

The GHG benefits resulting from the implementation of climate-smart agriculture and forestry management (CASF) practices for each participant enrolled in the Texas Climate-Smart Initiative (TCSI) will be estimated by comparing GHG emissions and soil organic carbon (SOC) accumulation against established baselines, with all units expressed in carbon units (kg ha^{-1} $year^{-1}$).

A 'baseline scenario' represents when management practices over the past five years are considered typical for the region, with minimal or no use of conservation management practices.

Baseline SOC ($SOC_{Baseline}$): The SOC determined using direct sampling before implementing the CSAF practice in a particular field.

Changes in SOC after the implementation of CSAF (ΔSOC): Annual changes in SOC will be determined using models at the end of one year ($SOC_{CSAF/Model\text{-}based}$) after implementing the CSAF practice in a particular field. The SOC changes after 3-4 years of implementation of CSAF will be determined using direct sampling of fields ($SOC_{CSAF/Sampling\text{-}based}$) and/or by modeling.

Baseline GHG ($GHG_{Baseline}$): The annual GHG emissions from a typical field with minimal or no use of conservation management practices. This will be established using calibrated models.

Changes in GHG after the implementation of CSAF (ΔGHG): The annual GHG emissions from a typical field after implementing CSAF practices (GHG_{CSAF}). This will be established using calibrated models.

One year will be 12 months after the implementation of the CSAF practice. In the case of crops, this will begin immediately after planting the main crop.

Annual GHG Benefits will be estimated using equation 1:

$$\textbf{Annual GHG benefit} = \Delta SOC + \Delta GHG \qquad [1]$$

where ΔSOC and ΔGHG are changes in organic carbon and GHG emissions after 1 year of implementing the CSAF practice compared to the baseline. The SOC is expected to increase, while GHG emission is expected to decline. These changes will be estimated using the following equations:

$$\Delta SOC = SOC_{CSAF/Model\text{-}based} - SOC_{Baseline}$$

$$\Delta GHG = GHG_{Baseline} - GHG_{CSAF}$$

Net GHG Benefits after 3-4 years of implementation will be established using equation 2:

$$\textbf{Net GHG benefit} = \Delta SOC + \Delta GHG \qquad [2]$$

$$\Delta SOC = SOC_{CSAF/Sampling\text{-}based} - SOC_{Baseline}$$

$$\Delta GHG = GHG_{Baseline} - GHG_{CSAF}$$

Net GHG Benefits due to manure management operations will be determined using modeled estimates using the Texas Manure Solutions protocol.

MODELING APPROACH

To quantify changes in SOC and GHG emissions, we will use simulated estimates using the Carbon Management Evaluation Tool (COMET)-Planner/ COMET-Farm, and/or by using other cropping systems or biogeochemical models. Model selection will depend on the type of system being evaluated. Other models proposed to use in this project include the Environmental Policy Integrated Climate (EPIC), Agricultural Policy/Environmental Extender (APEX), and/or the Decision Support System for Agrotechnology Transfer (DSSAT).

For GHG emission modeling of manure management practices, we will develop Texas Manure Solutions protocol, which will combine IPCC Tier 2 methodology with assessment of operation-specific manure management practices in Texas. This protocol will reflect the animal commodity, farm size, animal diet and housing, productivity, and manure management practices.

This protocol will minimize errors and uncertainty caused by using national average values for estimating GHG reductions from manure management projects. To estimate climate-smart benefits from CAFO, we will use manure characteristics to model GHG emissions using the Texas Manure Solutions protocol. We will also evaluate other existing GHG emission models (CARB/IPCC and DairyGEM). By comparing model estimates with actual GHG emissions measured from farms, we will be able to validate/improve our models.

GHG MEASUREMENT PLAN

Half-hourly GHG (CO_2, N_2O, and CH_4) emission data: A combination of eddy covariance flux techniques and long-term automated soil chambers equipped with trace gas analyzers will be installed in selected fields. Each field will serve as an 'eddy covariance flux site'.

Each CSAF eddy covariance flux site will be paired with a corresponding conventional site. This simultaneous comparison between CSAF and conventional practices is designed to provide gold standard GHG emission data for a minimum of 3 years.

Total number of eddy covariance flux sites: 10

Commodities of interest: Rice, pasture, and row crops.

Discrete GHG sample collection: Static chambers will be used for collecting GHG emission data from 10 to 20% of participants’ fields four times a year. Measurements will be made from a grid of size 15 to 25 acres.

CAFO GHG emission: 18 confined animal feeding operations (CAFOs), including dairy, livestock, poultry, and swine, will be monitored for GHG emissions. For these sites (15 large operations and 3 small operations), we will use auto-samplers fitted with trace gas analyzers to collect and analyze gas samples at each site when meteorological and operational conditions are favorable for sensor deployment.

	The analyzers will be set to measure GHG concentrations above lagoons, near manure piles, and inside barns on all participating farms. In addition, supplementary sampling points are needed on large farms which will be sampled and monitored by auto-samplers. These auto-samplers with trace gas analyzers will be used to measure emissions from manure storages piles, manure pits, compost piles/windrows, liquid/solid separation equipment, and manure covered feedlots, etc. from large farms. Smart floating chambers will be used for collecting and analyzing gas samples from lagoons, pits, and runoff holding ponds. Auto-samplers will be programmed to collect samples at specified time intervals or flow volume increments to allow us to sample over entire emission events. These instrumented sites will give us an opportunity to monitor emissions continuously and will serve as testbeds for model simulations of net SOC and GHG benefits.
SOIL SAMPLING	Soil sampling will be done on 15- or 25-acre grids at 0-15 and 15-30 cm depths before and 3 to 4 years after implementing CSAF practices. In addition, we will measure SOC in the full soil profile (i.e., 0-15, 15-30, 30-60, and 60-90 cm) for 20% of participants pre- and post-implementation of CASF practices for more detailed measurements. Baseline soil data: pH, electrical conductivity (EC), soil texture, and aggregate stability in the 0-15 cm depth and SOC and total nitrogen (TN) at 0-15 and 15-30 cm depths. CASF soil data: SOC and total nitrogen (TN) at all depths.

APPROACH TO QUANTIFYING ADDITIONAL ENCIRONMENTAL BENEFITS, IF APPLICABLE	None
ADDITIONALITY	Our project requires the enhancement of the CSAF practice if it is already implemented in the field.
PERMANENCE	According to our contract, the practice must remain in place for a minimum of three years.
LEAKAGE	TSSWCB Climate-Smart Planners will work with participants to develop their own Climate-Smart Management Plan with selected CSAF practices and implementation protocols during enrollment into the program. Our experts will take precautions to prevent carbon benefit leakage when implementing new practices. For instance, enhancing cover crop biomass by applying nitrogen fertilizers could lead to leakage, as nitrogen fertilizers can elevate nitrous oxide emissions and diminish overall greenhouse gas (GHG) benefits. We will not recommend combination of practices that will lead to leakage.
IMPACTS OF WEATHER	Weather may affect the implementation of CSAF practices. Delayed planting due to inclement weather could impact the GHG benefits. Any weather-related impact will be documented in our GHG benefits estimations.

MONITORING

Ongoing review and confirmation that the climate-smart practice has been implemented according to the agreed upon standard and documentation of any changes in the site, implementation, or GHG emissions impacts over time

PARTICIPANT MANAGE-MENT PLAN VISITS	The TCSI project will work with the Texas State Soil & Water Conservation Board (TSSWCB) to develop a practice management plan. The plan will list all climate smart practices that the participant agrees to install on their land. The management planner with the TSSWCB will ensure that the farmer has met all requirements agreed upon in the management plan before an incentive payment is paid to the farmer. The planner will go to the farm, view photographs (if possible), review farm operation records, and consult with Climate Smart Ambassadors to verify practices are correctly being instituted. The TCSI Climate Smart Ambassadors will visit the farmers land between 1-4 times a year to answer questions, visit the farmers operations, and collect soil samples from all participants. The ambassador will work closely with the TSSWCB planner to assist in giving updates so that the project can verify each participant is following their plan.
TCSI MOBILE APP	A mobile application will be developed for the landowner to upload geotagged images of the field and the practices.

REMOTE SENSING	Satellite-based remote sensing provides greater feasibility to monitor land use and crop growth due to its high temporal resolution and spatial coverage capabilities. The temporal changes in the field will be monitored through satellite imagery, with a preference for freely available satellite data, such as Landsat.

REPORTING
Documenting and sharing monitoring and measurement results with project partners, the recipient, and any third-party verification organization

DATA-BASE	Project will develop a database for distributing the data. Database will be integrated with a Climate-Smart Practice Evaluation Tool (CPET).
REPORTS TO USDA	The project manager will update progress, participant numbers, and expenditures each quarter.

VERIFICATION
Independent confirmation that measurement, monitoring and reporting information are complete, accurate and reliable

CONFIRM-ATION	An independent verification plan will be developed to examine the measurement, monitoring and reporting systems implemented by the participants to confirm that the project adheres to the established standards and methodologies.