CBA 2017 SYMPOSIUM

SCALING THE FINDINGS

OF THE

MARIN CARBON PROJECT

NOVEMBER 4TH, 2007

A STATEMENT

A 1.5% INCREASE
OF SOIL CARBON IN ARABLE
LAND WOULD REMOVE
ALL OF THE CO_2
ADDED
SINCE THE INDUSTRIAL
REVOLUTION.

8

TIMES

THE AMOUNT

REQUIRED TO

COOL THE PLANET!

GENERAL SYSTEMS THEORY

THE

CONSTRAINTS GIVEN:

REPLICABLE,

SCALABLE,

and GENERALLY

APPLICABLE.

ALSO:

USE EXISTING INFRASTRUCTURE

AND

SOLID SCIENCE

NO NEW 501(c)(3)!!!

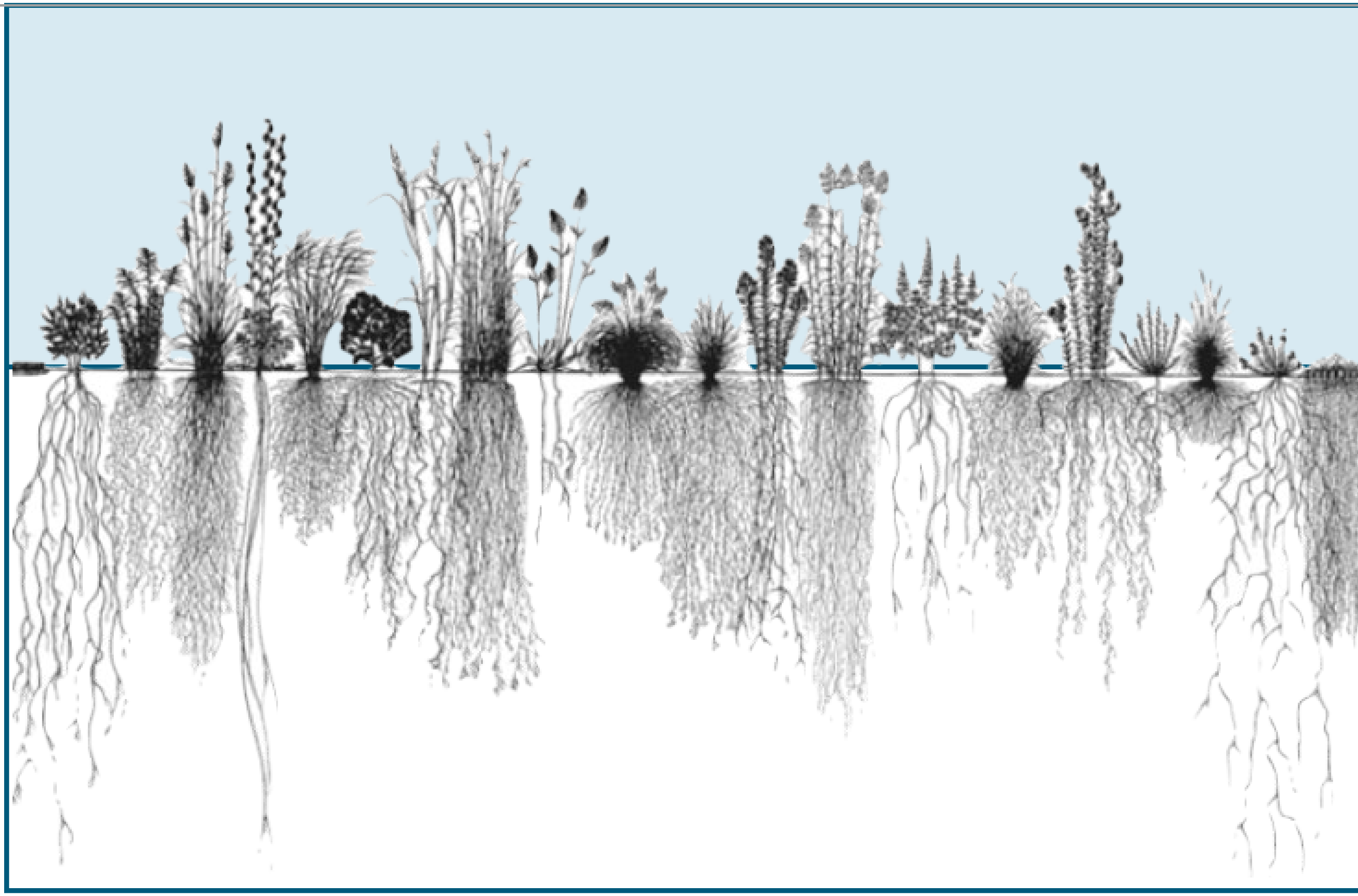
THE
MARIN
CARBON
PROJECT

RESEARCH
DEMONSTRATION
IMPLEMENTATION

WHAT IS
THE POTENTIAL?

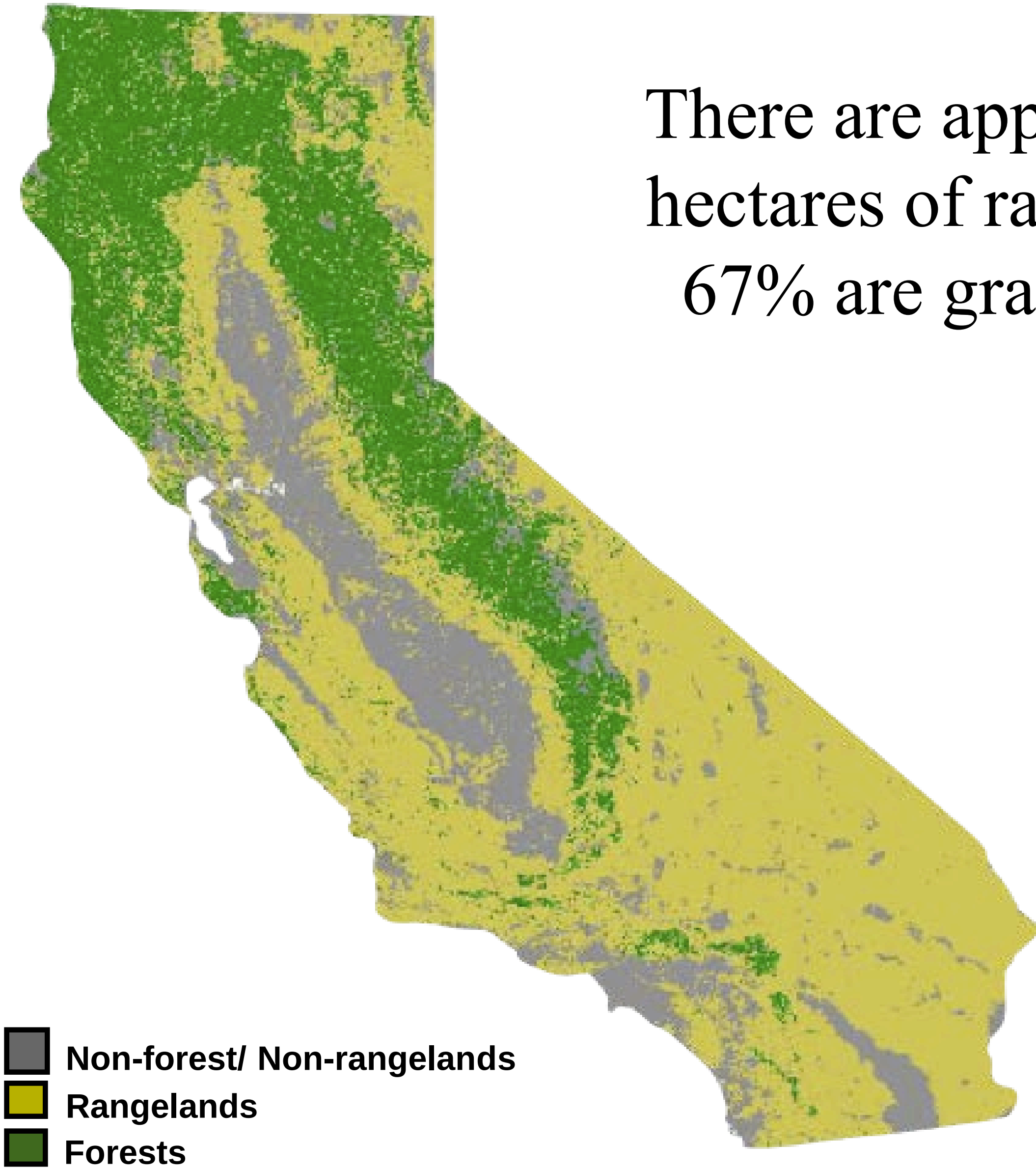
RANGELAND DEFINITION LITERATURE REVIEW BASELINE SURVEY

Grasslands store one-third of the world's soil carbon



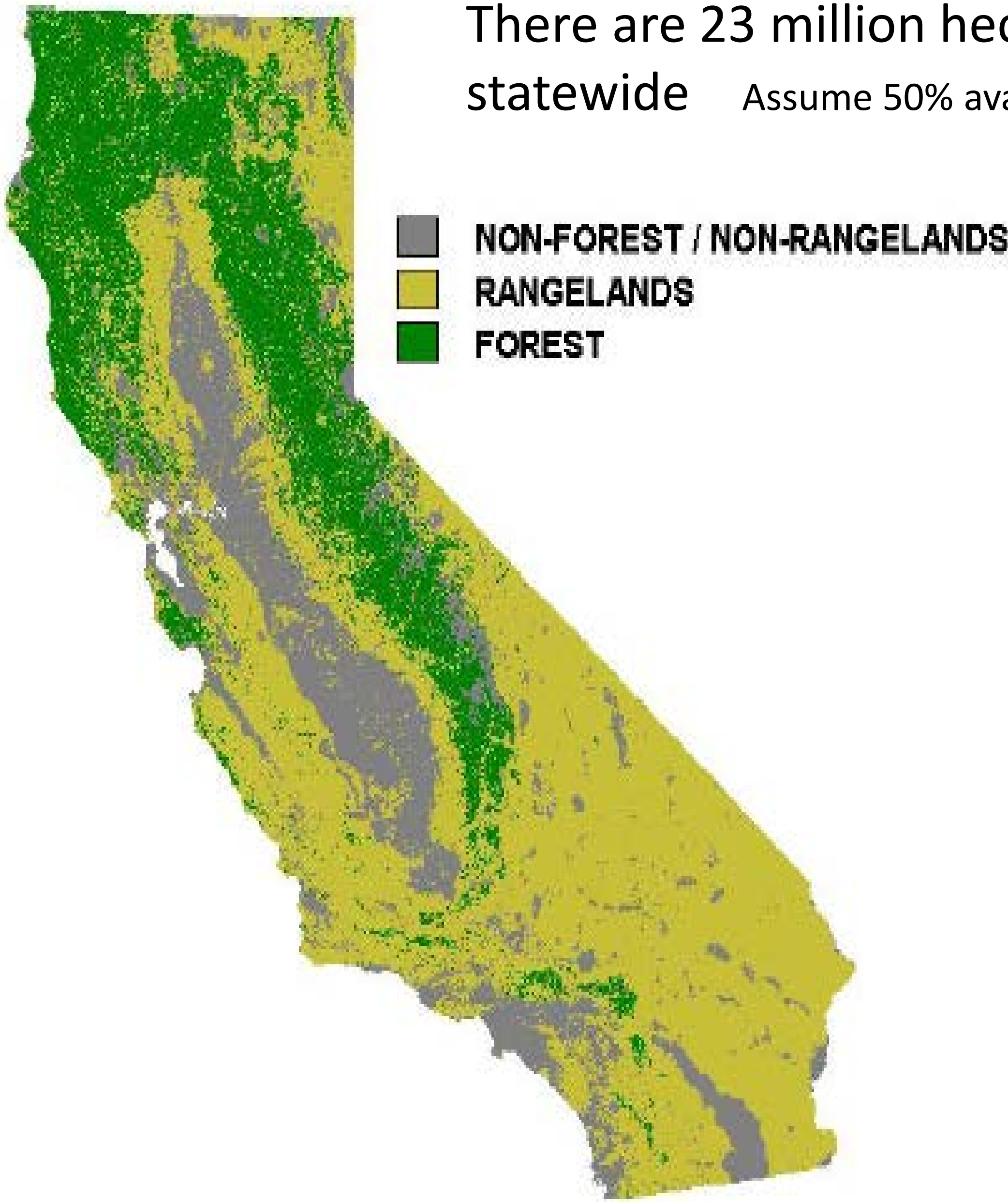
Grasses allocate a large percentage of their photosynthate (CARBON) belowground to roots, exudates and soil biota, including mycorrhizae

There are approximately 23 million hectares of rangeland in California: 67% are grasslands and pastures.



UCB Silver Lab , 2010

CALIFORNIA RANGELANDS and CARBON SEQUESTRATION

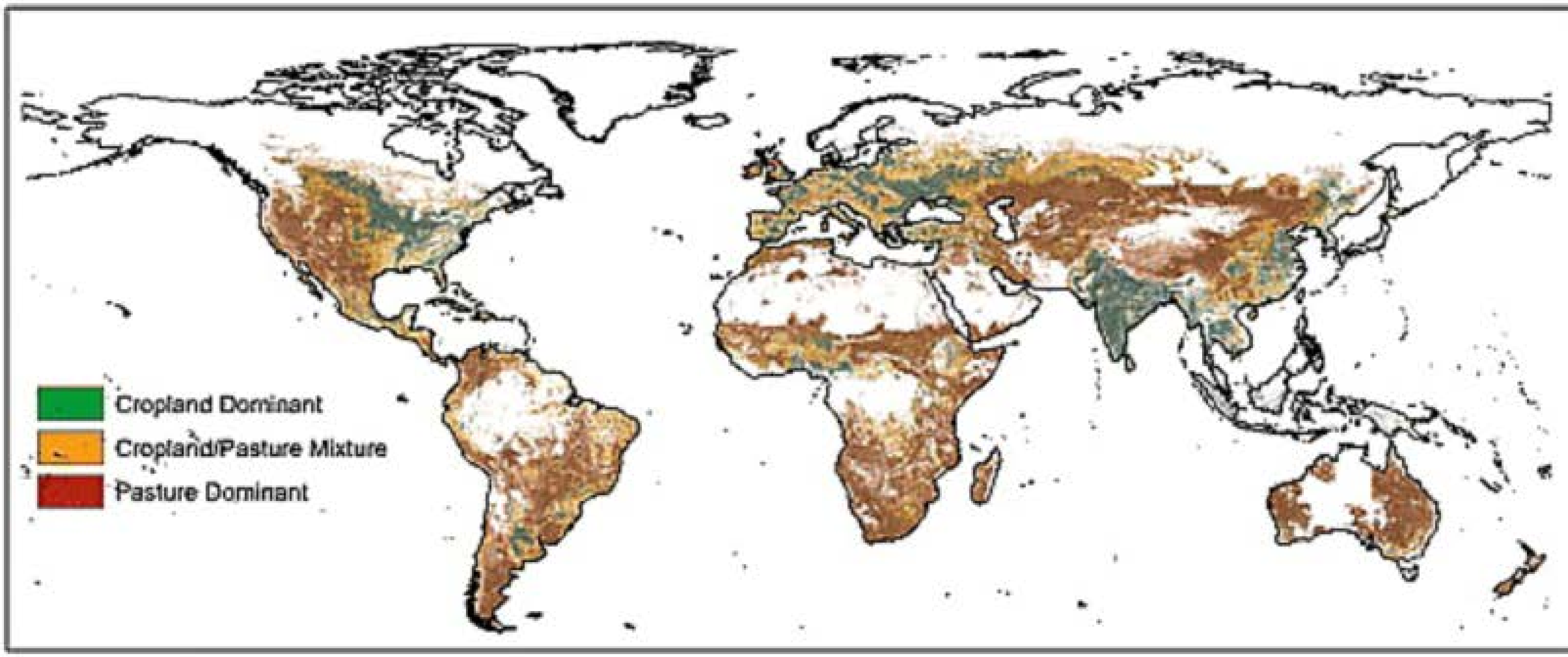


There are 23 million hectares of rangeland statewide Assume 50% available for C sequestration

At a rate of 1 MT C ha^{-1} y^{-1}
= 42 MMT CO_2e/y
At a rate of 5 MT C ha^{-1} y^{-1}
= 211 MMT CO_2e/y
At a rate of 10 MT C ha^{-1} y^{-1}
= 422 MMT CO_2e/y

Livestock ~ 15 MMT CO_2e/y
Commercial/residential ~ 41 MMT CO_2e/y
Transportation emits ~188 MMT CO_2e/y
Electrical generation ~109 MMT CO_2e/y

Grazing land and cropland are geographically expansive

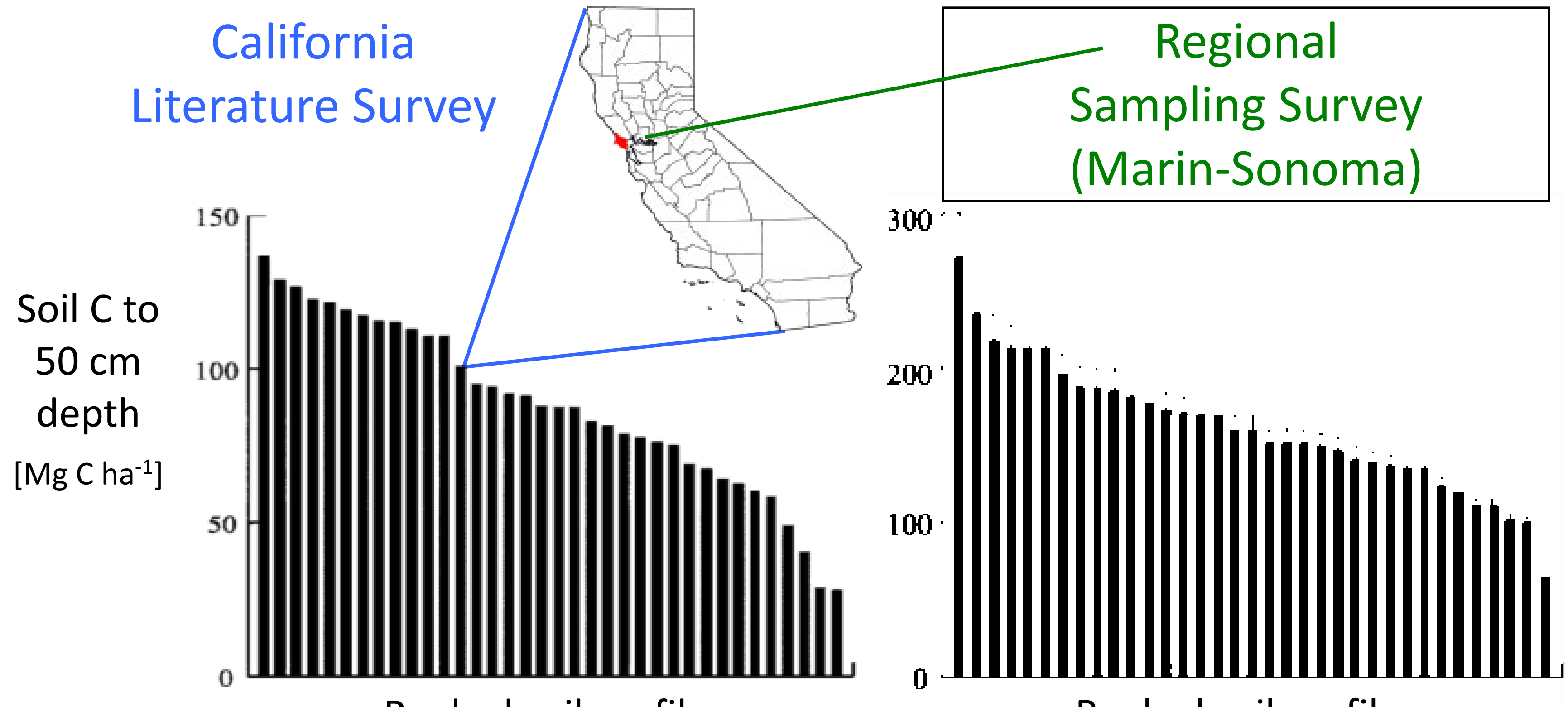


Ramankutty et al. 2008

THE SURVEY OF
35 RANCHES AND
DAIRIES
SHOWED
30 to 150 tons/C*/ha.

*DURABLE SOIL CARBON

Soil carbon pools vary widely, due to management history, precipitation, vegetation and soil type.



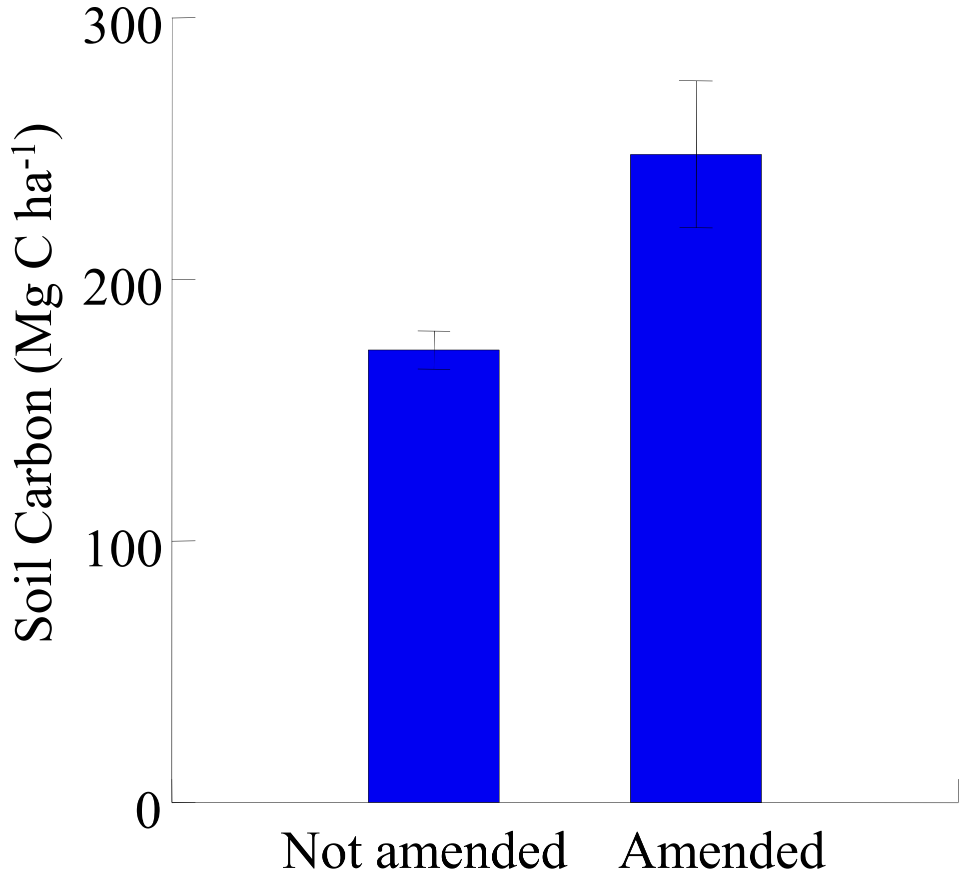
Ranked soil profiles
California rangelands

Ranked soil profiles
Marin Carbon Project

Silver, Ryals & Eviner 2010

Silver, Ryals, et al.

Organic matter (manure) additions increased soil carbon by 50 Mg C ha^{-1} in the top meter of soil



Analysis of 35 fields (1050 samples) from Marin and Sonoma Counties

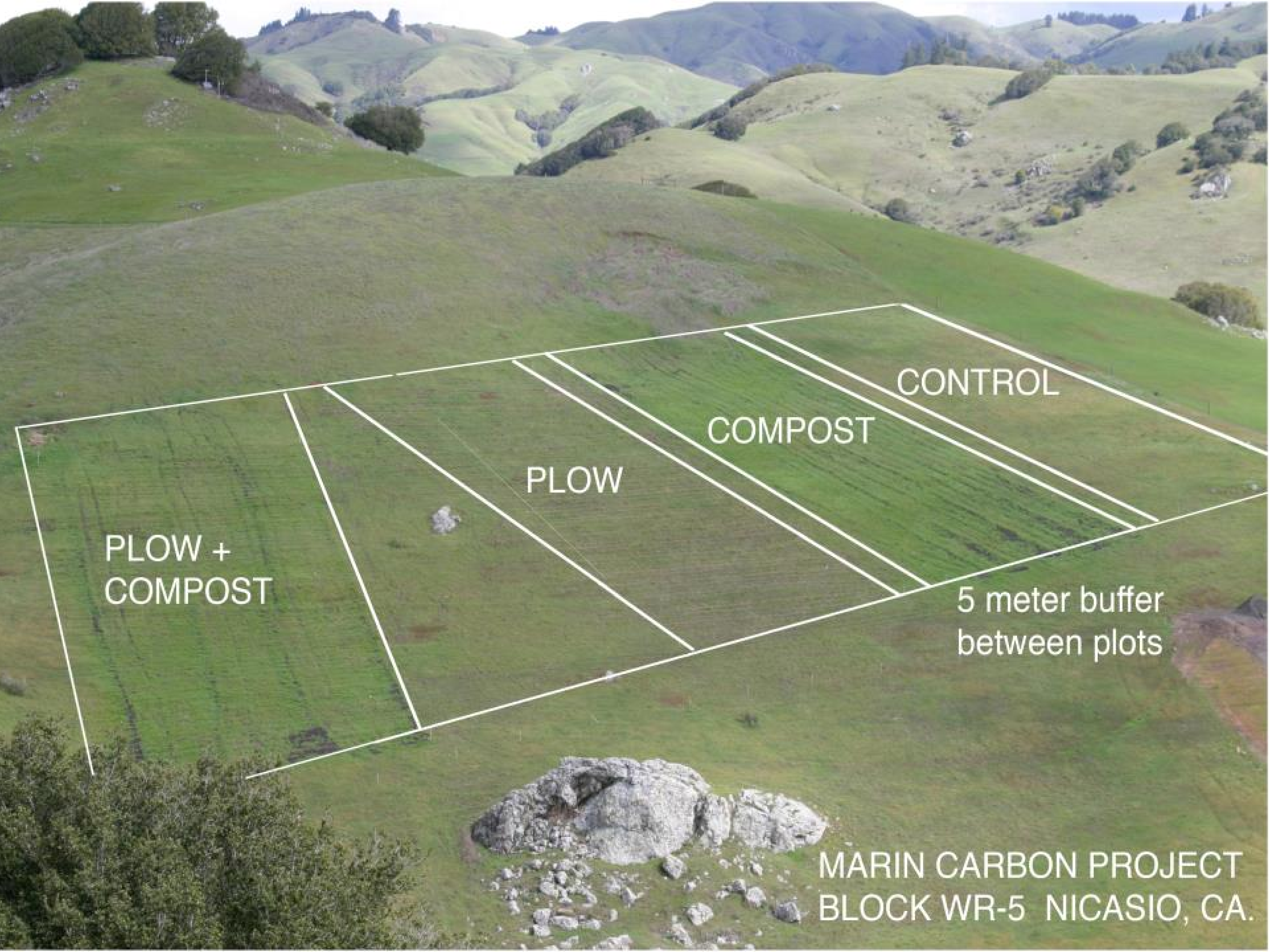
From Silver et al.

HIGH CARBON SOILS FROM DAIRY MANURE APPLICATION.

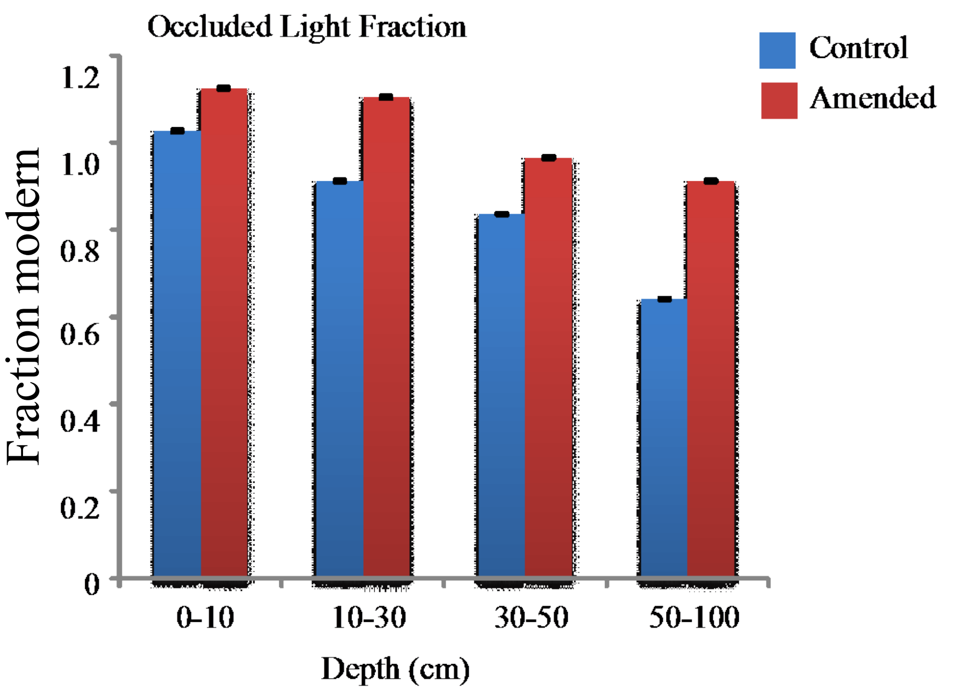
CARBON DATING:

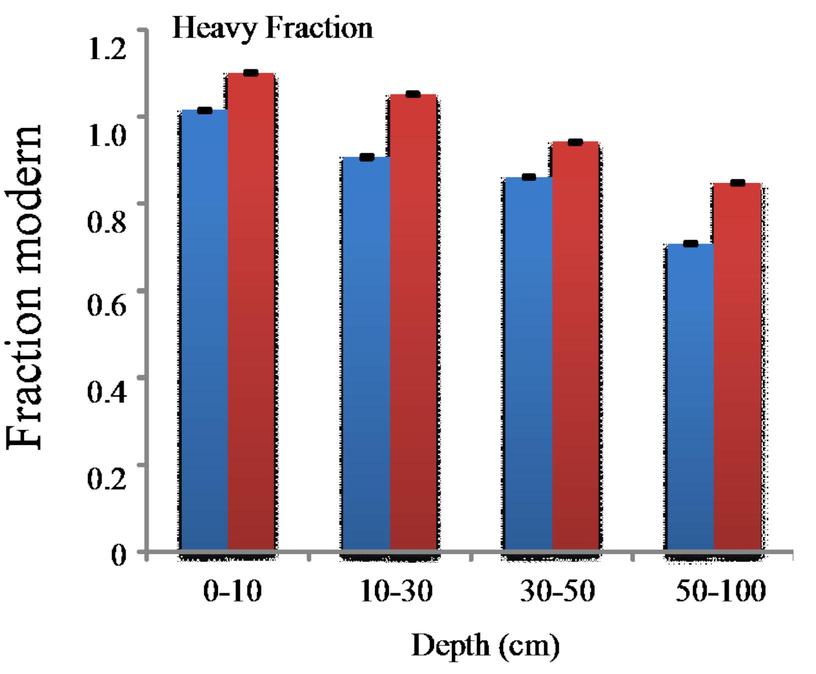
10 YEAR OLD DURABLE SOIL CARBON!

CONDUCT ORIGINAL RESEARCH WITHOUT THE EMISSIONS.


CONTROL
COMPOST
PLOW
PLOW +
COMPOST
5 meter buffer
between plots
MARIN CARBON PROJECT
BLOCK WR-5 NICASIO, CA.

Soil C from amendments can be stored in soil C pools with long turnover times



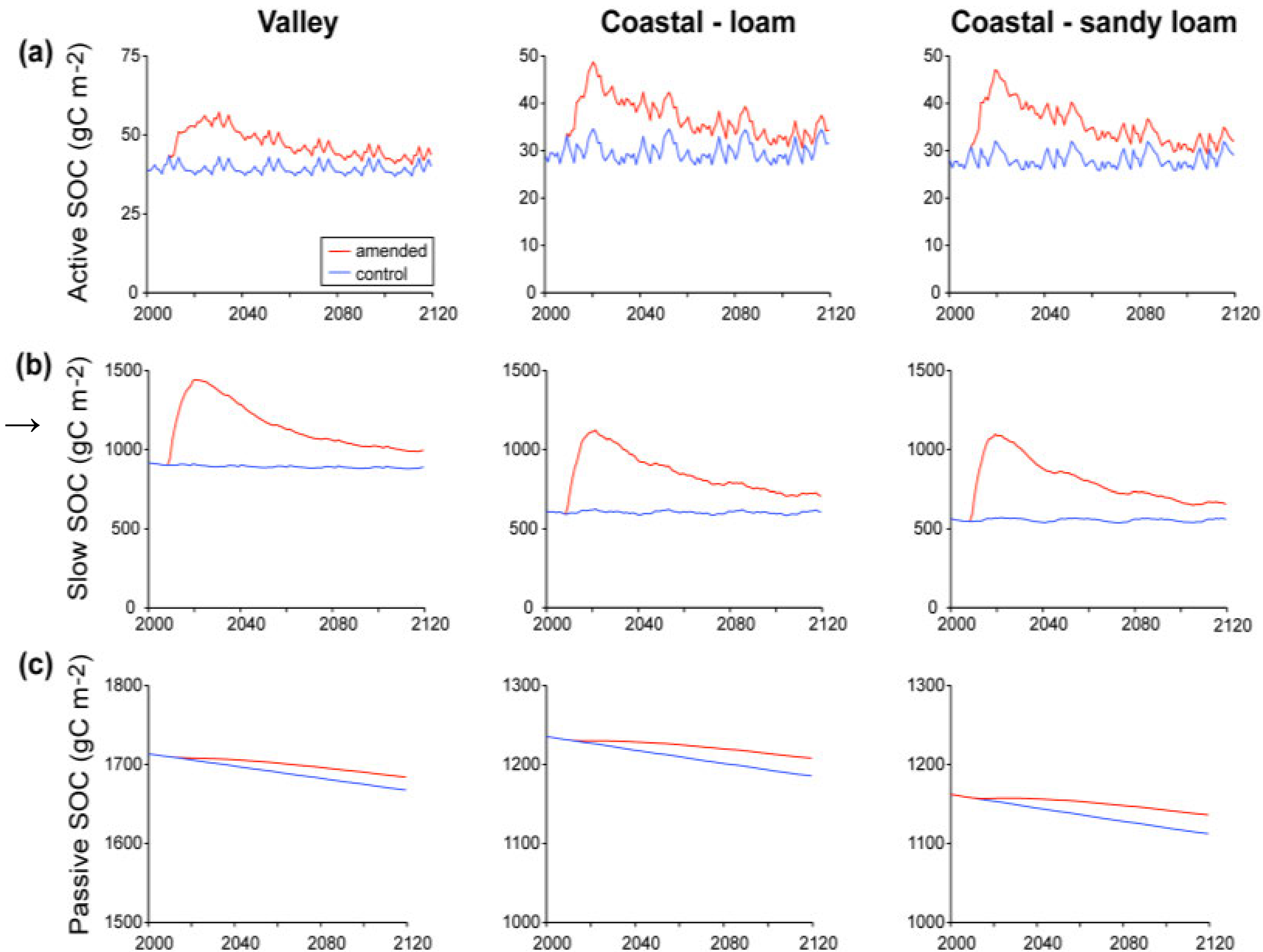


OLF: decades to centuries
HF: centuries to millennia

Analysis of ^{14}C in soil carbon fractions

Silver et al.

Model results suggest that C increase-effect may persist for > 100 years



Ryals et al.

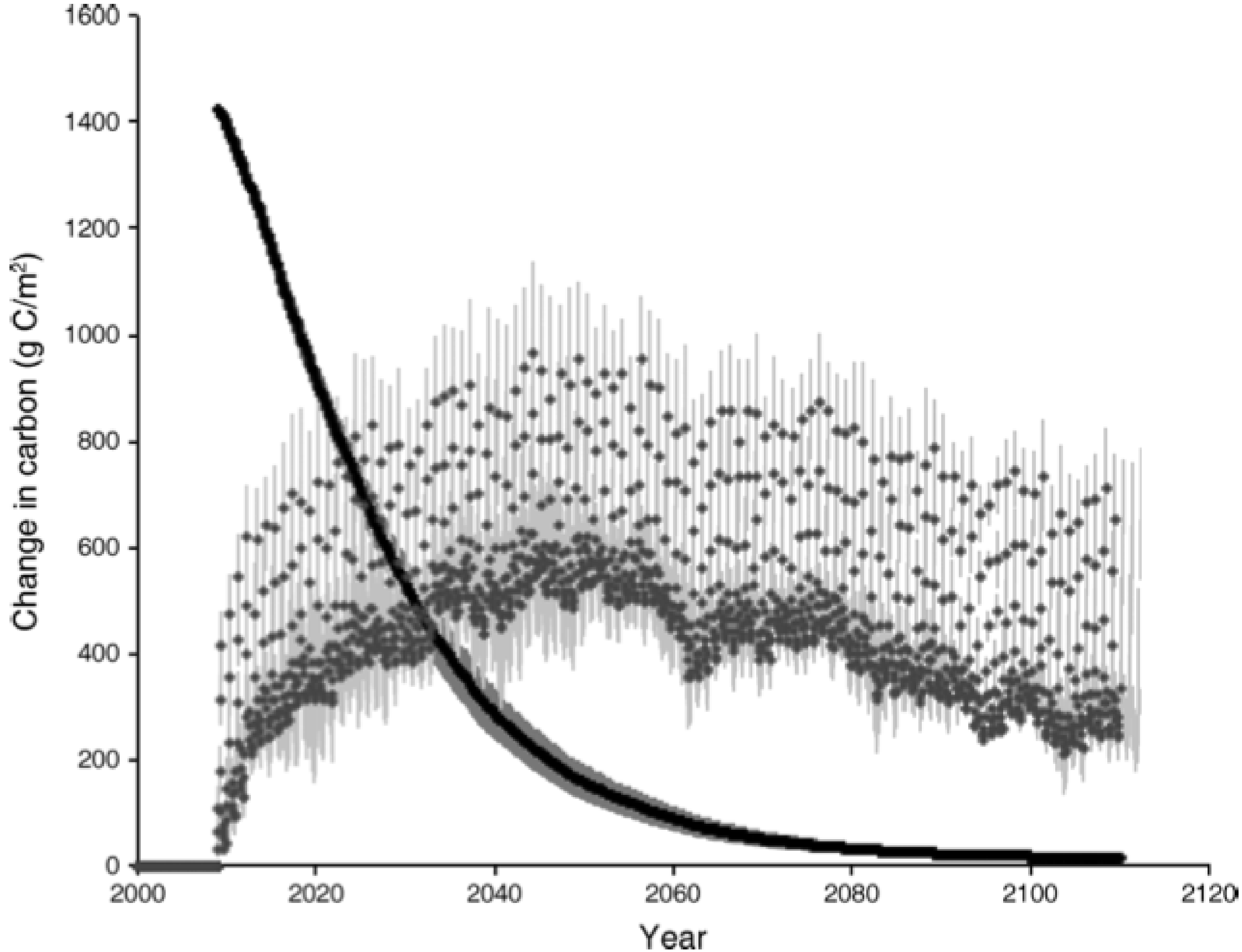
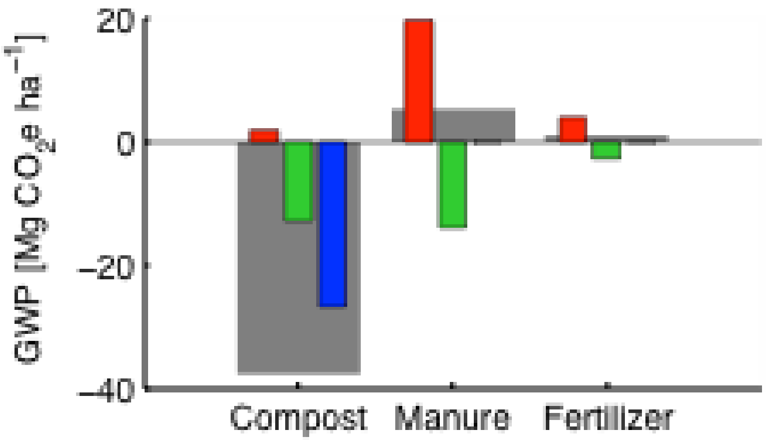
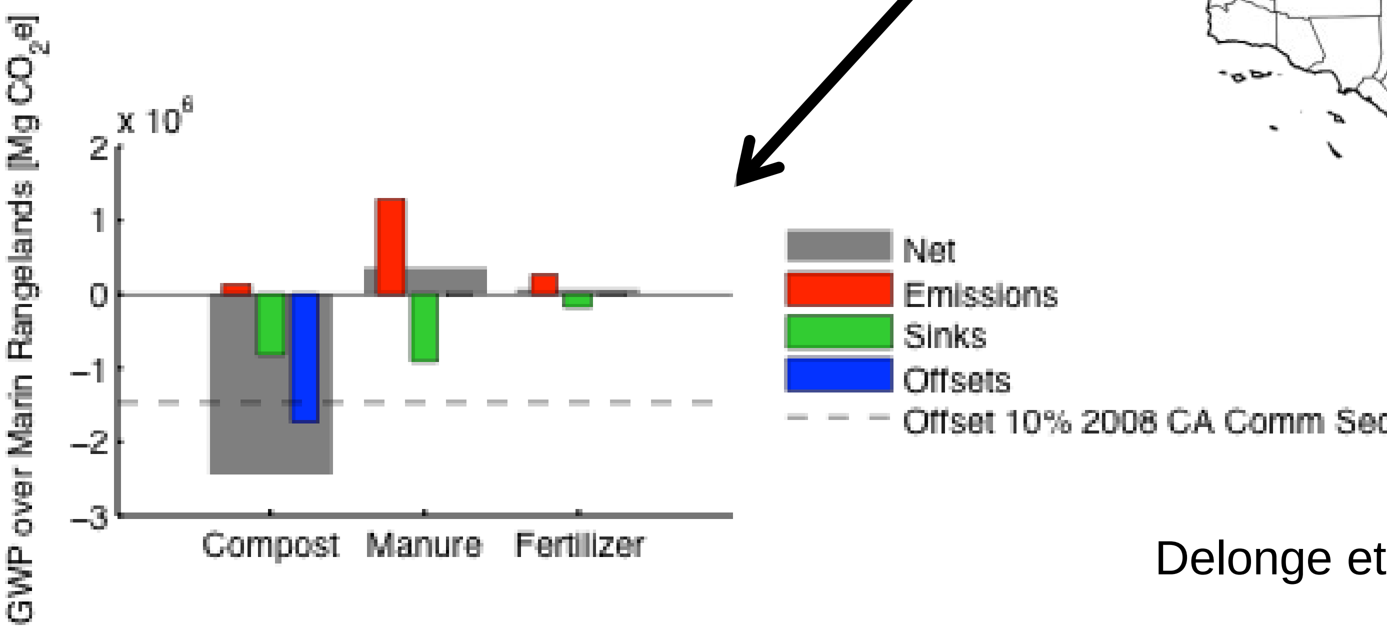


FIG. 3. The black line shows simulated decomposition of the compost following application to grassland soils. Gray circles show the monthly change in total ecosystem carbon, not including compost carbon. Values are averages across site characterizations, with standard error bars in light gray. Ryals et al, 2015. Ecological Applications, 25(2): 531–545.

Lifecycle Assessment: diverting organic materials from anaerobic storage and disposal to aerobic composting leads to large offsets from avoided methane emissions



65,000 ha
Marin
Rangelands



Delonge et al. 2013

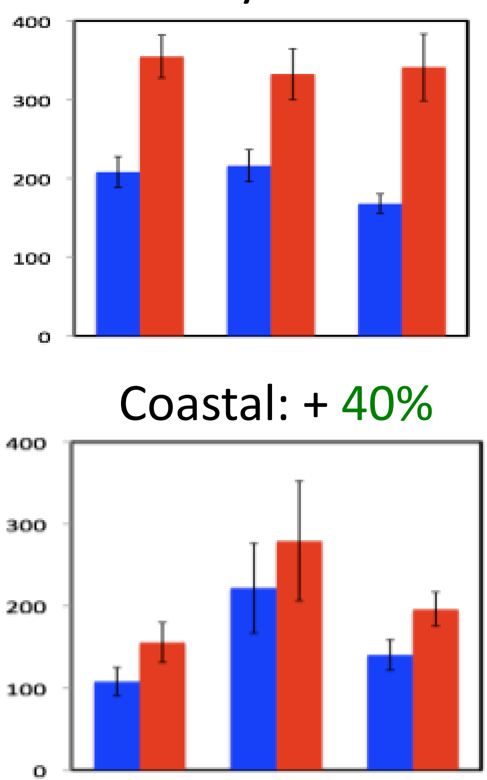
EARLY RESULTS ESTABLISHED THE CASE FOR COMPOST.

More forage, soil C on compost plots

Aboveground production (FORAGE!) [g m^{-2}]

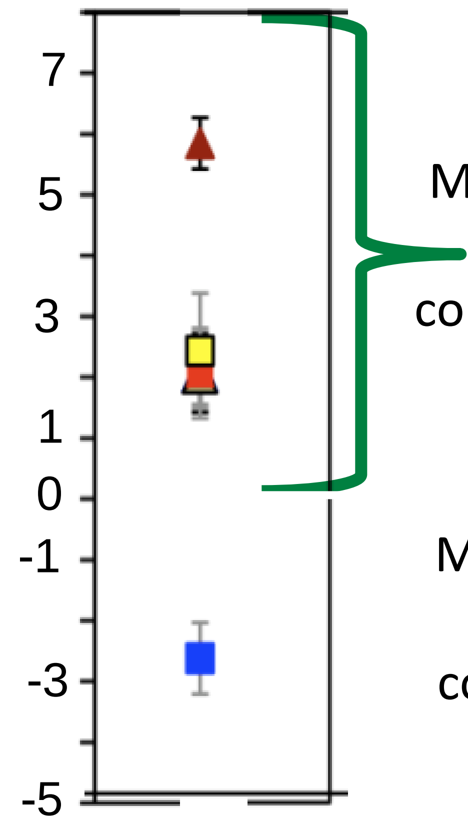
Valley: + 70%

Coastal: + 40%



compost control

Paired-plot difference in Net C Storage [g C m^{-2} y^{-1}]

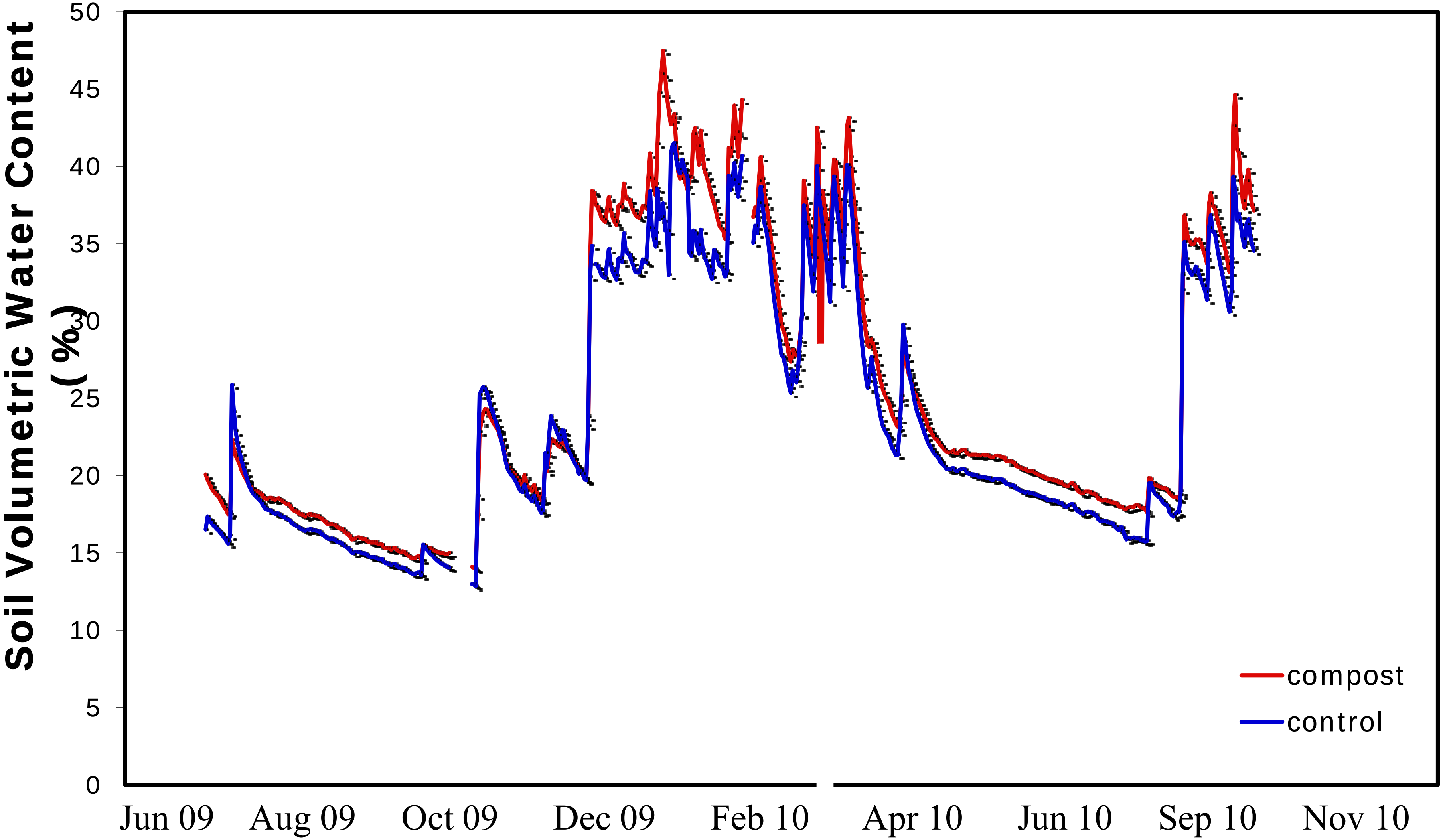


More C in compost plot

More C in control plot

Ryals & Silver 2013

Compost also increased soil moisture….



UCSFREC, Browns Valley, Ryals and Silver in prep

Supporting Science: MCP Published Papers

- *1. Soil Carbon Pools in California's Annual Grassland Ecosystems*. Whendee L. Silver,1 Rebecca Ryals,2 and Valerie Eviner3. Rangeland Ecol Manage 63:128–136 | January 2010 | DOI: 10.2111/REM-D-09-00106.1

- *2. Effects of organic matter amendments on net primary productivity and greenhouse gas emissions in annual grasslands*. REBECCA RYALS1 AND WHENDEE L. SILVER. Ecological Applications, 23(1), 2013, pp. 46–59, 2013 by the Ecological Society of America

- *3. Impacts of organic matter amendments on carbon and nitrogen dynamics in grassland soils*. Rebecca Ryals a, *, 1 Whendee L. Silver a Michael Kaiser b, 2,Margaret S. Torn c Asmeret Asefaw Berhe b. Soil Biology & Biochemistry 68 (2014) 52e61

- 4. *Long-term climate change mitigation potential with organic matter management on grasslands*. MELANNIE D. HARTMAN, WILLIAM J. PARTON, MARCIA S. DELONGE, AND WHENDEE L. SILVER. Ecological Applications, 25(2), 2015, pp. 531–545, 2015 by the Ecological Society of America

- *5. A Lifecycle Model to Evaluate Carbon Sequestration Potential and Greenhouse Gas Dynamics of Managed Grasslands*

- 6. Marcia S. DeLonge,* Rebecca Ryals, and Whendee L. Silver. Ecosystems (2013) 16: 962–979. DOI: 10.1007/s10021-013-9660-5. *6. Grassland compost amendments increase plant production without changing plant communities*. Rebecca Ryals,1,3,† Valerie T. Eviner,2 Claudia Stein,1,4. Katharine N. Suding,1,5 and Whendee L. Silver1. Ecosphere March 2016 v Volume 7(3) v Article e01270

- *7. Long-term impacts of manure amendments on carbon and greenhouse gas dynamics of* rangelands. JUSTINE J. OWEN 1 , WILLIAM J. PARTON 2 and WHENDEE L. S ILVER1 REBECCA RYALS, Global Change Biology (2015), doi: 10.1111/gcb.13044

- *8. Greenhouse gas emissions from dairy manure management: a review of field-based studies*. J U S T I N E J . O W E N and WHENDEE L. S ILVER. Global Change Biology (2014), doi: 10.1111/gcb.12687

- *9. Greenhouse Gas Mitigation Opportunities in California Agriculture Review of Emissions and Mitigation Potential of Animal Manure Management and Land Application of Manure*. Justine J. Owen*Ermias Kebreab** Whendee Silver*. Nicholas Institute for Environmental Policy Solutions, Report, NI GGMOCA R 6, February 2014

- *10. Greenhouse Gas Mitigation Opportunities in California Agriculture Review of California Rangeland Emissions and Mitigation Potential*. Marcia S. DeLonge, Justine J. Owen Whendee L. Silver. Nicholas Institute for Environmental Policy Solutions, Report NI GGMOCA R 4, February 2014

SCALING THROUGH POLICY & COMMUNICATION

Building Frameworks for Soil Carbon Sequestration in Agriculture: Planning, Tools & Technical Assistance

- Carbon Farm Planning, based on USDA Natural Resources Conservation Service Conservation Planning, administered by Resource Conservation Districts *(Lead: Marin Carbon Project)*
- Development of American Carbon Registry Protocol: Compost Application on Grazed Rangelands *(MCP, EDF, ECT)*
- Development of COMET Planner *(MCP, USDA NRCS, Colorado State University, John Wick)*
- Creation of 5th Pillar of Climate CA Change Strategy; Natural and Working Lands *(MCP, Carbon Cycle Institute, John Wick, CalCAN, CAFF, Pt. Blue, TNC, EDF others)*
- California Healthy Soils Initiative *(MCP, Carbon Cycle Institute, John Wick, CARCD, CalCAN, CAFF, CAW, Kiss the Ground, Food Policy Councils', Various Environmental NGOs, CA Citizens etc)*
- Support for development of COMPOST Planner *(CDFA, Colorado State University, USDA NRCS, John Wick)*

Supporting CA Compost Markets: Policy

Building off of AB 1826, Chesbro. (Requires businesses to recycle their organic waste on and after April 1, 2016)

AB 1045, Irwin. Organic waste: composting.

- Requires all state agencies to coordinate around rules and permitting for compost facilities

AB 876, McCarty. Compostable organics.

- Directs counties to document organic waste and create plans for diversion

SB 1383, Lara. Short-lived climate pollutants: methane emissions: dairy and livestock: organic waste: landfills.

- Contains monies, digesters, alternative manure management, reduction of wasted food as well as compost facilities

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AB 876, McCarty. Directs counties to document organic waste and create plans for diversion . *(EEC/John Wick, MATTS Company, CA Municipal Governments: San Francisco, Bakersfield, San Diego Food System's Alliance, Kiss the Ground)*

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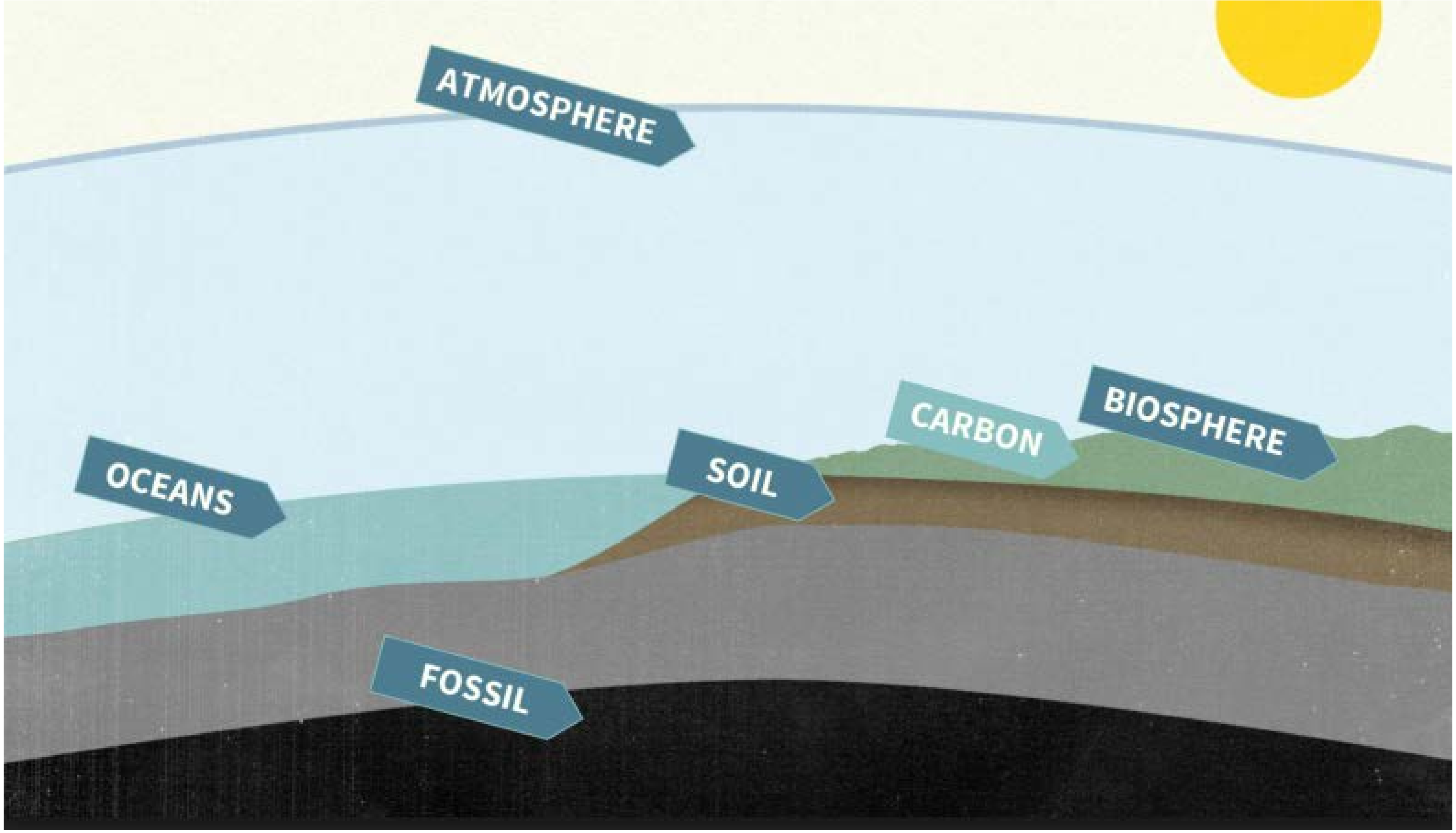
(EEC/John Wick, CAW, CA Composting Coalition, CA Association of Compost Producers, Agricultural Council, Farm Bureau, Dairy Cares, Governors Office)

Supporting Regional Compost Development

- Identifying materials for supply at the regional level and convening local agencies to review support/rules for local production of compost
- On farm composting: SWRCB reviewing Compost GO for on farm composting and herbivore manure at small and medium scale
- On farm composting: How to open new materials from orchards and other burned sources to the alternative of composting *(two day summit Nov 7th-8th Parlier CA).*
- Community composting: LA, Santa Barbara, San Diego, Oakland supporting development of small producer coalition and regulations

Supporting Shared Communications

The Soil Story



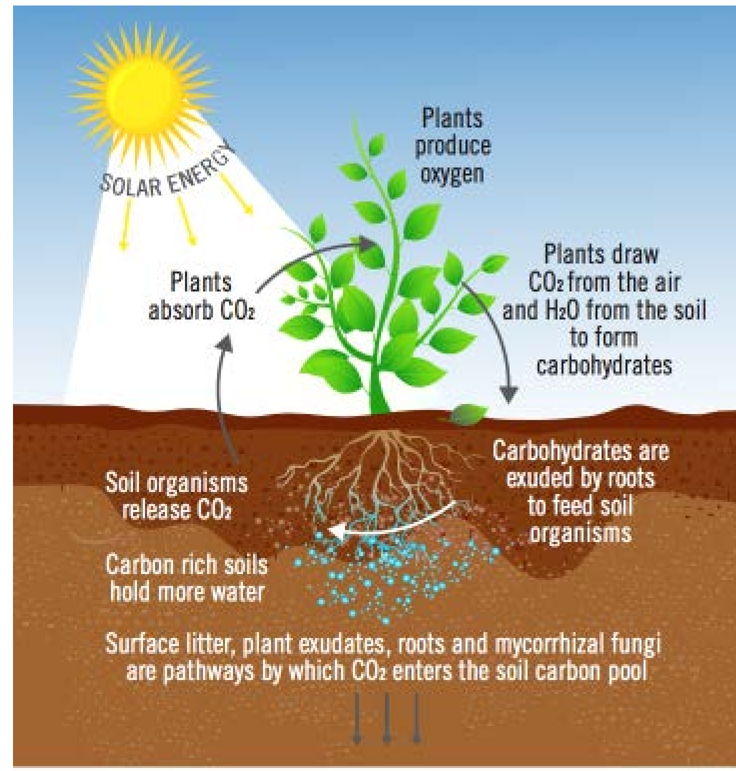
Creating Broad and Basic Visual Communications *(Dustin Kahn, Fibershed)*

Applications of composted organic matter to grazed grasslands contribute to climate change mitigation while sustaining productive lands and reducing waste loads

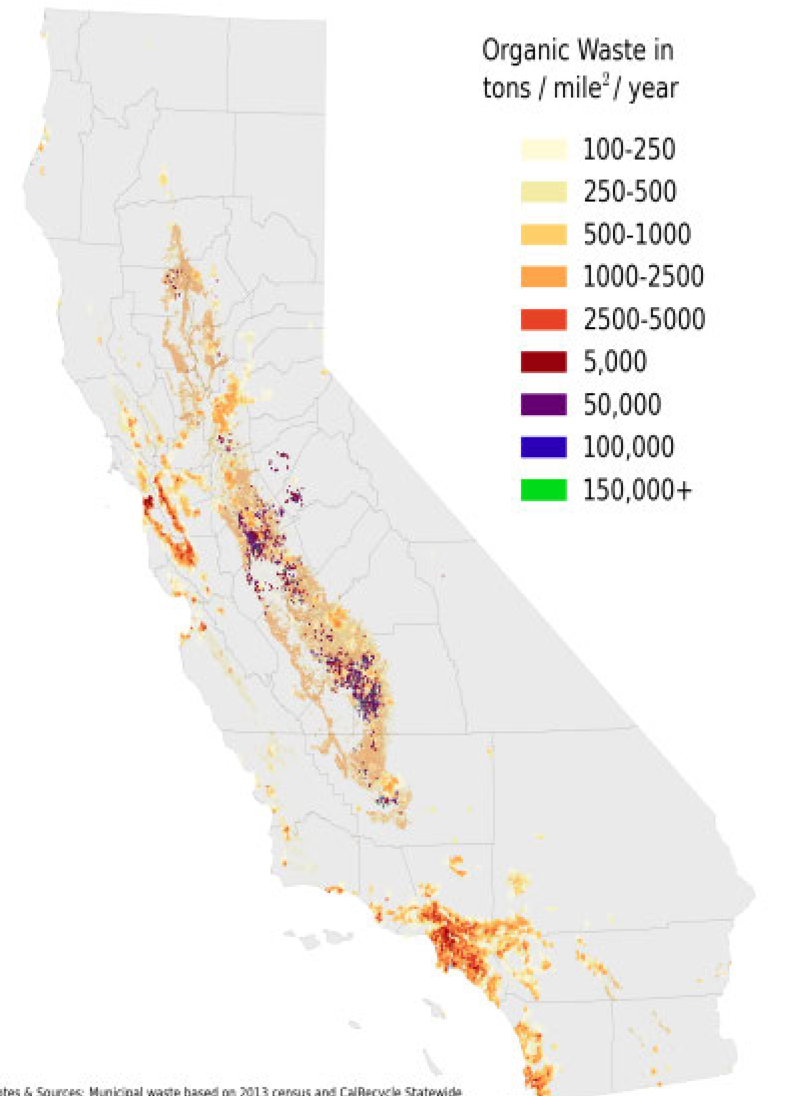
No compost applied = Net carbon loss

One time application of ½ inch of compost = increased water holding capacity, increased forage production, and 1 ton of CO2e sequestered per hectare (2.47 acres) per year, ongoing for 30 years without additional compost applications

– Citation?

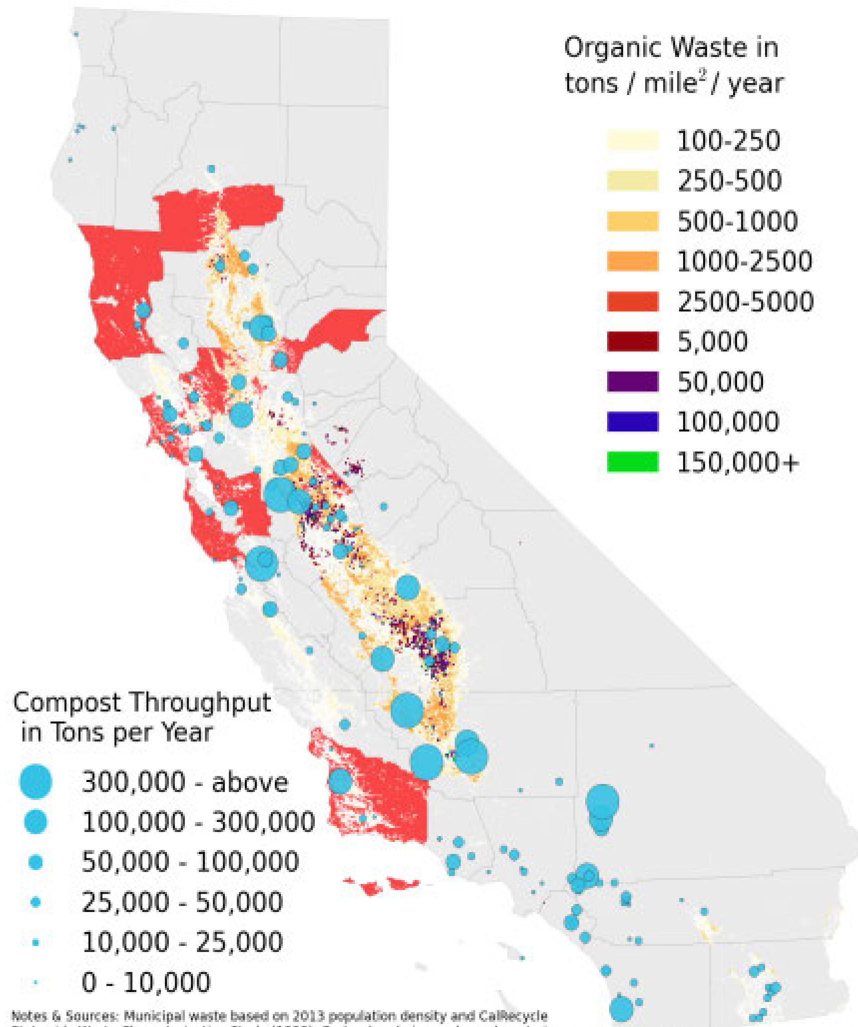


Organic Waste from Cities, Perennial Crops, and Dairy Farms



Notes & Sources: Municipal waste based on 2013 census and CalRecycle Statewide Waste Characterization Study (1999). Orchard and vineyard wood waste is from Kroodsma & Field (2006) and and NASA CropScape (2014). Dairy cattle manure from CA Water Board (2012) and Agricultural Waste Management Handbook (1992).

Throughput of Compost Facilities, Organic Waste from Cities, Perennial Crops, and Dairies, and RCDs with Carbon Farming Potential Demo Projects



Notes & Sources: Municipal waste based on 2013 population density and CalRecycle Statewide Waste Characterization Study (1999). Orchard and vineyard wood waste is from Kroodsma & Field (2006) and NASA CropScape (2014). Dairy cattle manure is from CA Water Board (2012) and Agricultural Waste Management Handbook (1992). Compost facility throughouput is from CalRecycle (2015).

Organizing Through Collaboration

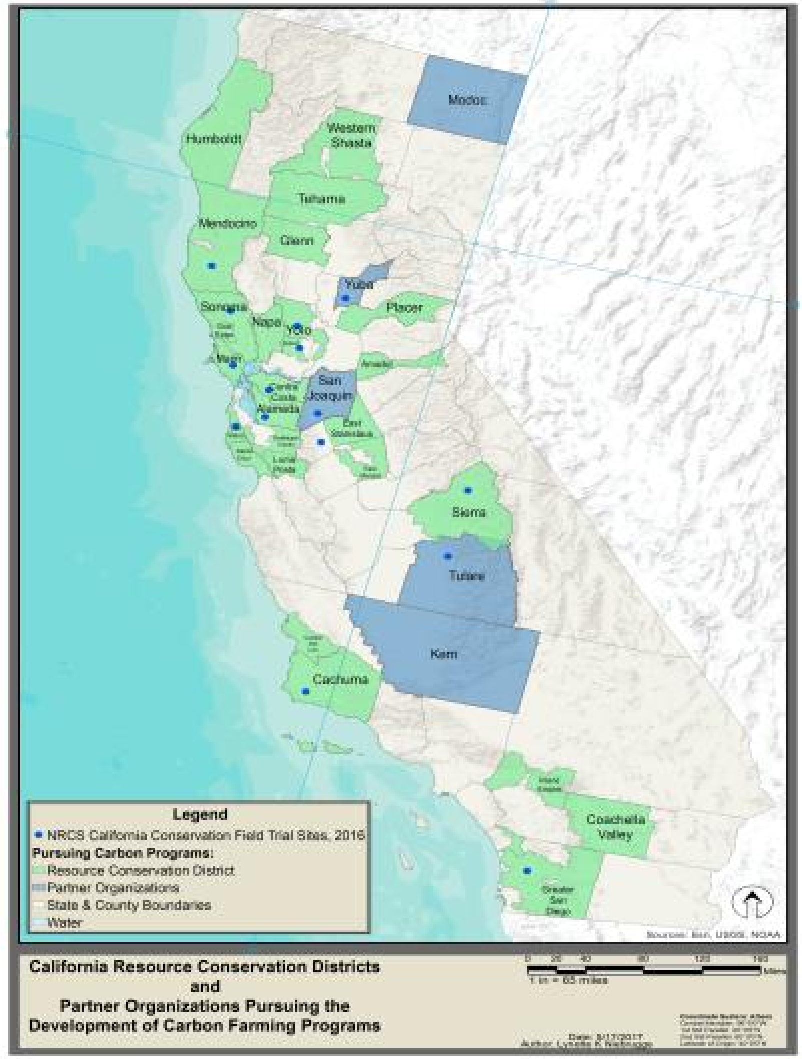
Supporting Adoption of Practices: Compost Field Trials and Carbon Farm Planning

- NRCS Field Trails for Compost Application on Grazed Rangelands, 15 sites in CA *(CA NRCS, John Wick, CA Soil Health Network, Pelayo Alvarez)*

- Carbon Farm Planning Capacity, 33 RCD's *(Carbon Cycle Institute, Calla Rose Ostrander)*

- Climate Beneficial Ag Coop, 140 Producers in Nothern CA *(Fibershed)*

- Beneficial Grazing Promotion: TomKat Ranch, Rush Ranch, Pt Blue Conservation, Savory Institute, HMI, Quivira



Preliminary results from greenhouse experiment

Dr. Rebecca Ryals*

Student Team Members: Kate Porterfield, Steven Heisey, Gavin McNicol

*Currently at University of Hawaii, Manoa. Will be at University of California, Merced beginning January 2018

Research Question:

What are the effects of land application of biosolids and other human organics on crop production, soil carbon and nutrient dynamics, and soil water retention?

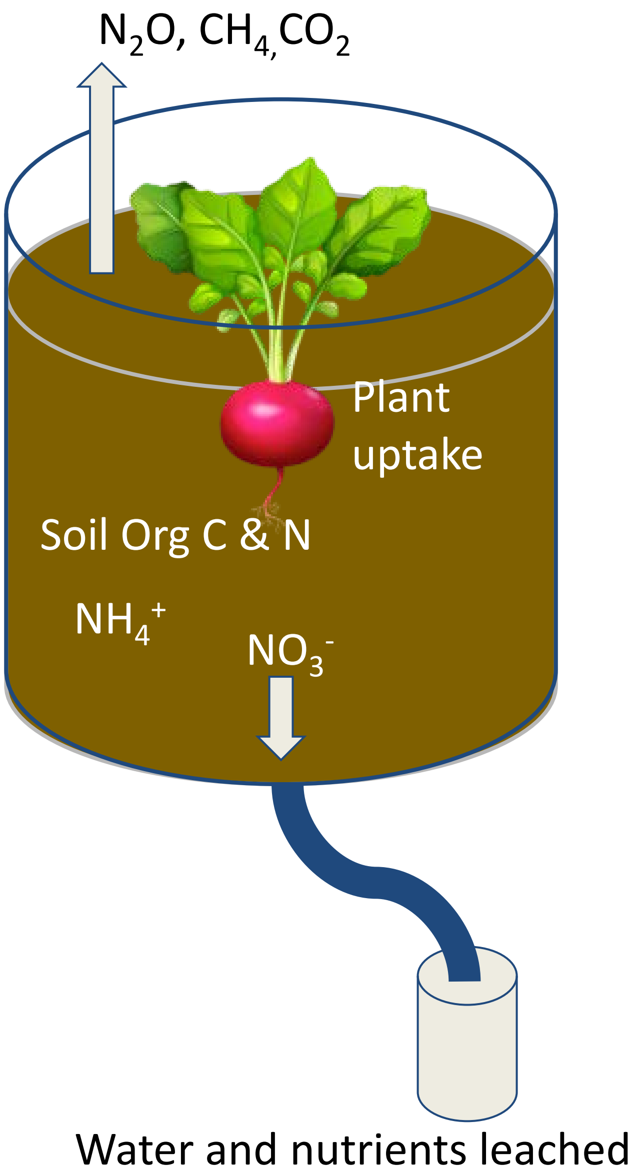
Greenhouse Experimental Design

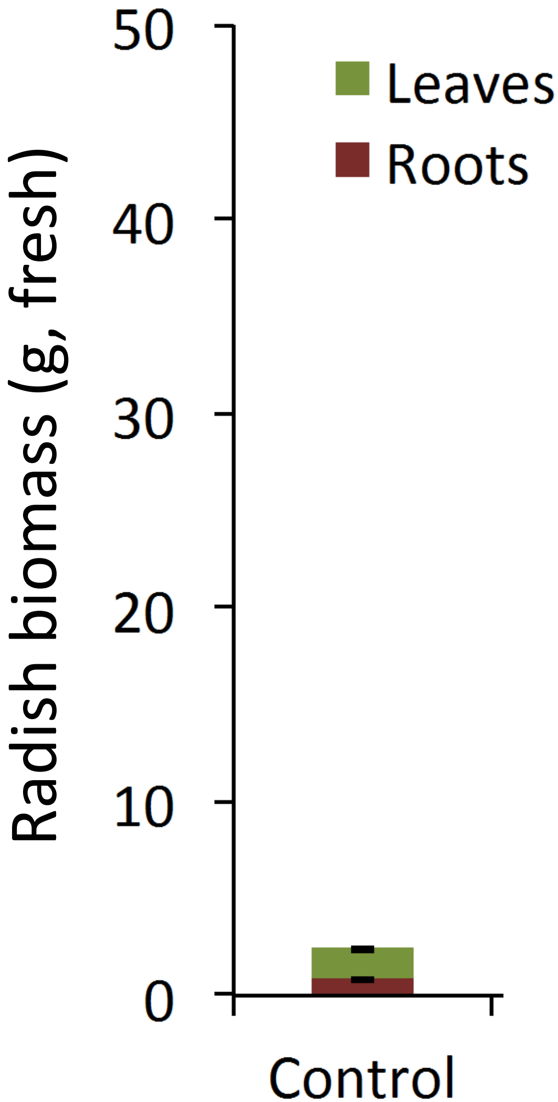
We are measuring:

- Nitrate, ammonium, and phosphate leaching
- Soil greenhouse gas emissions
- Water retention
- Above and below ground crop production
- Crop macro- and micronutrient content
- Soil microbial communities
- Legacy effect (1x application, 2 crop cycles)

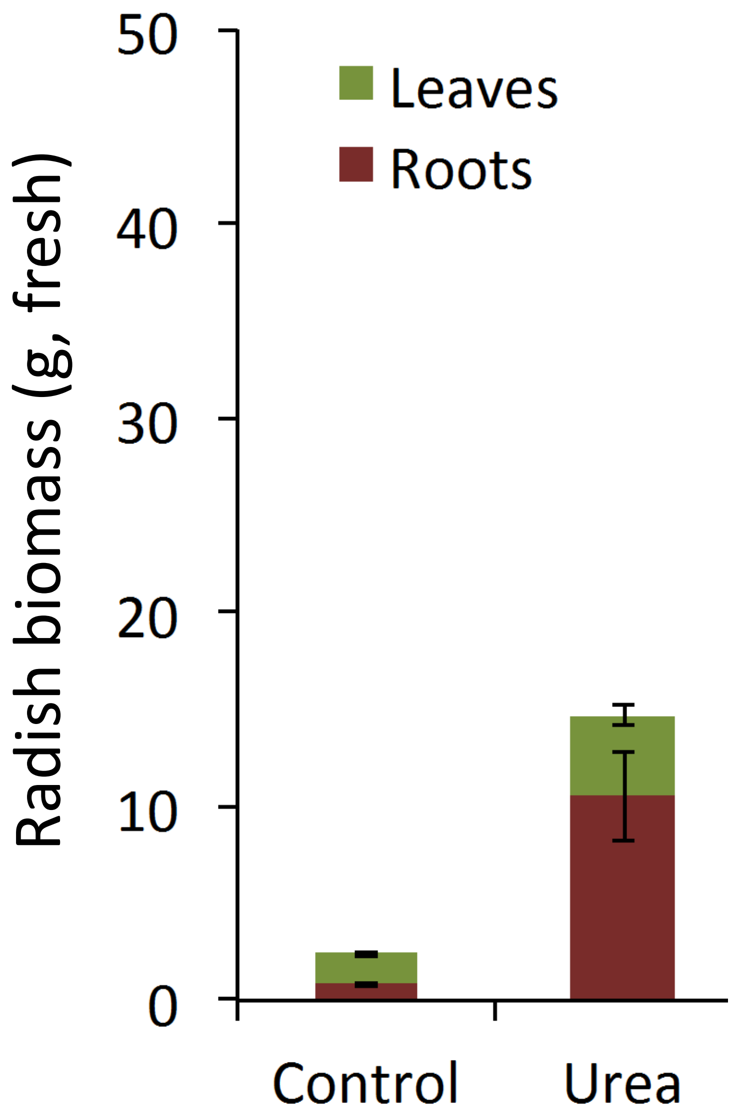
Treatment Groups (N=3; applied at 100 kg PAN/ha):

Unfertilized control
+ Urea
+ EcoSan
+ Biosolids pellets
+ Liquid biofertilizer

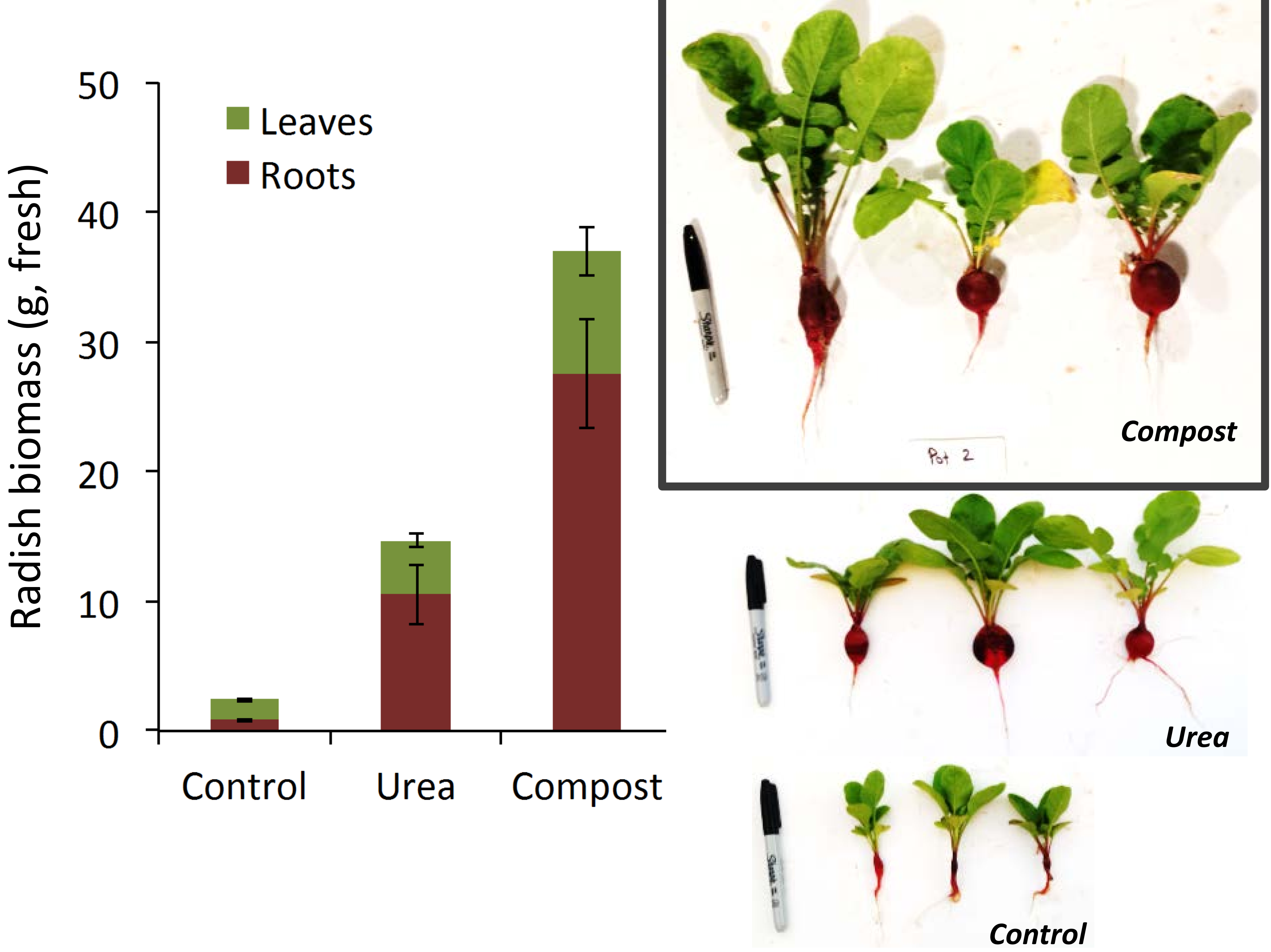




Tropical soils are depleted of nutrients, making it difficult for farmers to grow food without inputs.

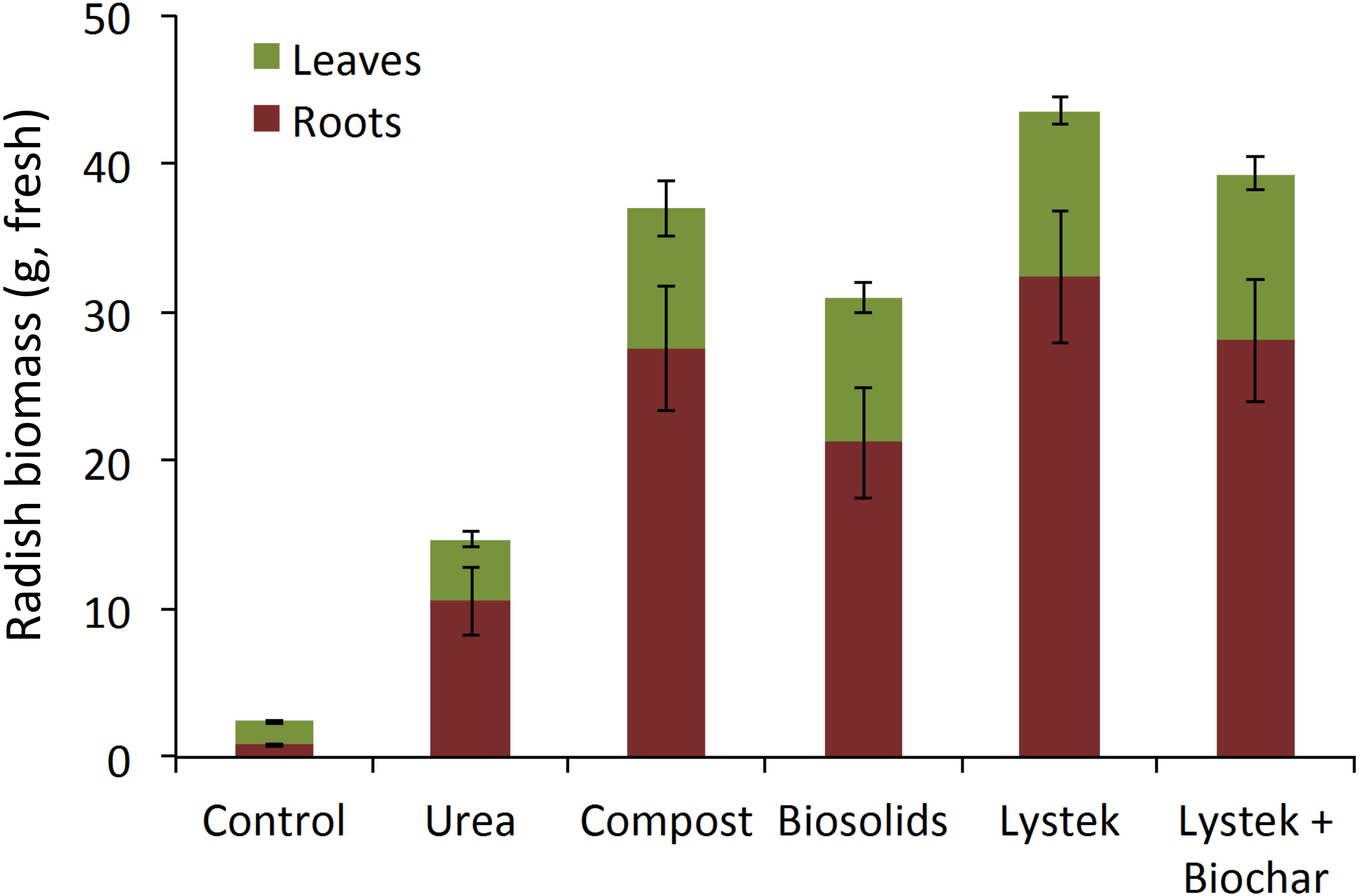


Fertilizer increases production 6-fold compared to unfertilized control.

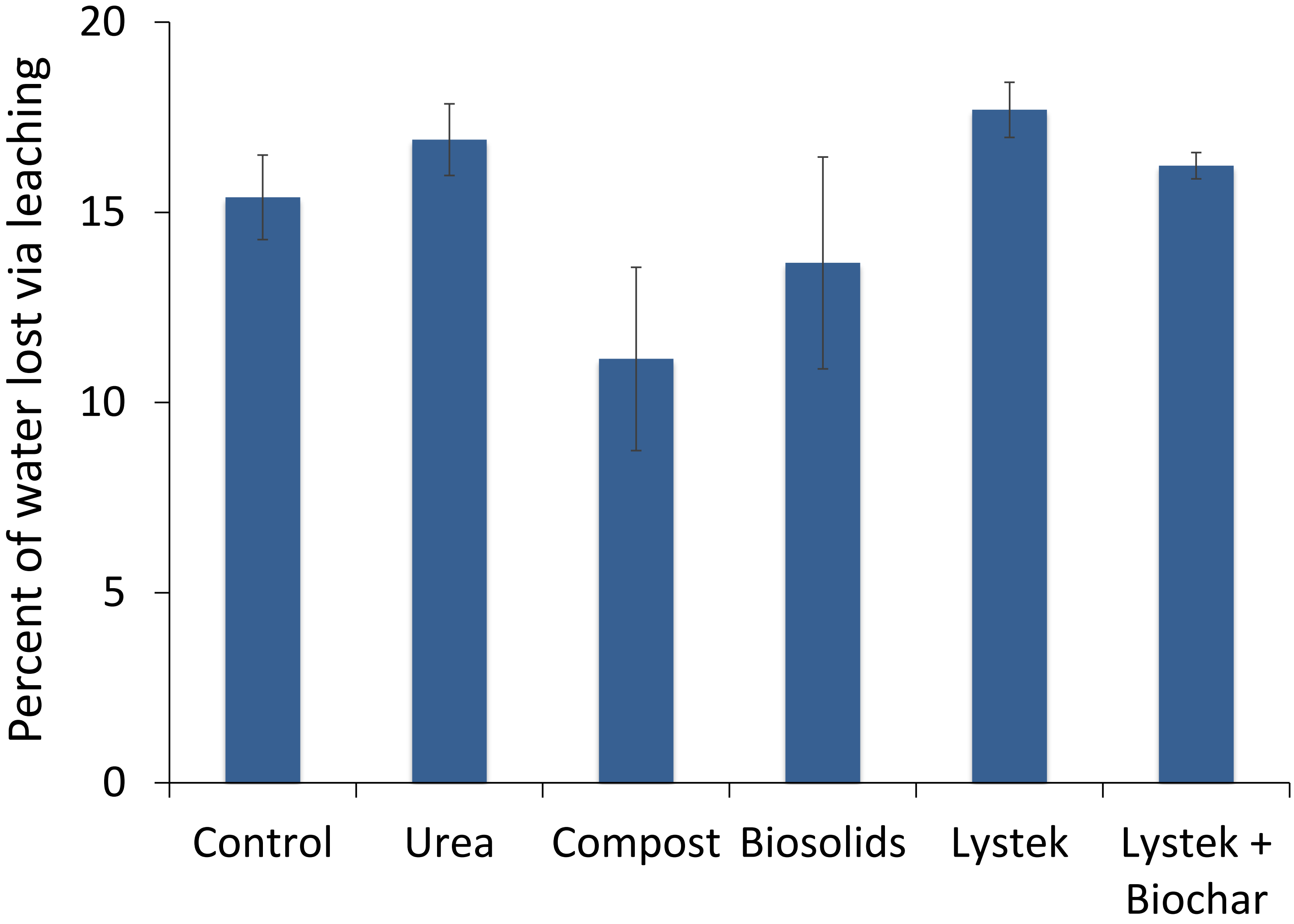


Radish biomass (g, fresh)
0
10
20
30
40
50
Leaves
Roots
Control
Urea
Compost
Pot 2
Compost
Urea
Control

Amendments derived from human organics boost crop yields by 2 to 3x compared to urea



Composted feces and biosolids reduce the amount of leachate and increase soil water retention



Preliminary results and next steps

- Organic amendments improve crop nutrient uptake and growth.
- Soil water retention is improved with organic matter amendments.
- Experiment is on-going. Many more results to come, including crop nutrient content, soil aggregation, soil carbon and nitrogen, plant available nitrogen, and soil greenhouse gas emissions.
- Results from greenhouse experiment will be used to inform field experiment in California to refine understanding of best use and management of biosolids and other human organic amendments.

THE SAME PEOPLE
AT SAME PLACE
DOING THE
SAME THING,
WITH A NEW IDEA.

DAMS

“Billions and billions of tons of what had been free-flowing water is now sequestered in set locations around the middle latitudes,
moving it away from the equator.
Furthermore, most of the dams are at
high altitudes, not sea level.
This shift of mass towards the axis has fundamentally changed the wobble of the earth.
This has proved that we have the power to change even the motion of the earth itself.” DR. IAIN STEWART