

Is there potential for California alfalfa production to be climate neutral?



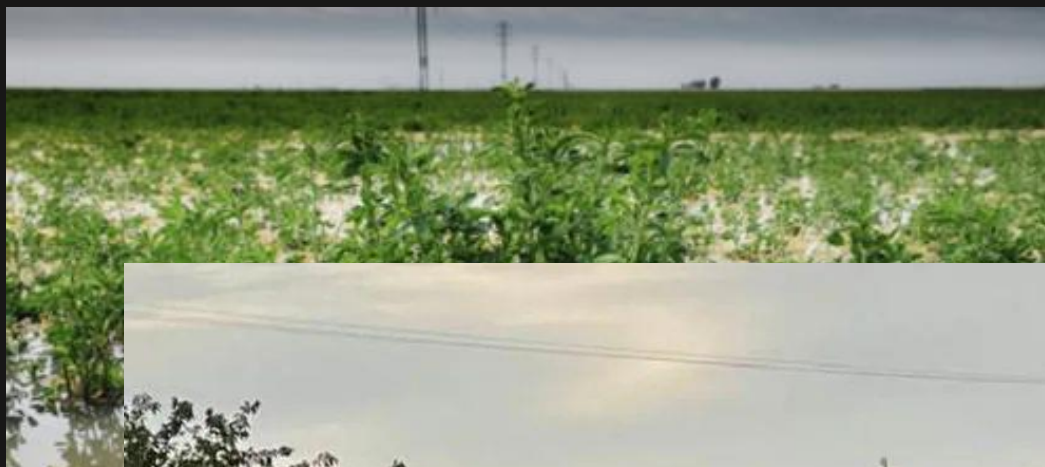
Gina Nichols¹, Dan Putnam¹, Cameron Pittelkow¹

¹University of California, Davis





<https://www.beeculture.com/catch-the-buzz-dairy-alfalfa-doesnt-get-to-bloom-but-beef-alfalfa-does-where-to-put-your-bees-is-simple/>



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<https://westernagnetwork.com/premium-alfalfa-hay-delivered-by-amazon-prime>



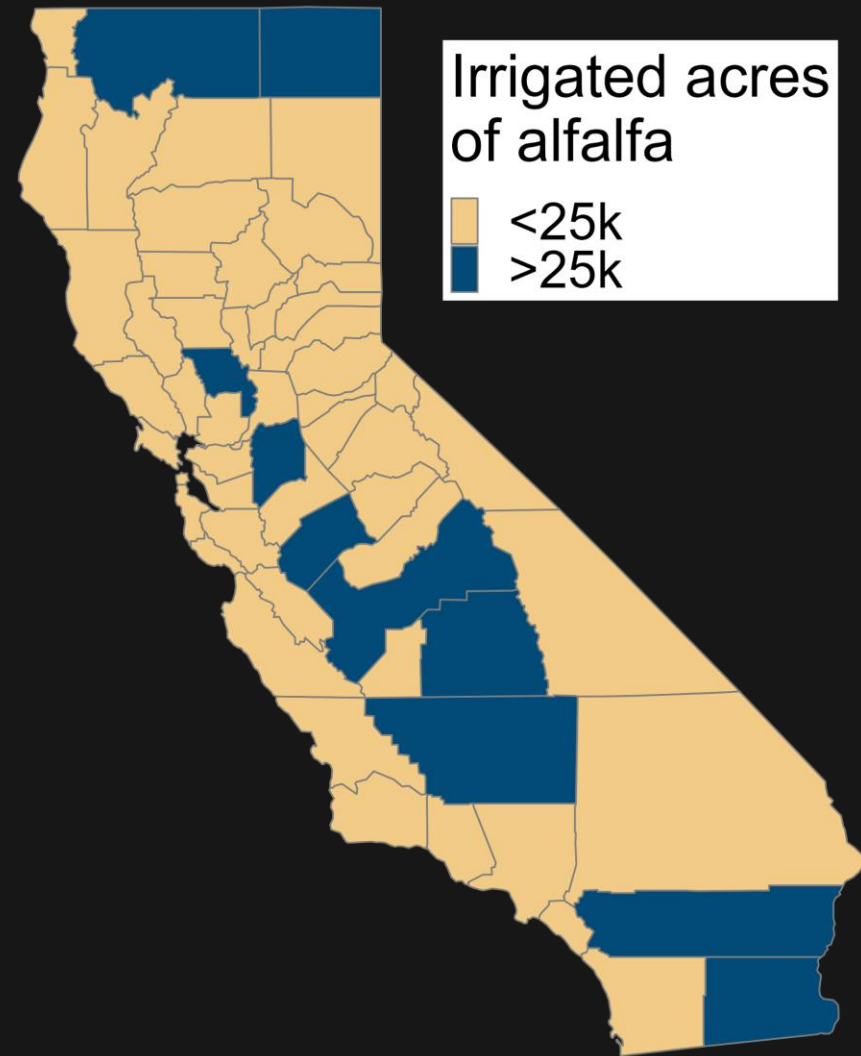


Narrow lens:
Not a great crop for California.

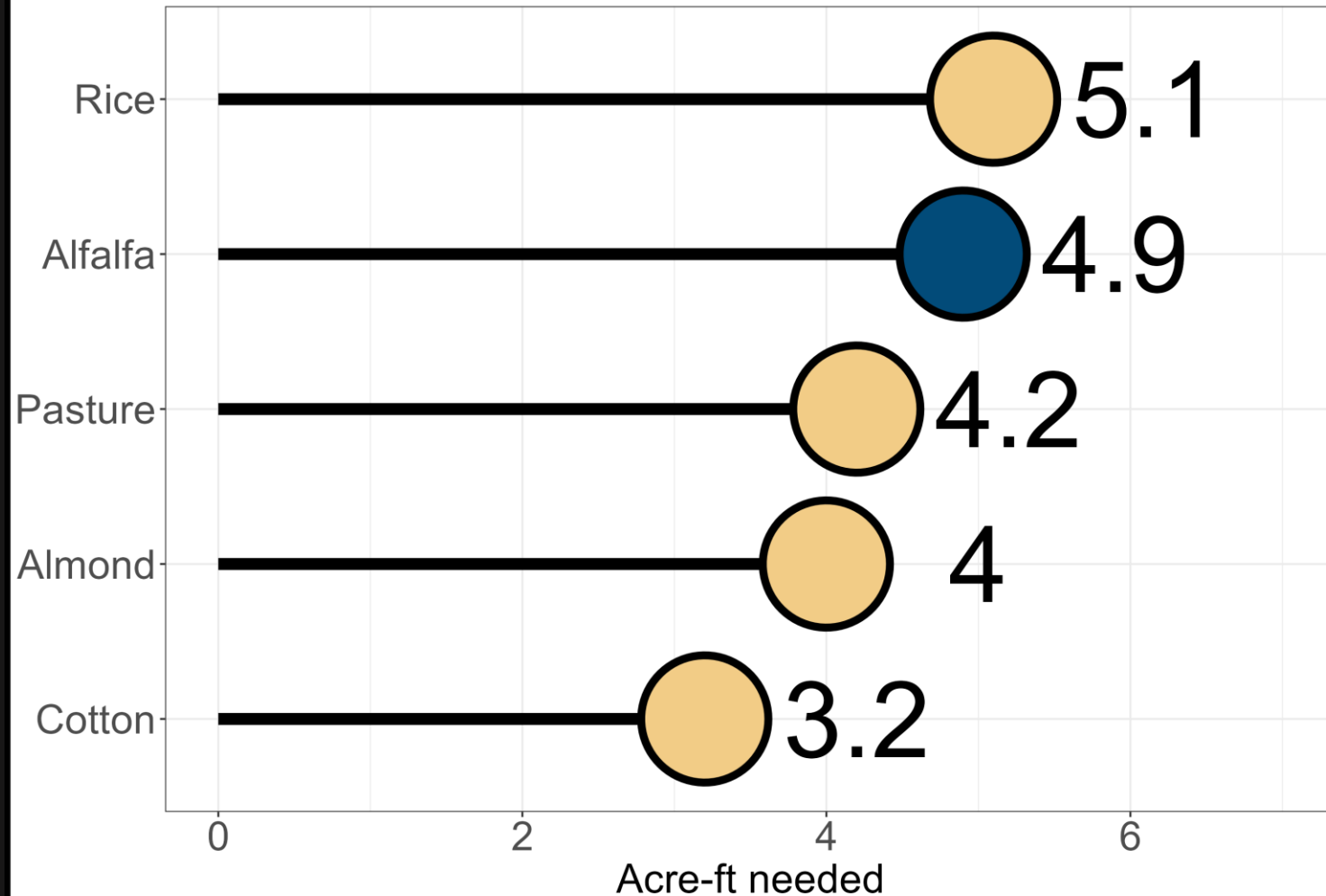


Narrow lens:
Not a great crop for California.

Broader lens:
Is that true?



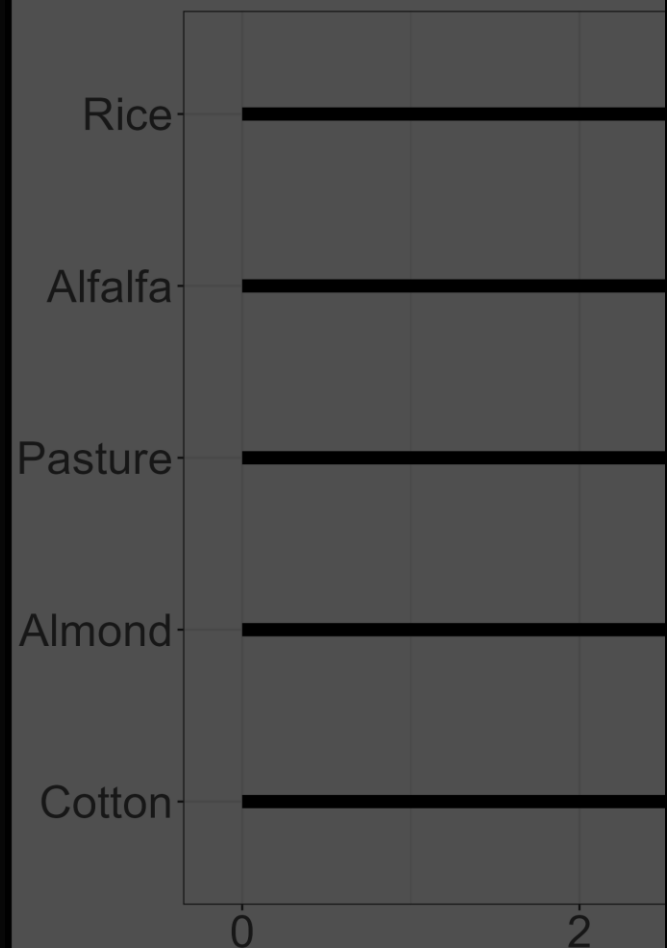
Alfalfa has the 2nd highest water requirements per acre



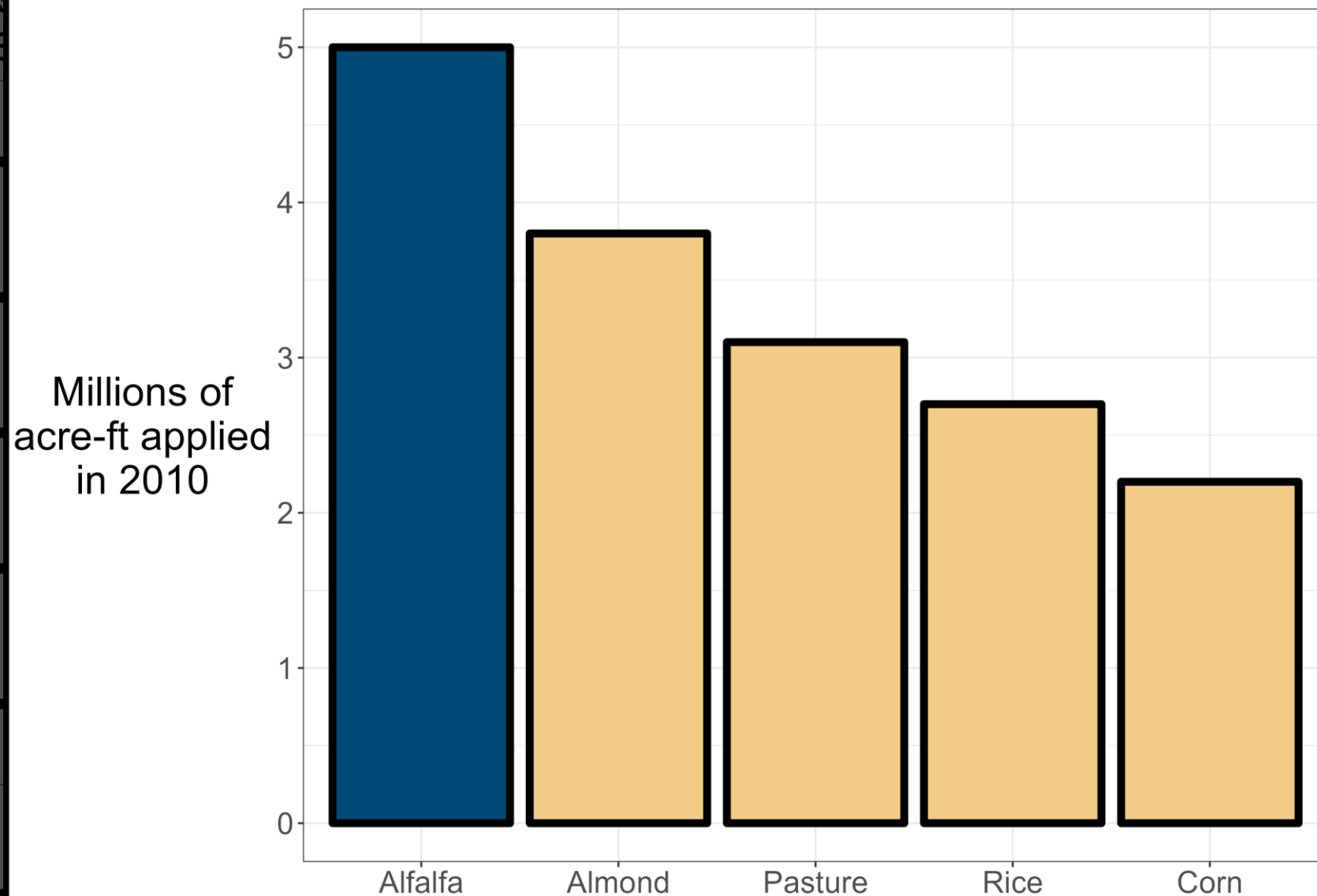
Data from Department of Water Resources, 2010

Data from NASS 2017

Alfalfa has the 2nd highest water requirements per acre



Alfalfa has the highest water application of all California crops







One of the only wetland bird feeding areas left in California (*Bray & Klebenow 1988*)

Provides 'free' nitrogen to subsequent crop (*Putnam & Pettygrove 2015*)

Provides productive years without soil disturbance

Flexible water user (*Montazar et al. 2020*)





Close proximity to dairies lowers transportation requirements

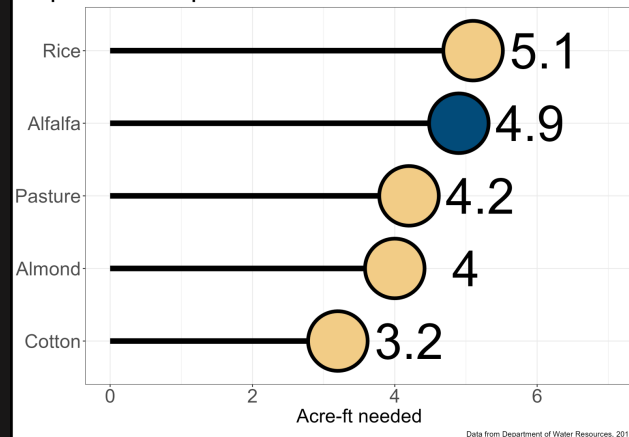
Lower yield variability compared to rainfed regions

Yields are consistently twice the US average



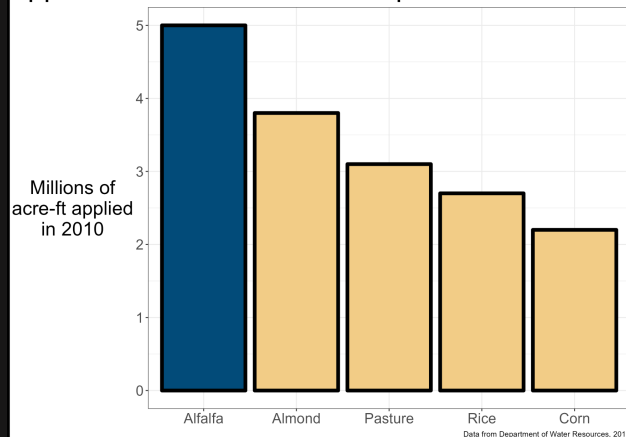


Alfalfa has the 2nd highest water requirements per acre



+

Alfalfa has the highest water application of all California crops



+

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Use Life Cycle Assessment methodologies to estimate climate impacts of California alfalfa production



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Functional unit:

System boundaries:

Impact factors:

Flows:

Functional unit:

1 hectare-year of land (carbon emissions)

1 Mg of dry yield (carbon efficiency)

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System boundaries:

Cradle to roadside (~80% of alfalfa is sold)

Impact factors:

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1 hectare-year of land (carbon emissions)

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System boundaries:

Cradle to roadside (~80% of alfalfa is sold)

Impact factors:

Piece together from publicly available sources

Flows:

← → ↻ coststudies.ucdavis.edu/en/current/commodity/alfalfa/

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Functional unit:

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1 Mg of dry yield (carbon efficiency)

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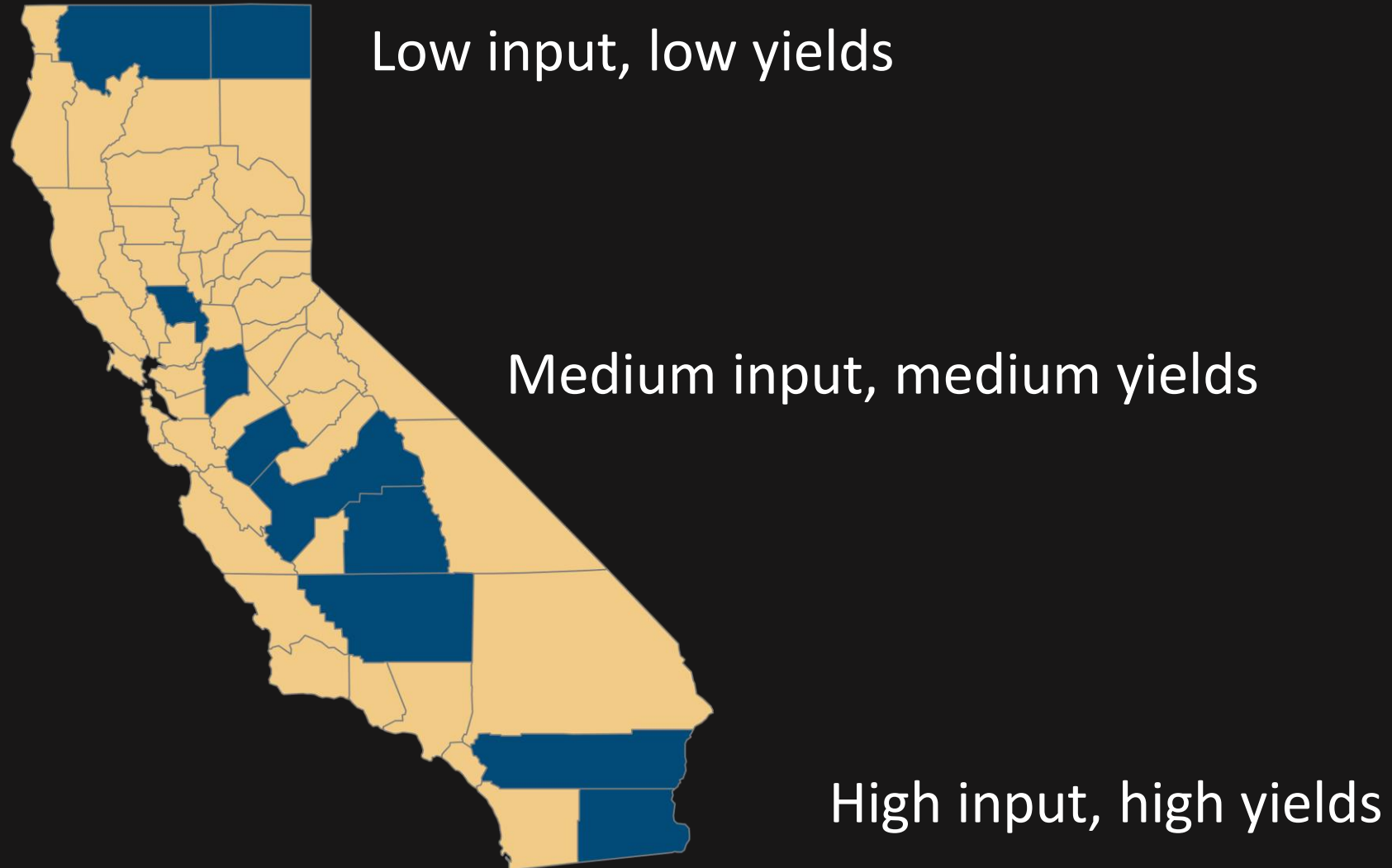
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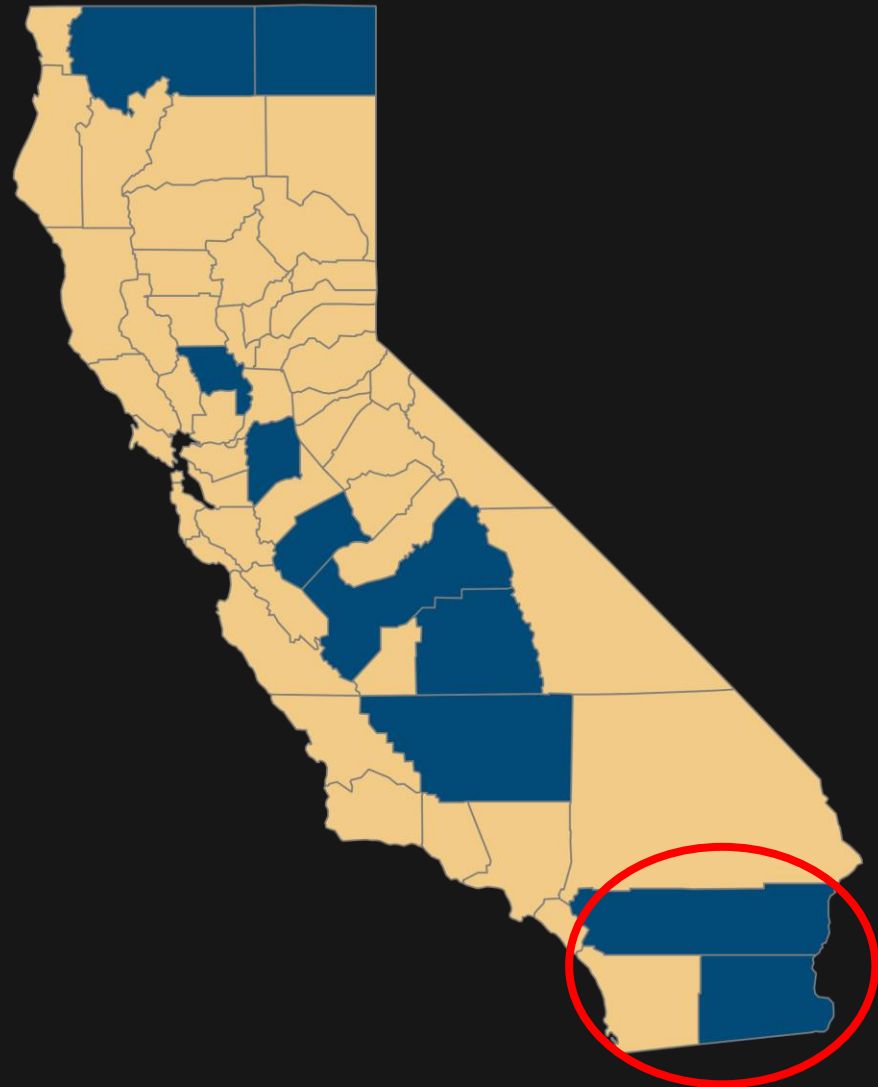
Impact factors:

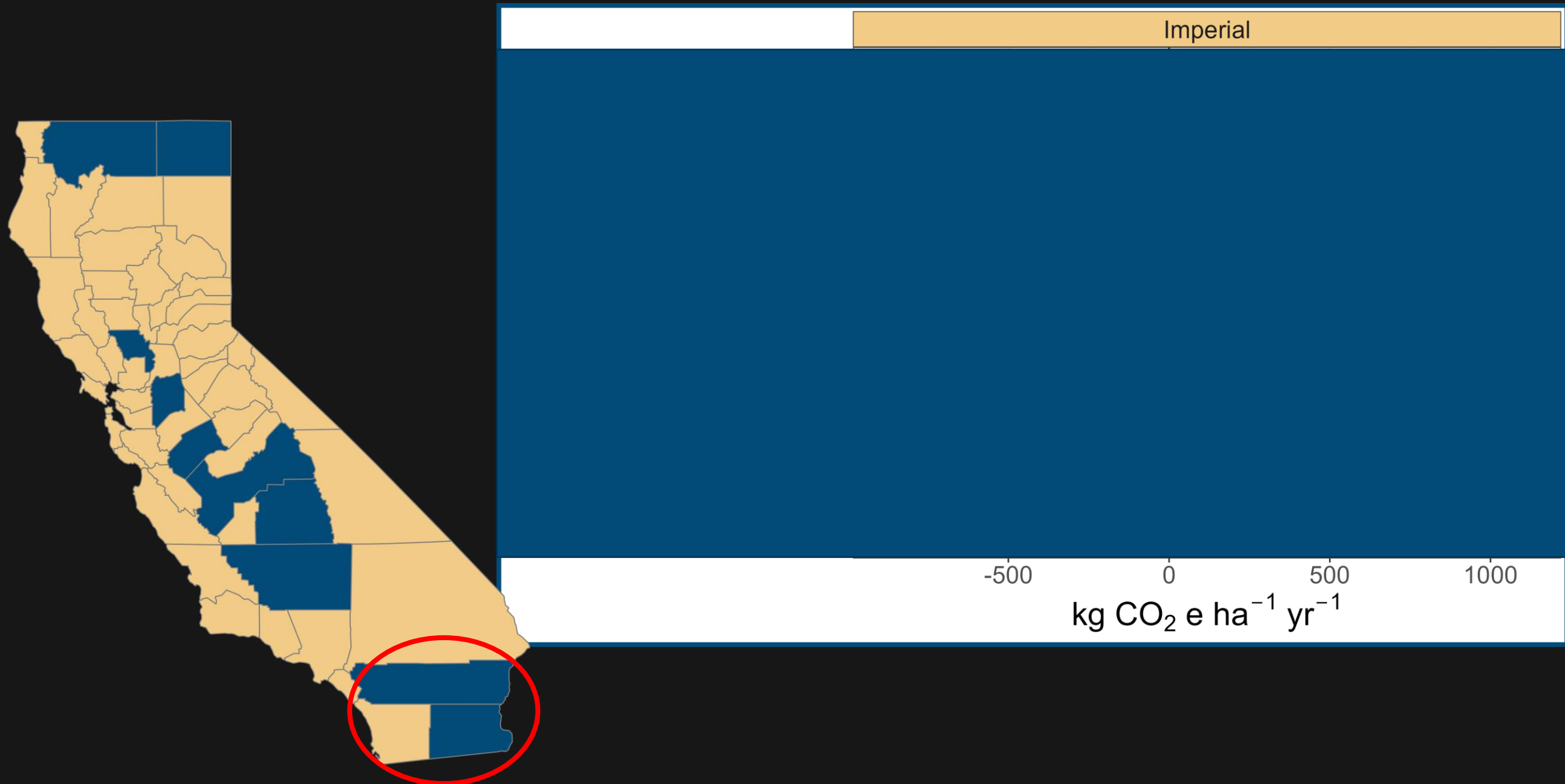
Piece together from publicly available sources

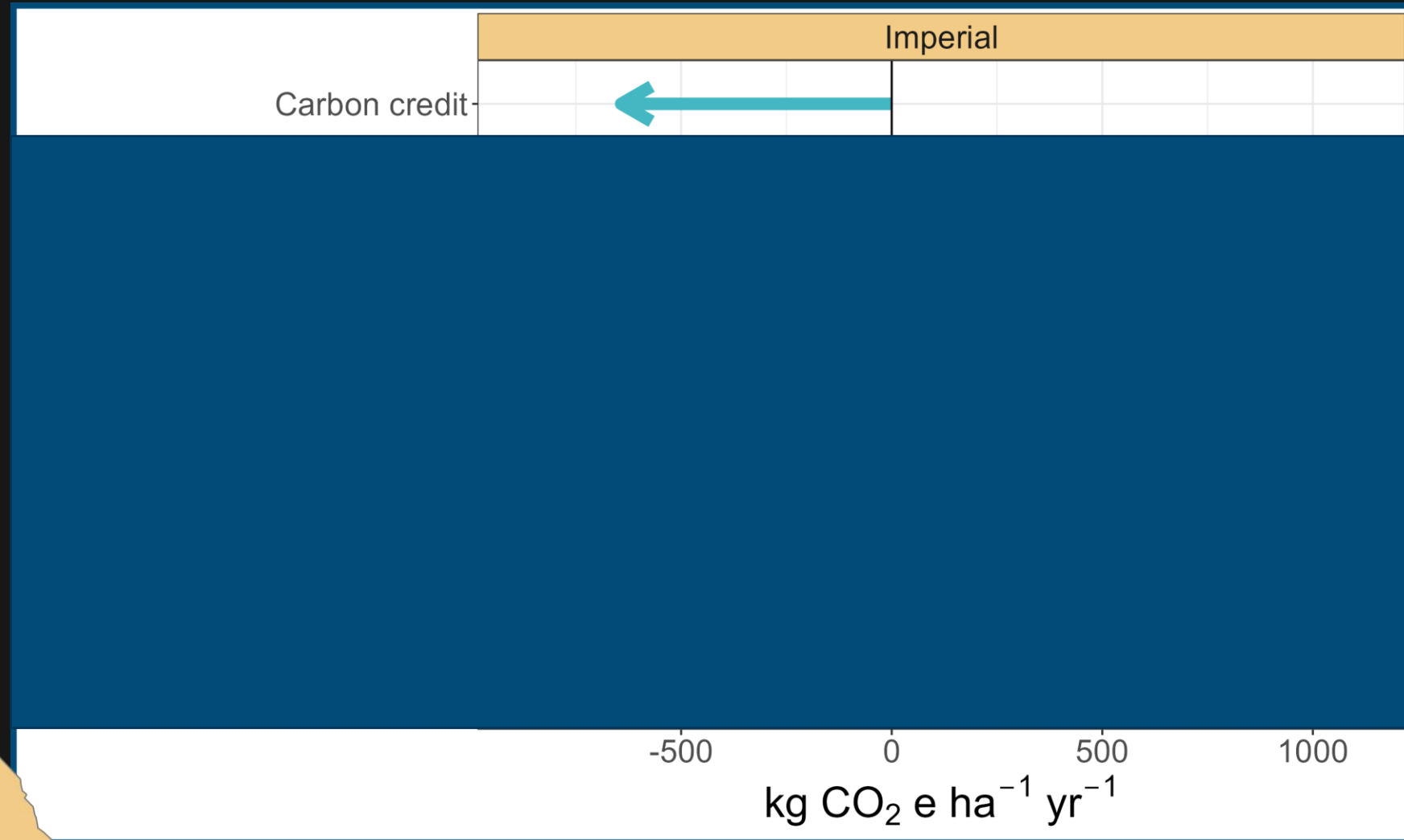
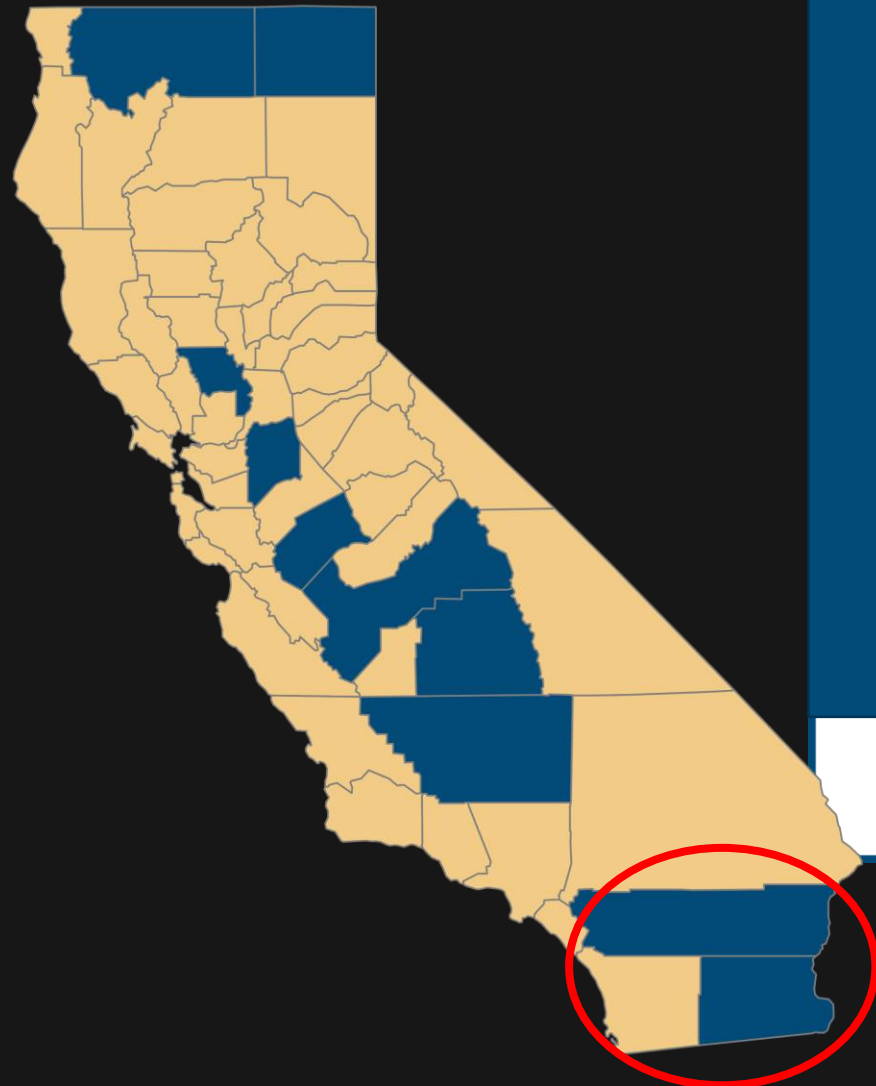
Flows:

Enterprise budgets, California Healthy Soils tool





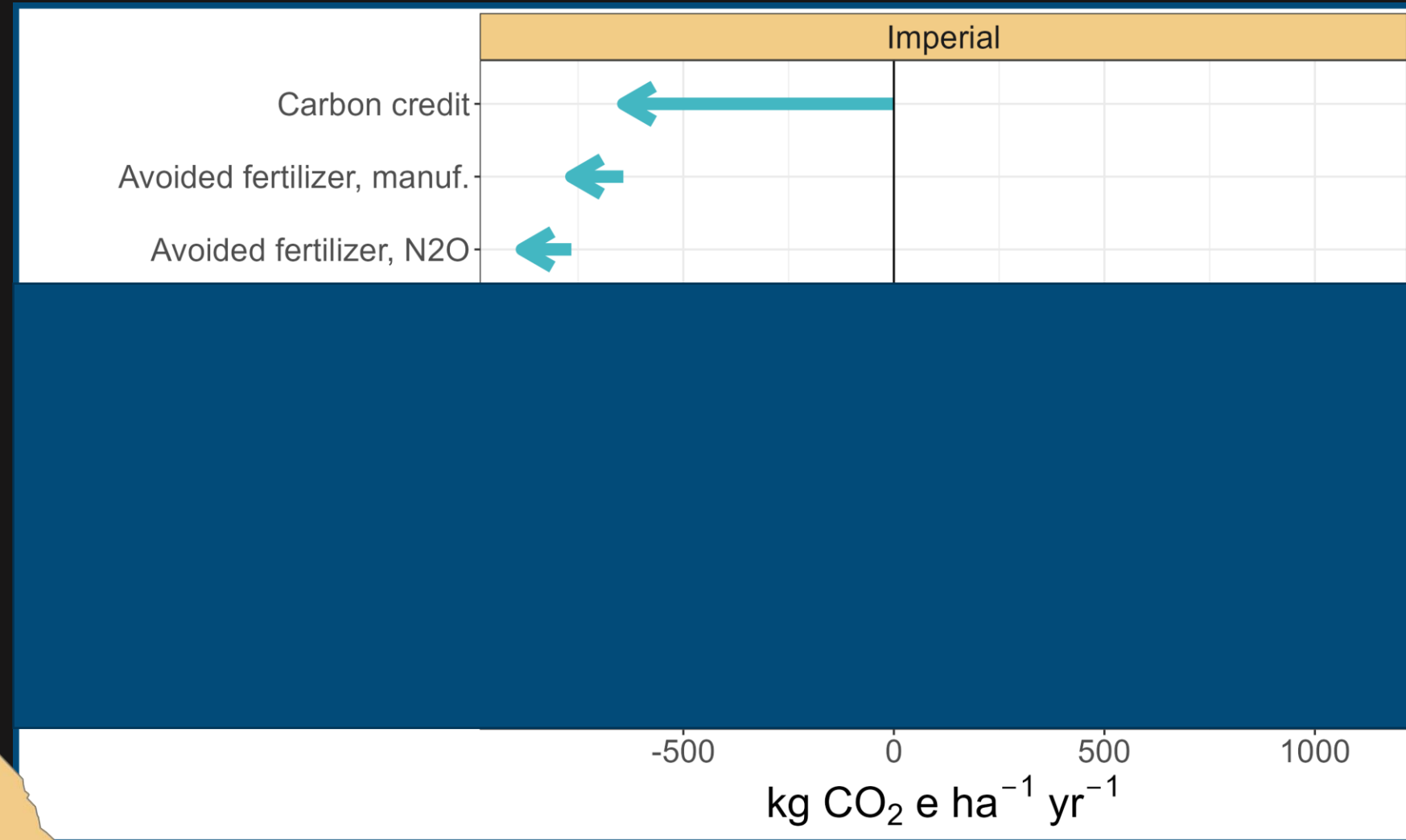
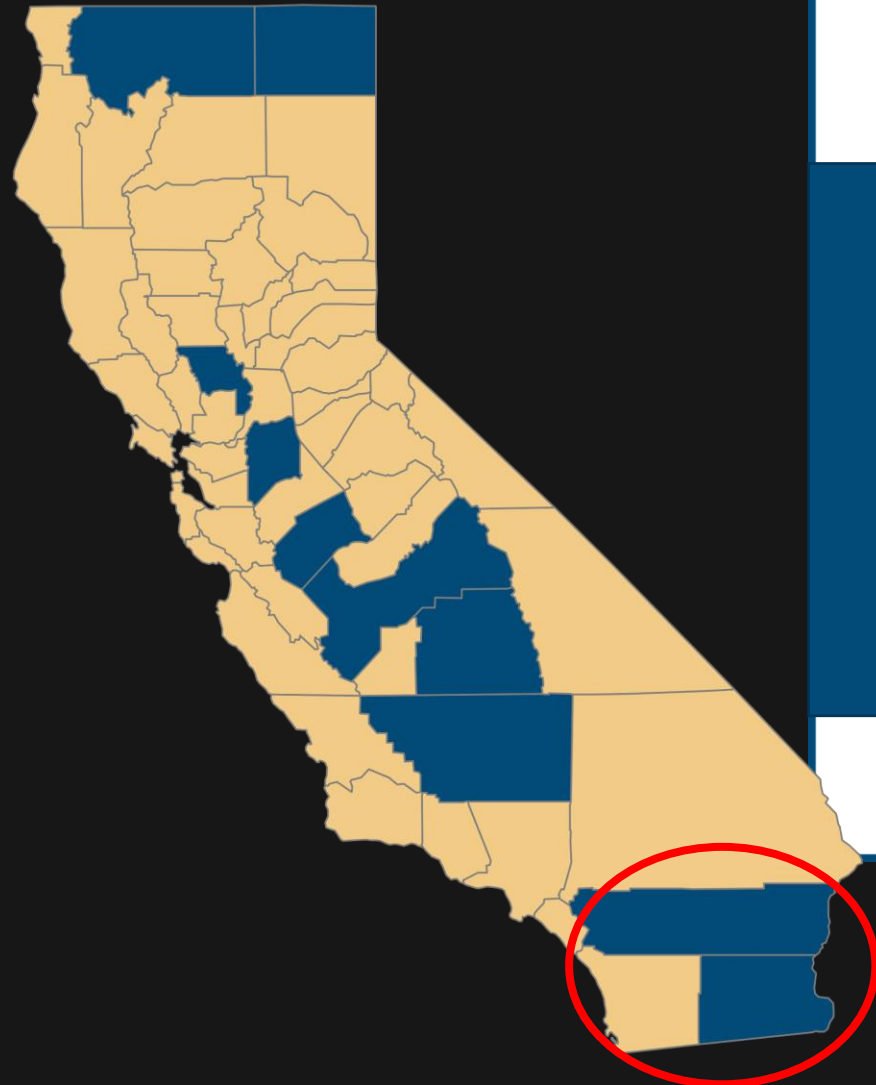


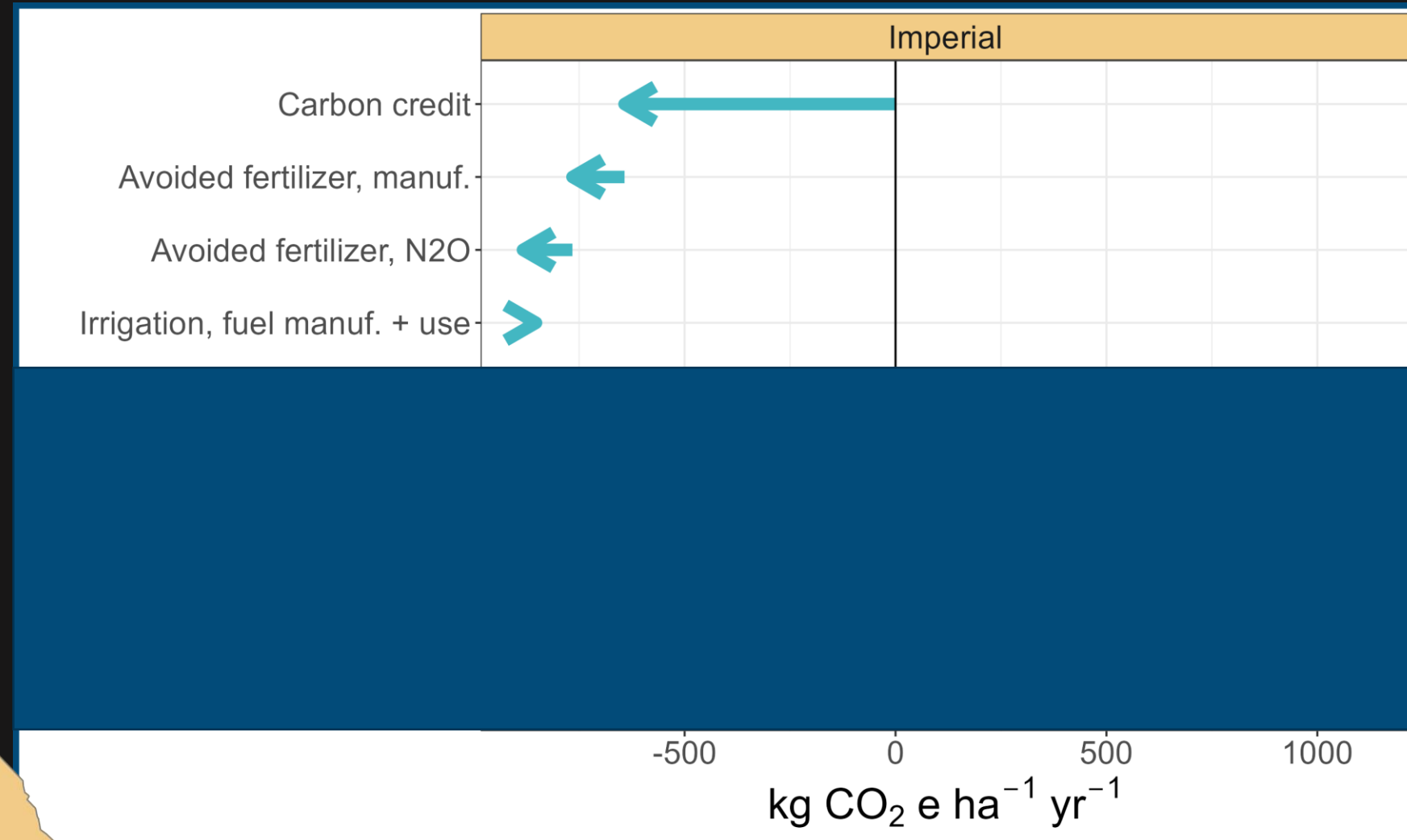
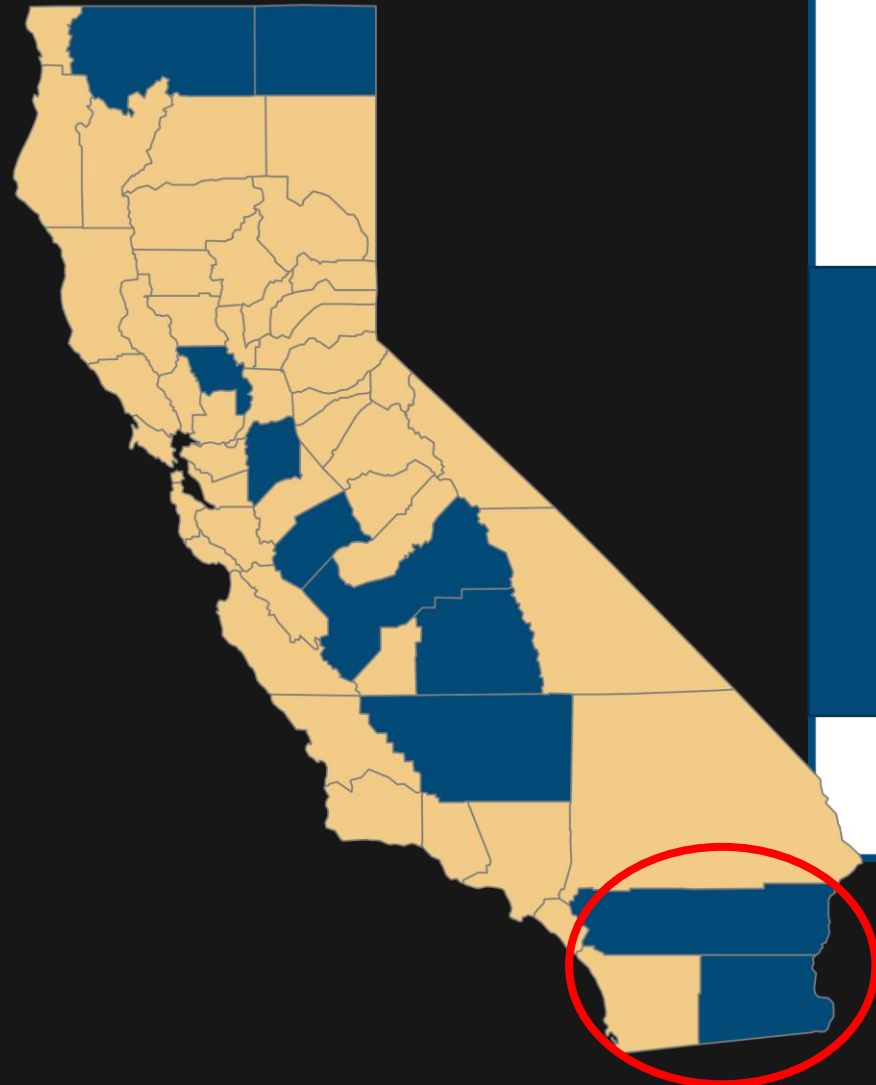


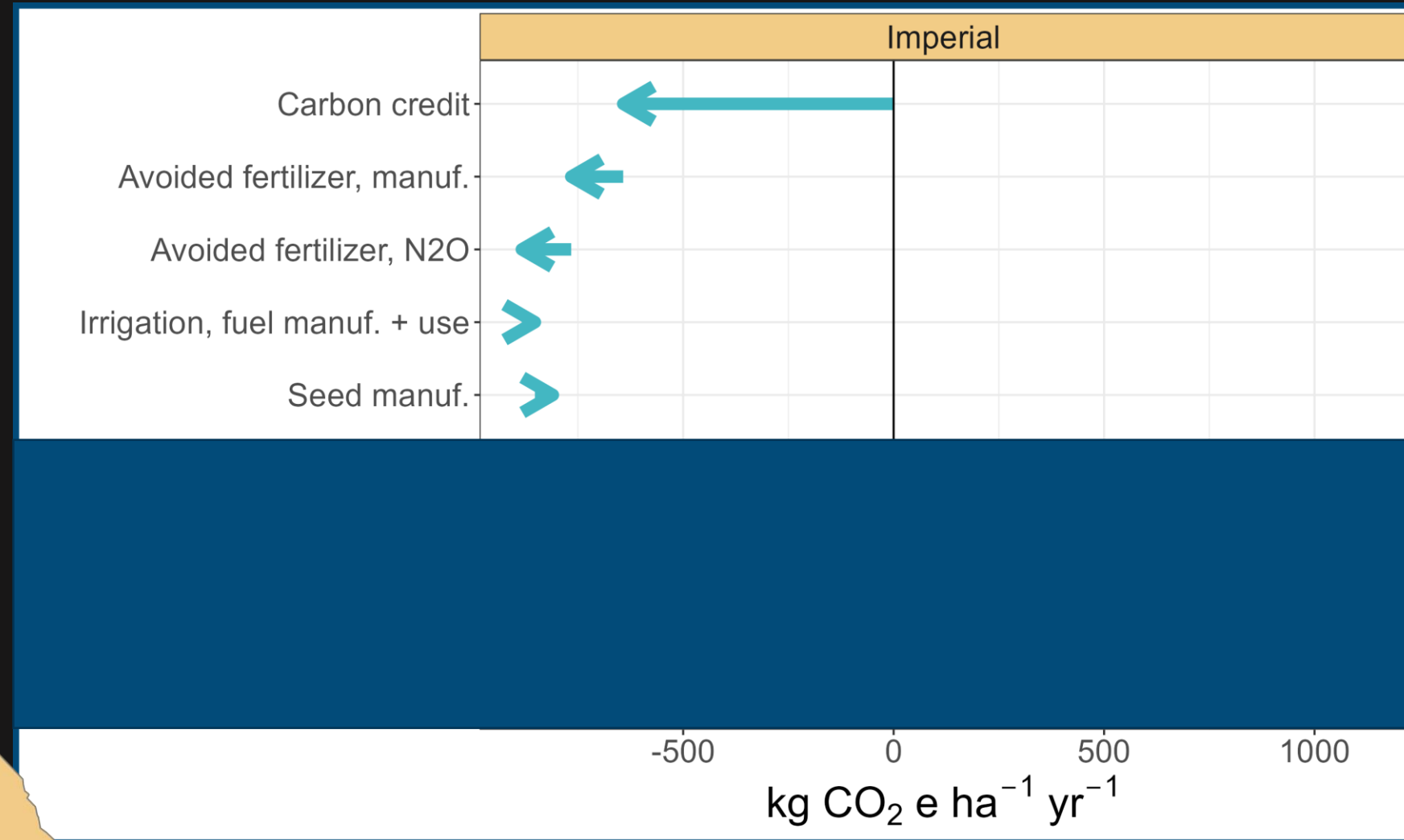
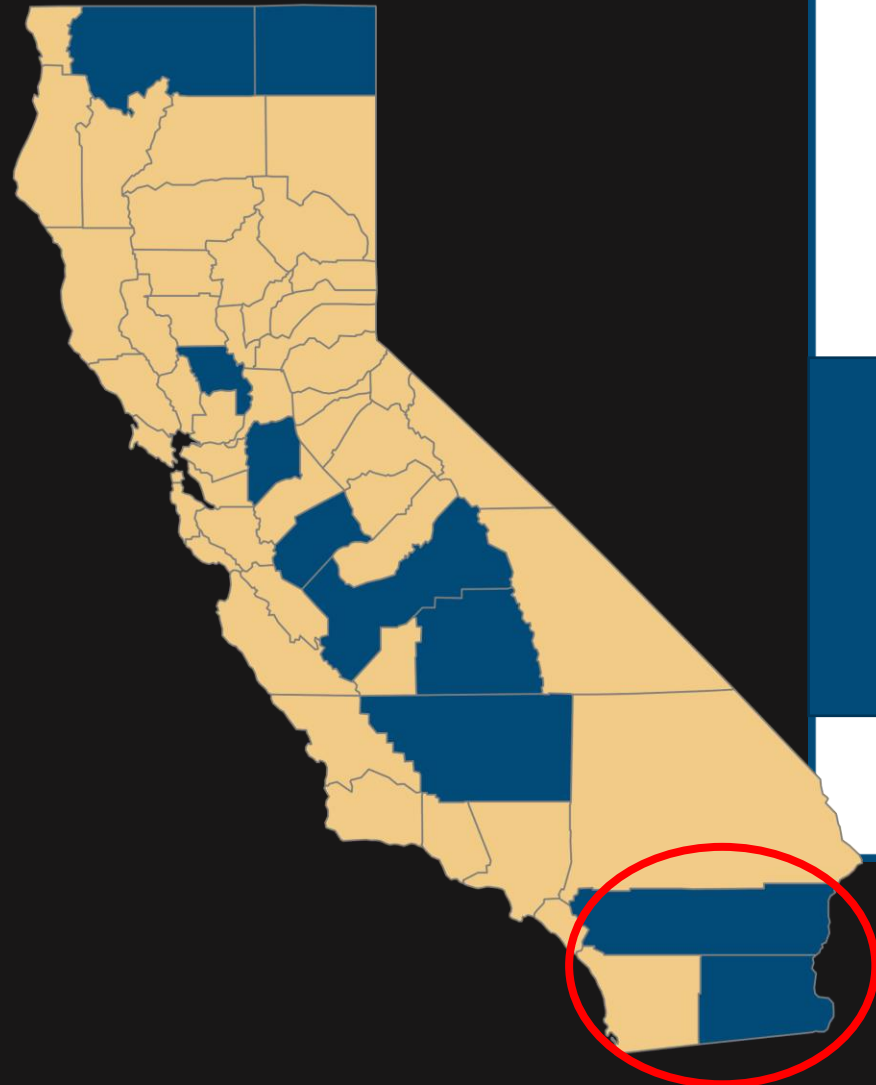
The Alfalfa N Credit

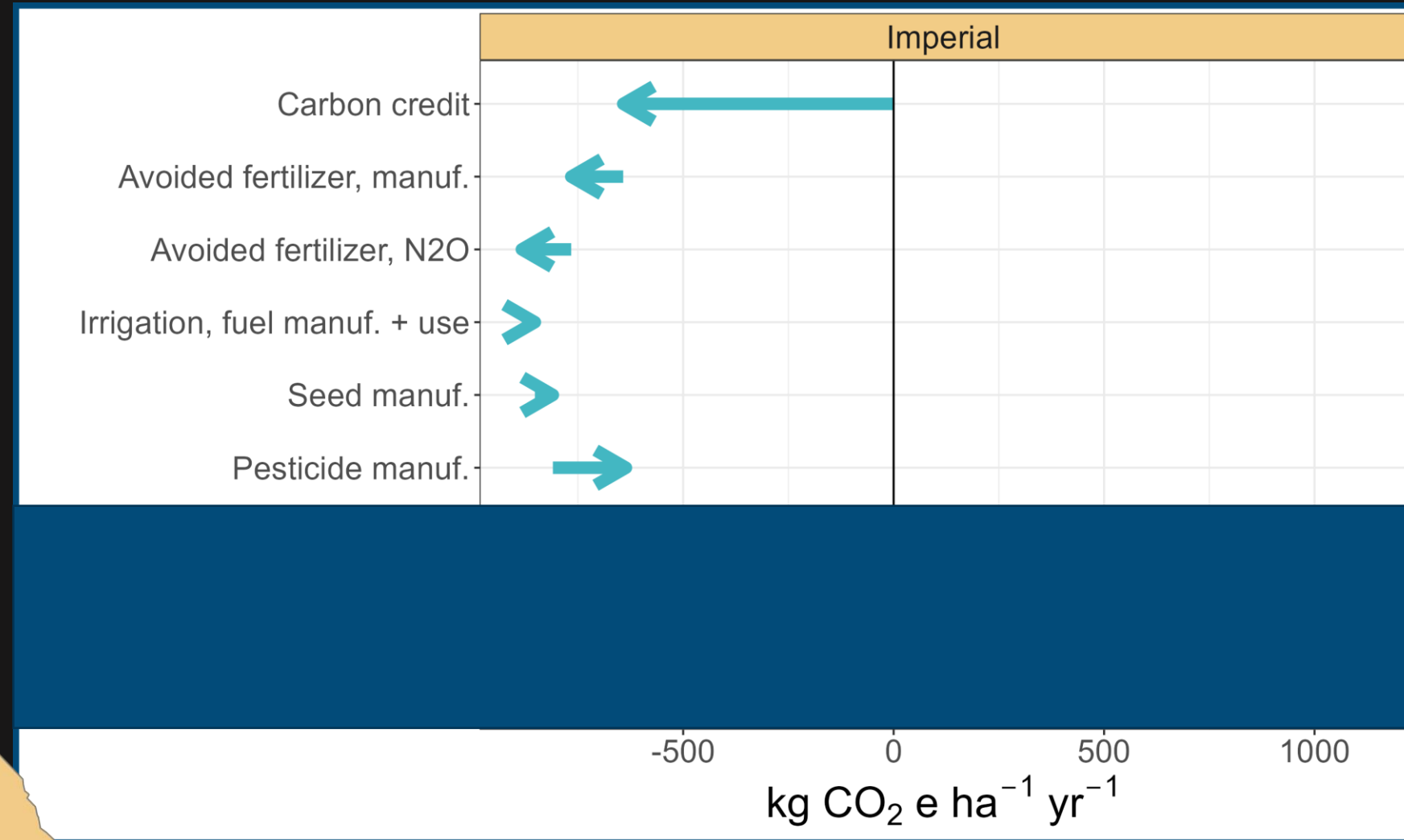
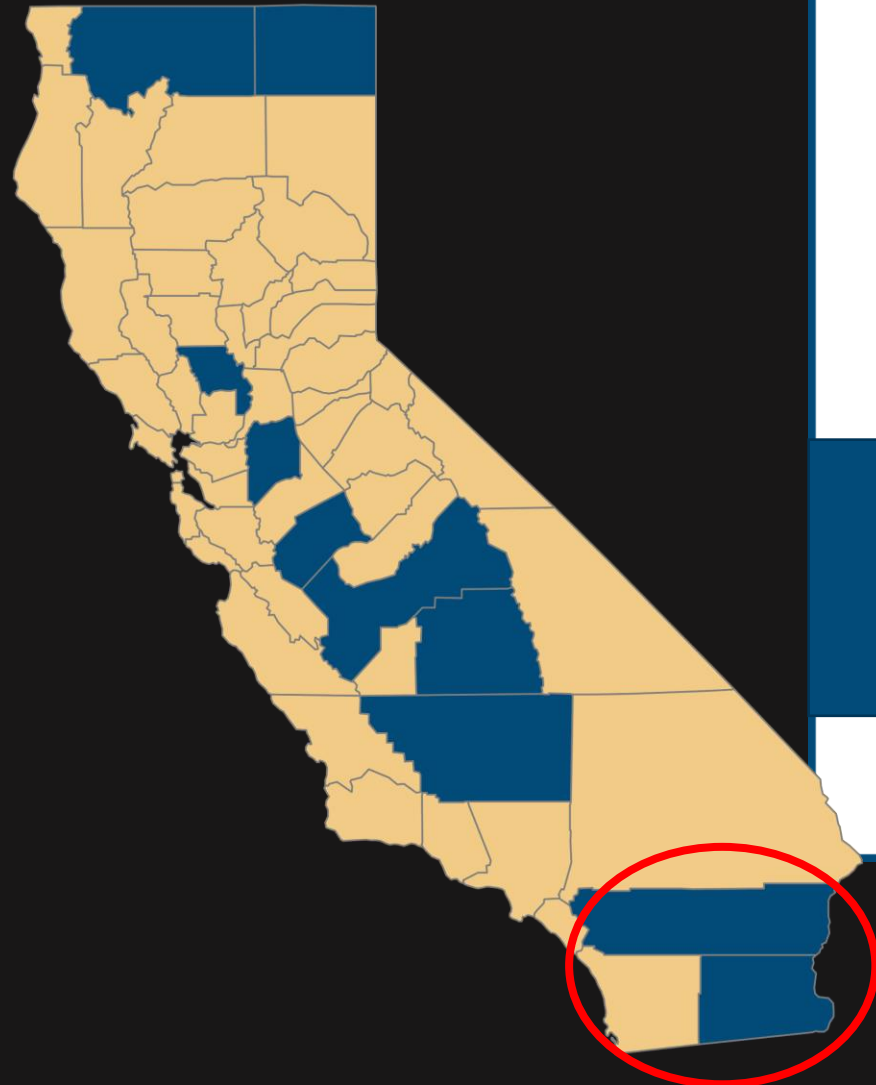
The amount of N that is supplied by the previous alfalfa crop is called a N credit. According to various university studies, farmers planting corn after alfalfa can take N credits from 40 to 190 lb/acre, depending on such factors as the quality of the previous alfalfa stand, soil types, and other growing conditions.¹⁻⁷ As a recommendation, Midwestern universities suggest that applied N fertilizer for corn following a good alfalfa stand can be reduced by up to 100% for first-year corn and by up to 50% or more for second-year corn.²

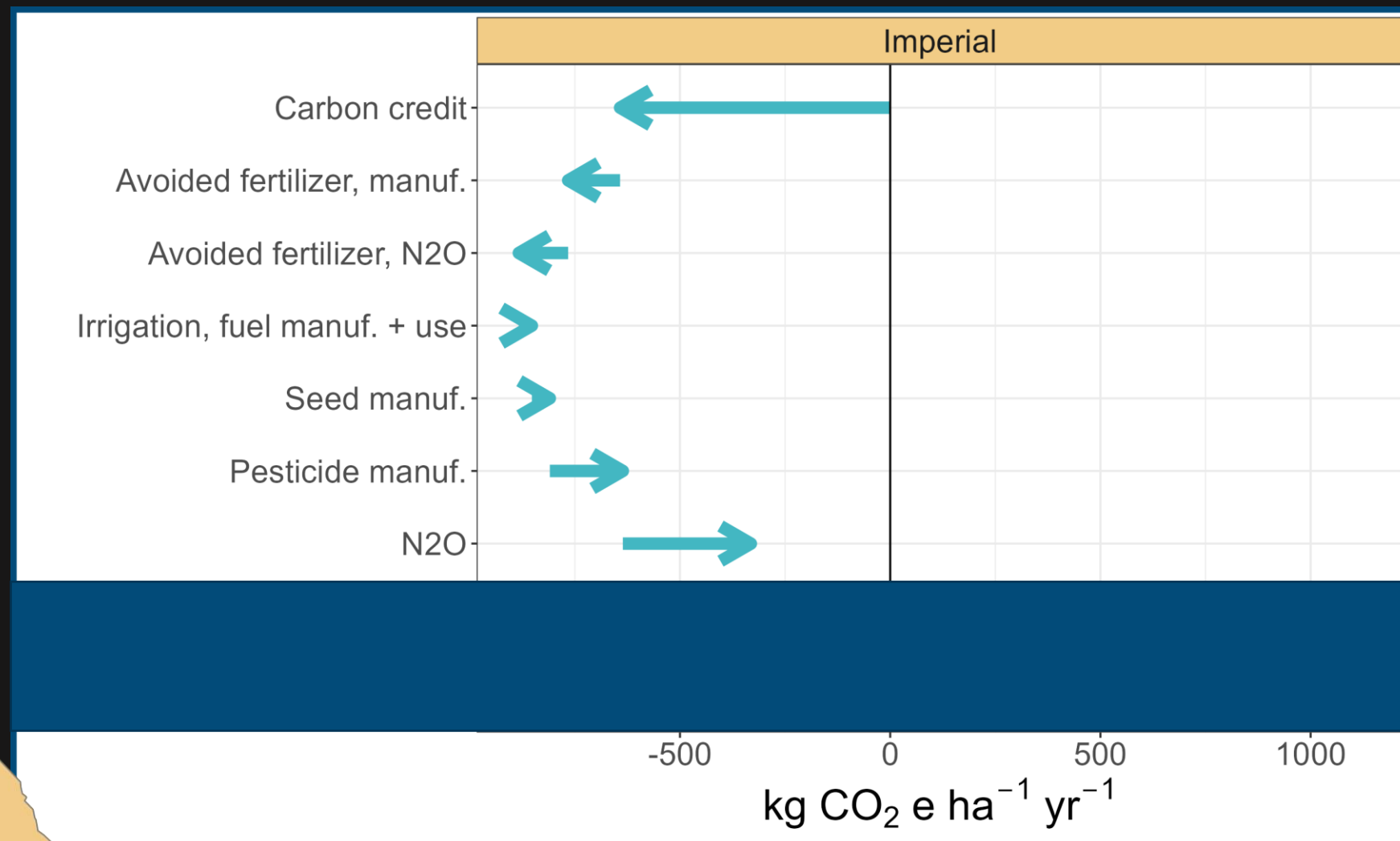
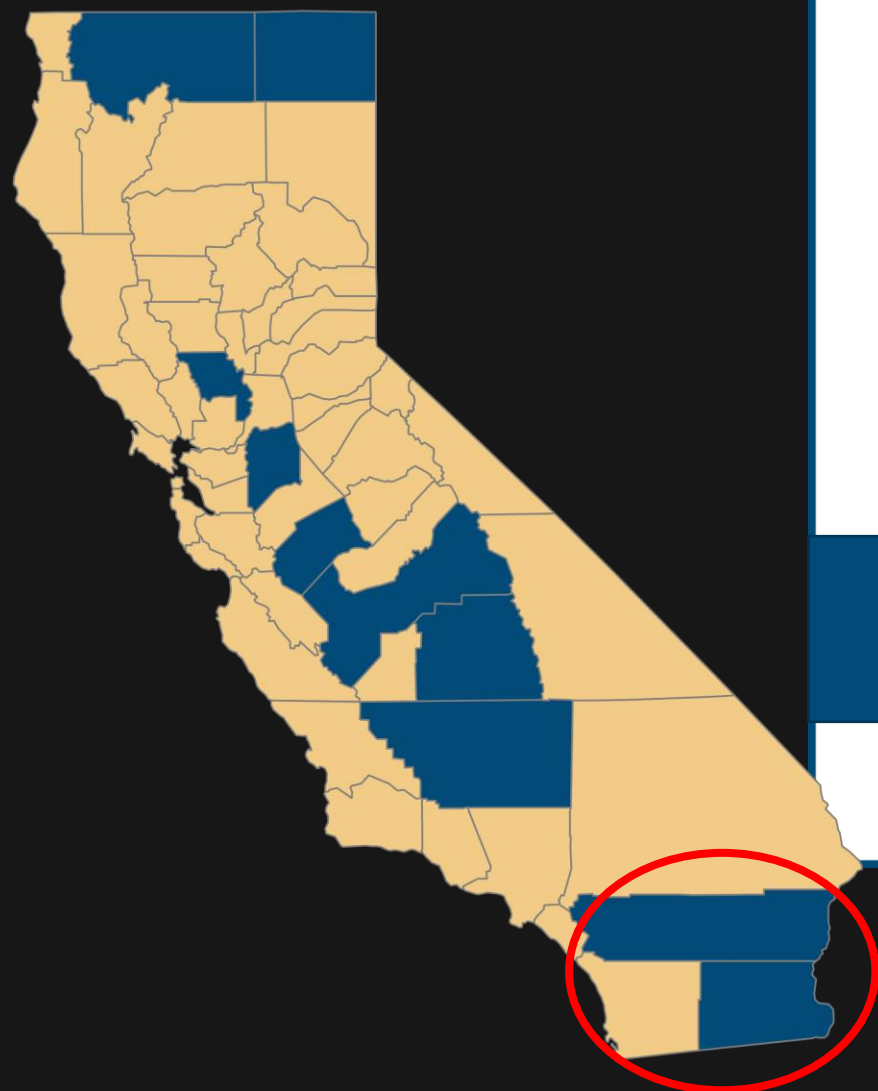
Fully account for cropping system impacts *(Costa et al. 2020 Int J LCA)*

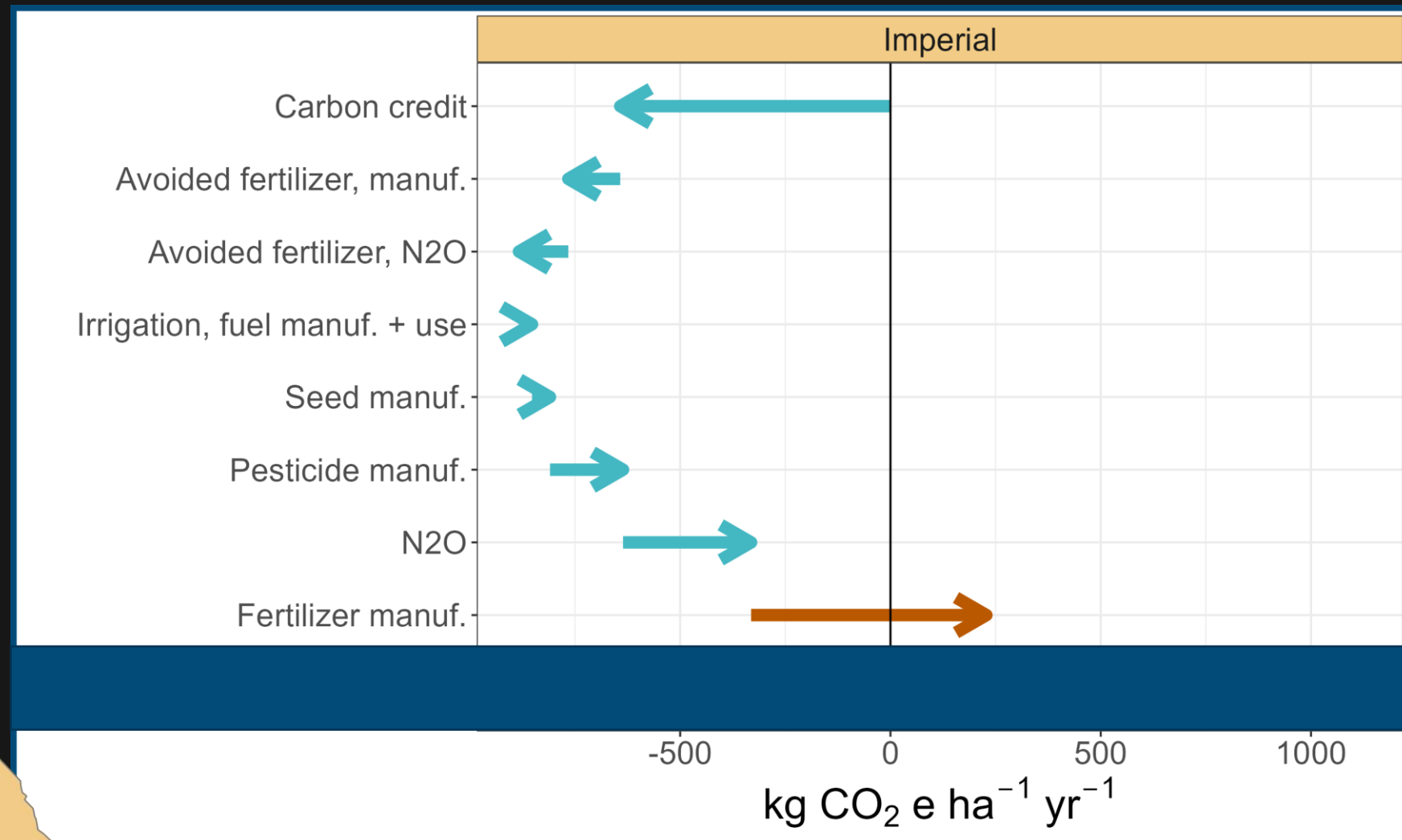
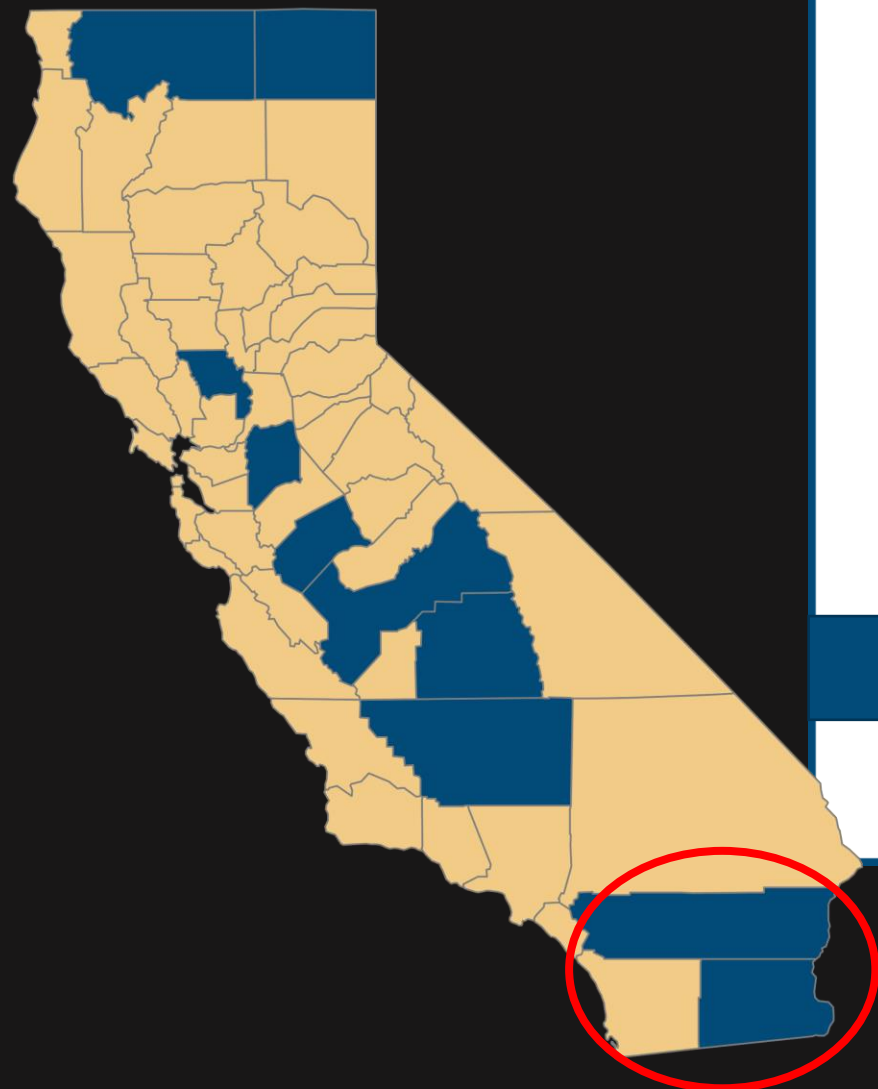


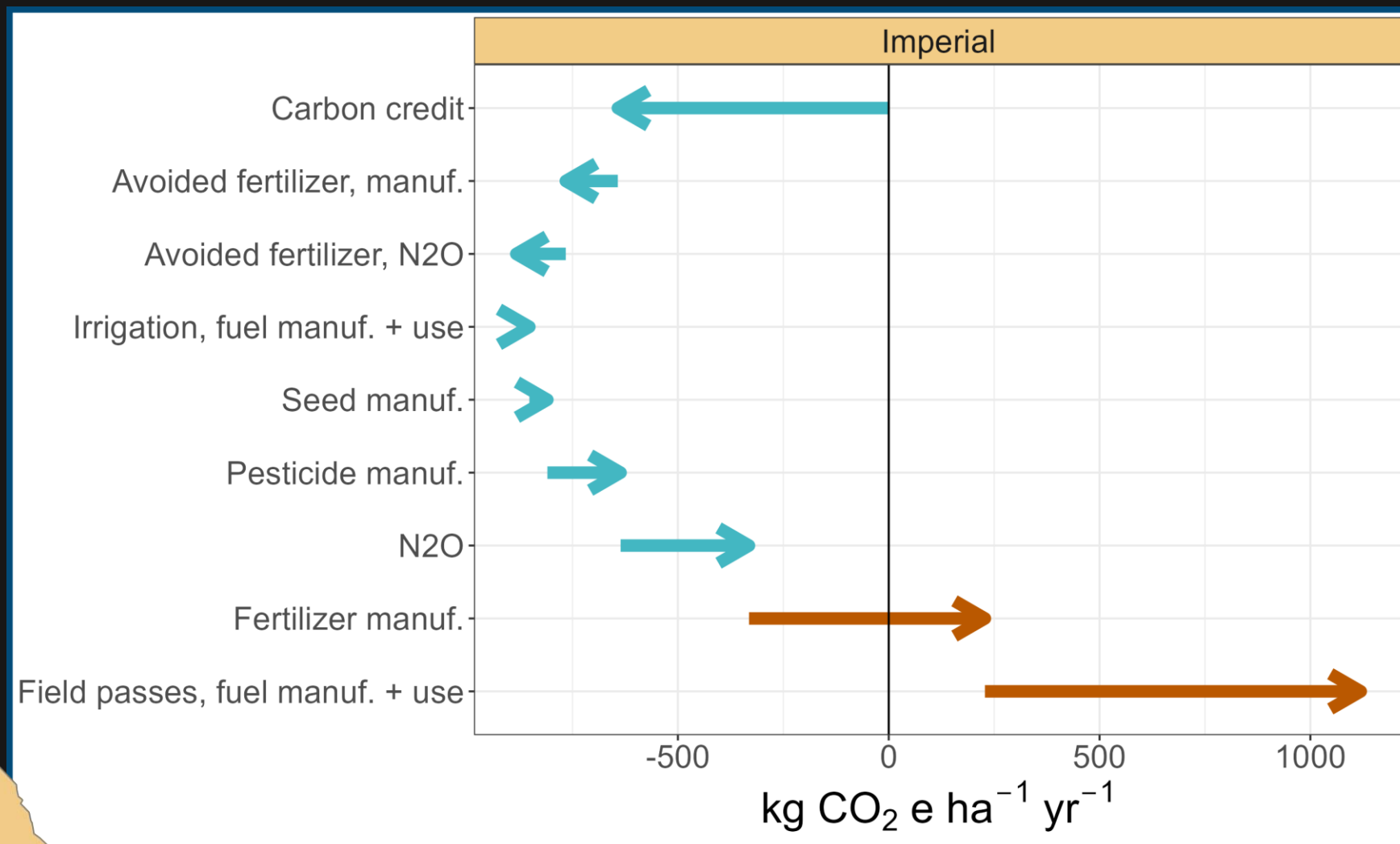
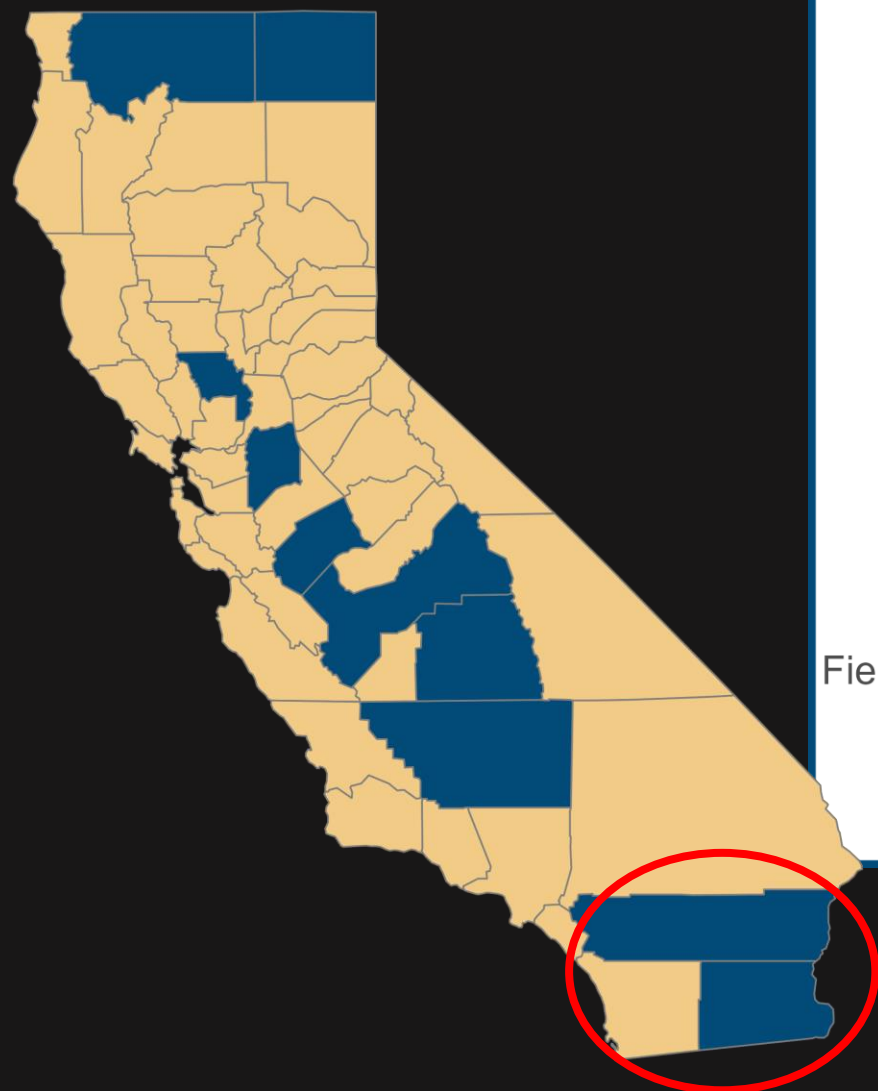


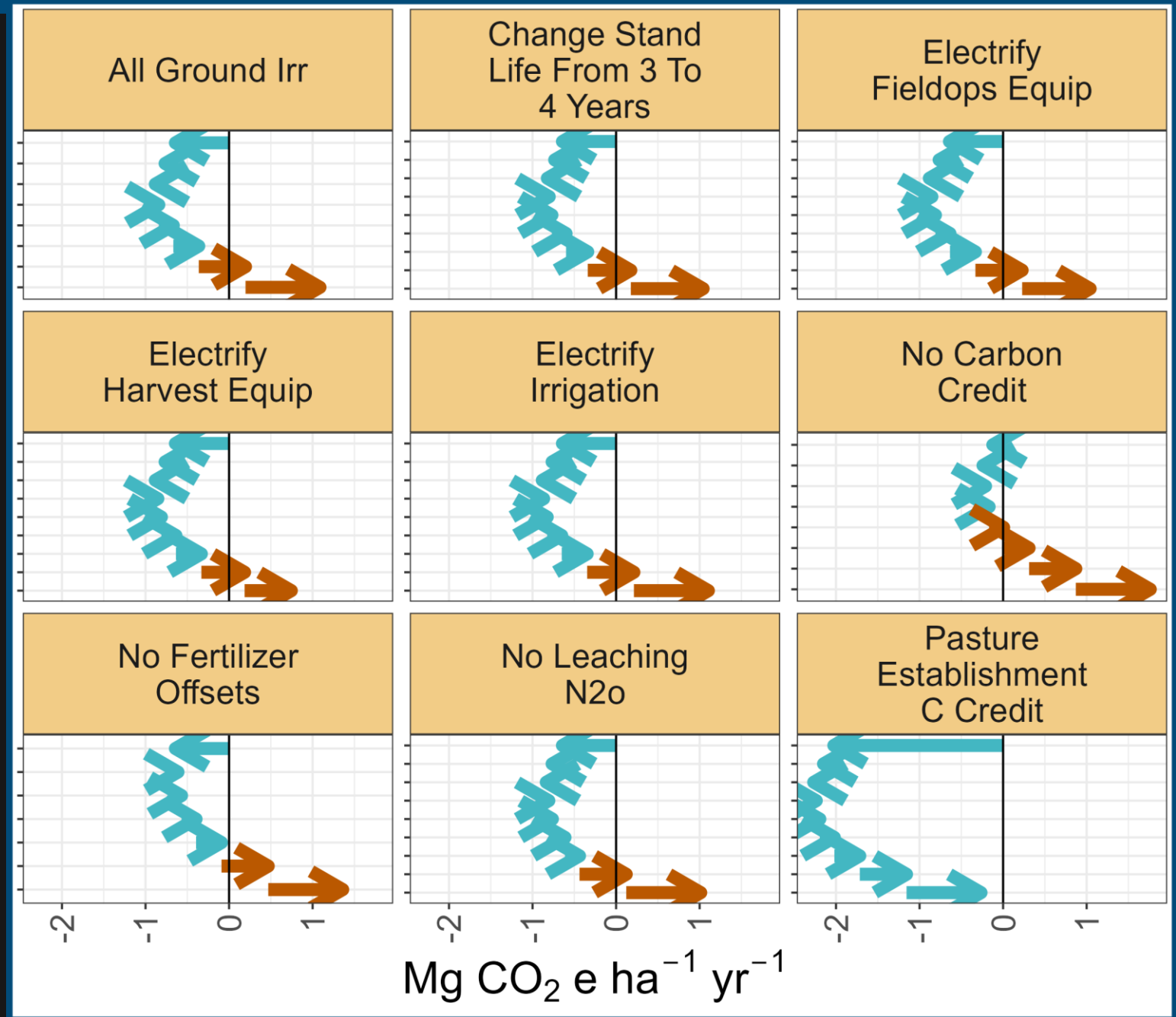
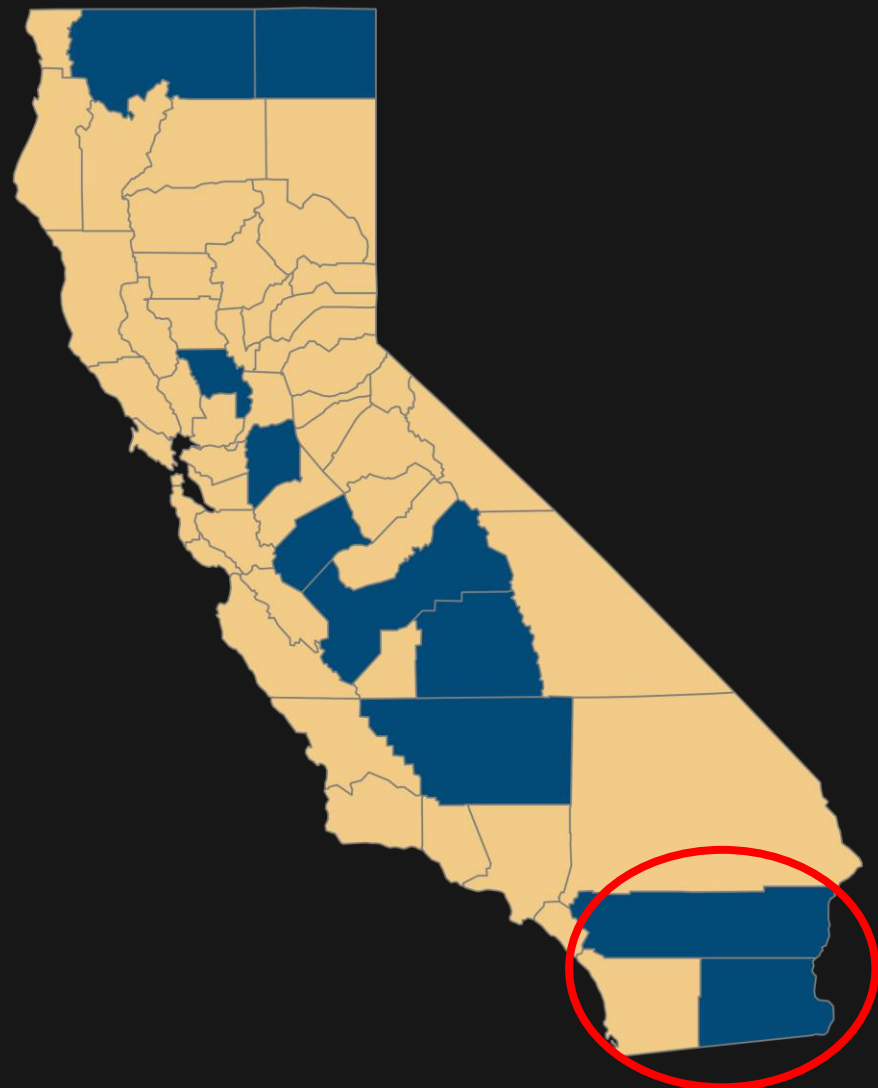


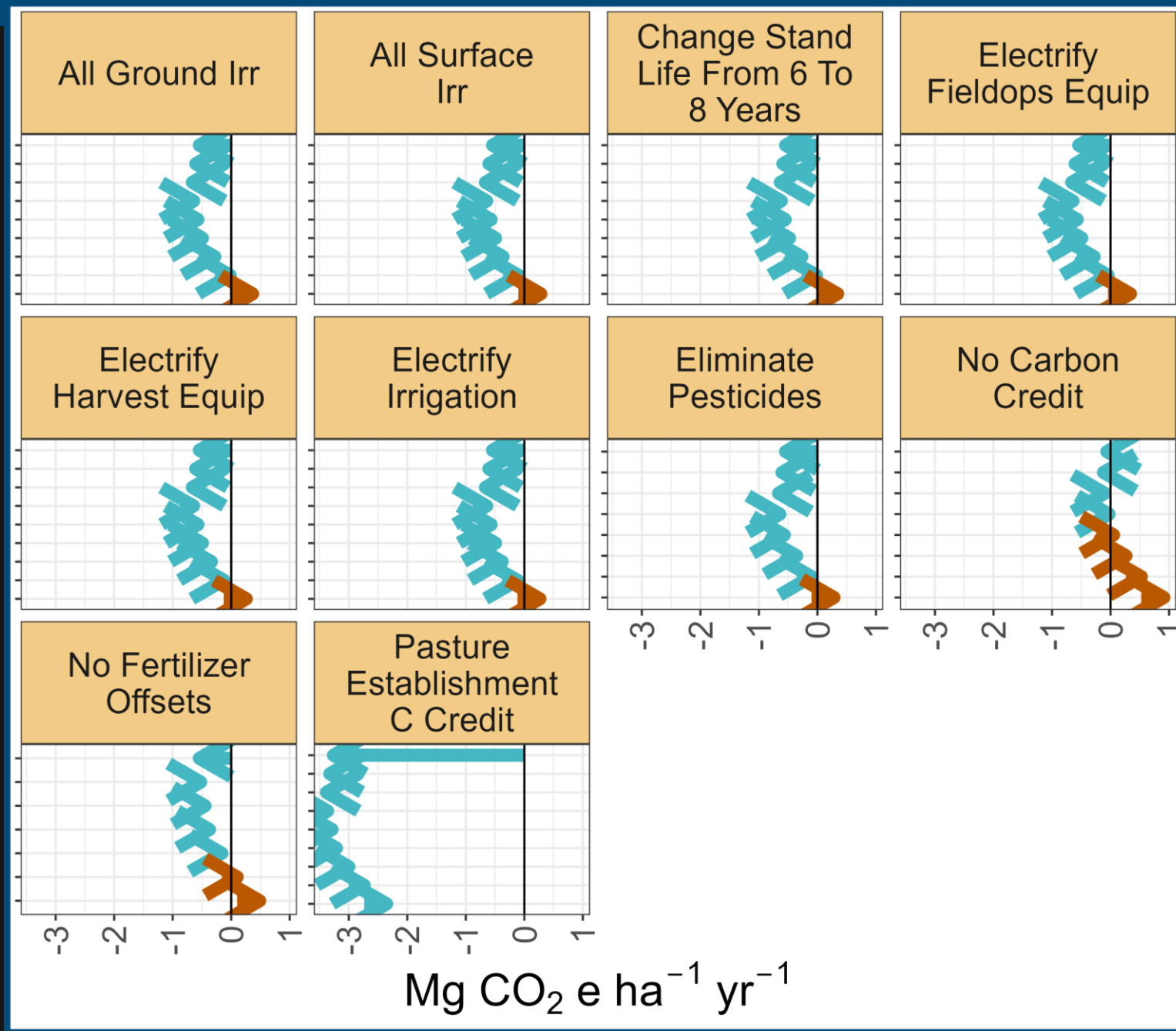
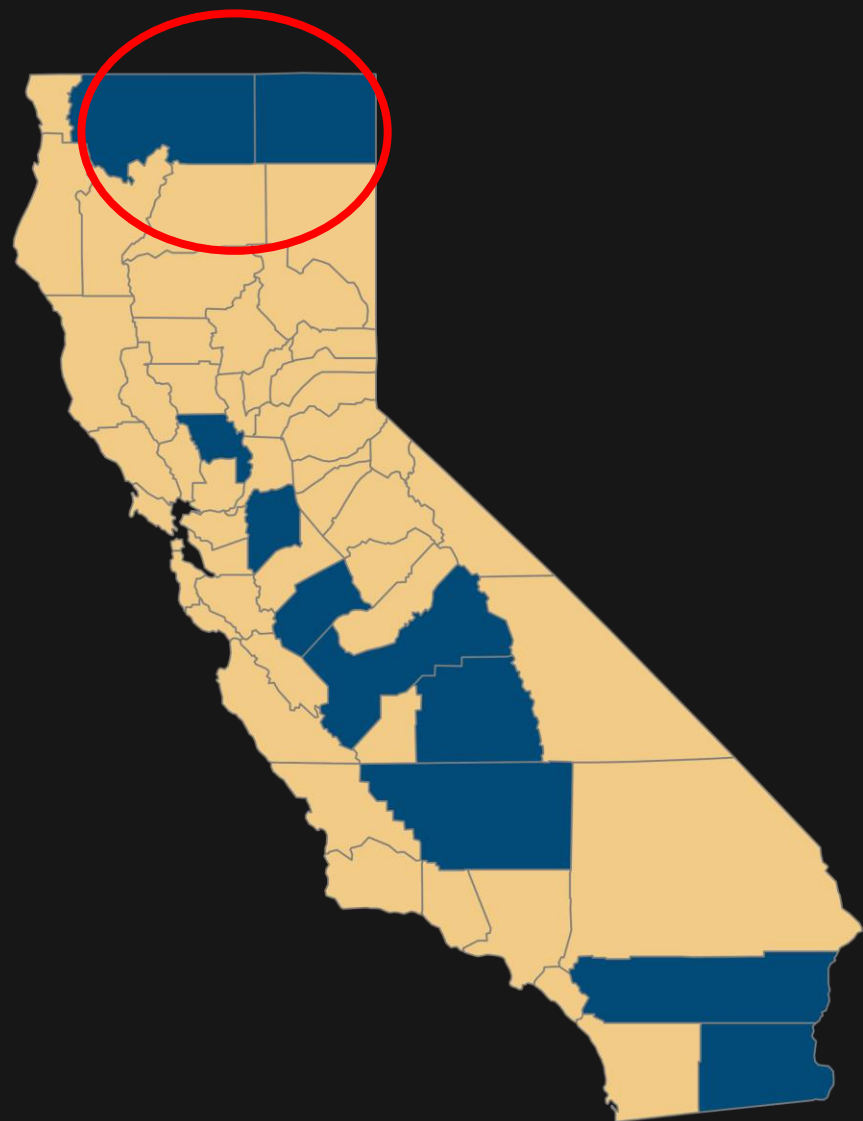


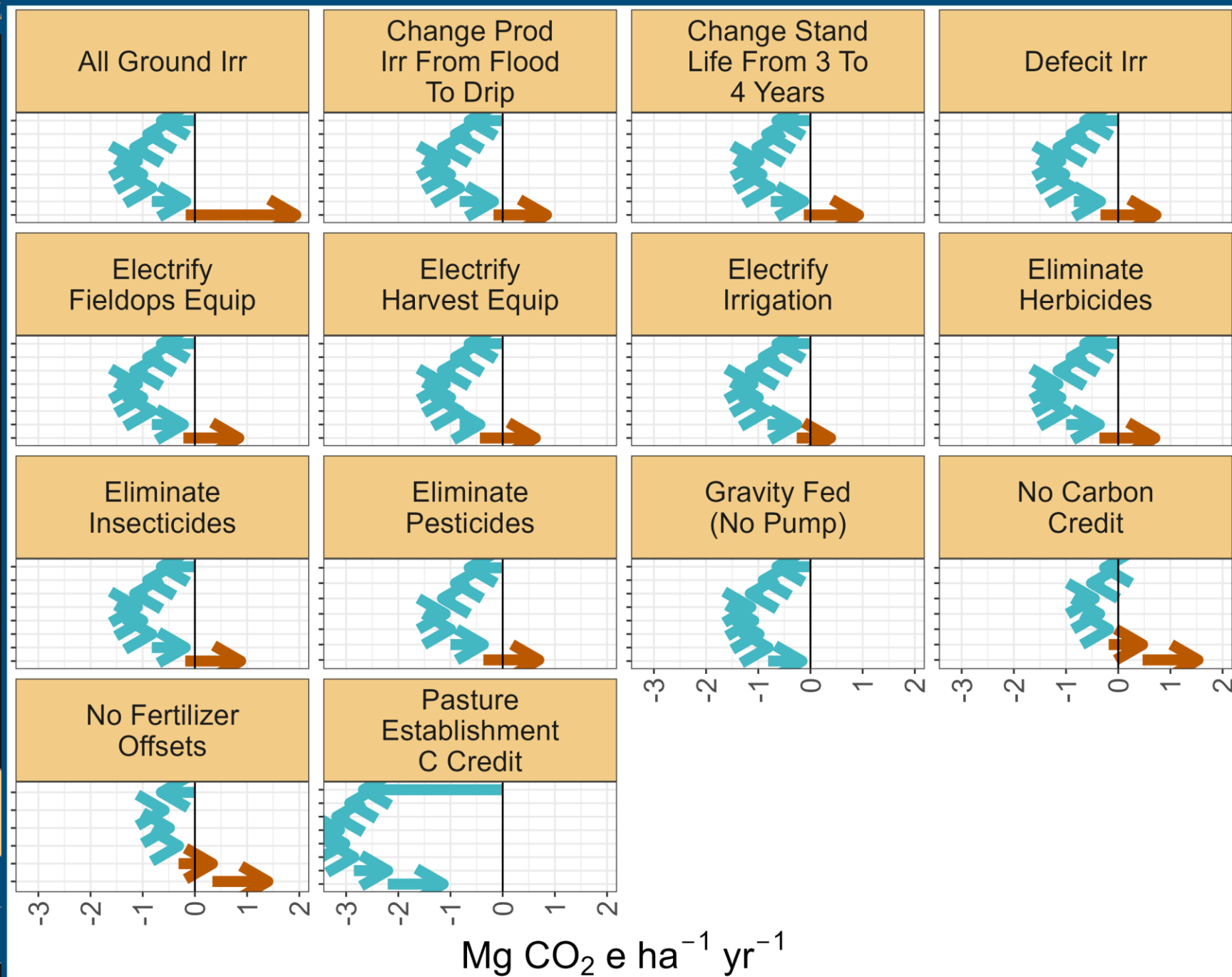


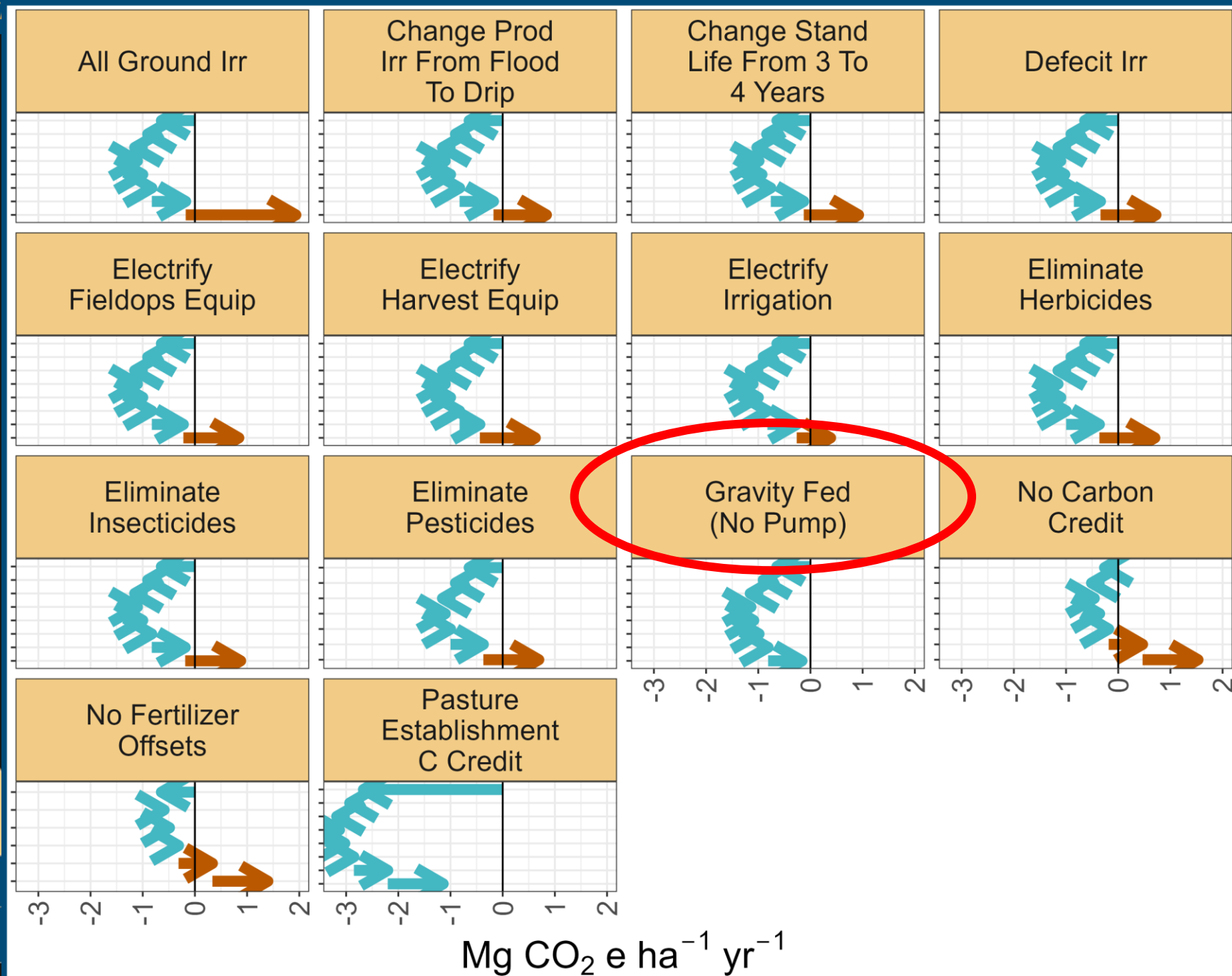


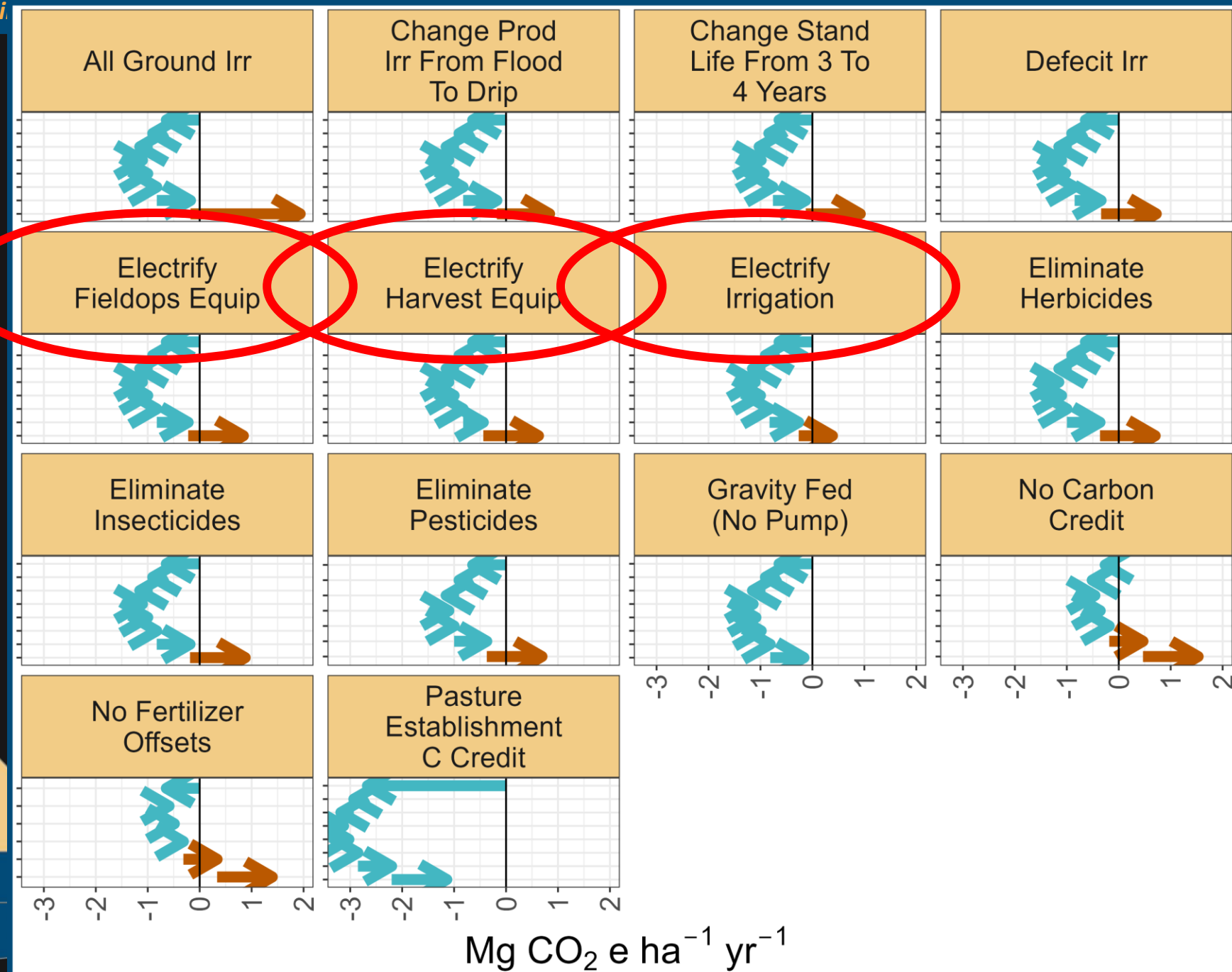












“It shall be the goal of the State to transition to 100% zero-emission off-road vehicles and equipment by 2035 where feasible.”



1. General rule of thumb: CA alfalfa emits $\sim 1 \text{ Mg net CO}_2\text{e ha}^{-1} \text{ yr}^{-1}$
2. The assumed carbon sequestration piece of alfalfa is significant
3. Restricting access to surface water has significant impact on energy use/GHG emissions
4. Focus groups/surveys could help create scenarios that are meaningful to producers...



Impact factors:

Category	Description	Source
Manufacturing	Fertilizers, pesticides, fuel	REET, NRCS, Audsley et al. 2009)
Fuel use	Diesel, propane, electricity	EPA
Seed	Growing seed	Imperial County results
Soil emissions	Soil N ₂ O emissions	IPCC
Soil carbon changes	CO ₂ sequestration/emissions	California Healthy Soils
Avoided fertilizer application	Avoided manufacturing of fertility products	REET
Avoided soil emissions	Avoided soil N₂O emissions	IPCC



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

Project Name:

County:

Siskiyou

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)****Practice Implementation****Decrease Fallow Frequency or Add
Perennial Crops to Rotations****Payment Scenario***(Note: Payment Scenarios may have different payment rates but do not affect GHG reductions)*

Basic Rotation



Specialty Crops



NRCS Conservation Practices	Emission Reduction Coefficients (ERC) (tonnes CO ₂ equivalent per acre per year)			Estimated HSP payment dollars for the Project Term
	Greenhouse Gases			
	Carbon Dioxide (CO ₂)	Nitrous Oxide (N ₂ O)	Methane (CH ₄)	
Conservation Crop Rotation (CPS 328) - Decrease Fallow Frequency or Add Perennial Crops to Rotations-Basic Rotation	0.21	0.01	N.E. **	\$61.44/Acre

Decrease fallow frequency or add perennial crops to rotations



NRCS Conservation Practices

Conservation Crop Rotation (CPS 328) - Decrease Fallow Frequency or Add Perennial Crops to Rotations-Basic Rotation

Emission Reduction Coefficients (ERC)
(tonnes CO₂ equivalent per acre per year)

Greenhouse Gases

Carbon
Dioxide
(CO₂)

Nitrous Oxide
(N₂O)

Methane
(CH₄)

Estimated HSP payment dollars for the Project Term

0.21

0.01

N.E.**

\$61.44/Acre

MENTAL FARMING & INNOVATION

soils program

Sequester carbon and
reduce nitrous oxide
emissions

THE OFFICE OF ENVIRONMENTAL FARMING & INNOVATION

soils program

NRCS Conservation Practices

Conservation Crop Rotation (CPS 328) - Decrease Fallow Frequency or Add Perennial Crops to Rotations-Basic Rotation

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0.01

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