



# Iowa Perspectives – Agriculture and Carbon

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OF SCIENCE AND TECHNOLOGY

# Carbon Science **FOR** Carbon Markets

## Emerging Opportunities in Iowa

Published on the ISU  
Extension Store:  
[store.extension.iastate.edu/  
product/16214](http://store.extension.iastate.edu/product/16214)

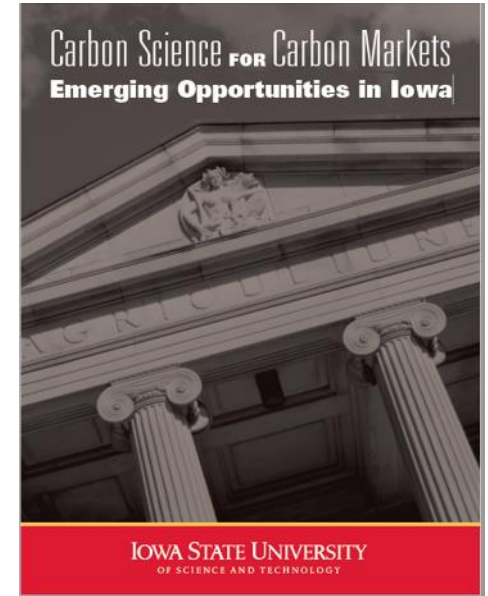


Contributions from:

- 51 scientists
- 13 departments
- 4 colleges
- 4 institutes and centers

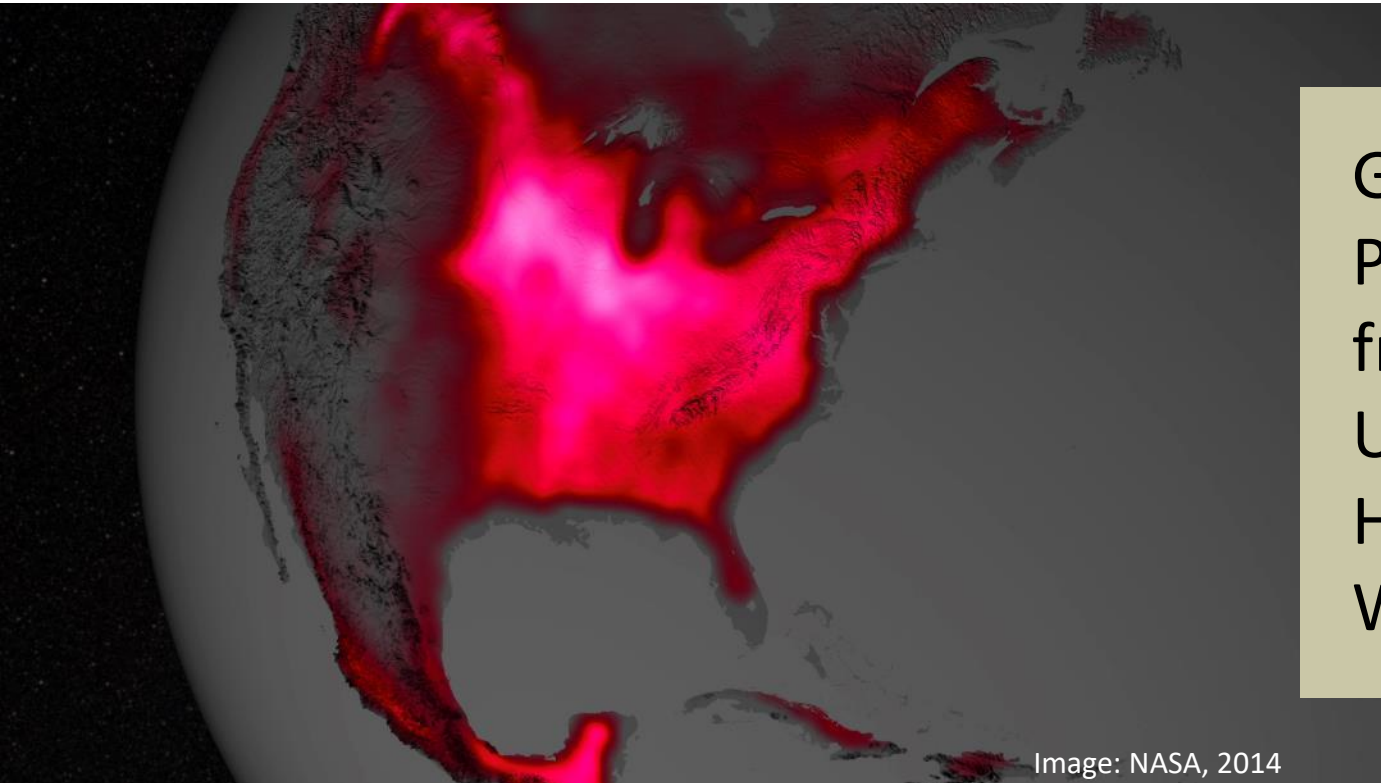
# Overview of Report

- Carbon Markets – Past and Present
- Measuring, Reporting, and Verification
- Cropping Systems and Land Management
- Livestock Practices
- Agricultural Carbon Planning
- Agriculturally-Based Engineering Technologies
- Agricultural Practice Adoption
- Process-Based Models
- Life Cycle Assessment of Carbon Removal Technologies





# Iowa Advantage: Productivity at Scale

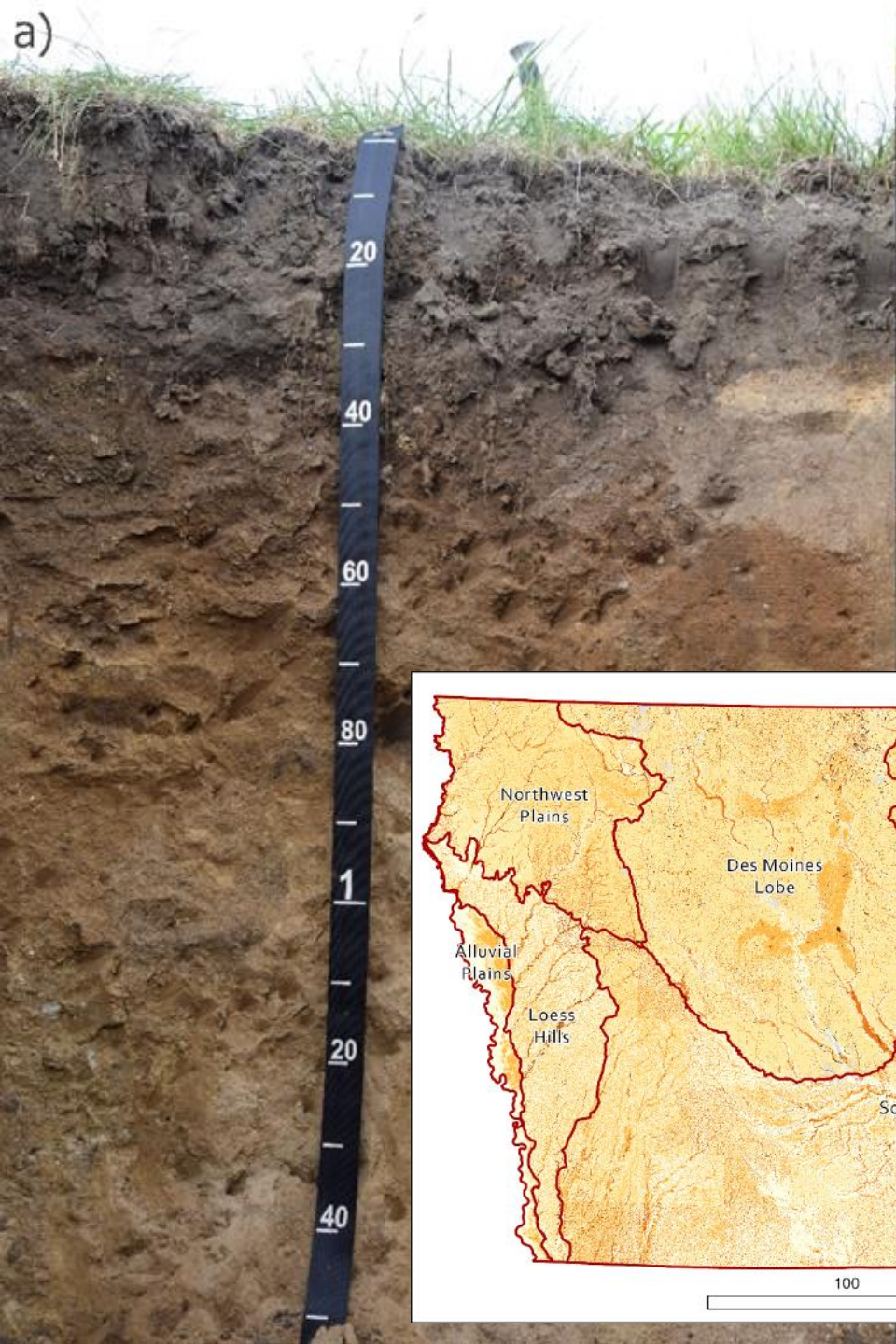


Gross Primary  
Production  
from  
US Corn Belt  
Highest in  
World

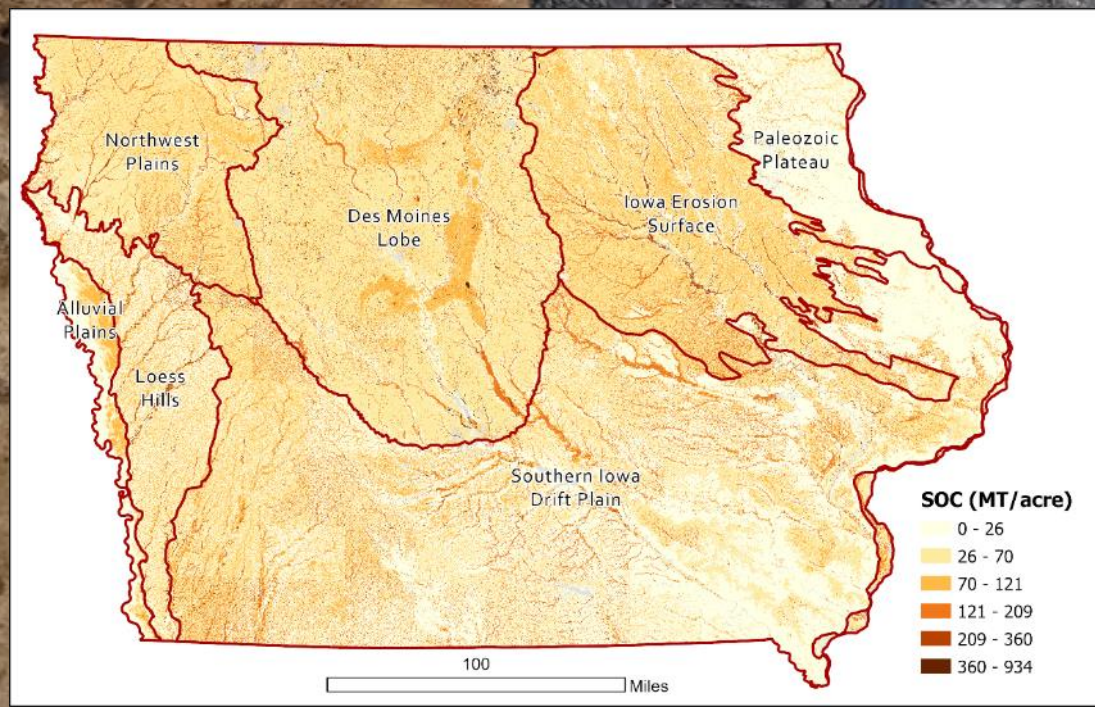
sun-induced chlorophyll fluorescence (SIF)



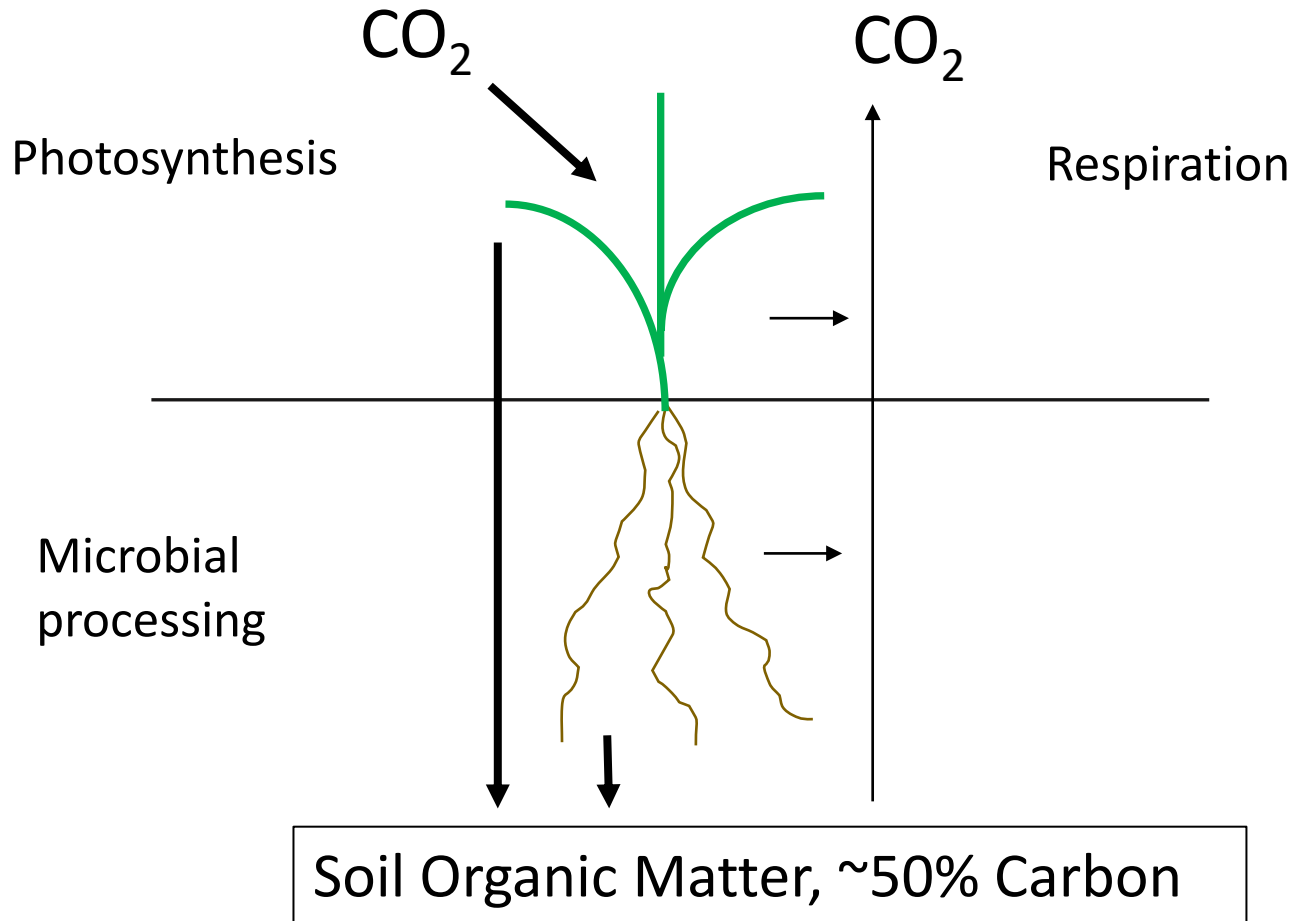
a)



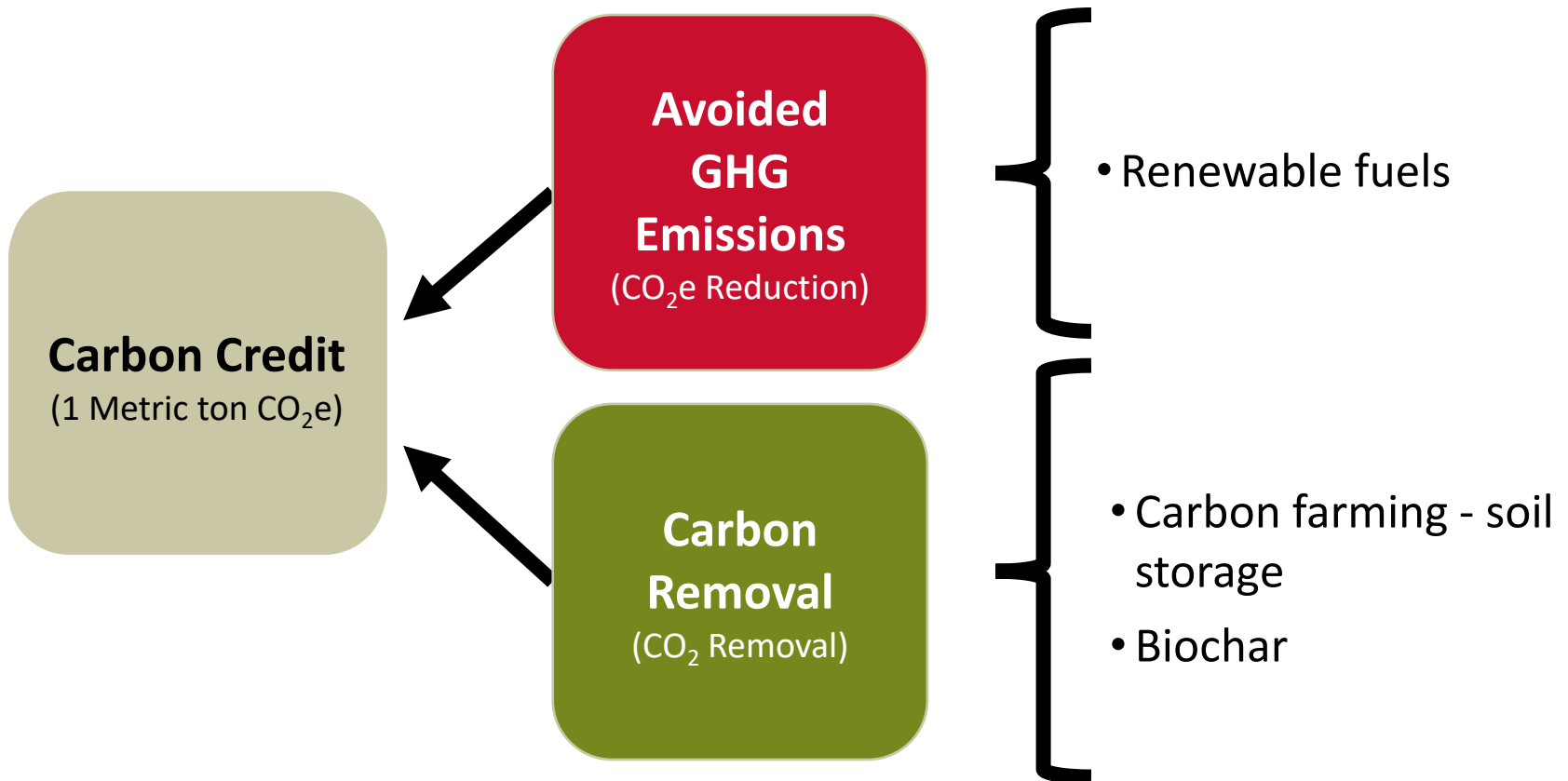
b)



# Carbon Cycle



# Pathways to Carbon Value





# Drivers – Soil Carbon Economy

Government & Corporate	Farm-Level
Net zero commitments, USDA programs, private sector programs	Historic losses of soil carbon – erosion, tillage, drainage
Nearly all current anthropogenic CO <sub>2</sub> removal is from land management (2Gt), as other CO <sub>2</sub> removal methods \$\$\$ or not to scale yet*	Payments for changes in practices or outcomes
Co-benefits of practices	Co-benefits of practices
	Increased resilience to climate extremes

\*Smith et al. 2023. The State of Carbon Dioxide Removal

# Limitations – Soil Carbon Economy

Government & Corporate	Farm-Level
Variability of soil carbon, slow rate of change – limits ability to measure (Monitoring, Reporting, and Verification)	Market value carbon credits is far too low
Reliance on models	Multiplicity of programs
Limited permanence	‘Additionality’
Science unknowns, nitrous oxide, etc.	Long-term – climate change impacts on yield and stored carbon

# Cropping Systems and Land Management

**Known** – No-till and cover crops tend to increase soil organic carbon in the topsoil compared to more intensive tillage systems.

**Unknown** – How application of multiple practices concurrently such as no-till + cover crops influence soil carbon stocks for the entire soil profile.



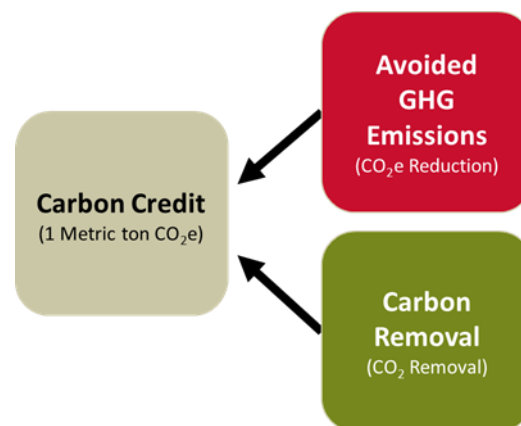
NRCS/SWCS Photo by Lynn Betts



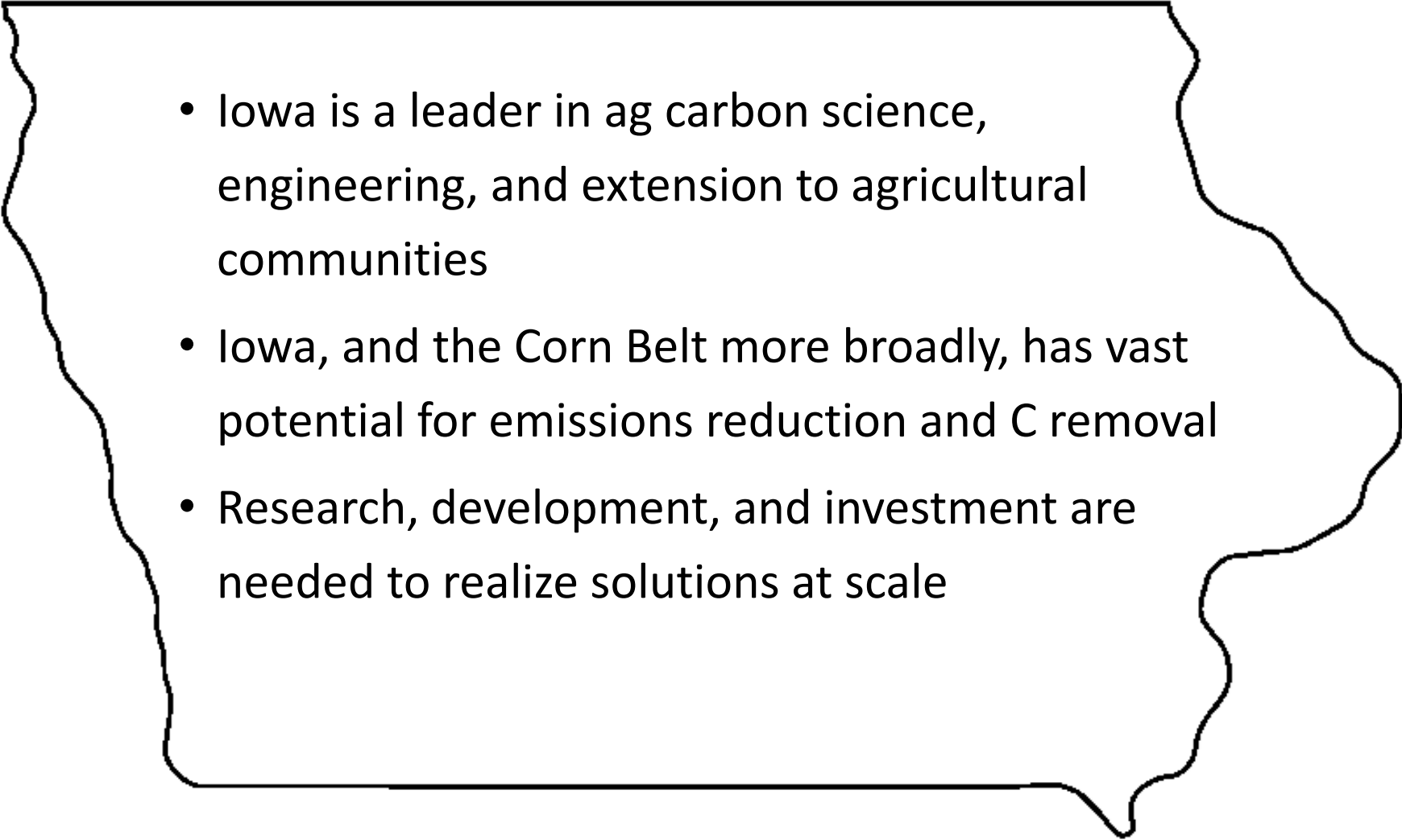
# Emissions Change be Significant (even if soil carbon change is not...)

Corn-Soybean-Oats-Alfalfa  
vs. Corn-Soybean

- 64% less fossil energy
- 64% less carbon dioxide
- 63% less nitrous oxide
- 76% less methane
- 64% less total CO<sub>2</sub>e (less N)



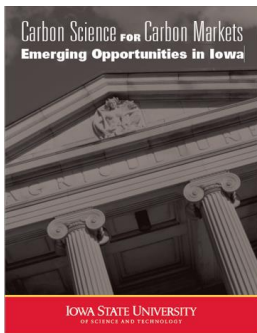
# Iowa and Carbon Space

- 
- Iowa is a leader in ag carbon science, engineering, and extension to agricultural communities
  - Iowa, and the Corn Belt more broadly, has vast potential for emissions reduction and C removal
  - Research, development, and investment are needed to realize solutions at scale

# For More Information

## ISU Carbon Report

carbon.extension  
.iastate.edu



## ISU Extension Carbon Website

carbon.extension  
.iastate.edu



## Conversations About Carbon Webinars

Our Latest Conversations

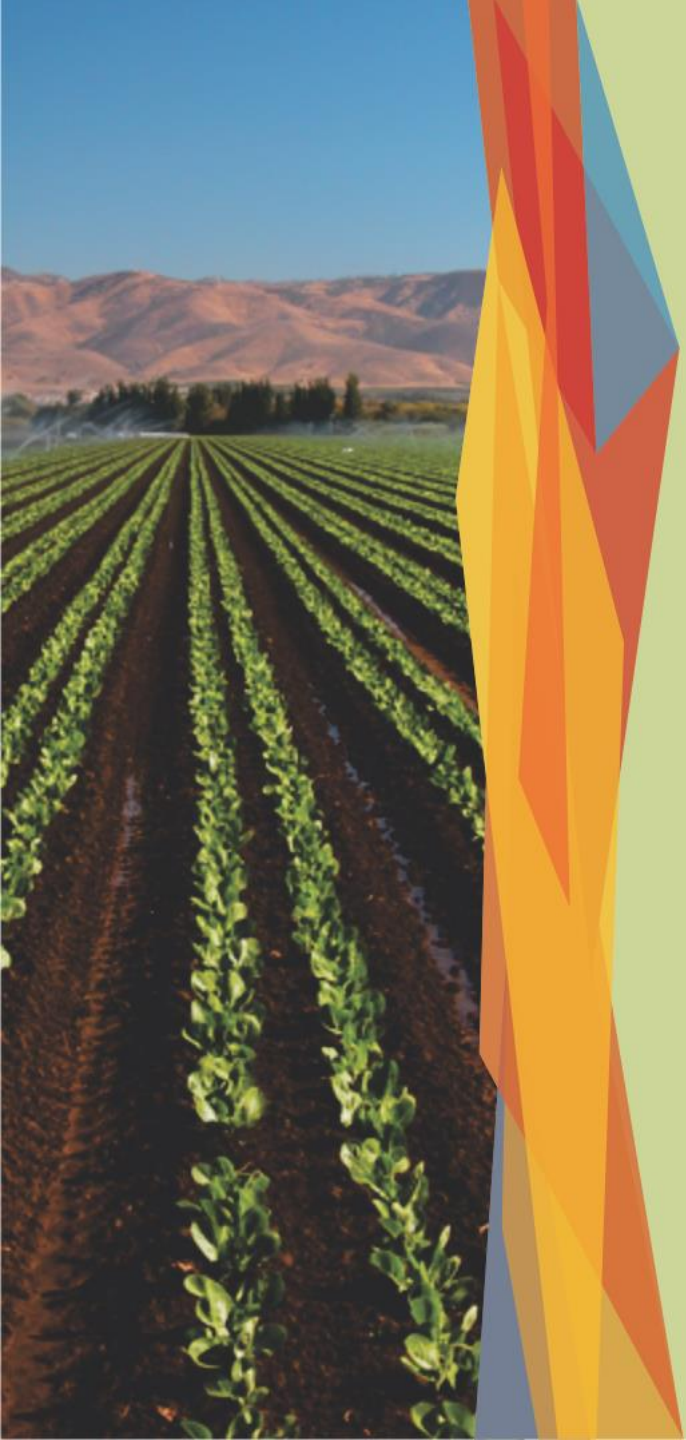


www.biorene  
w.iastate  
.edu/convers  
ations-about-  
carbon



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# Climate Smart Agriculture in California

Guihua Chen, Ph.D.

Senior Environmental Scientist

Office of Environmental Farming and Innovation

California Department of Food and Agriculture (CDFA)



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# California Agriculture

- \$51 billion in farm production
- Diversity in crops, farms and regions
- More than 400 commodities
- Our climate gives us an advantage on specialty crops for health and nutrition



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# Climate Challenge

- Ongoing drought scenario product of climate change
- Recent rains helpful but ephemeral
- Preparing for hotter, drier future amid extreme heat
- Food demand to increase



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# Ag Vision

California Agriculture is growing opportunity for farmers and ranchers, individuals and communities, and demonstrating leadership on climate change.

## **Priorities**

1. Foster climate-smart, resilient, and restorative food systems
2. Build healthy, local communities
3. Drive next generation talent and tools
4. Enhance understanding of agriculture
5. Collaborate on smarter regulations



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# Climate Smart Agriculture

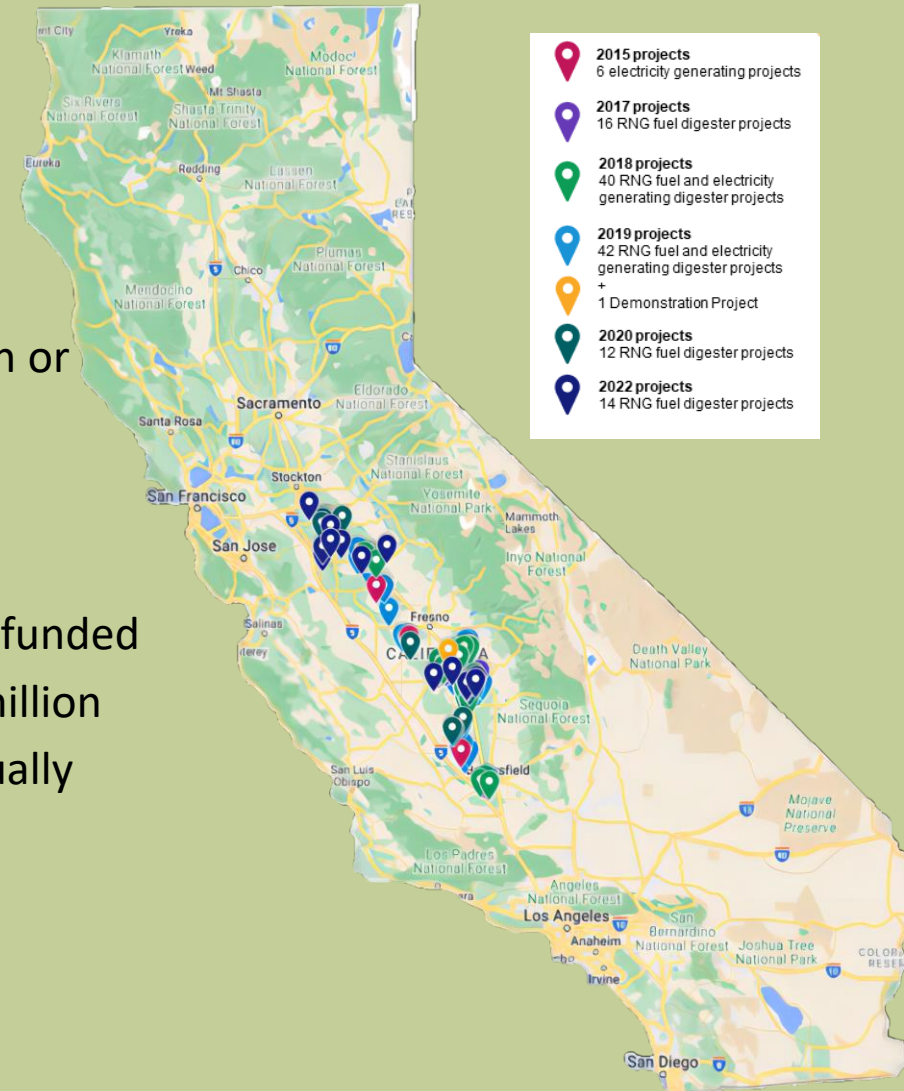
- California Climate Solutions: Ag is part of the solution
- Reducing Livestock Methane Emissions
  - **Dairy Digester Research and Development Program (DDRDP)**
  - **Alternative Manure Management Program (AMMP)**
  - Enteric Fermentation Research
- Improving Irrigation Efficiency
  - **State Water Efficiency and Enhancement Program (SWEET)**
- Improving Soil Health and Carbon Sequestration
  - **Healthy Soils Program:**
    - **Demonstration Program**
    - **Incentives Program**
- Sustainable Pest Management
- Providing Technical Assistance
  - Technical Assistance Program



**Tools have been developed to calculate greenhouse gas reduction benefits for each program.**

# Dairy Digester Research and Development Program (DDRDP)

- Competitive grant program providing financial assistance to CA dairy operations for the implementation of anaerobic dairy digesters that result in methane emissions reductions
- Methane must be used for energy production or transportation fuel
- Up to \$1,600,000 per project, 2-year term
- Impacts:
  - 131 incentive and demonstration projects funded
  - \$213 million awarded, matched by \$432 million
  - 2.3 million MTCO<sub>2</sub>eq GHG reductions annually
  - Projects have 10-year life



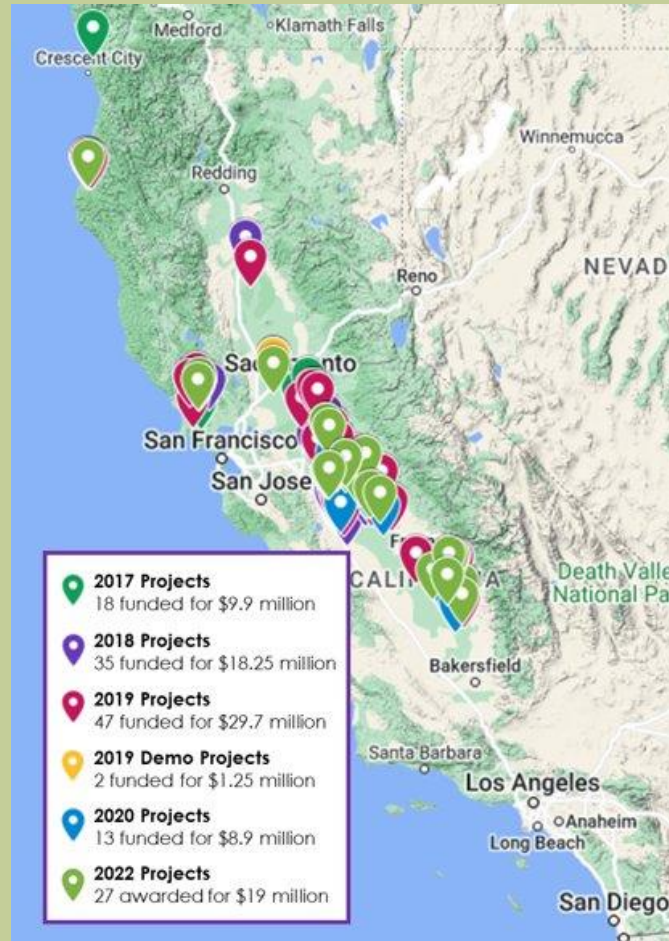




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# Alternative Manure Management Program



- Competitive grant program providing financial assistance to CA dairy and livestock operators for the implementation of non-digester manure management practices that result in methane emissions reductions
- **Eligible Practices:**
  1. Pasture-based management
  2. Alternative manure treatment and storage
  3. Solid separation or
  4. Flush-to-scrape conversion in conjunction with treatment and/or drying
- Up to \$750,000 per project, 2-year term
- **Impacts:**
  - 142 projects funded
  - \$86 million awarded
  - 260,000 MTCO<sub>2</sub>eq GHGs reductions annually
  - Projects have 5-year life



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# State Water Efficiency and Enhancement Program

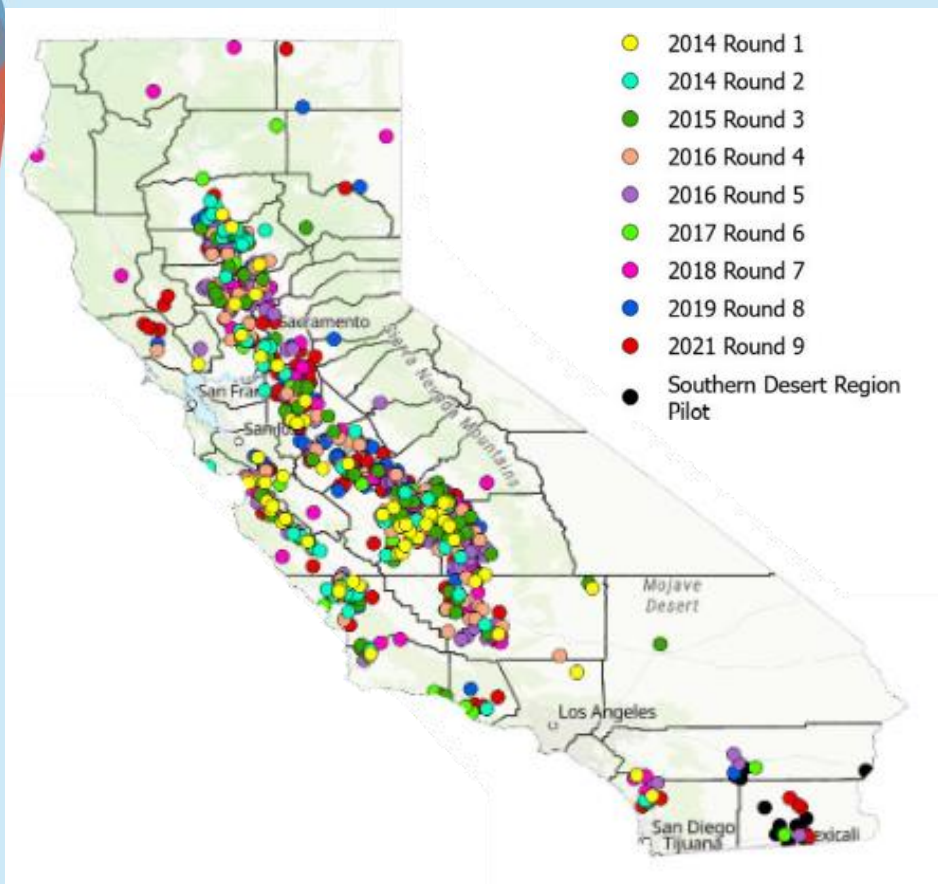
SWEEP provides financial assistance in the form of grants to implement irrigation systems that reduce greenhouse gases **and** save water on California agricultural operations.

- Eligible system components include soil moisture monitoring, drip systems, pump retrofits, variable frequency drives and installation of renewable energy to reduce on-farm water use and energy.
- Tools have been developed to estimate water savings from irrigation management and system improvements and GHG emission reductions from pump improvements, reduced pumping and renewable energy.
- Up to \$200,000 per project, 2-year term.



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# SWEEP Outcomes



## Impacts:

- Over 1,100 Projects
- \$126 Million awarded
- GHG Emissions reductions 90,000 MT of CO<sub>2</sub>eq annually
- Water savings estimated at 150,000 Acre-ft annually
- Projects have 10-year life





# Healthy Soils Program

The objectives of the HSP are to increase statewide implementation of conservation management practices that improve soil health, sequester carbon and reduce atmospheric greenhouse gases (GHGs).

- **Incentives Program:** Provides incentives to farmers/ranchers to implement conservation management practices.
  - Up to \$100,000 per project (proposed increase in 2023)
- **Demonstration Program:** Provides funds to universities, resources conservation districts and nonprofits to demonstrate implementation of conservation practices, collect data on GHG reductions, soil health, cost-benefits, ecosystem service, and other co-benefits, and provides education to farmers/ranchers.
  - Up to \$300,000 for research focused Type A per project, \$150,000 for outreach focused Type B per project (in 2023)



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# HSP Conservation Management Practices

## I. Cropland Management Practices

- 1) Compost Application (USDA NRCS CPS 808)
- 2) Conservation Crop Rotation (USDA NRCS CPS 328)
- 3) Cover Crop (USDA NRCS CPS 340)
- 4) Mulching (USDA NRCS CPS 484)
- 5) Nutrient Management (USDA NRCS CPS 590) (15% reduction in fertilizer application *only*)
- 6) Residue and Tillage Management - No-Till (USDA NRCS CPS 329)
- 7) Residue and Tillage Management - Reduced Till (USDA NRCS CPS 345)
- 8) Strip Cropping (USDA NRCS CPS 585)
- 9) Whole orchard Recycling (USDA NRCS CPS 808)

## II. Grazing Lands Practices

- 1) Compost Application (USDA NRCS CPS 808)
- 2) Prescribed Grazing (USDA NRCS CPS 528)
- 3) Range Planting (USDA NRCS CPS 550)
- 4) Silvopasture (USDA NRCS CPS 381)



## III. Woody Cover Establishment

- 1) Alley Cropping (USDA NRCS CPS 311)
- 2) Hedgerow Planting (USDA NRCS CPS 422)
- 3) Multi-story Cropping (USDA NRCS CPS 379)
- 4) Riparian Forest Buffer (USDA NRCS CPS 391)
- 5) Tree/Shrub Establishment (USDA NRCS CPS 612)
- 6) Windbreak/Shelterbelt Establishment (USDA NRCS CPS 380)

## IV. Herbaceous Cover Establishment

- 1) Conservation Cover (USDA NRCS CPS 327)
- 2) Contour Buffer Strips (USDA NRCS CPS 332)
- 3) Field Border (USDA NRCS CPS 386)
- 4) Filter Strip (USDA NRCS CPS 393)
- 5) Forage and Biomass Planting (USDA NRCS 512)
- 6) Grassed Waterway (USDA NRCS CPS 412)
- 7) Herbaceous Wind Barrier (USDA NRCS CPS 603)
- 8) Riparian Herbaceous Cover (USDA NRCS CPS 390)
- 9) Vegetative Barriers (601) (USDA NRCS CPS 601)



# Model Estimation on GHGs Reduction Benefits

**Step 1: Begin by naming your project and selecting your state and county**

Project Name:  County:

**Step 2: Select your agricultural system**

Cropland
  Orchard or Vineyard
  Grazing Land

**Step 3: Select a NRCS Conservation Practice Standard, Conservation Practice Implementation, and Payment Scenario associated with conservation planning objectives that best describe your project. You may add multiple practices, including from different agricultural systems, by returning to Step 2**

**Conservation Practice Standard (CPS)**

- Alley Cropping (CPS 311)
- Compost Application (Interim CPS 808)
- Conservation Cover (CPS 327)
- Conservation Crop Rotation (CPS 328)
- Contour Buffer Strips (CPS 332)
- Cover Crop (CPS 340)
- Field Border (CPS 386)
- Filter Strip (CPS 393)

**Practice Implementation**

- 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

**Payment Scenario**  
(Note: Payment Scenarios may have different payment rates but do not affect GHG reductions)

Basic (Organic and Non-organic)  
 Multiple Species (Organic and Non-organic)

**Step 4: Enter the enrollment amount associated with each conservation practice you selected**

Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions and Payments Associated with Selected Conservation Practices\*  
(Metric Tonnes CO<sub>2</sub> equivalent per year)<sup>[1990]</sup>

NRCS Conservation Practices <small>(Click Practice Name for Documentation)</small>	Enter Unit Value (acres or feet)	Carbon Dioxide	Nitrous Oxide	Methane	Total CO <sub>2</sub> -Equivalent	Estimated HSP payment dollars for the Project Term
<a href="#">Fresno, CA Cover Crop (CPS 340) - Add Legume Seasonal Cover Crop to Irrigated Cropland - Multiple Species (Organic and Non-organic)</a> <small>[delete]</small>	58.3 Acre(s)	21	-7	0	14	\$22,044.40
<b>Total</b>		21	-7	0	14	<b>\$22,044.40</b>

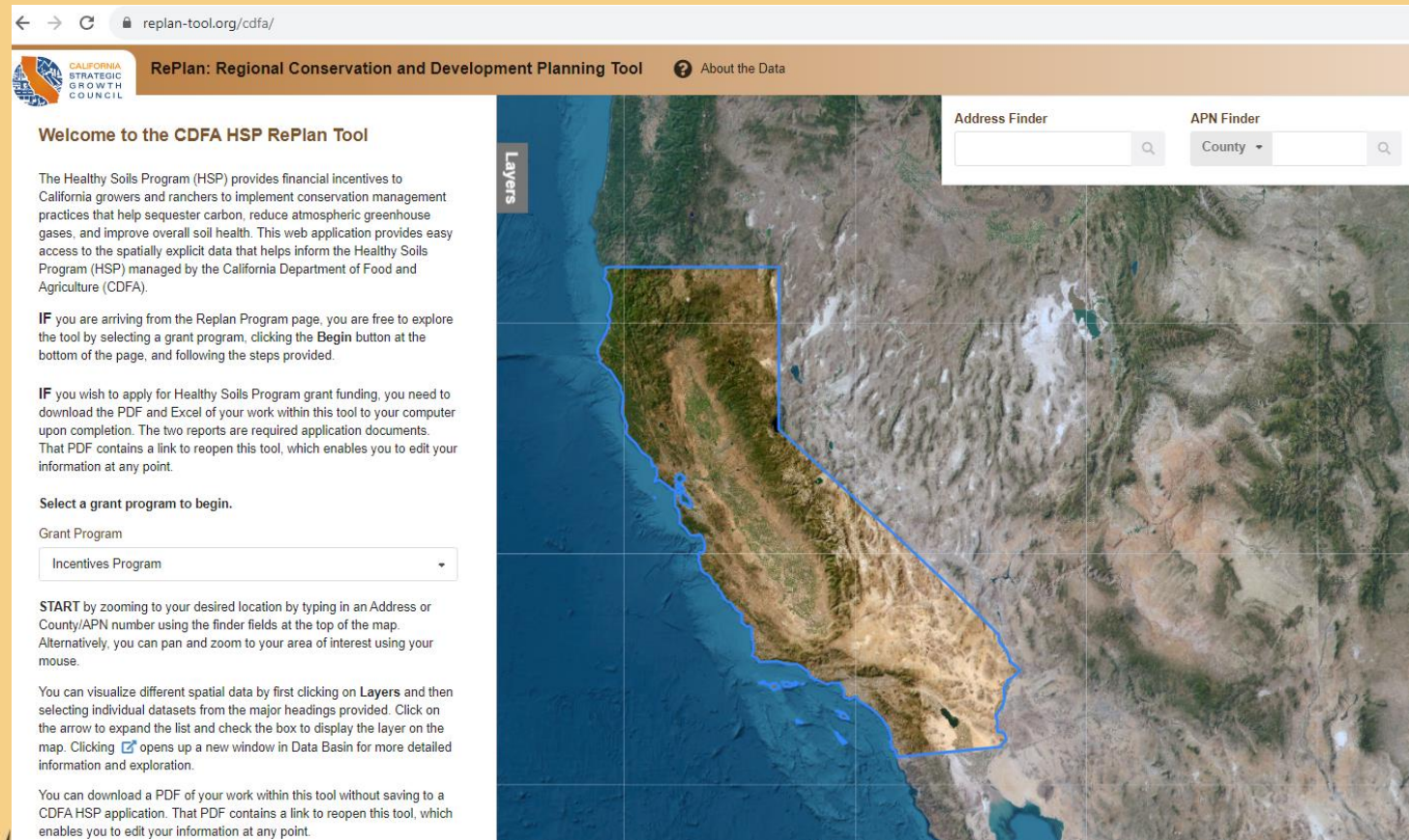
\*Negative values indicate a loss of carbon or increased emissions of greenhouse gases  
 \*\*Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice  
 \*\*\*Final payment may be different than estimated payment, pending application review and approval

[Download Results](#)

<http://comet-planner-cdfahsp.com/>



# Mapping Tool – Friendly and Easy Application Tool for Project Design and Budget Calculation



replan-tool.org/cdfa/

**RePlan: Regional Conservation and Development Planning Tool** About the Data

**Welcome to the CDFA HSP RePlan Tool**

The Healthy Soils Program (HSP) provides financial incentives to California growers and ranchers to implement conservation management practices that help sequester carbon, reduce atmospheric greenhouse gases, and improve overall soil health. This web application provides easy access to the spatially explicit data that helps inform the Healthy Soils Program (HSP) managed by the California Department of Food and Agriculture (CDFA).

**IF** you are arriving from the Replan Program page, you are free to explore the tool by selecting a grant program, clicking the **Begin** button at the bottom of the page, and following the steps provided.

**IF** you wish to apply for Healthy Soils Program grant funding, you need to download the PDF and Excel of your work within this tool to your computer upon completion. The two reports are required application documents. That PDF contains a link to reopen this tool, which enables you to edit your information at any point.

**Select a grant program to begin.**

Grant Program  
Incentives Program

**START** by zooming to your desired location by typing in an Address or County/APN number using the finder fields at the top of the map. Alternatively, you can pan and zoom to your area of interest using your mouse.

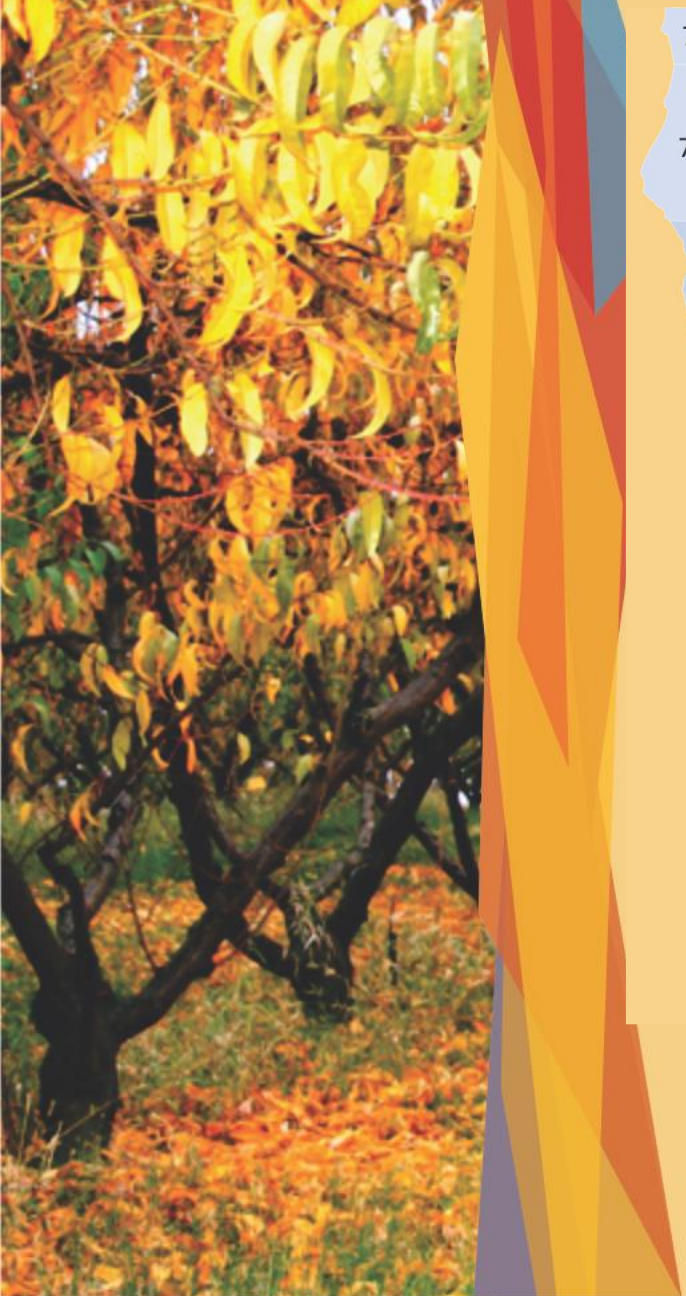
You can visualize different spatial data by first clicking on **Layers** and then selecting individual datasets from the major headings provided. Click on the arrow to expand the list and check the box to display the layer on the map. Clicking  opens up a new window in Data Basin for more detailed information and exploration.

You can download a PDF of your work within this tool without saving to a CDFA HSP application. That PDF contains a link to reopen this tool, which enables you to edit your information at any point.

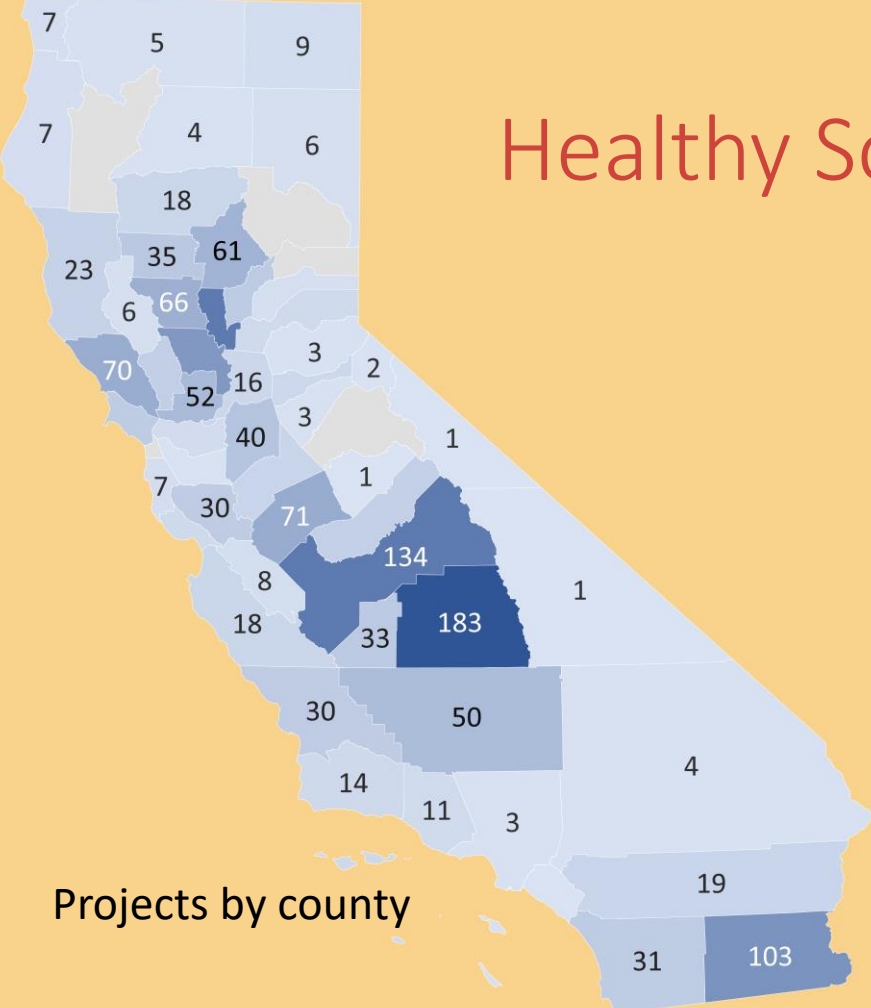
Address Finder  
APN Finder  
County

Layers





# Healthy Soils Program Outcomes



Projects by county

Competitive grant program funded during 2017 - 2022

- 1600 projects funded
- \$106 million awarded
- \$8 million (voluntarily)
- 130,000 acres covered
- 360,000 MTCO<sub>2</sub>eq GHG reductions annually
- 3-year project term
  - Soil management practices implemented once per year
  - Woody plantings expected to have 10-year life time





# Challenges

- **Program Fund Uncertainty**
  - Funding source varies depending on state budget availability
  - Programs may not receive funds every year
- **Healthy Soils Program - Implementation Challenges**
  - Weather:
    - Projects cancelled due to drought (no crop grown)
    - Cover crop and other planting practices heavily depend on rainfall
  - Sources of materials: compost availability and/or transportation
  - Long-term implementation





CDFA website:  
[www.cdfa.ca.gov](http://www.cdfa.ca.gov)

Our Climate Smart Ag page:  
[www.cdfa.ca.gov/oefi](http://www.cdfa.ca.gov/oefi)



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# LAND HEALTH DASHBOARD

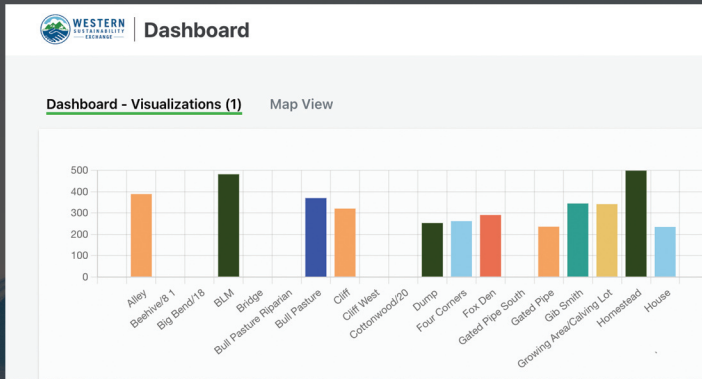
*A simple, map-based tool to capture & visualize grazing data*



*Make confident management decisions on your range*

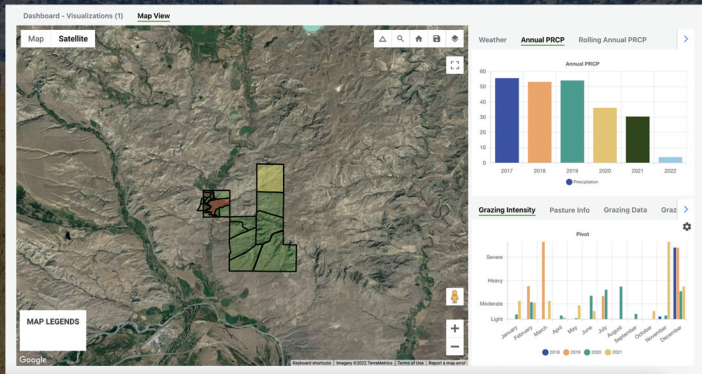


# Focus on key metrics that measure progress on your ranch



## TRACEABLE DATA POINTS:

Monitor grazing (intensity, frequency, season, rest, number of pastures), as well as range, soil, biological, weather/precipitation, carbon, and bare ground data.



- TRACK & VISUALIZE GRAZING ACTIVITIES
- DEVELOP A FOCUSED ADAPTIVE GRAZING PLAN
- MONITOR ECOLOGICAL HEALTH OVER TIME
- EASILY SHARE DATA AND REPORTS

*Improve production on your ranch*

increase rest days per pasture

move more frequently

alternate seasons of use

optimize stock density

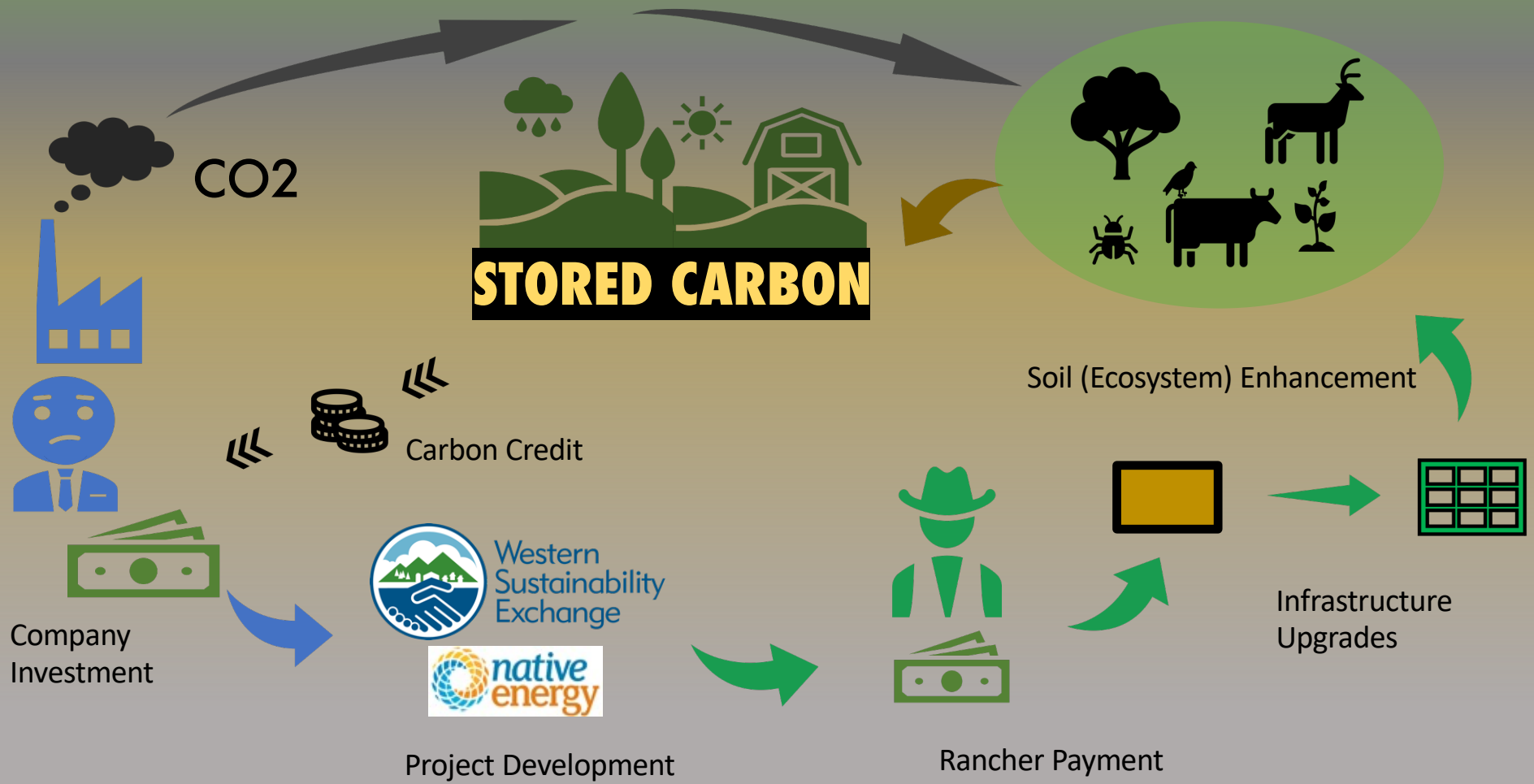
increase herd size



**WESTERN**  
SUSTAINABILITY  
EXCHANGE



# Grasslands Carbon Trading Diagram





# NORTHERN GREAT PLAINS IMPROVED GRAZING CARBON PROJECT OVERVIEW FOR PARTICIPANTS



## PROJECT OVERVIEW

The Northern Great Plains Improved Grazing Carbon Program (IGCP) pays land managers (ranchers) to implement practices that increase the potential for the soil to sequester additional soil organic carbon.

Carbon is the measure of the energy in the system that drives improved ecosystem functions such as increased water holding capacity of soils, increased water infiltration rates, and better soil structure that can help mitigate drought and increase available forage on rangeland. The program supports ranchers, financially and technically, to deploy these practices and bring them access to carbon markets for twenty years.

The practices include more pasture splits to increase stocking density and livestock movement, reduce days grazed on all pastures, and prioritize rest on all land managed. Native measures, reports, and verifies the carbon sequestered in the soil to develop and transact carbon credits in voluntary markets.



### UPFRONT CAPITAL

The project assumes infrastructure is needed to meet the improved grazing goals on your grazed land. The project can bring upfront capital to help cover those costs before carbon sequestration can be measured, bridging a key gap in the development of a carbon project

### CARBON MANAGEMENT GOALS

The practices include more pasture splits to increase stocking density and livestock movement, reduced days grazed on all pastures, and prioritizing rest on all land managed

### RANCH COMMITMENT

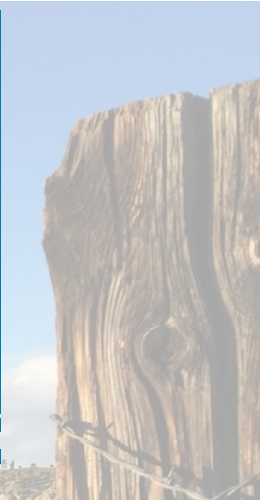
The land operator contracts with Native for 20 years of carbon credits through improved grazing practices on all land managed. Landowners make statement of public intent to manage land for soil health for 30 years. If landowners do not make commitment; discounts are made to total carbon credit volume.

# PROJECT OVERVIEW

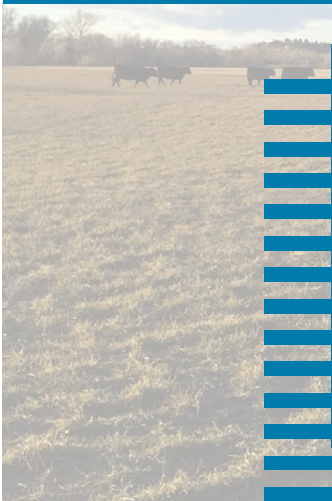


## Overview of the Project Structure

Native takes the risk on the carbon sequestration so that the operation can count on the up-front financial assistance to make changes on the ranch. Once the ranch is able to manage their land above the 'baseline' practices (usually after about 3-5 years of what we call "HelpBuild term"), they then can receive year to year payments for their improved management practices based on how much carbon is sequestered in a given year (we call this the "Outcomes-Based term").



**HelpBuild Investment:** Native has used its Help Build financing structure since we started developing projects for the voluntary carbon market. At its core, HelpBuild acknowledges that there is a disproportionate burden on producers to finance the adoption of new technologies, new management practices, or otherwise facilitate an intervention that results in a climate benefit. Native acknowledges that burden and works with producers and brings capital upfront for the infrastructure or technology improvements needed to achieve project goals. In exchange for the upfront funding, Native secures the rights to a fixed quantity of the Verified Emissions Removals (VERs) (i.e., carbon credits).



**Outcome Based Payments:** If upfront capital isn't needed for infrastructure to support the transition and long-term commitment to improved grazing, Native pays the rancher per VER issued onto the carbon registry as soon as they are verified. In the case of outcomes-based payments, the rancher likely has grant or capital funds to implement the infrastructure or technology needed to achieve the project goals, but implementation faces other barriers, as the important principle of additionality still is relevant for eligibility across all IGCP participants. Native still manages all carbon asset development activities, including measuring baseline carbon stocks, analyzes and reports the data, and verifies the emission removals with a third party in order to have an issued VER to sell in the marketplace.

**Terms of Commitment:** Project contracts with the land operator is 20 years. Project commitment for the landowner is done through making public this intent, such as by filing a statement with the county clerk's land records. If project participants are not willing or able to have their lessor sign these documents, a discount in issued carbon credits is made to account for the increased carbon permanence risk. The project participant commits to a commercially reasonable effort to continue long-term management practices consistent with project objectives for improved soil health.



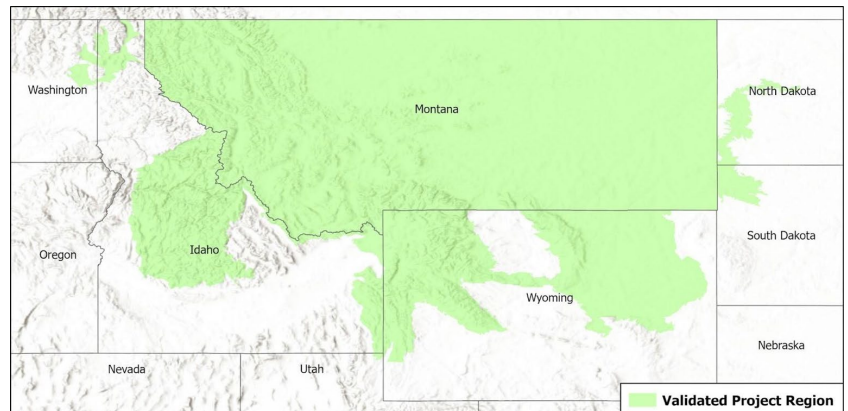
# ELIGIBILITY

Eligibility for the program depends on both the core requirements from the project methodology (Verra VM0026 currently), as well as Native's own criteria. This includes:

**No (or minimal) previous history of regenerative management.** This is critical as our belief is that the most degraded land has the most ability to sequester carbon over the next 30-50 years as the baseline carbon stock is low. After a little system jumpstart (and hopefully some rain), regeneration across the landscape can begin to happen in just a few years. Even if the ranch has been working on rotations and more intensive management for years, it is likely still eligible and quite possible there may still be a lot of carbon sequestration potential in the soil.

## Validated Project Region.

The project is undergoing validation for the state of Montana and some MLRAs that extend into neighboring states based on where the soil carbon model has been tested. We intend to begin a new program of activities in 2022 with an expanded geographic zone, but ranches will be prioritized based on those that fall within the geographic region illustrated to the right:



**Commitment to the land and ranch operations.** Native is hoping to sign a 20-year contract with participating ranches and guarantee to pay a minimum fee per mtCO<sub>2</sub>e ranchers store in the soil. Native is looking to build long term partnerships.

**Greater than 2,500 acres under livestock management.** At some point, Native hopes to minimize the ranch data management and carbon verification needs to where it's efficient to include ranches at small marginal costs. However, at this time, we need to include larger ranches to increase the pool of carbon credits available to sell and cover fixed project costs.

**Willingness to work and grow in uncertainty.** The science behind soil carbon sequestration, the dynamic nature of soil, best land management practices, and carbon markets are a lot of moving variables that mix together to create the challenge and opportunity we have right now. Native hopes to find willing partners to enjoy the ride with us.