CALIFORNIA BIORESOURCES ALLIANCE

11^{TH} ANNUAL SYMPOSIUM WEST SACRAMENTO

NOVEMBER 1^{st} 2016

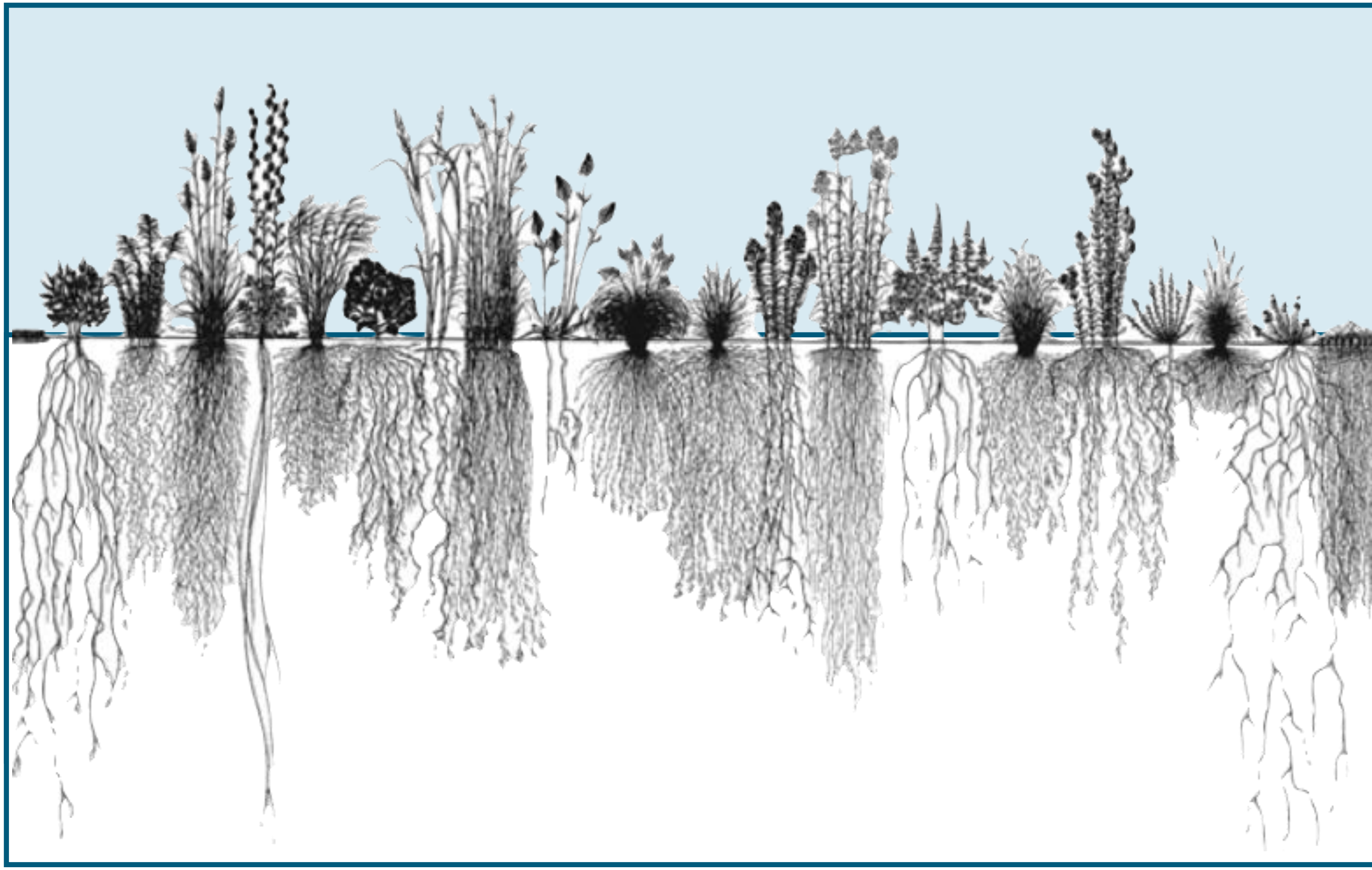
REVERSING GLOBAL WARMING


SAN FRANCISCO

Idaho Fescue *(Festuca idahoensis)*

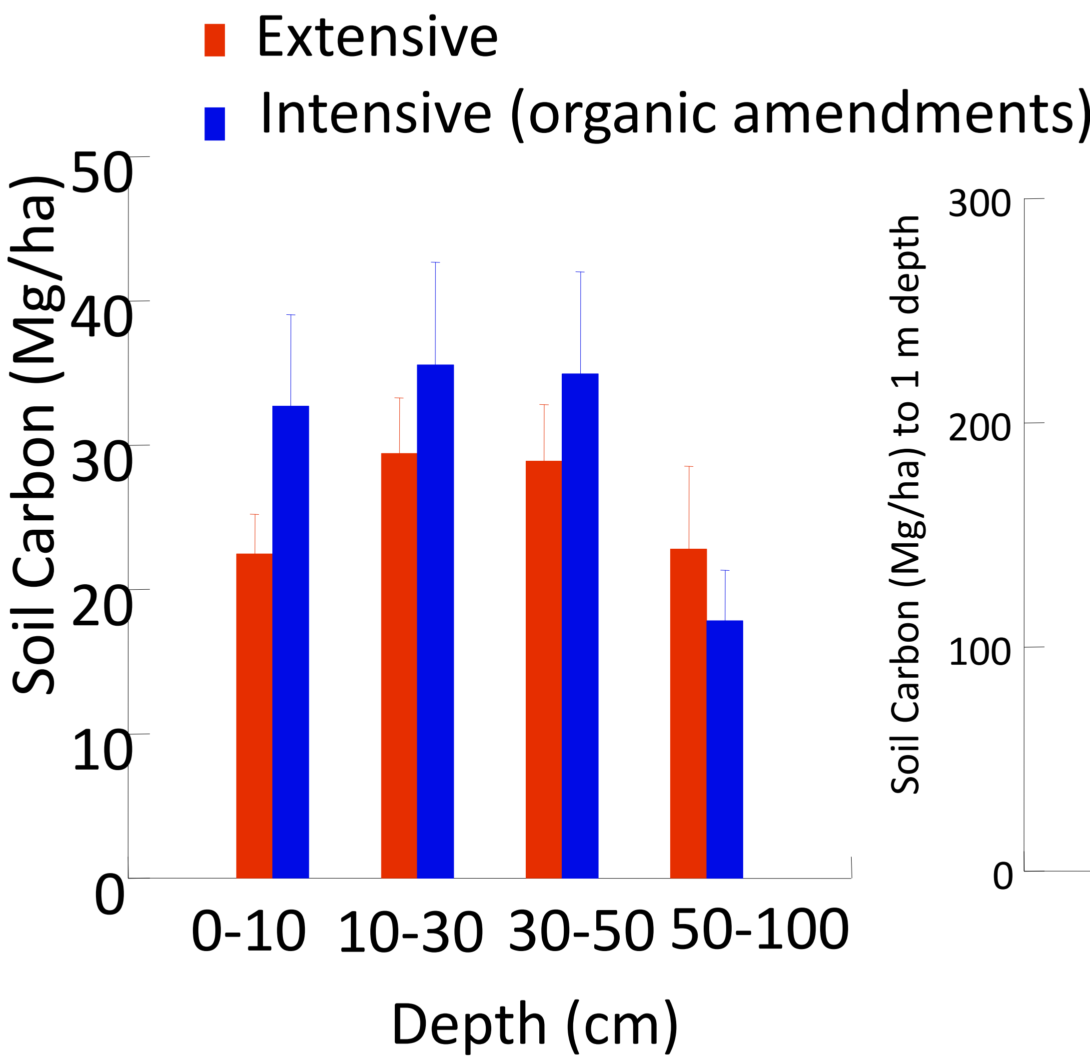
Grass plants are straws
that sip carbon from the air.

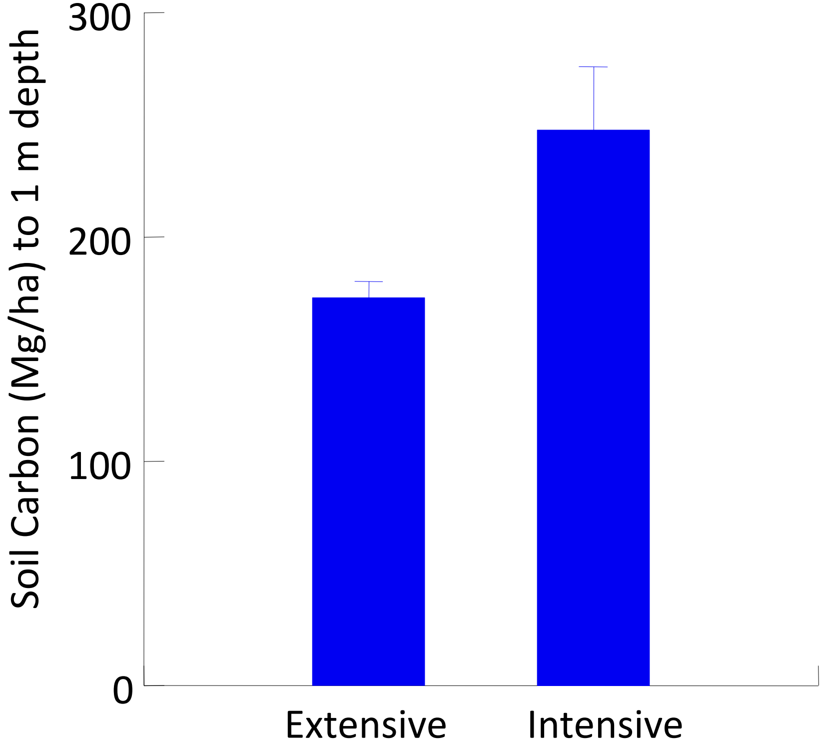
Grasslands store one-third of the world's soil carbon



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

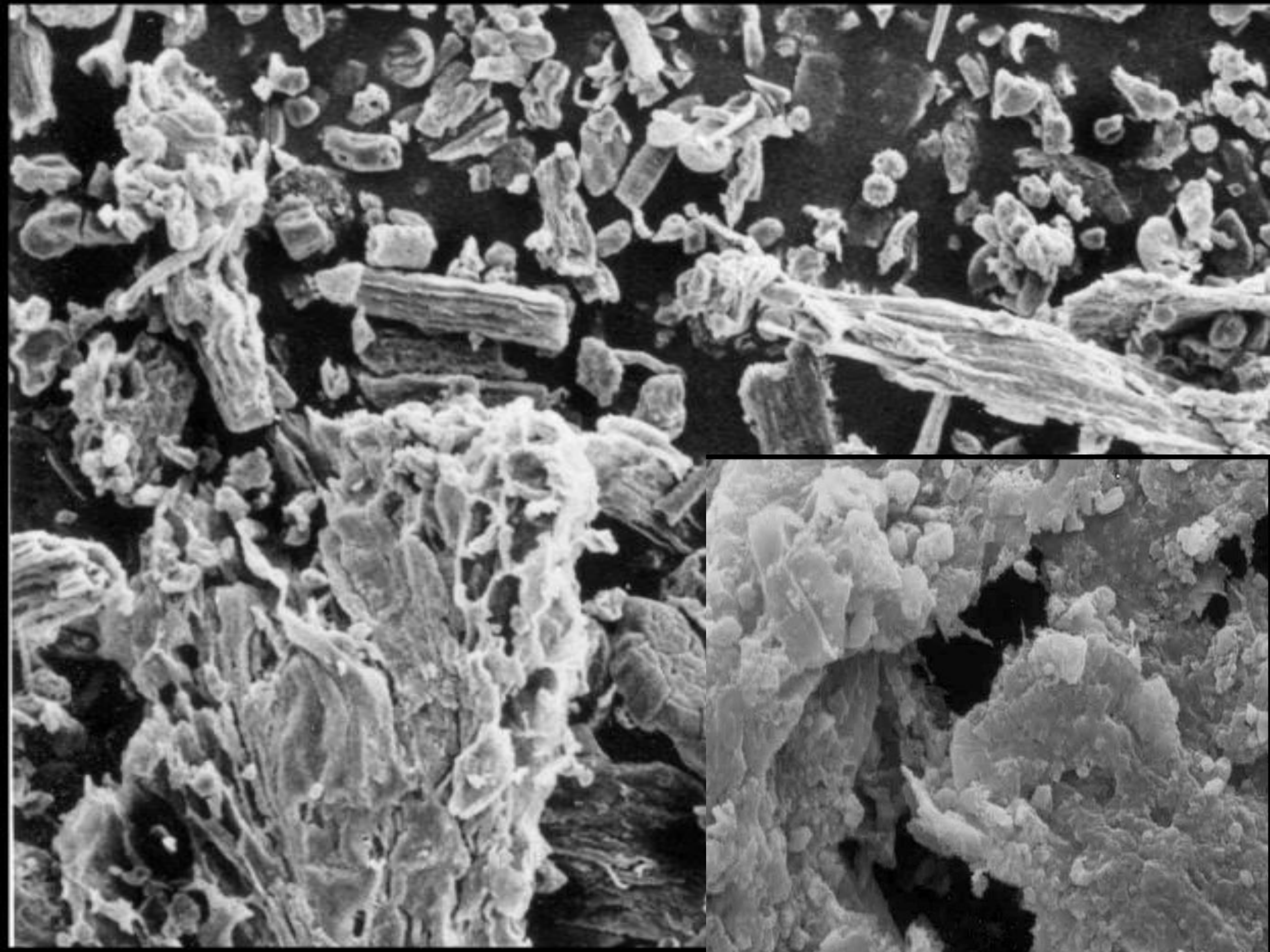
Organic amendments increased soil carbon by 50 Mg C ha^{-1} in the top meter of soil

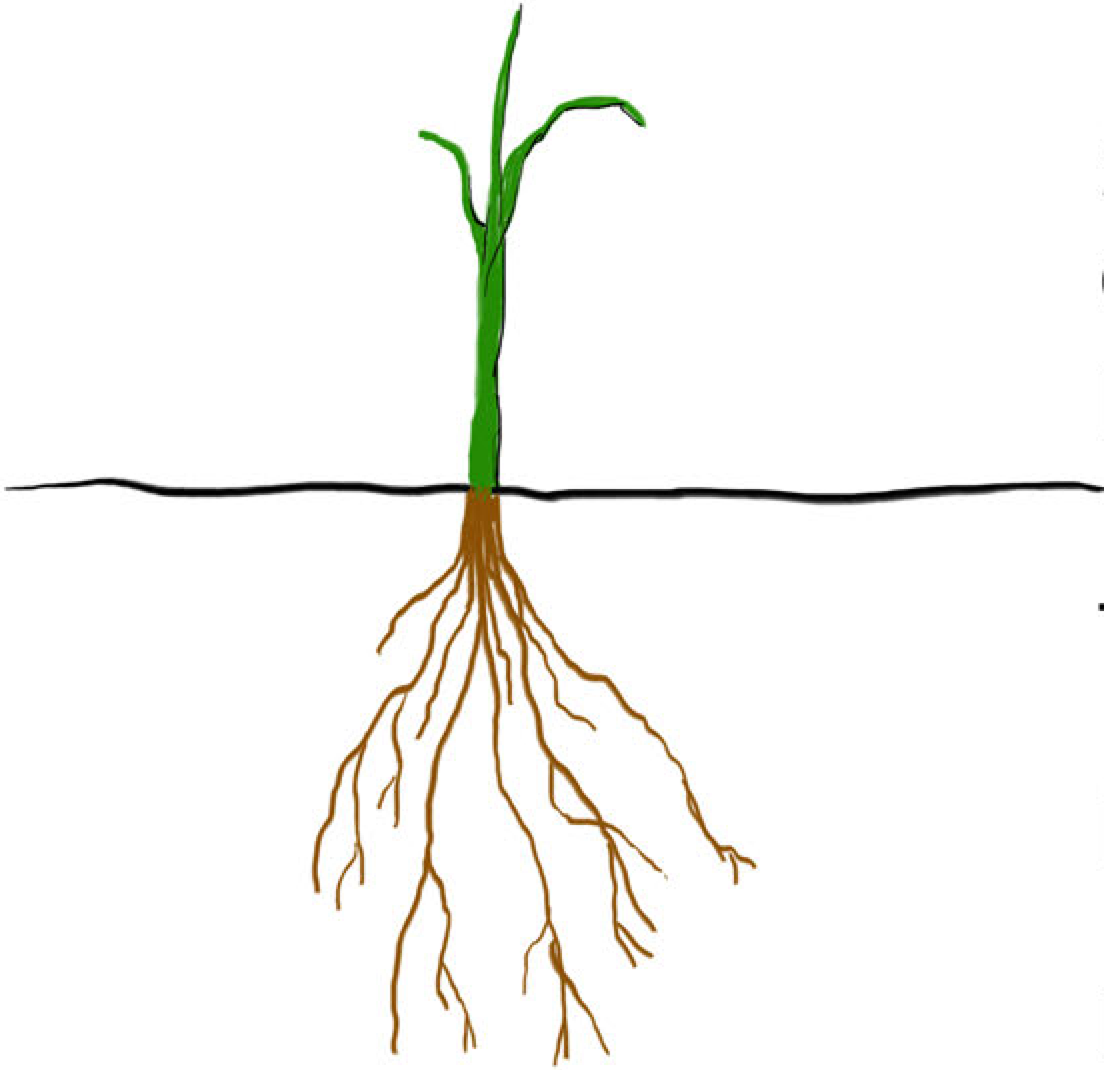




In 1996, French Nuclear testing
Released a very unique Carbon Isotope
Into the atmosphere.
Scientists use this isotope as a
“Distinct Time Stamp.”

“We were looking for a needle
in a haystack,
and we found **bricks**
of 10 year old French carbon
a meter deep
in Marin County soils!”



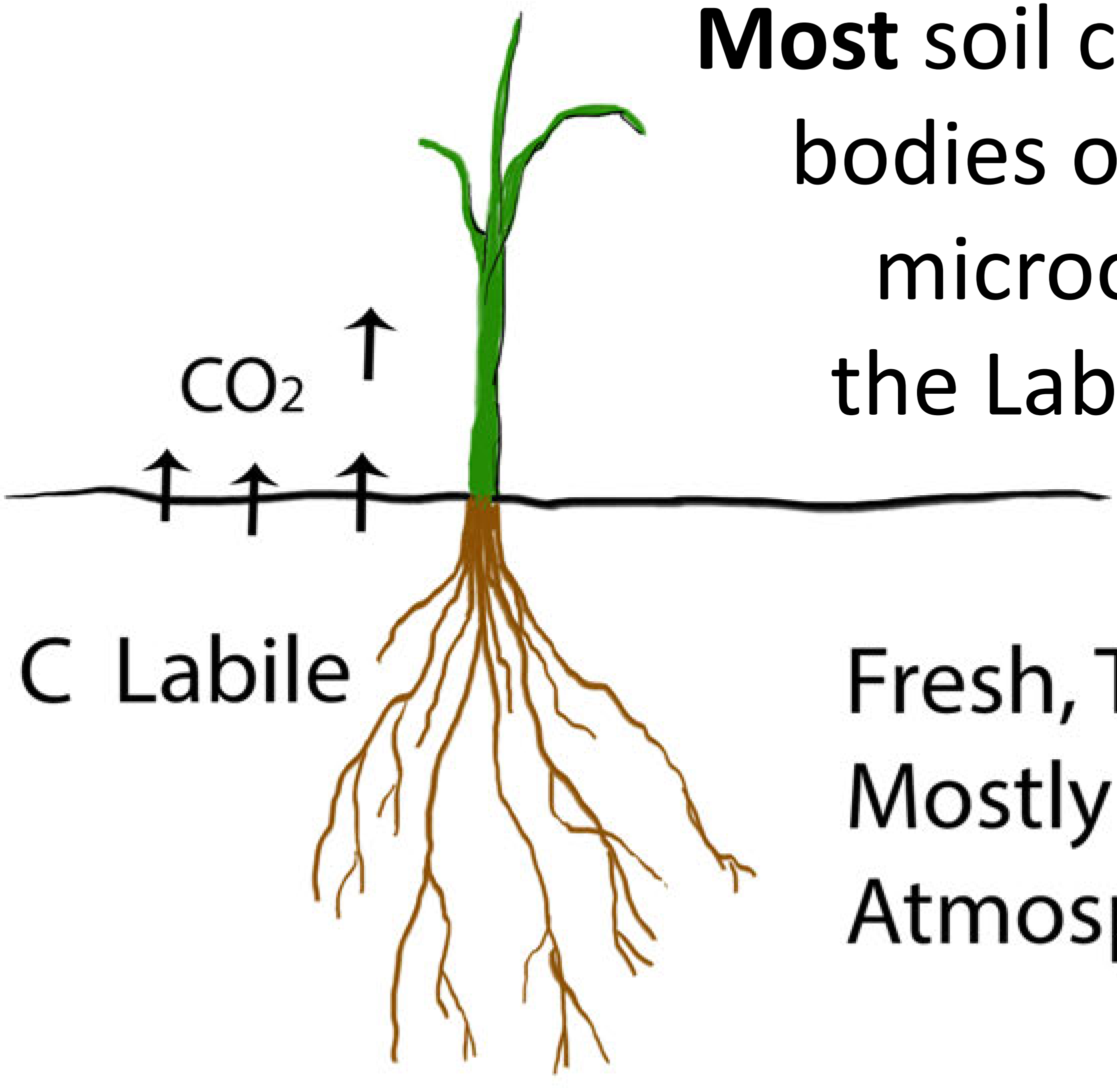


SOIL
CARBON
FRACTIONS:

TEMPORARY

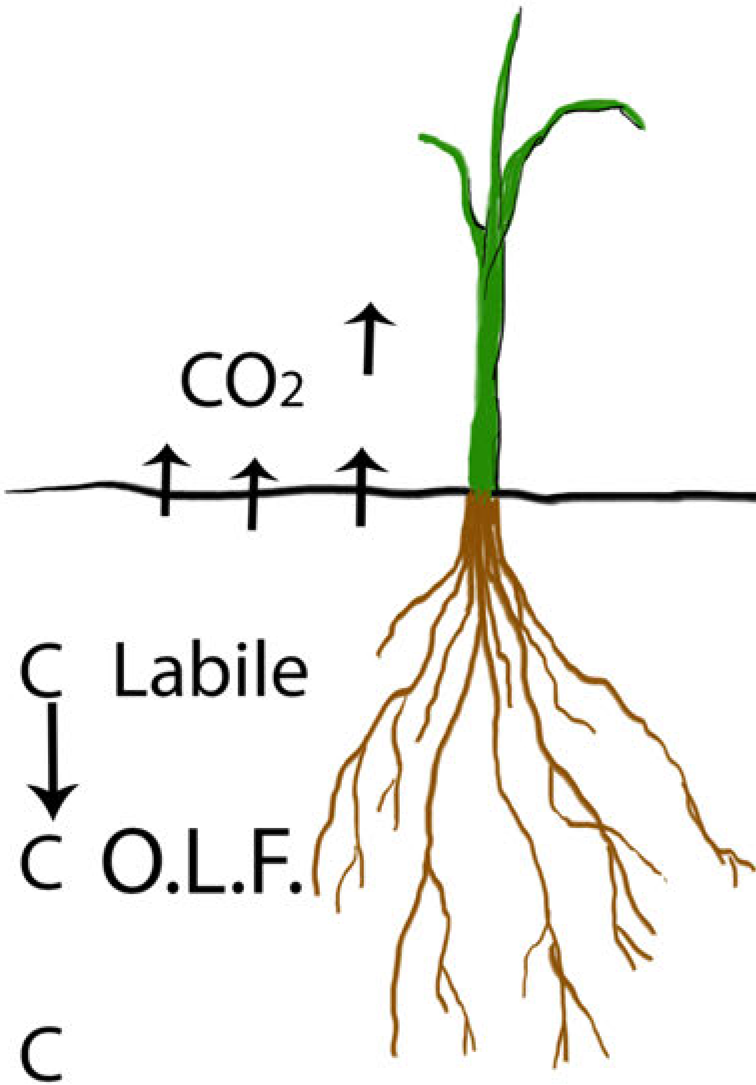
DECADES

PERMANENT



Most soil carbon is in the bodies of plants and microorganisms, the Labile fraction.

Fresh, Temporary, Mostly Returns to the Atmosphere as CO_2.

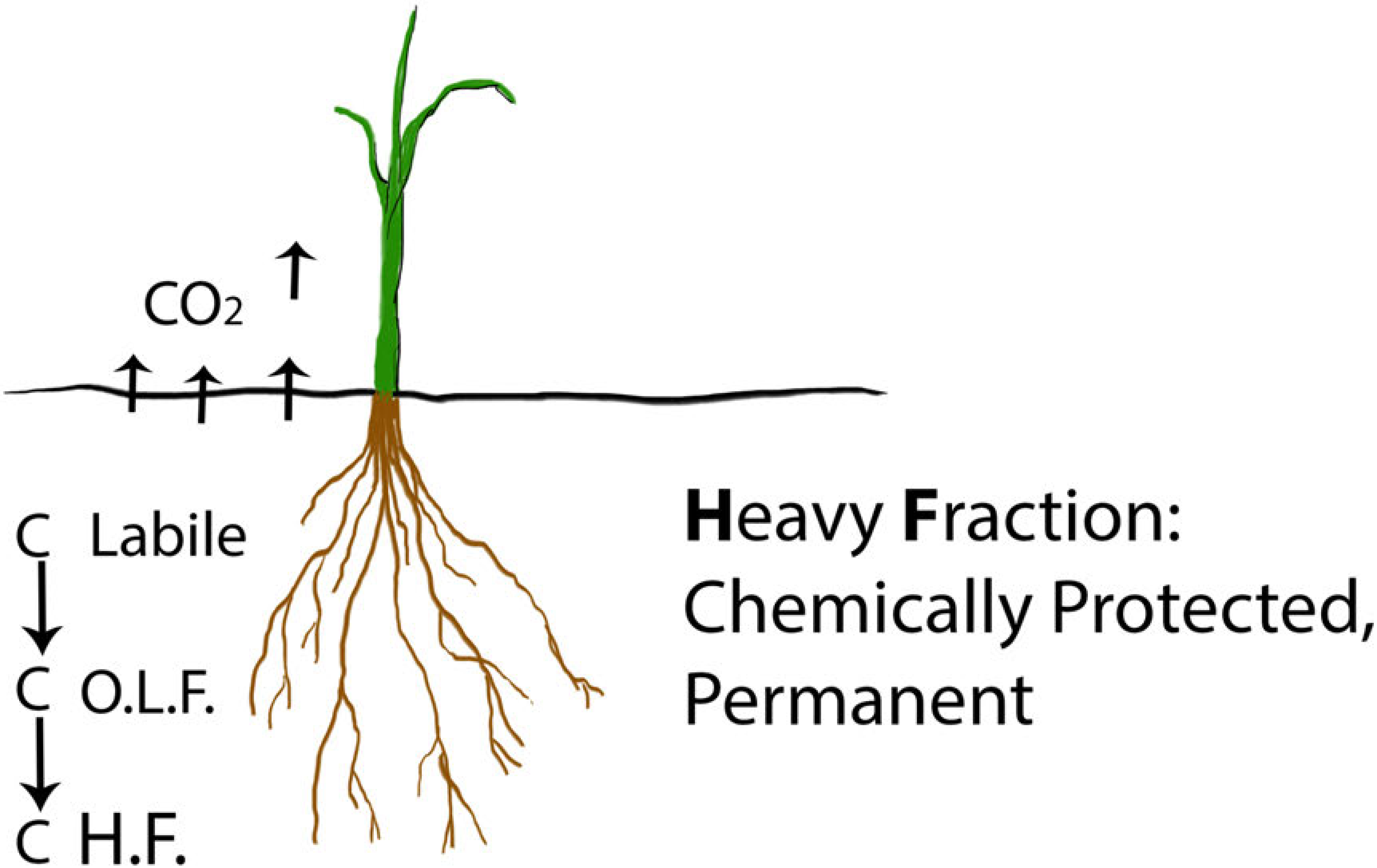


Occluded **L**ight **F**raction:

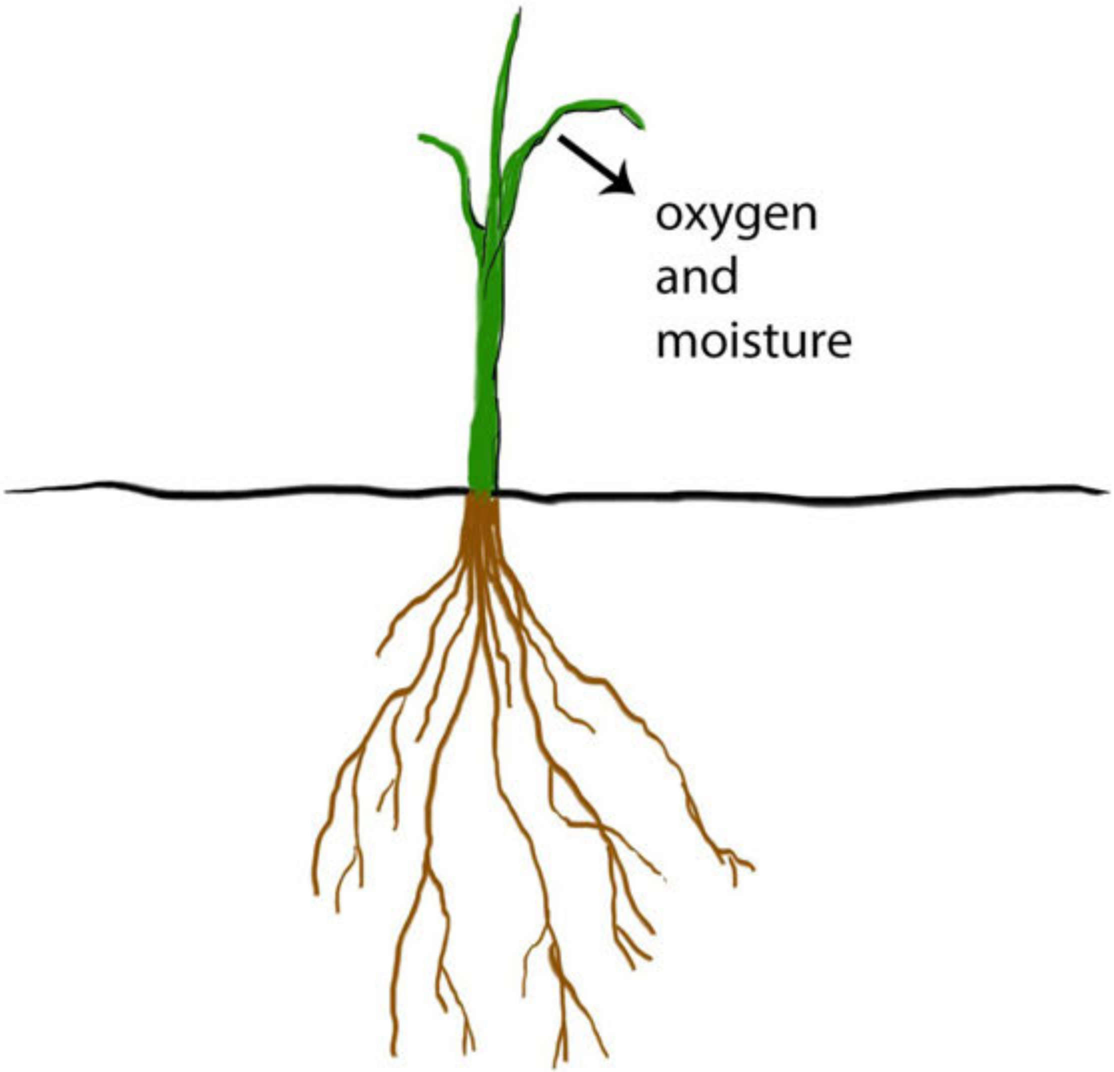
-Physically Protected

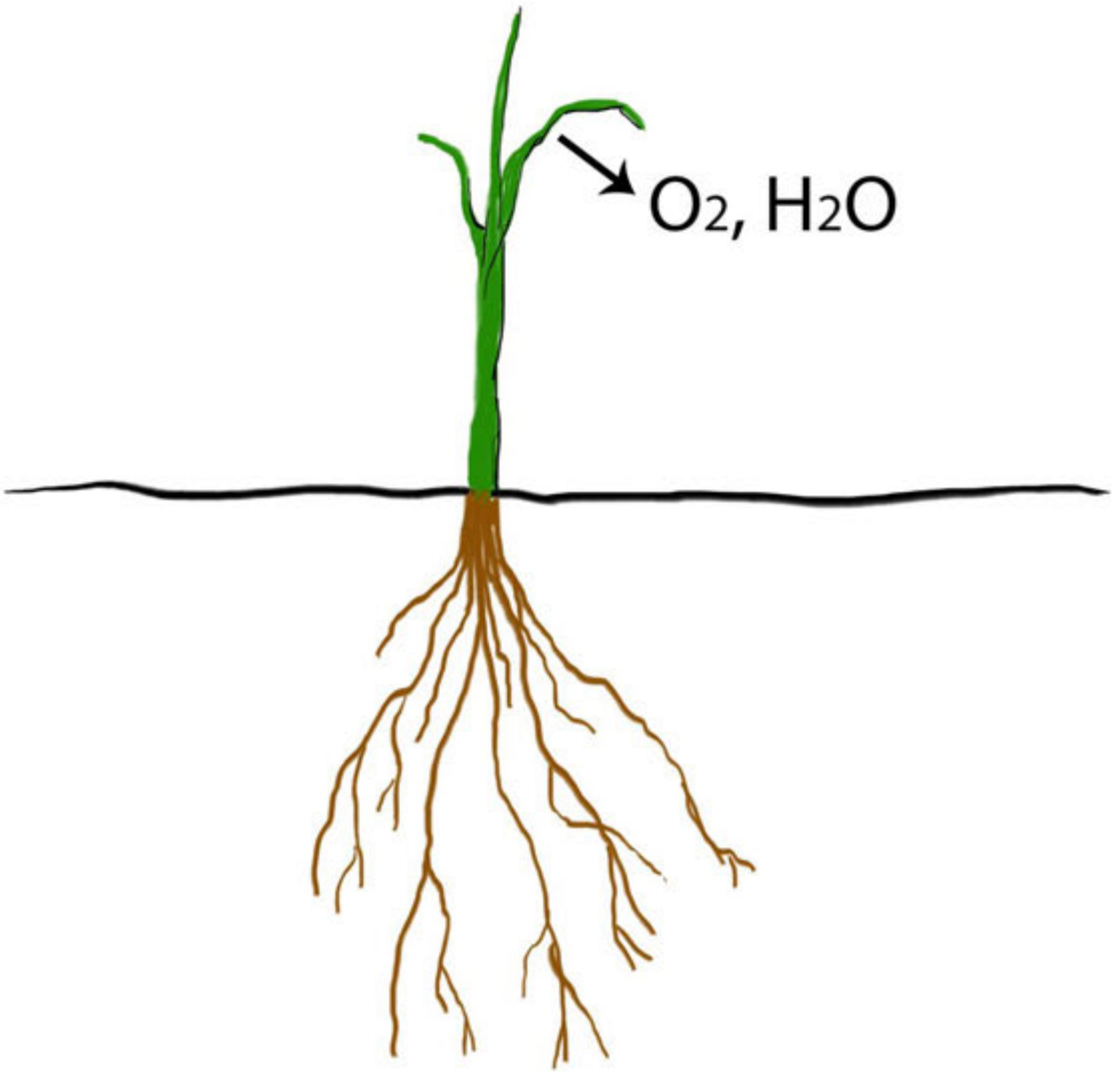
-Lasts Decades

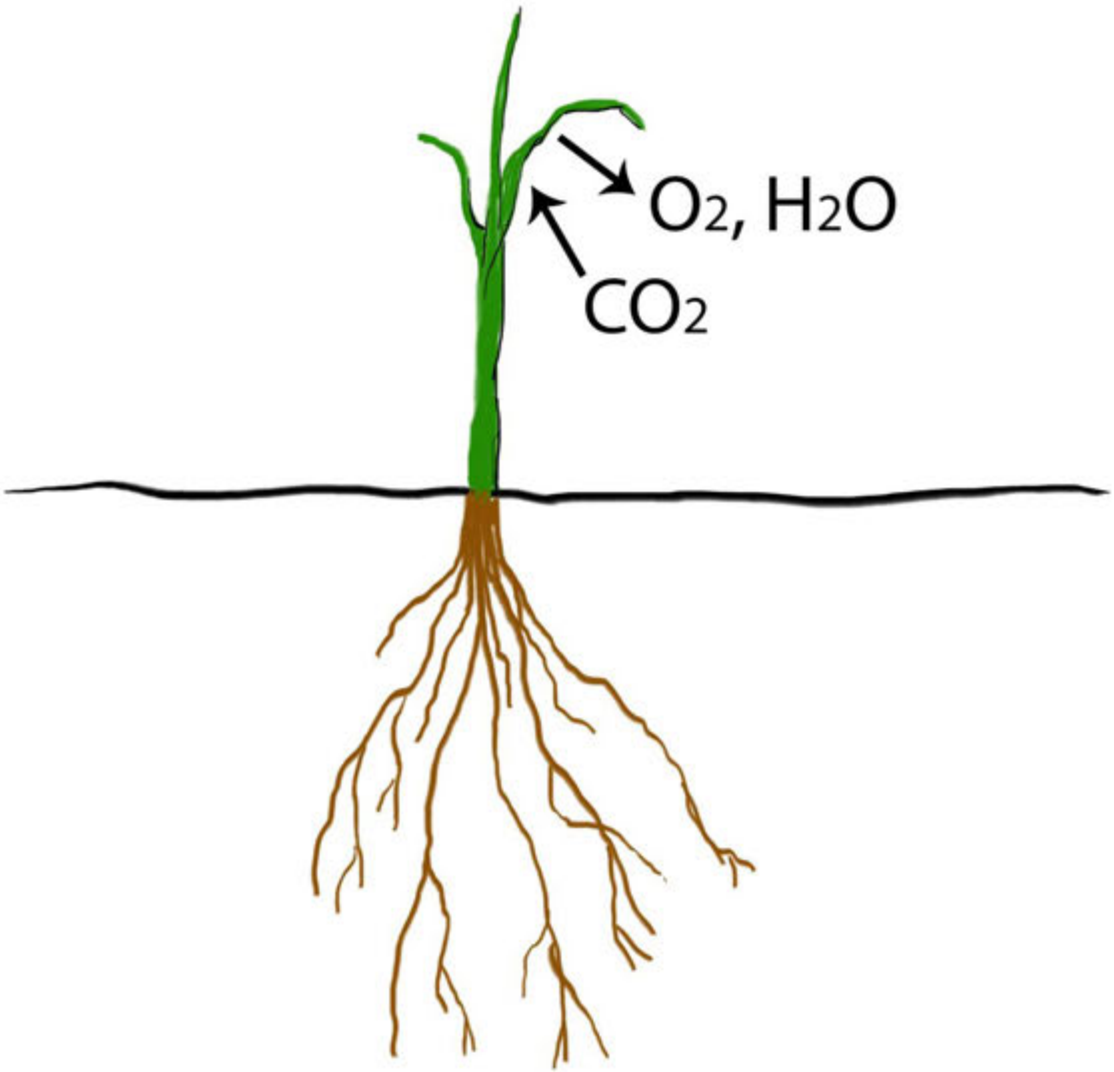
-Holds Lots of Water



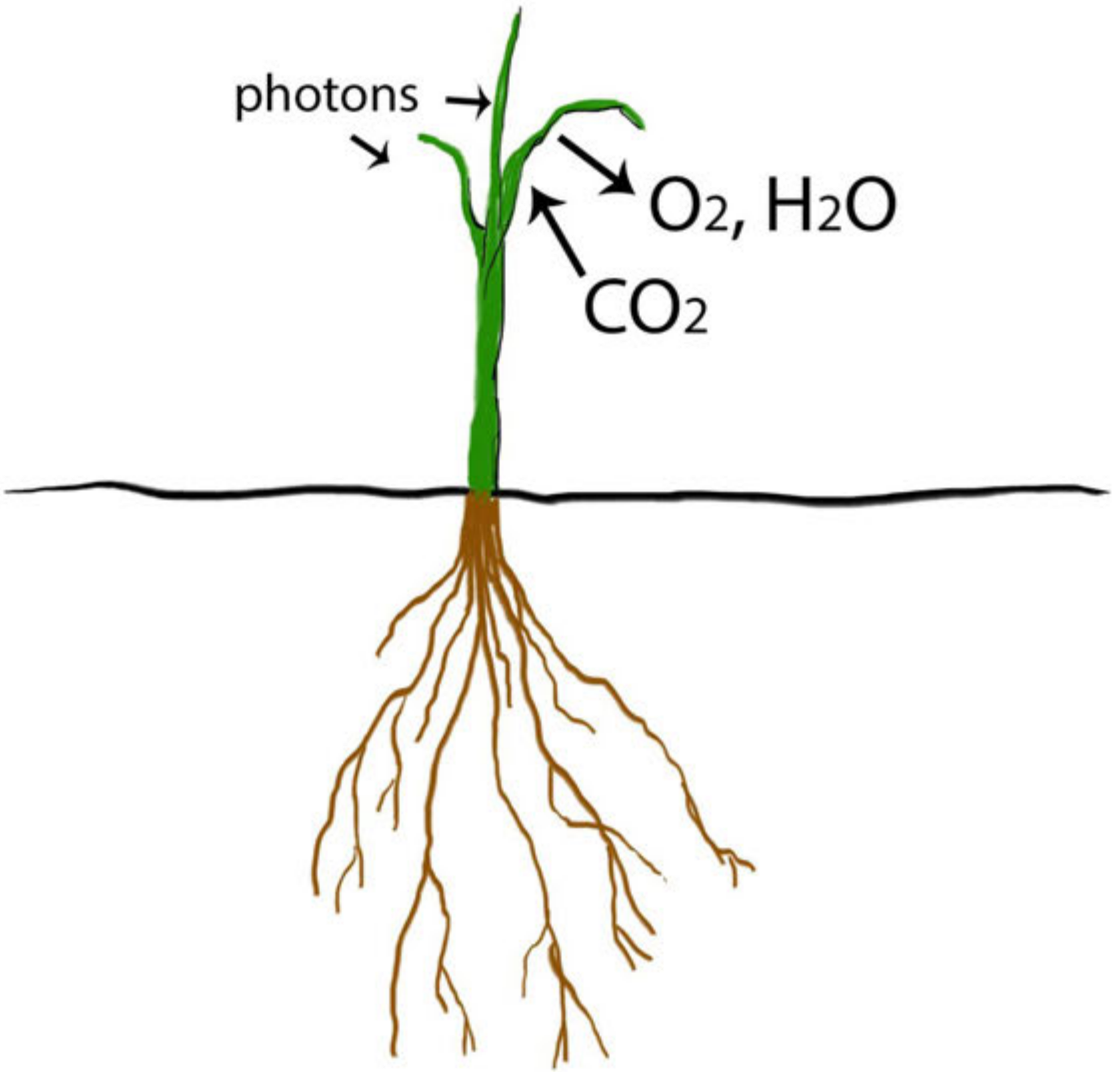
CO2
C Labile
C O.L.F.
C H.F.
Heavy **F**raction:
Chemically Protected,
Permanent

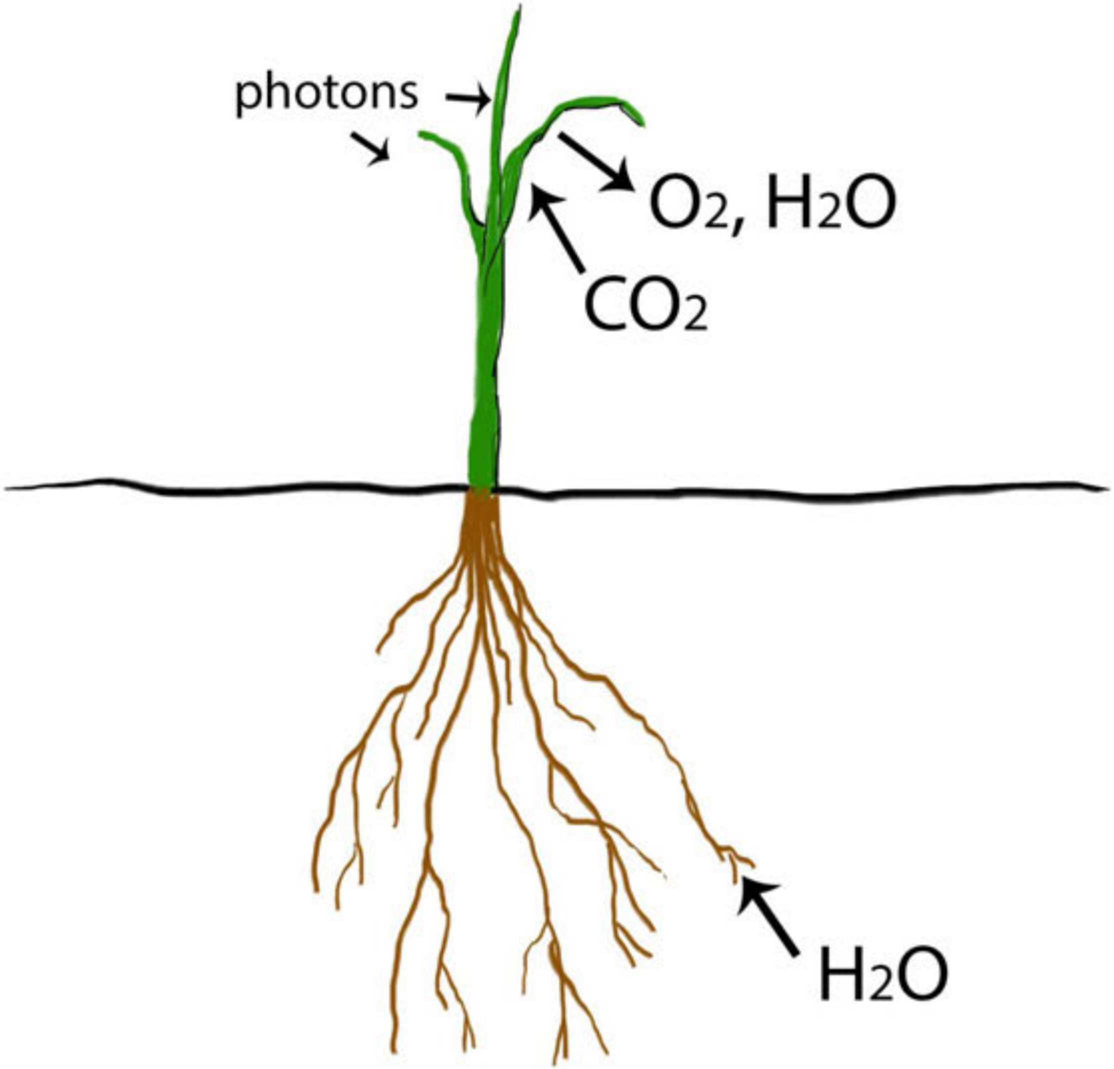

oxygen
and
moisture

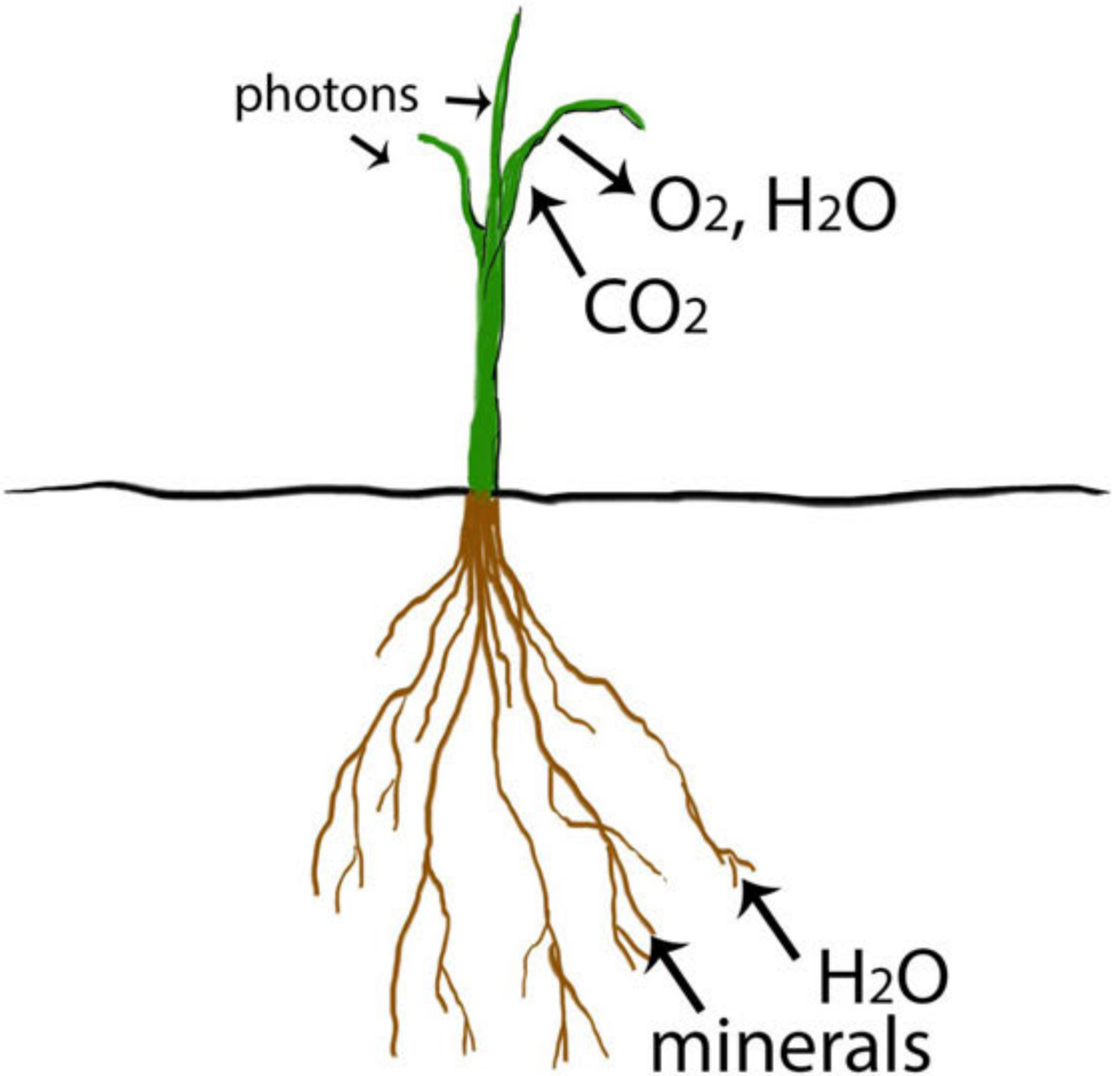

O2, H2O

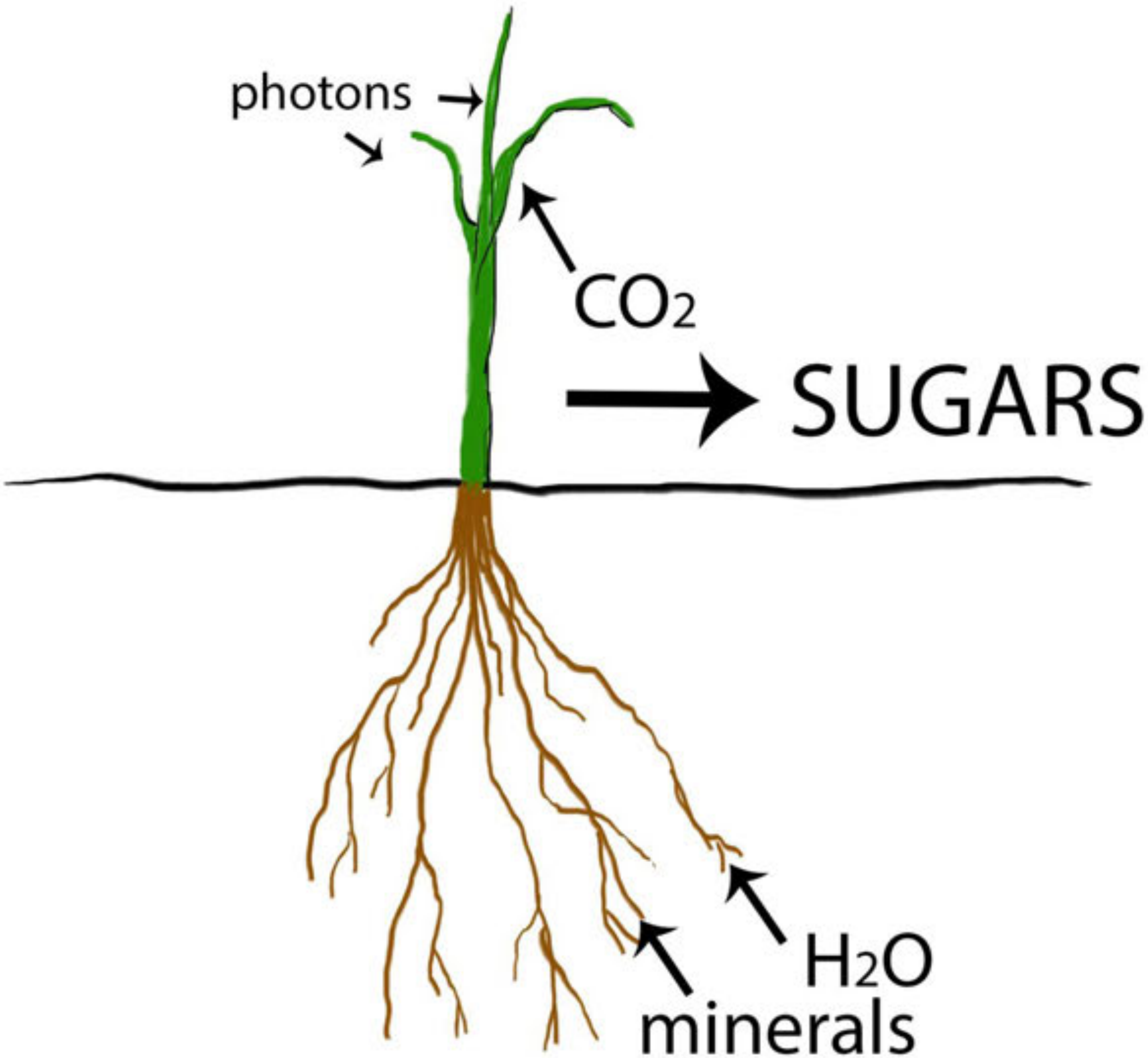


O_2, H_2O
CO_2

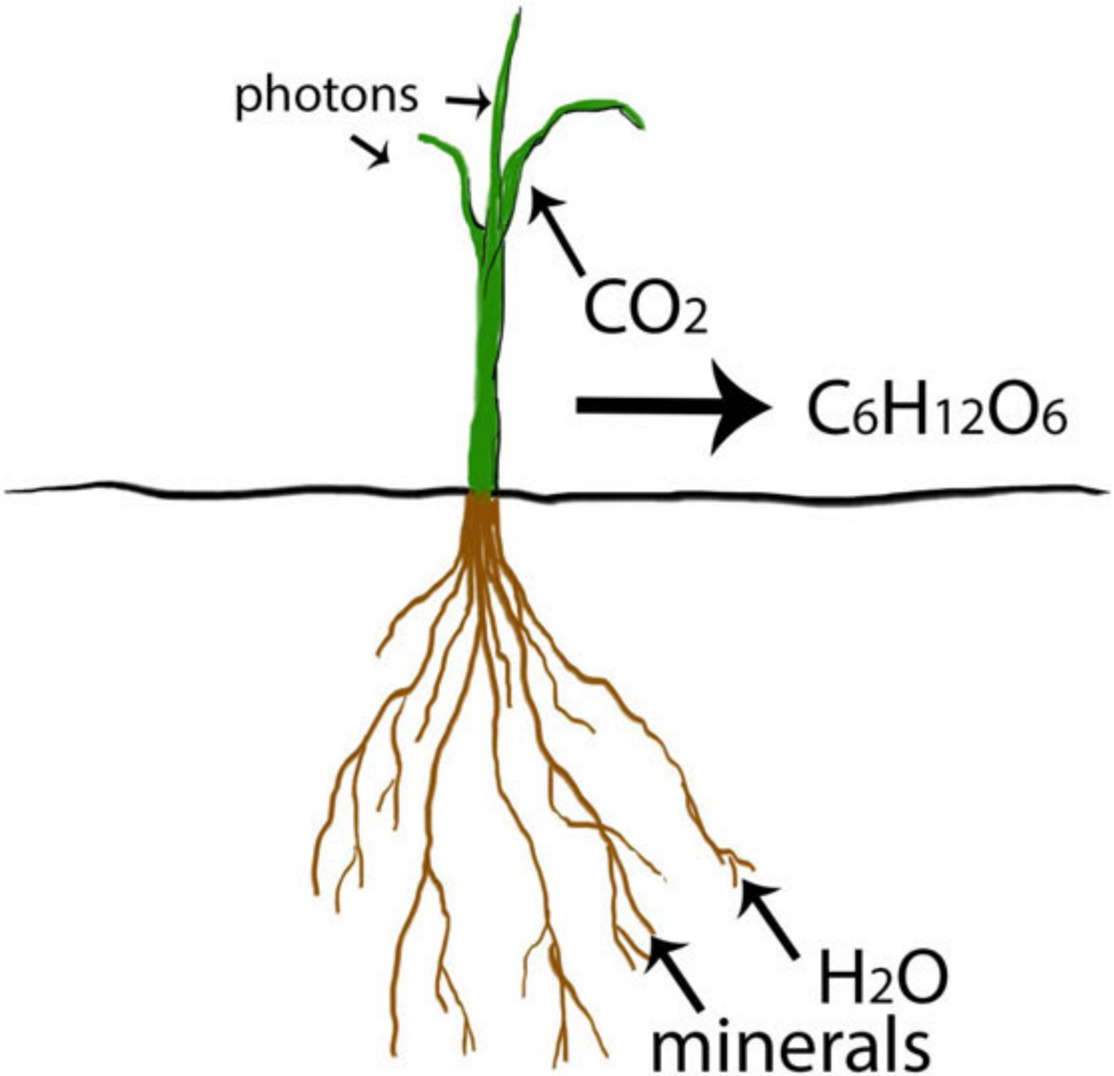

photons
O2, H2O
CO2

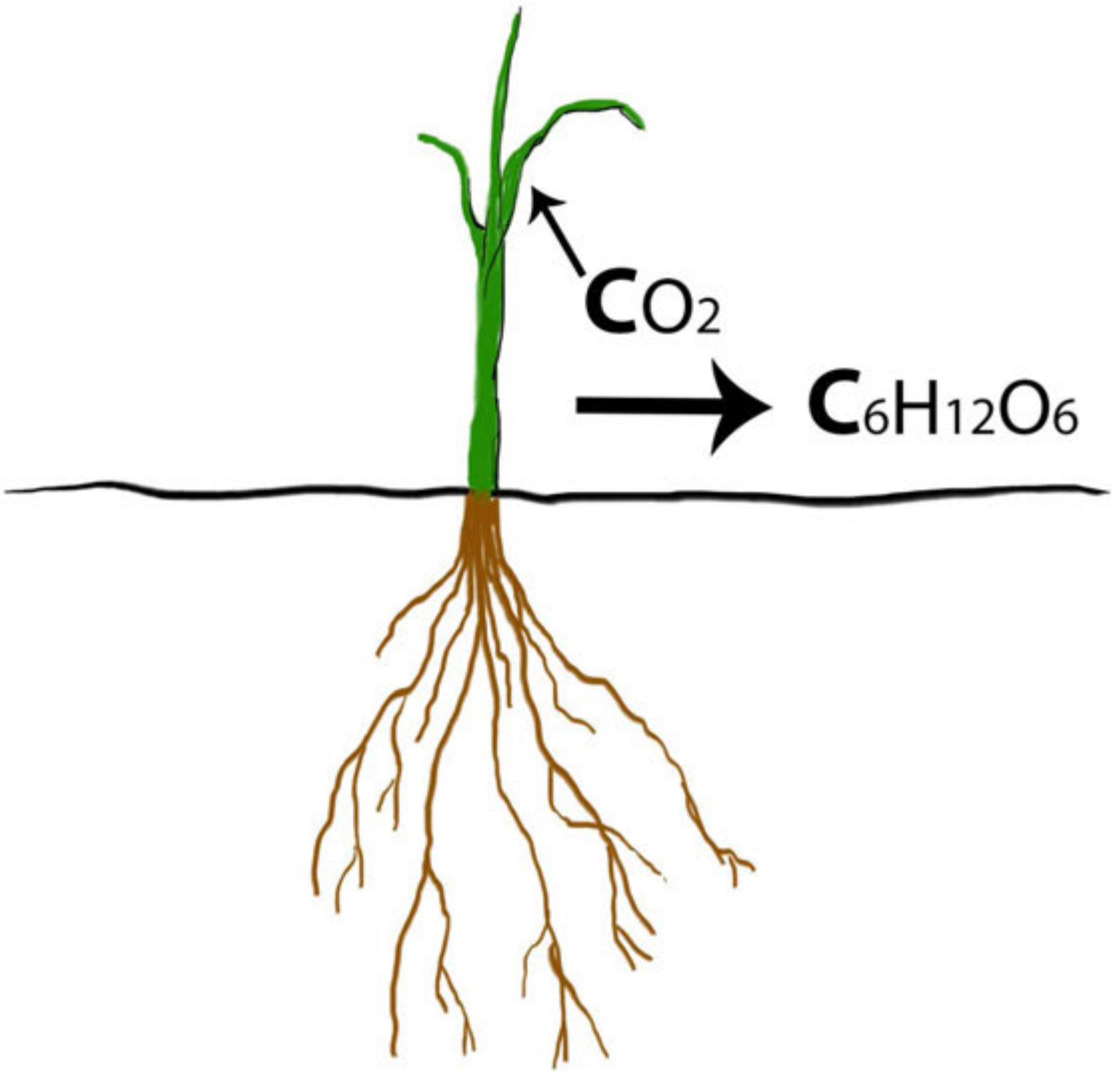

photons
O2, H2O
CO2
H2O


photons
O_2, H_2O
CO_2
H_2O
minerals

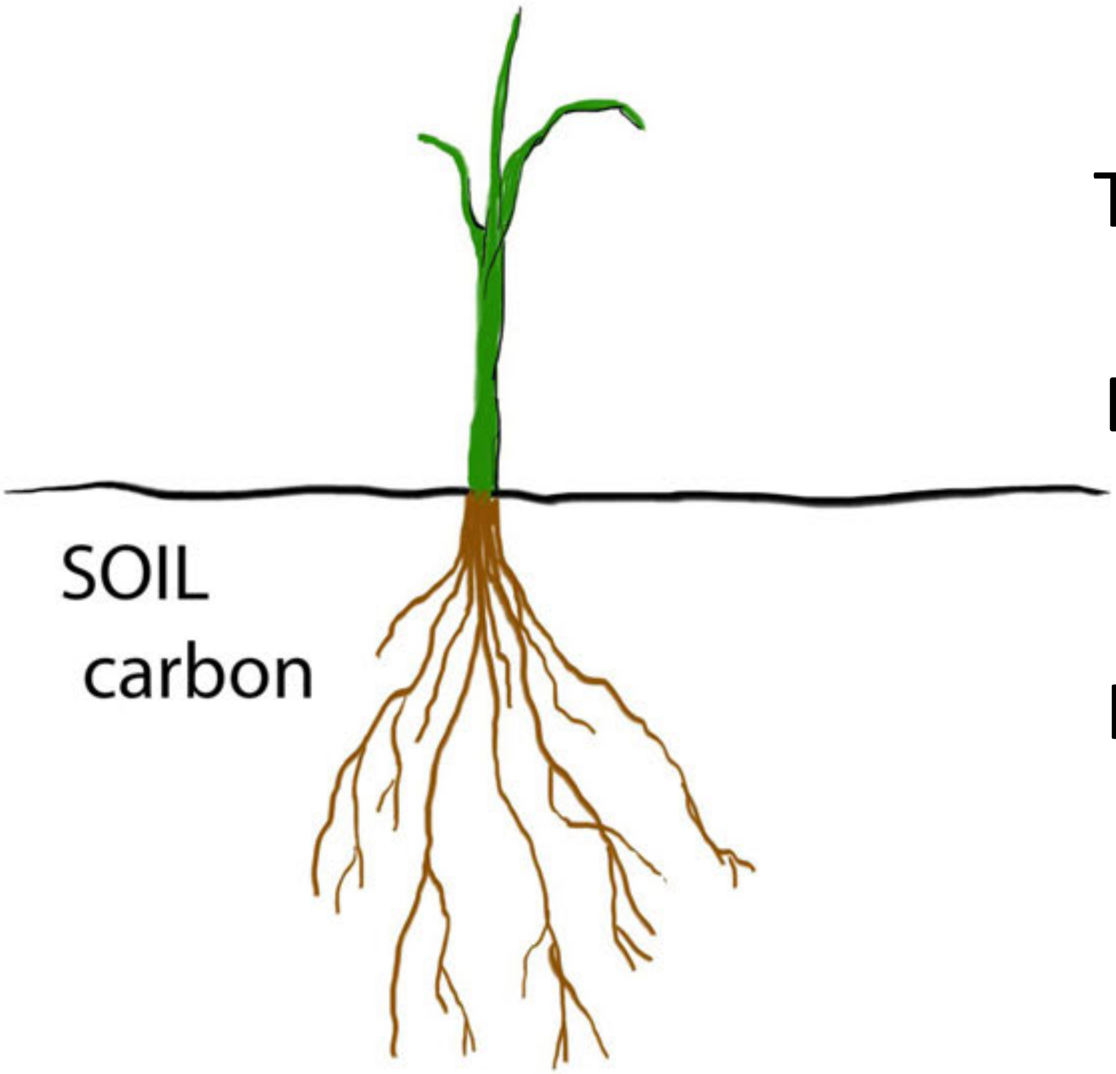


photons
CO_2
SUGARS
H_2O
minerals

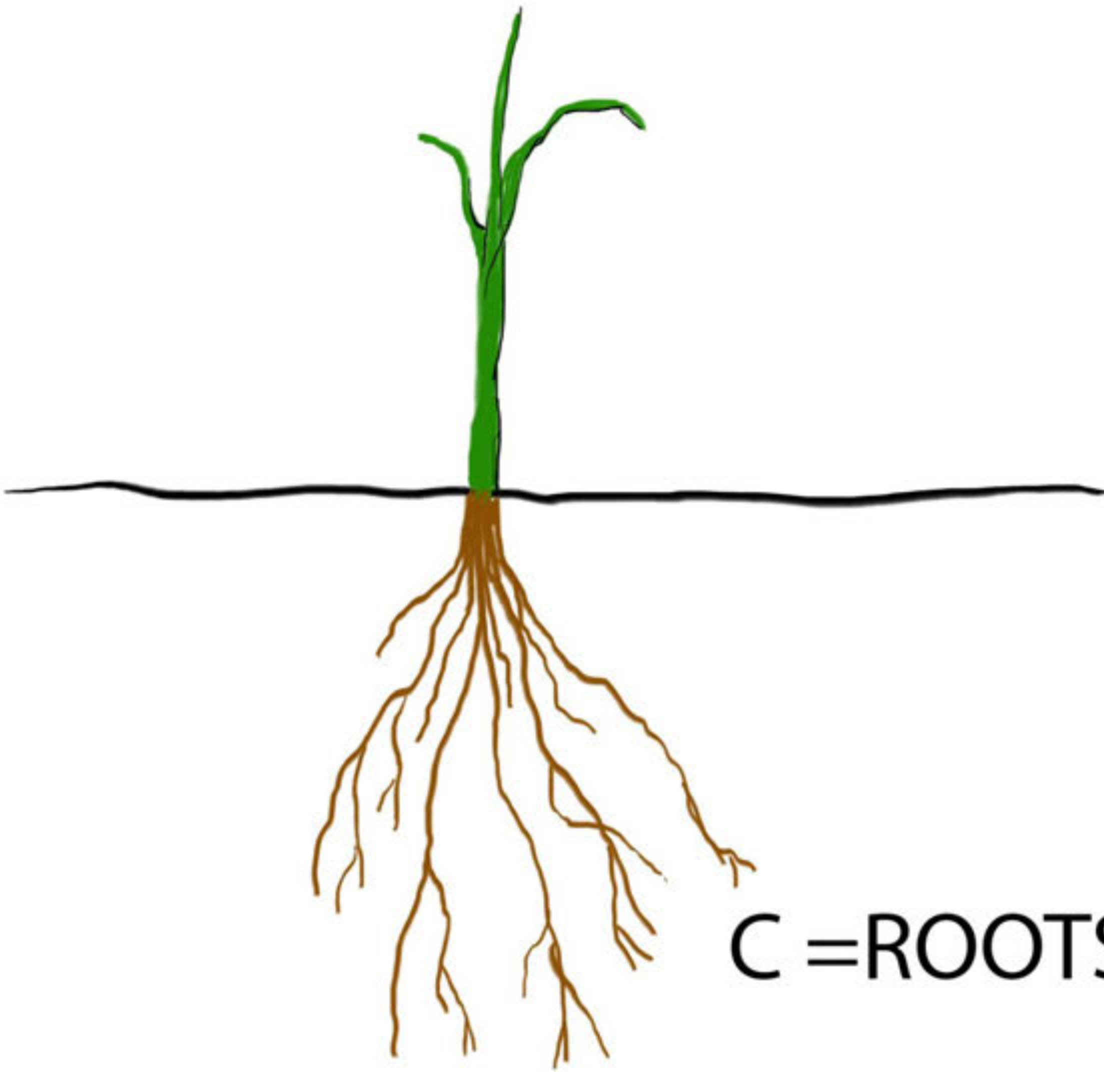

photons
CO_2
$C_6H_{12}O_6$
H_2O
minerals



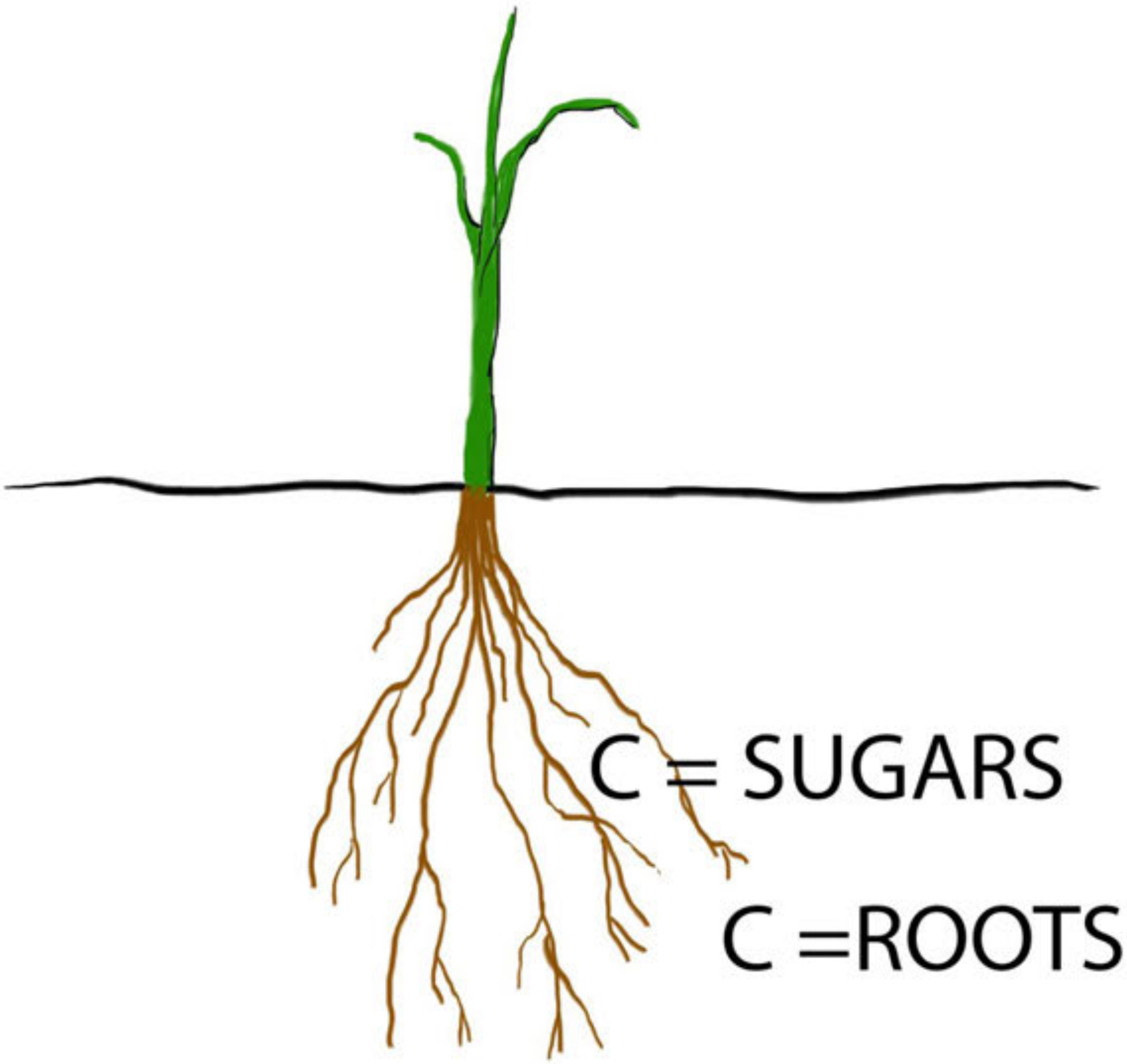
ALL OF THE
CARBON
IN
CARBOHYDRATES
COMES FROM
THE **AIR.**

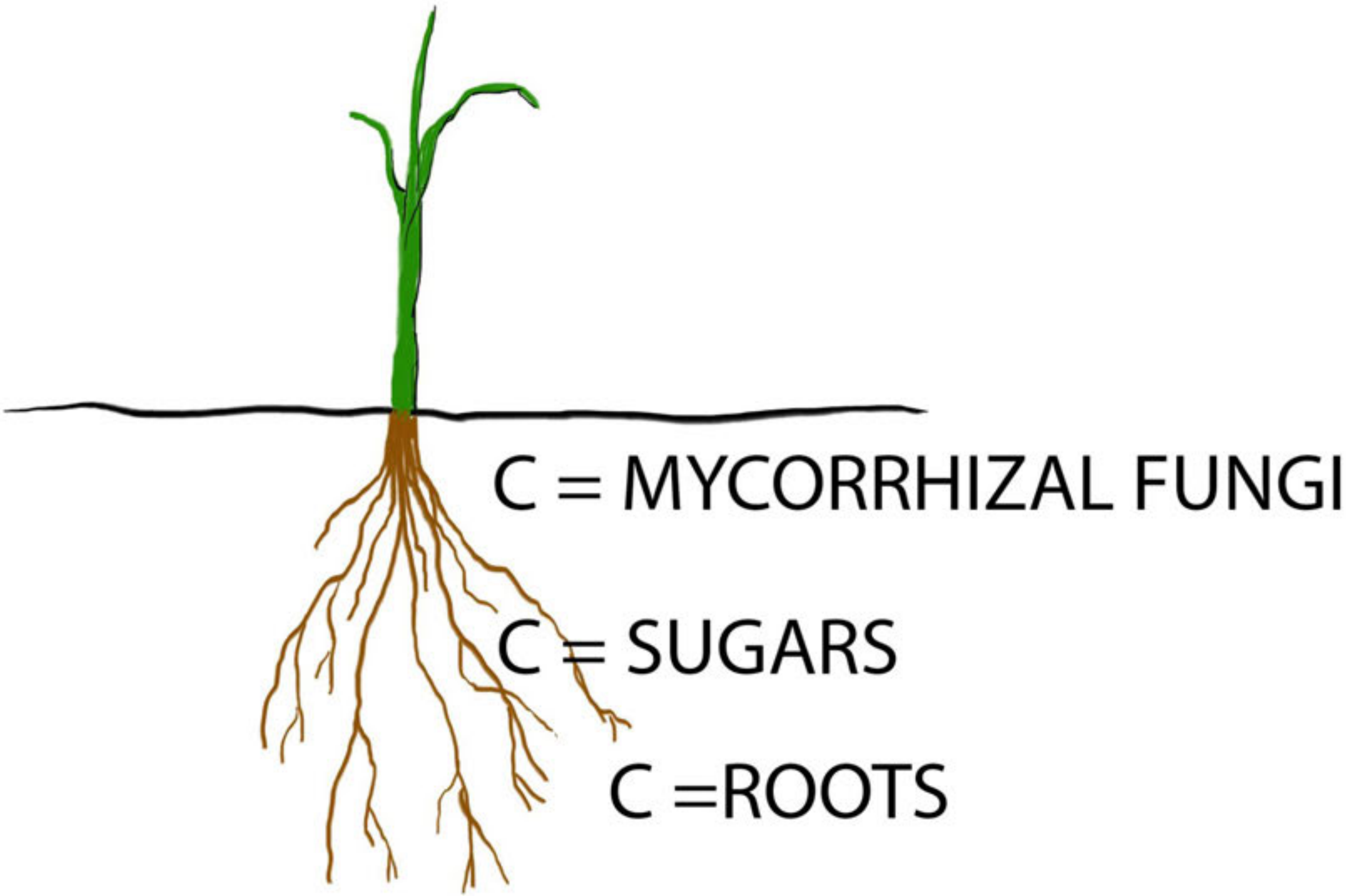


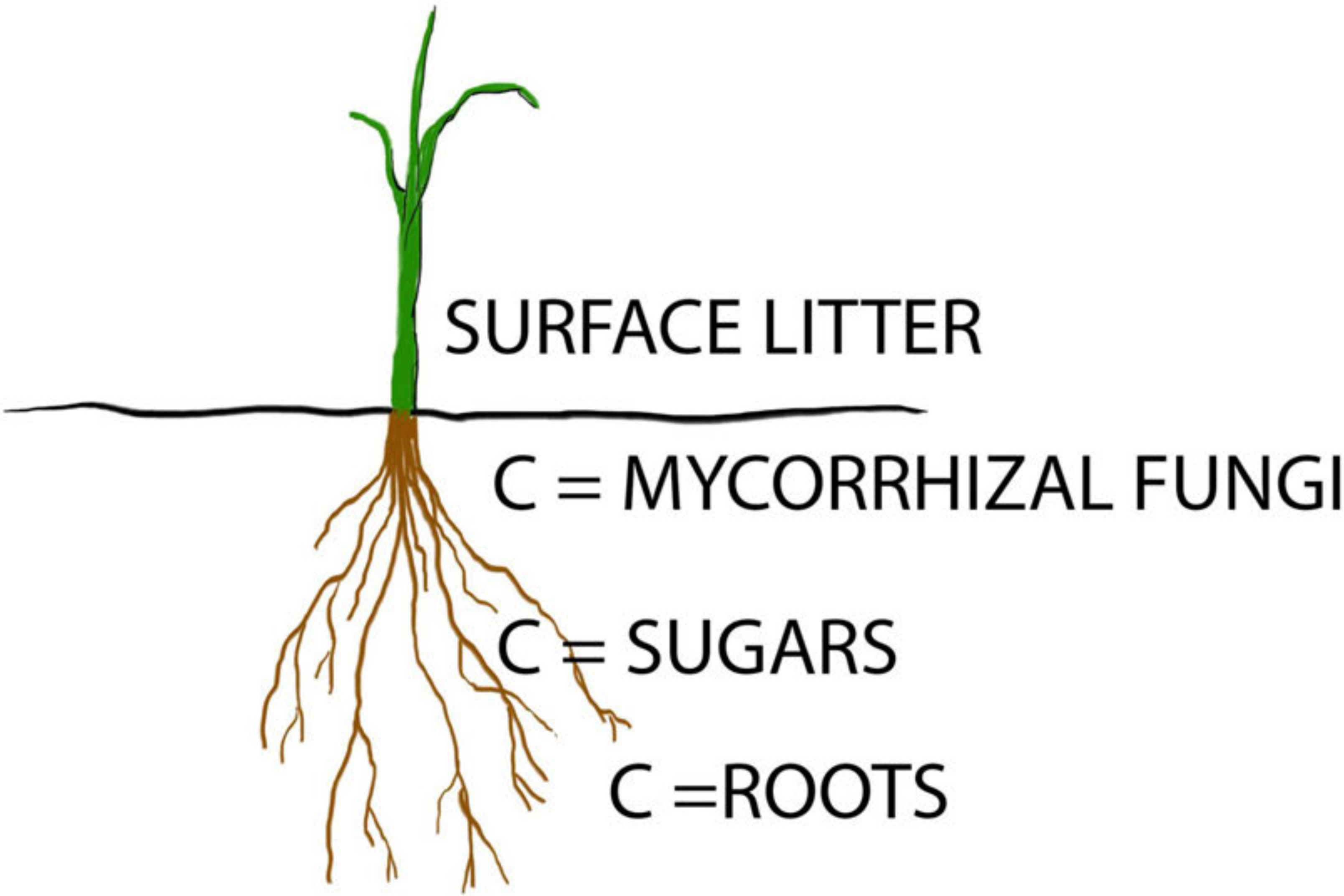
THERE IS CARBON
IN THE SOIL,
BUT IT DOES NOT
ENTER THE
PLANT.
IN FACT, IT’S THE
OPPOSITE!

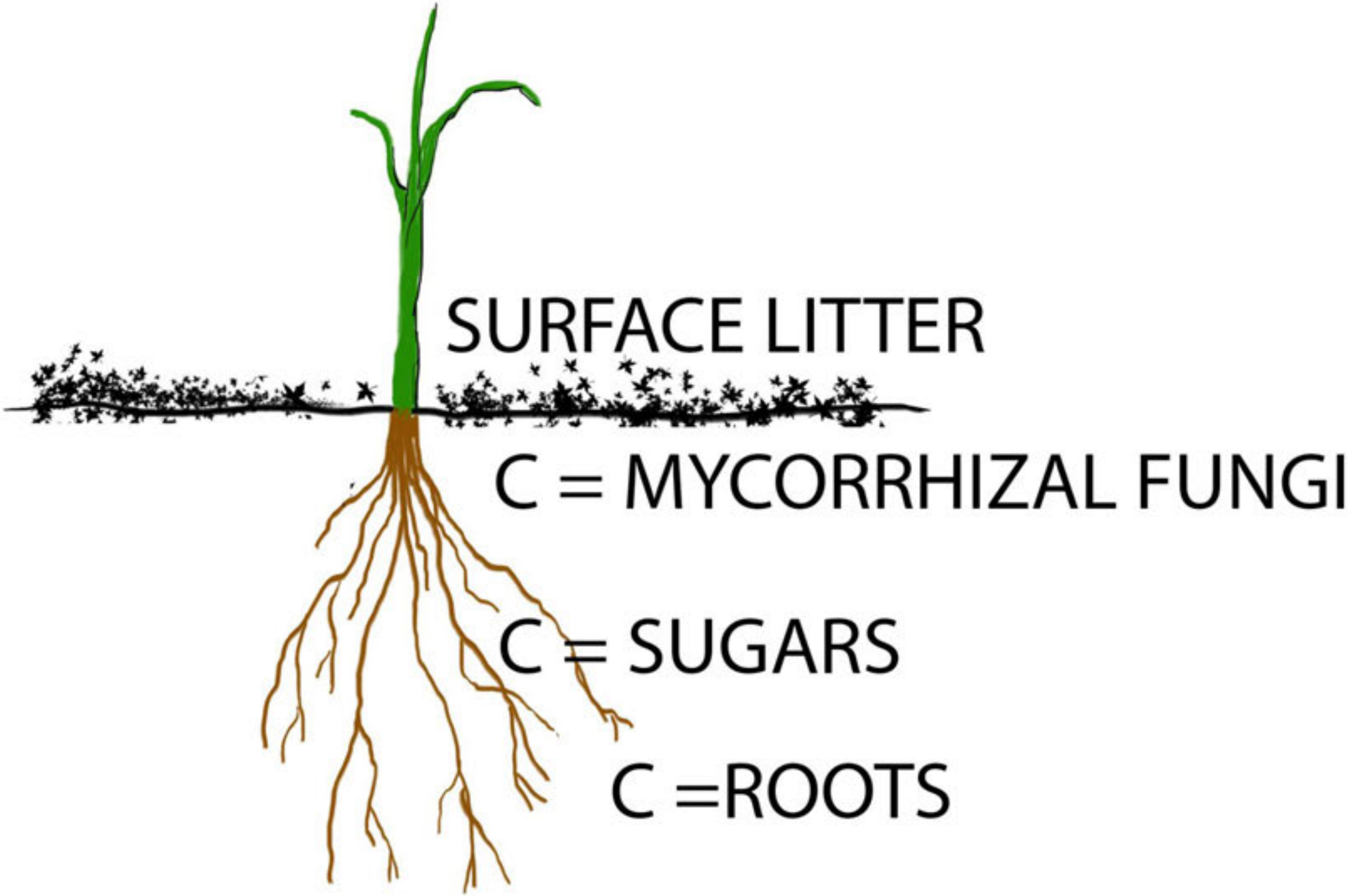


C =ROOTS

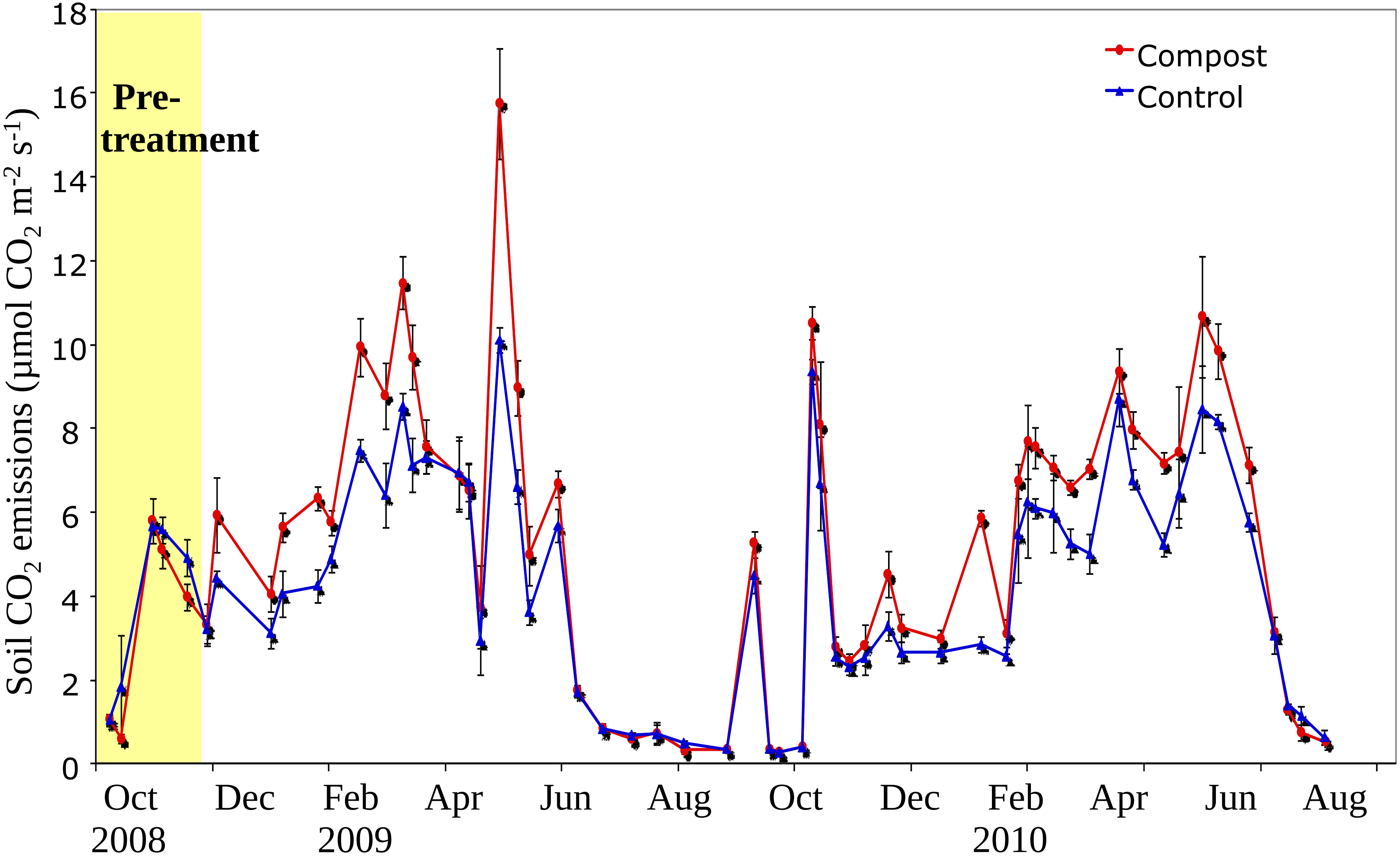

C = SUGARS
C =ROOTS


C = MYCORRHIZAL FUNGI
C = SUGARS
C =ROOTS


SURFACE LITTER
C = MYCORRHIZAL FUNGI
C = SUGARS
C =ROOTS

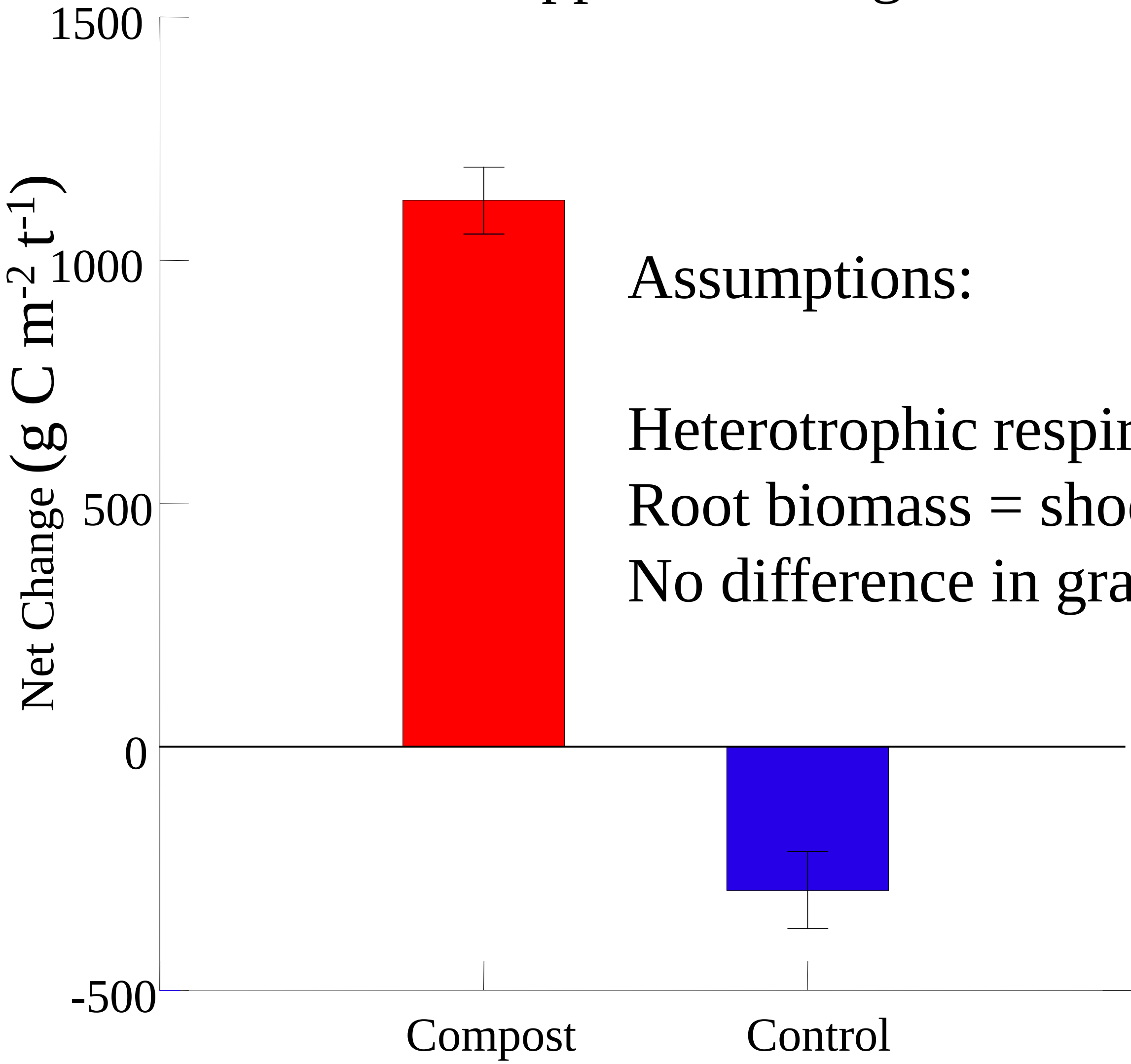

SURFACE LITTER
C = MYCORRHIZAL FUNGI
C = SUGARS
C =ROOTS

Compost addition increased soil respiration over the first two years of the experiment



Browns Valley, Ryals and Silver in prep

Organic amendments increased system carbon by over 14.8 Mg C/ha in year 1; net gain, beyond compost additions was approx. 0.8 Mg C/ha.

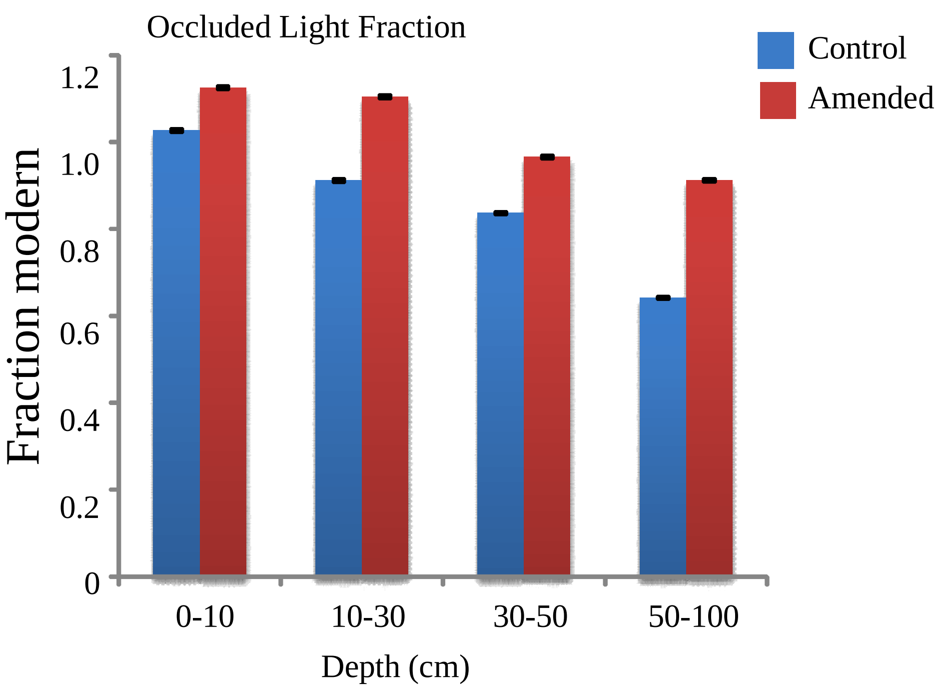


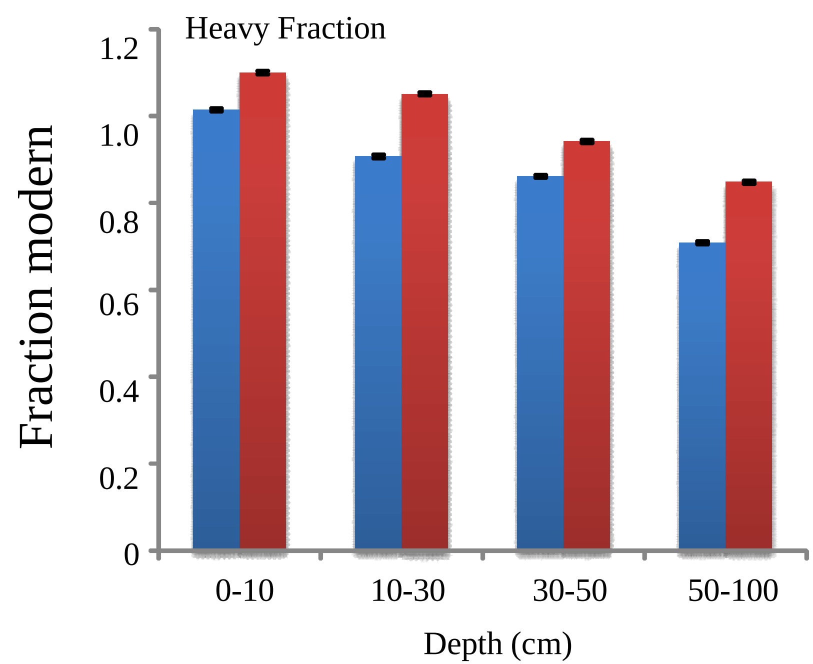
Assumptions:

Heterotrophic respiration = 50% of total
Root biomass = shoot biomass
No difference in grazed biomass

Nicasio, Ryals and Silver in prep

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. in prep.

Welcome to Century Homepage!

CENTURY 4

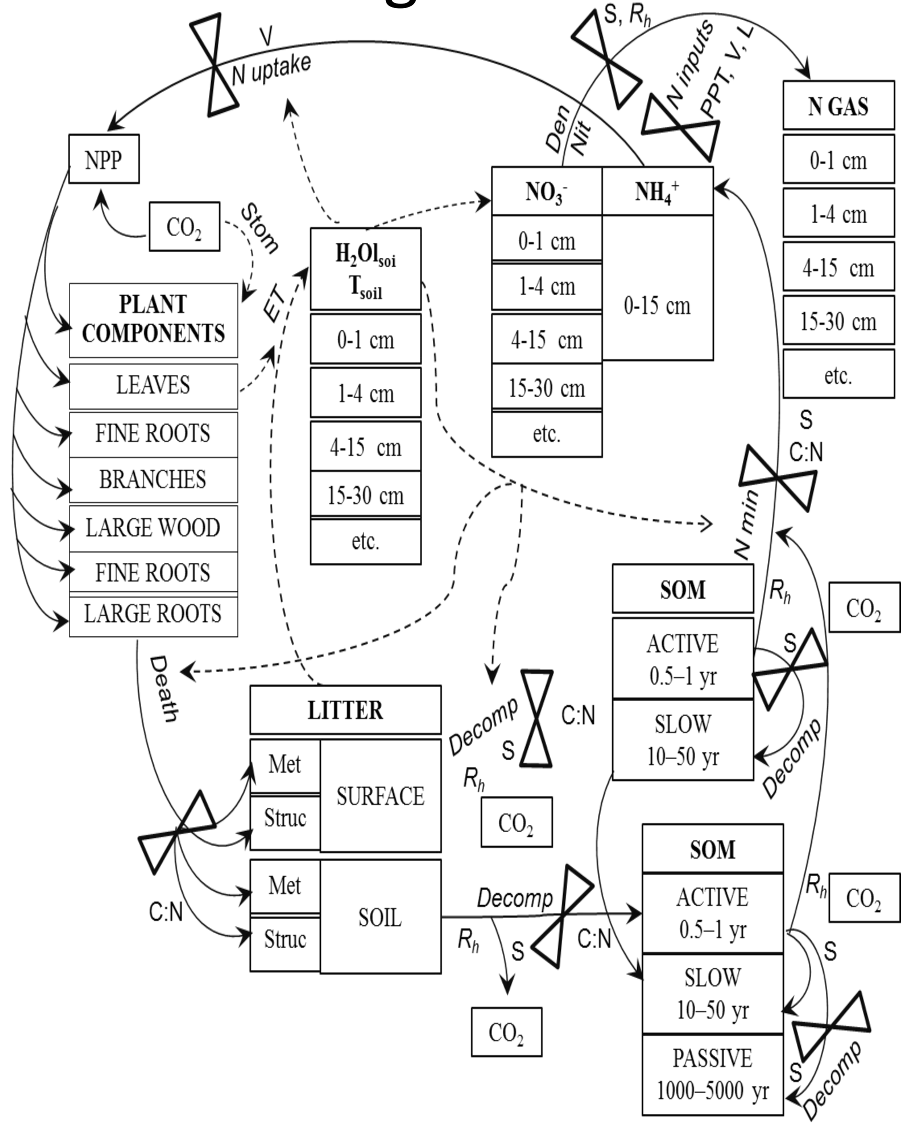
The **CENTURY** model is a general model of plant-soil nutrient cycling which is being used to simulate carbon and nutrient dynamics for different types of ecosystems including grasslands, agricultural lands, forests and savannas.

The **CENTURY** is composed of a soil organic matter/ decomposition submodel, a water budget model, a grassland/crop submodel, a forest production submodel, and management and events scheduling functions.

It computes the flow of carbon, nitrogen, phosphorus, and sulfur through the model's compartments. The minimum configuration of elements is C and N for all the model compartments. The organic matter structure for carbon(C), nitrogen(N), phosphorus(P) and sulfor(S) are identical; the inorganic components are computed for the specific inorganic compound.

On behalf of the entire CENTURY group, thank you again for your interest in the model. If you have any question about the Century, please contact our webmaster.

DayCent Flow Diagram



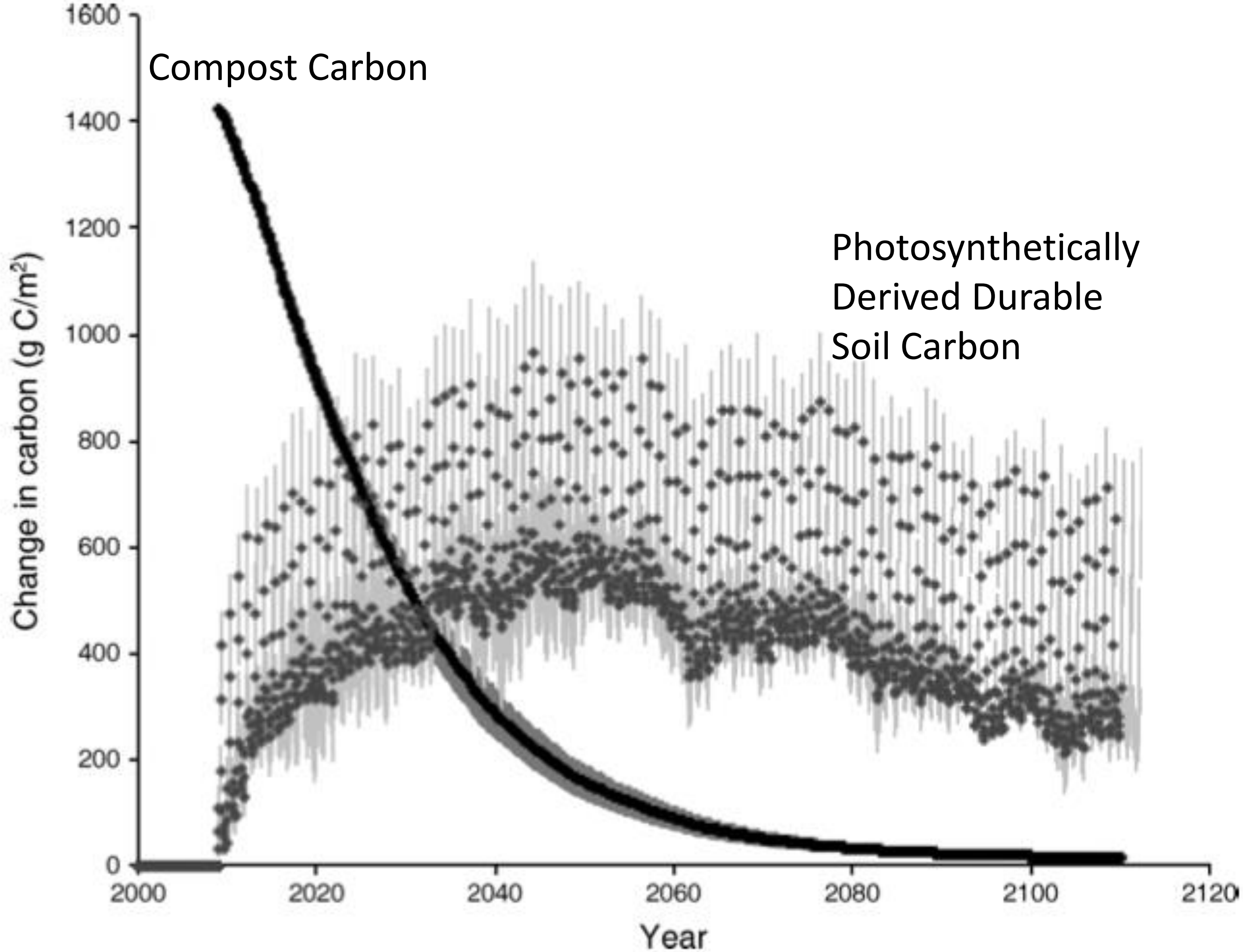
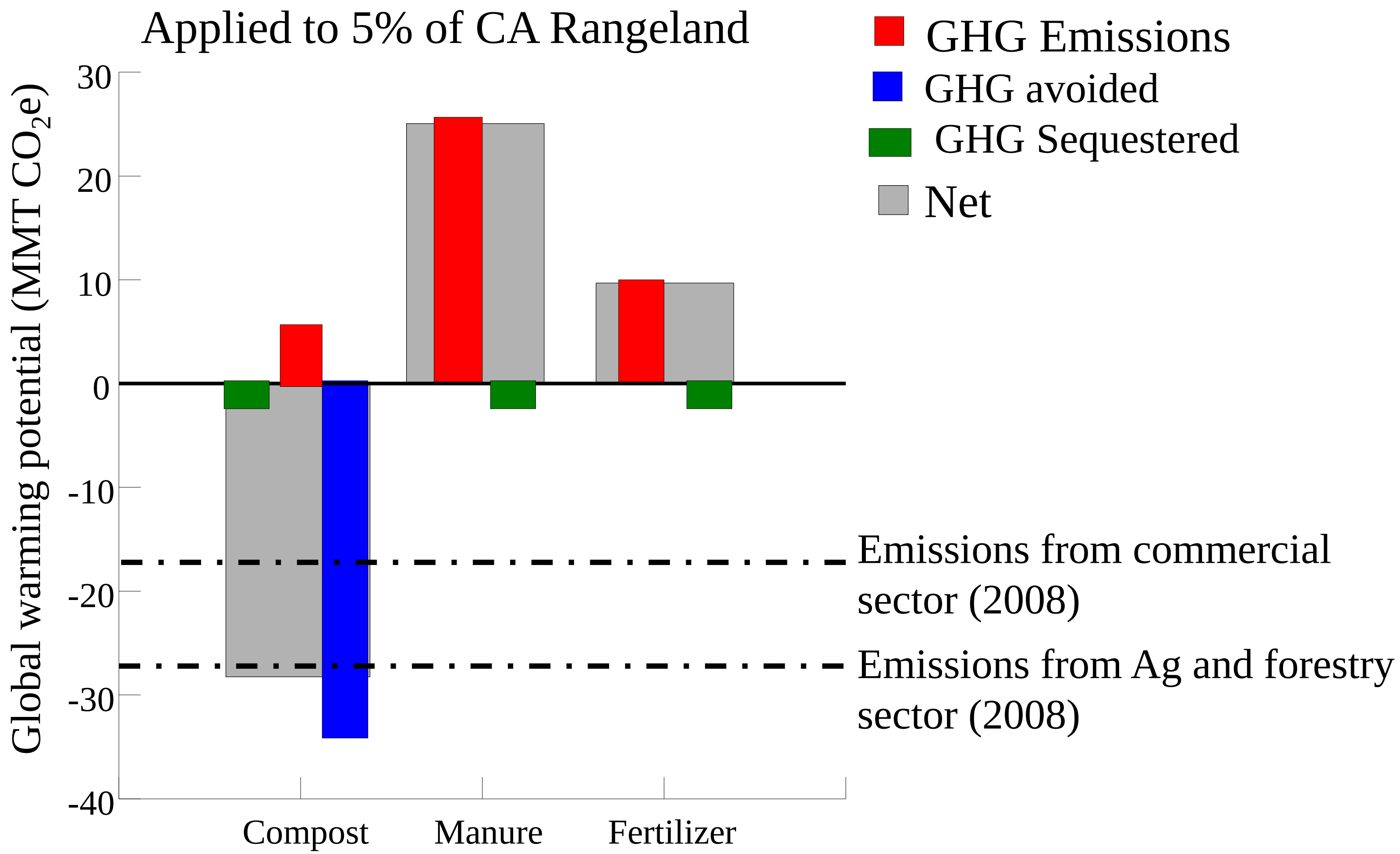


FIG. 3. The black line shows simulated decomposition of the compost following application to grassland soils. Gray circles show the monthly change in total ecosystem carbon, not including compost carbon. Values are averages across site characterizations, with standard error bars in light gray. Ryals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

A SINGLE APPLICATION OF ½"COMPOST WILL RESULT IN 30 – 100 YEARS OF ONGOING SOIL CARBON SEQUESTRATION!

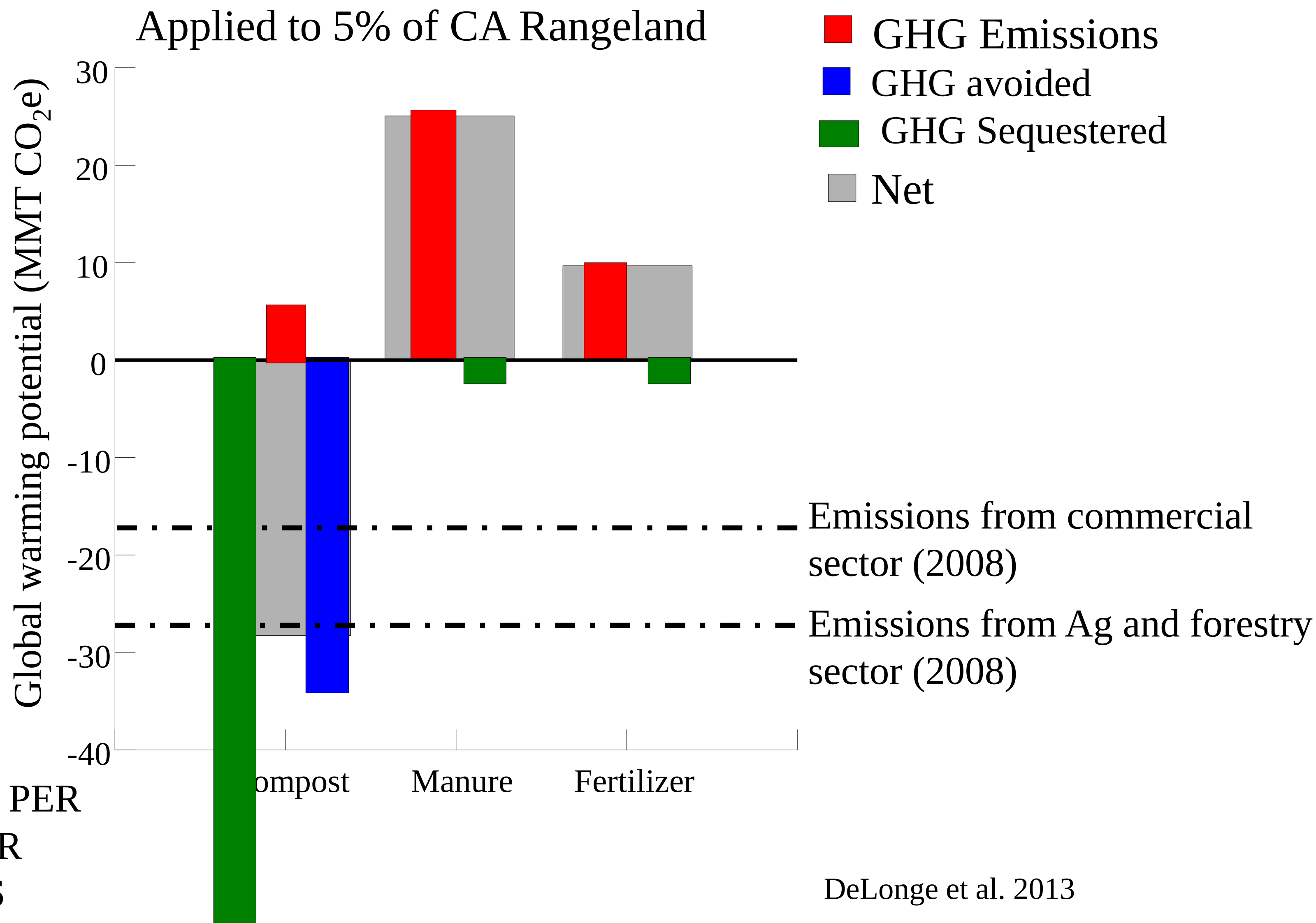
AND PERHAPS ¼" WOULD PRODUCE THE SAME RESULTS.

Life Cycle Assessment suggests significant GHG mitigation potential statewide



DeLonge et al. 2013

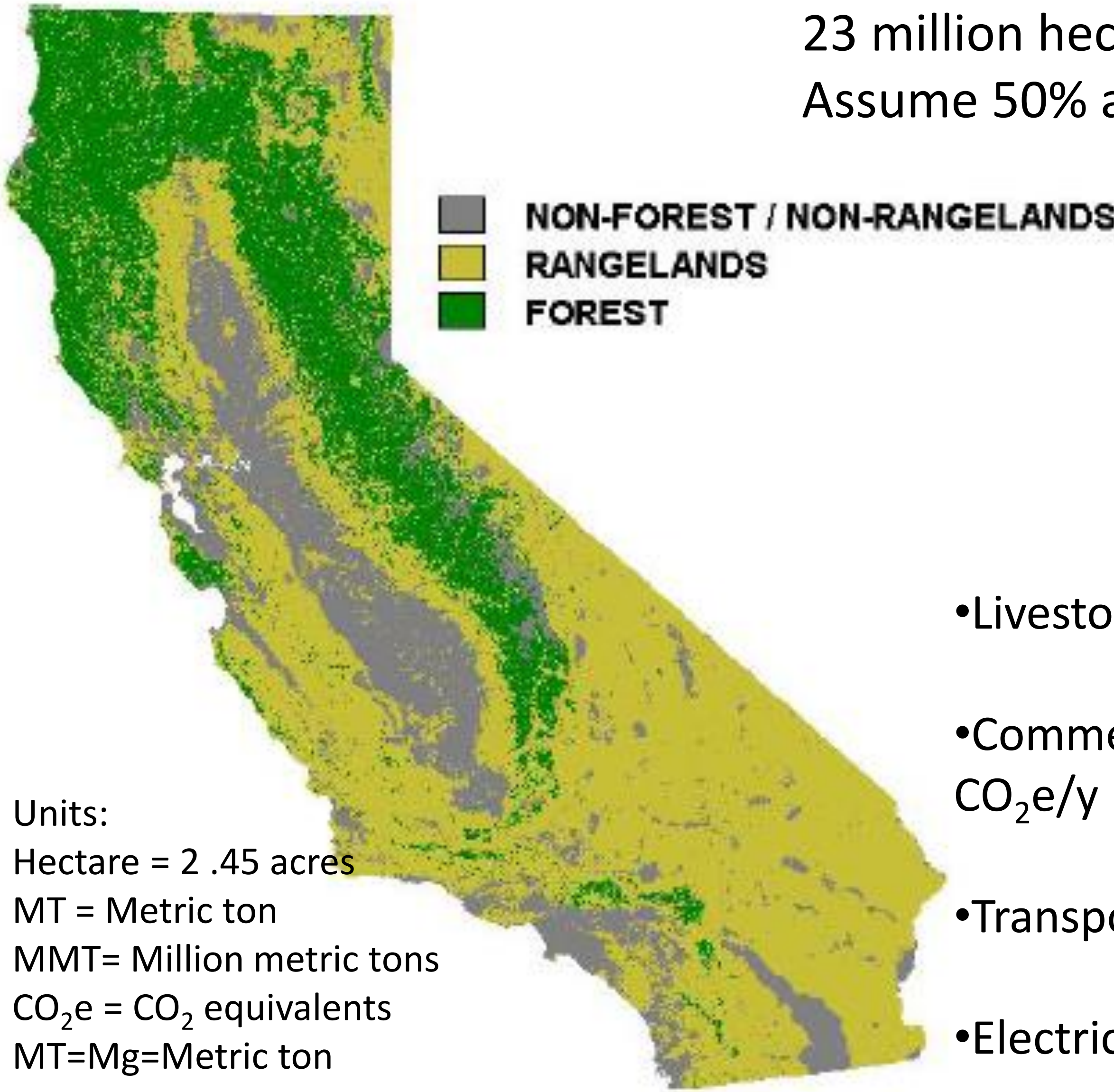
Life Cycle Assessment suggests significant GHG mitigation potential statewide



ONE TON PER YEAR FOR 30 YEARS

DeLonge et al. 2013

California Rangelands and Carbon Sequestration



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

Units:
Hectare = 2 .45 acres
MT = Metric ton
MMT= Million metric tons
CO_2e = CO_2 equivalents
MT=Mg=Metric ton

Moderating Climate Change with Soil Carbon Management

CARBON CYCLE INSTITUTE

MARIN CARBON PROJECT

USGS science for a changing world

INTRODUCTION

- Climate change is ongoing with changes in weather patterns and increases in extreme events, such as the current California drought.
- Biosequestration removes carbon from the atmosphere and stores it in plants and soil, increases soil water holding capacity, increases net primary productivity, and enhances other ecosystem services.
- Marin Carbon Project (MCP)research showed increases in soil water holding capacity (WHC) associated with topical applications of compost.
- The 25% WHC increase modeled here is based on first year increases in soil carbon on MCP treatment plots. (Ryals, R and W. Silver, 2013. Ecological Applications, 23(1), pp. 46–59).
- Composting is a particularly powerful biosequestration strategy due to both the avoidance of methane production by diversion of organic materials away from anaerobic decomposition in landfills and manure lagoons, and through enhanced NPP resulting from soil quality improvement following compost application. (DeLonge et al, 2013, Ecosystems 16: 962–979).

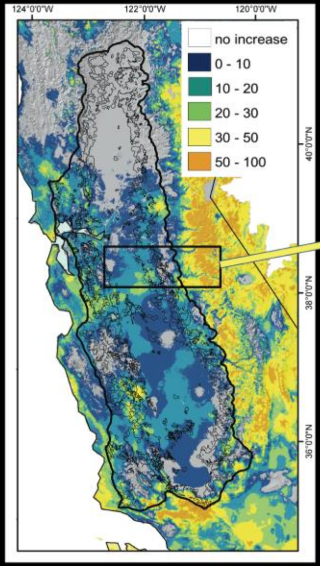
CLIMATE CHANGE AND HYDROLOGY

- The hydrologic impacts of climate change include changes in water availability and increases in demand for water.
- This translates into environmental stress that relates to wildfire, forest die-off, desertification, and loss of riparian zones and groundwater.
- Climatic water deficit is a key indicator of landscape stress.

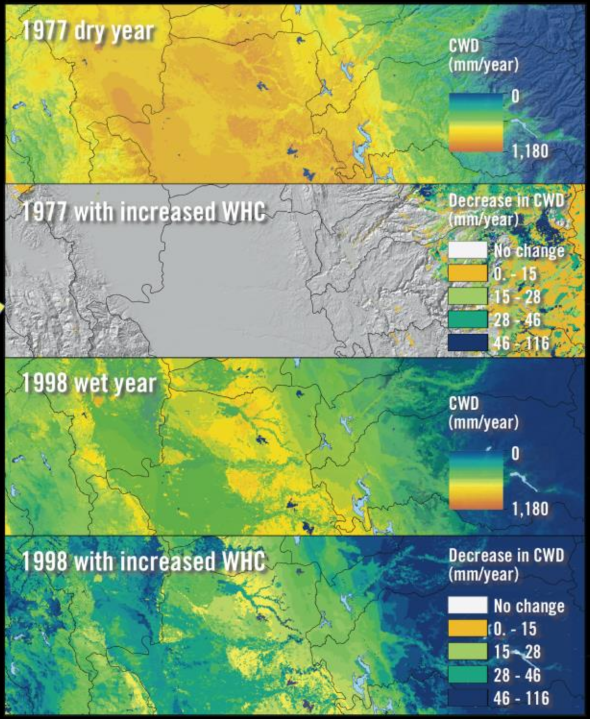
CLIMATIC WATER DEFICIT (CWD)

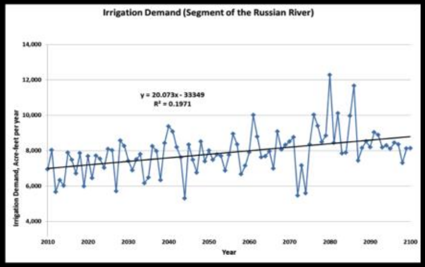
- Annual evaporative demand that exceeds available water
- CWD = potential – actual evapotranspiration
- Defines the level of hydroclimatic stress on the landscape
- Integrates climate, energy loading, drainage, and available soil moisture storage and addresses irrigation demand

Projected Increase in CWD by 2085 (mm/year)

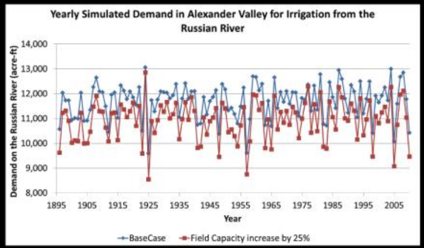


Much of California's rangelands are projected to increase in CWD by 10 to 30 mm (or 527,000 to 5,278,000 AF for the entire state) by end-of-century.





CWD has been shown to correlate to irrigation demand in the Russian River's Alexander Valley. Projections indicate a potential increase in demand of nearly 2,000 ac-ft/yr by the end of the century.

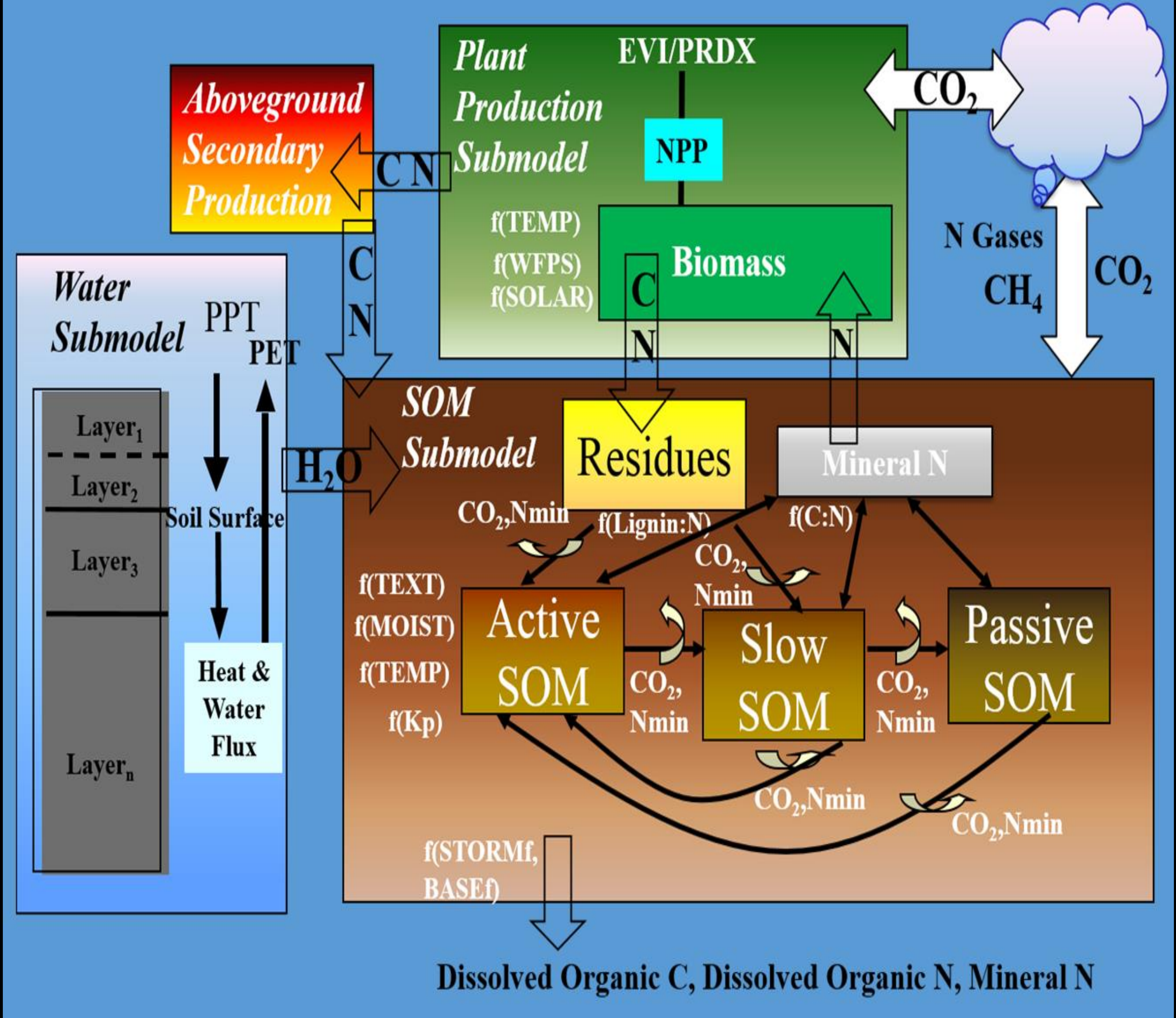


If we increase water holding capacity of the soil by 25%, we reduce CWD and correlated losses due to demand from the Russian River by approximately 6.6% or 776 AF/year.

Climatic water deficit is shown for a wet year, 1998, and dry year, 1977, for a slice across the Central Valley and up into the Tuolumne River basin. Also shown is the change in CWD when soil water holding capacity is increased by 25%. Whereas in a dry year compost only contributes to reducing CWD in relatively shallow soils (because there isn't enough precipitation to fill the increased WHC in deeper soils), in wetter years all soils see a big decrease in CWD due to filling of soils including the increased WHC. Thus, all else being equal, benefits of increased WHC accrue primarily in shallower, non-irrigated soils in drier years. In addition, when rainfall occurs in less frequent, more intense events, as expected in CA under climate change scenarios, the effects of increased soil organic matter, including increased rates of infiltration, increased pore space, and increased hydraulic conductivity, result in the capacity to absorb and hold more rainfall, and sustain the landscape through the season.

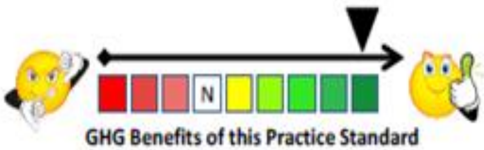
IMPLICATIONS AND NEXT STEPS

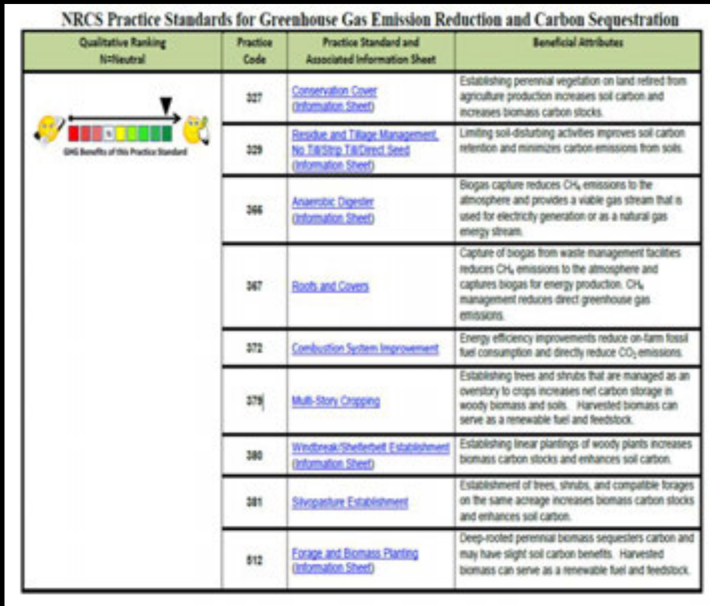
- Climate change is likely to reduce the extent and productivity of both rangelands and arable lands due to increases in climatic water deficit.
- Increases in evaporative demand and irrigation demand will reduce groundwater and surface water availability.
- Increases in soil water holding capacity and infiltration rate can increase ecosystem resilience by reducing the climatic water deficit, increasing productivity and available water, and helping to compensate for changing climatic conditions, including drought, increased rainfall intensity, and decreased rainfall predictability.
- Amendments of compost to rangelands can sequester carbon in soils, mitigate greenhouse gas emissions and increase soil water holding capacity and infiltration rate.
- Sensitivity analyses can help identify soil types that may benefit the most from strategic soil management and addition of compost.
- Local experimentation is needed to provide confidence in the mapping of climatic water deficit and changes due to compost amendments.
- These quantification and mapping methods can be applied to regions, river basins, or continents.



Plant Production Submodel
EVI/PRDX
NPP
Biomass
f(TEMP)
f(WFPS)
f(SOLAR)
CO_2
N Gases
CH_4
CO_2
Aboveground Secondary Production
C N
C
N
Water Submodel
PPT
PET
$Layer_1$
$Layer_2$
$Layer_3$
$Layer_n$
Soil Surface
Heat & Water Flux
H_2O
SOM Submodel
Residues
Mineral N
CO_2,Nmin
f(Lignin:N)
f(C:N)
CO_2, Nmin
f(TEXT)
f(MOIST)
f(TEMP)
f(Kp)
Active SOM
Slow SOM
Passive SOM
CO_2, Nmin
CO_2, Nmin
CO_2,Nmin
CO_2,Nmin
f(STORMf, BASEf)
Dissolved Organic C, Dissolved Organic N, Mineral N

NRCS Practice Standards for Greenhouse Gas Emission Reduction and Carbon Sequestration

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
	327	Conservation Cover (Information Sheet)	Establishing perennial vegetation on land retired from agriculture production increases soil carbon and increases biomass carbon stocks.
	329	Residue and Tillage Management, No Till/Strip Till/Direct Seed (Information Sheet)	Limiting soil-disturbing activities improves soil carbon retention and minimizes carbon emissions from soils.
	366	Anaerobic Digester (Information Sheet)	Biogas capture reduces CH_4 emissions to the atmosphere and provides a viable gas stream that is used for electricity generation or as a natural gas energy stream.
	367	Roofs and Covers	Capture of biogas from waste management facilities reduces CH_4 emissions to the atmosphere and captures biogas for energy production. CH_4 management reduces direct greenhouse gas emissions.
	372	Combustion System Improvement	Energy efficiency improvements reduce on-farm fossil fuel consumption and directly reduce CO_2 emissions.
	379	Multi-Story Cropping	Establishing trees and shrubs that are managed as an overstory to crops increases net carbon storage in woody biomass and soils. Harvested biomass can serve as a renewable fuel and feedstock.
	380	Windbreak/Shelterbelt Establishment (Information Sheet)	Establishing linear plantings of woody plants increases biomass carbon stocks and enhances soil carbon.
	381	Silvopasture Establishment	Establishment of trees, shrubs, and compatible forages on the same acreage increases biomass carbon stocks and enhances soil carbon.
	512	Forage and Biomass Planting (Information Sheet)	Deep-rooted perennial biomass sequesters carbon and may have slight soil carbon benefits. Harvested biomass can serve as a renewable fuel and feedstock.



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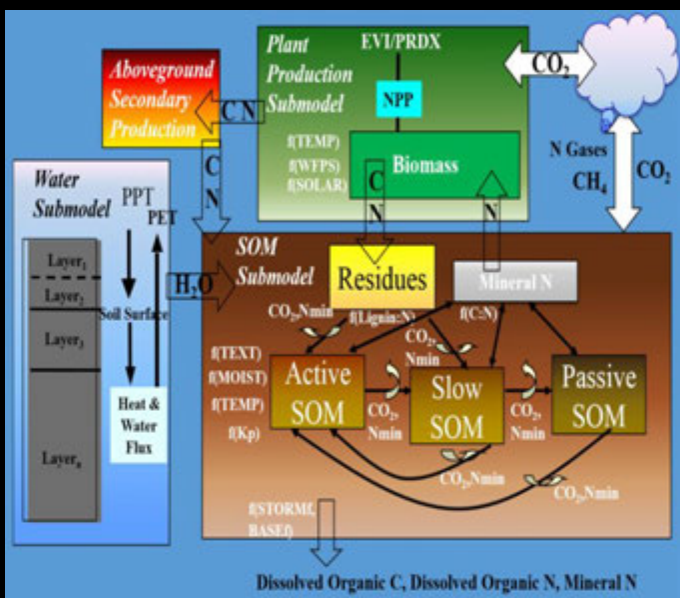
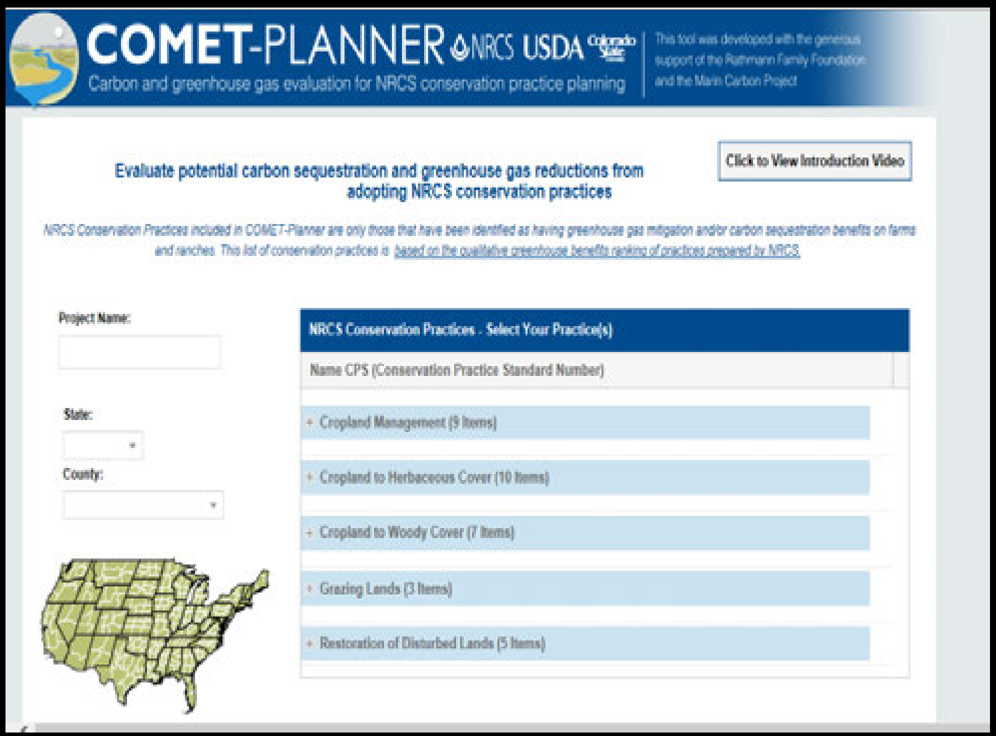




COMET-PLANNER

Carbon and greenhouse gas evaluation for NRCS conservation practice planning

NRCS USDA Colorado State

This tool was developed with the generous support of the Rathmann Family Foundation and the Marin Carbon Project

Evaluate potential carbon sequestration and greenhouse gas reductions from adopting NRCS conservation practices

NRCS Conservation Practices included in COMET-Planner are only those that have been identified as having greenhouse gas mitigation and/or carbon sequestration benefits on farms and ranches. This list of conservation practices is based on the qualitative greenhouse benefits ranking of practices prepared by NRCS.

PROJECT NAME:

State:

County:

NRCS Conservation Practices - Select Your Practice(s)

Name CPS (Conservation Practice Standard Number)

- + Cropland Management (8 Items)
- + Cropland to Herbaceous Cover (10 Items)
- + Cropland to Woody Cover (7 Items)
- + Grazing Lands (4 Items)
- + Restoration of Disturbed Lands (5 Items)

Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions[1]
(tonnes CO_2 equivalent per year)

NRCS Conservation Practices (Click Practice Name for Documentation)	Enter Acreage	Carbon Dioxide (CO_2)	Nitrous Oxide (N_2O)	Methane (CH_4)	Total CO_2-Equivalent
	Total	0.00	0.00	0.00	0.00

[1]Negative values indicate a loss of carbon or increased emissions of greenhouse gases
[2]Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

Download and Print COMET-Planner Results

How are your carbon sequestration and greenhouse gas emission reduction estimates calculated?

Emission reduction coefficients were derived from recent meta-analyses and reviews. Coefficients were generalized at the national-scale and differentiated by dry and humid climate zones. More information on quantification methods can be found in the COMET-Planner Report .

Each emission reduction is calculated using the following equation:

Emission reduction = Area (acres) * Emission Reduction Coefficient (ERC)

Emission Reduction Coefficients (ERC)
(tonnes CO_2 equivalent per acre per year)

NRCS Conservation Practices	Greenhouse Gases		
	Carbon Dioxide (CO_2)	Nitrous Oxide (N_2O)	Methane (CH_4)

Recommended use of COMET-Planner

This evaluation tool is designed to provide generalized estimates of the greenhouse gas impacts of conservation practices and is intended for initial planning purposes. Site-specific conditions (not evaluated in this tool) are required for more detailed assessments of greenhouse gas dynamics on your farm. Please visit COMET-Farm if you would like to conduct a more detailed analysis.

Please contact Amy Swan (Amy.Swan@colostate.edu) for more information

This tool was developed with the generous support of the Rathmann Family Foundation and the Marin Carbon Project

Carbon Farm Plans

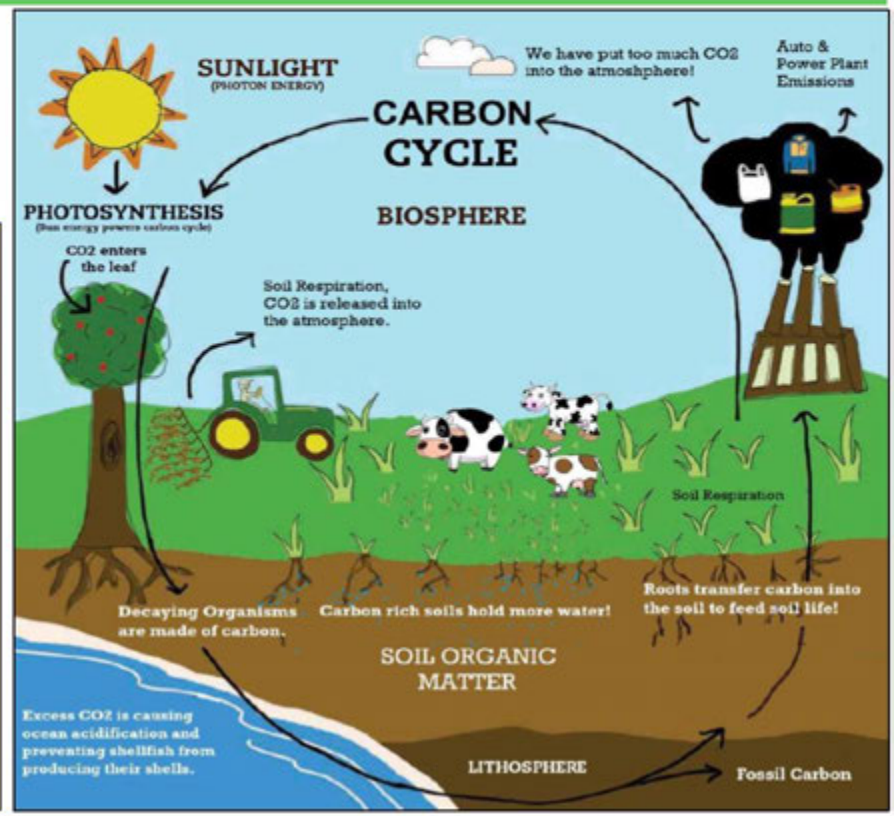
CARBON FARM PLANNING in Marin

Assistance is available for farmers and ranchers!
Plan for carbon sequestration and climate adaptation conservation practices with Marin RCD!

Potential List of Conservation Practice(s)* in a Carbon Farm Plan:

- Compost Application • Anaerobic Digester
- Silvopasture/ Shrub & Tree Establishment
- Windbreak/ Shelterbelt/ Hedgerow
- Riparian and Wetland Restoration
- Filter Strips • Grassed Waterways
- Forage & Biomass Planting
- Rangeland Management
- Prescribed Grazing and Range Planting
- Nutrient Management
- Residue & Tillage Management, No-Till
- Cover Crops

*NRCS Standard Conservation Practices



We will complete 20 Carbon Farm Plans in the next 3 years, thanks to RCPP!

FIRST PRINCIPLES OF THERMOPHILIC COMPOSTING

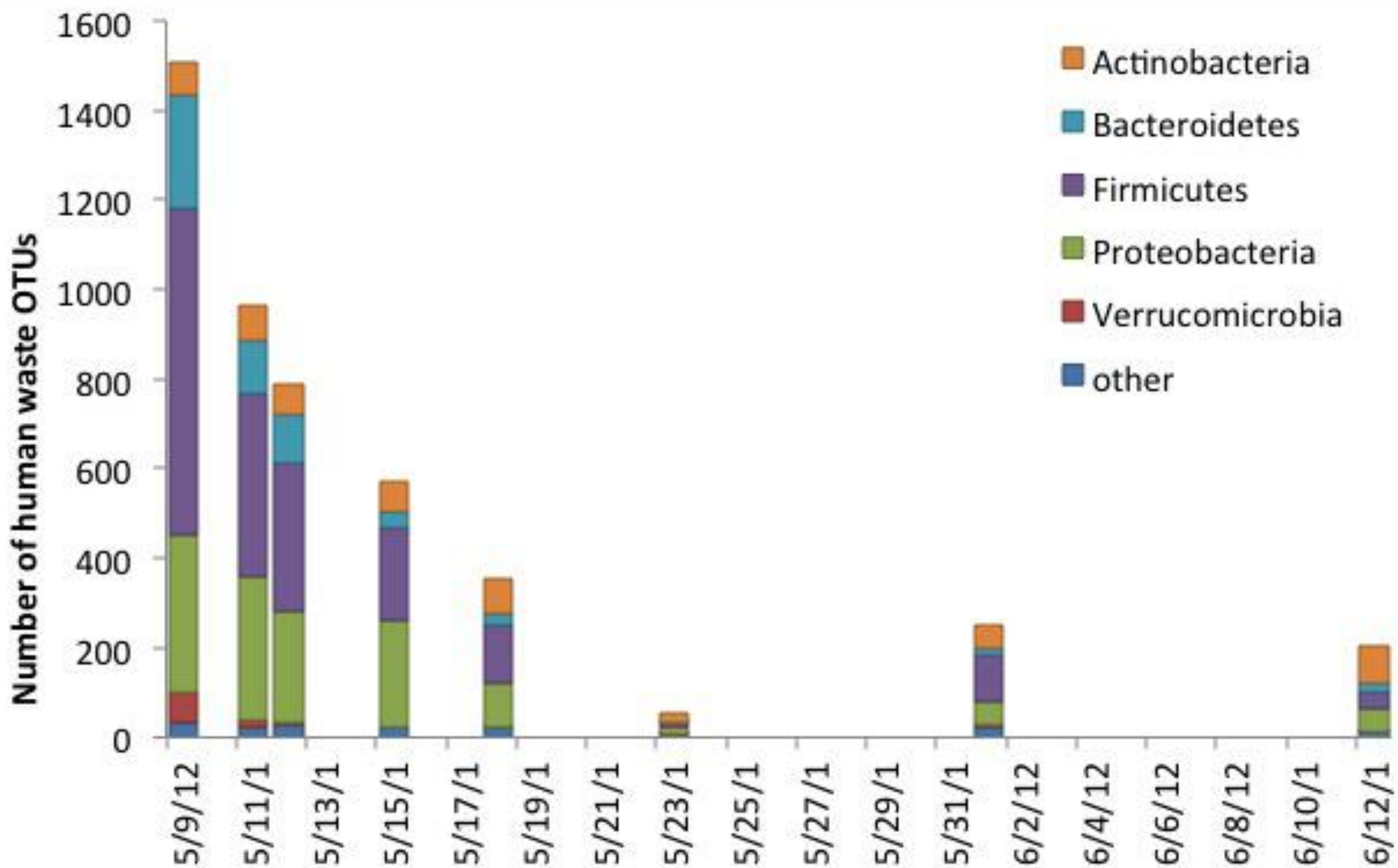

acer

EXPANDED FEEDSTOCKS


United
SITE SERVICES


100
80
120
60
140
REOTEMP
40
160
20
°F
180
0
200
REOTEMP INST. CORP.
SAN DIEGO, CALIF. U.S.A.


@51070600640317042907402702063716
GeneChip®
phylochip
P/N: 510706
Lot #: 4027020
Exp. Date: 04/29/07
For Research Use Only
UNITED STATES OF AMERICA
IN GOD WE TRUST
LIBERTY
QUARTER DOLLAR



1600
1400
1200
1000
800
600
400
200
0
Number of human waste OTUs
Actinobacteria
Bacteroidetes
Firmicutes
Proteobacteria
Verrucomicrobia
other
5/9/12
5/11/1
5/13/1
5/15/1
5/17/1
5/19/1
5/21/1
5/23/1
5/25/1
5/27/1
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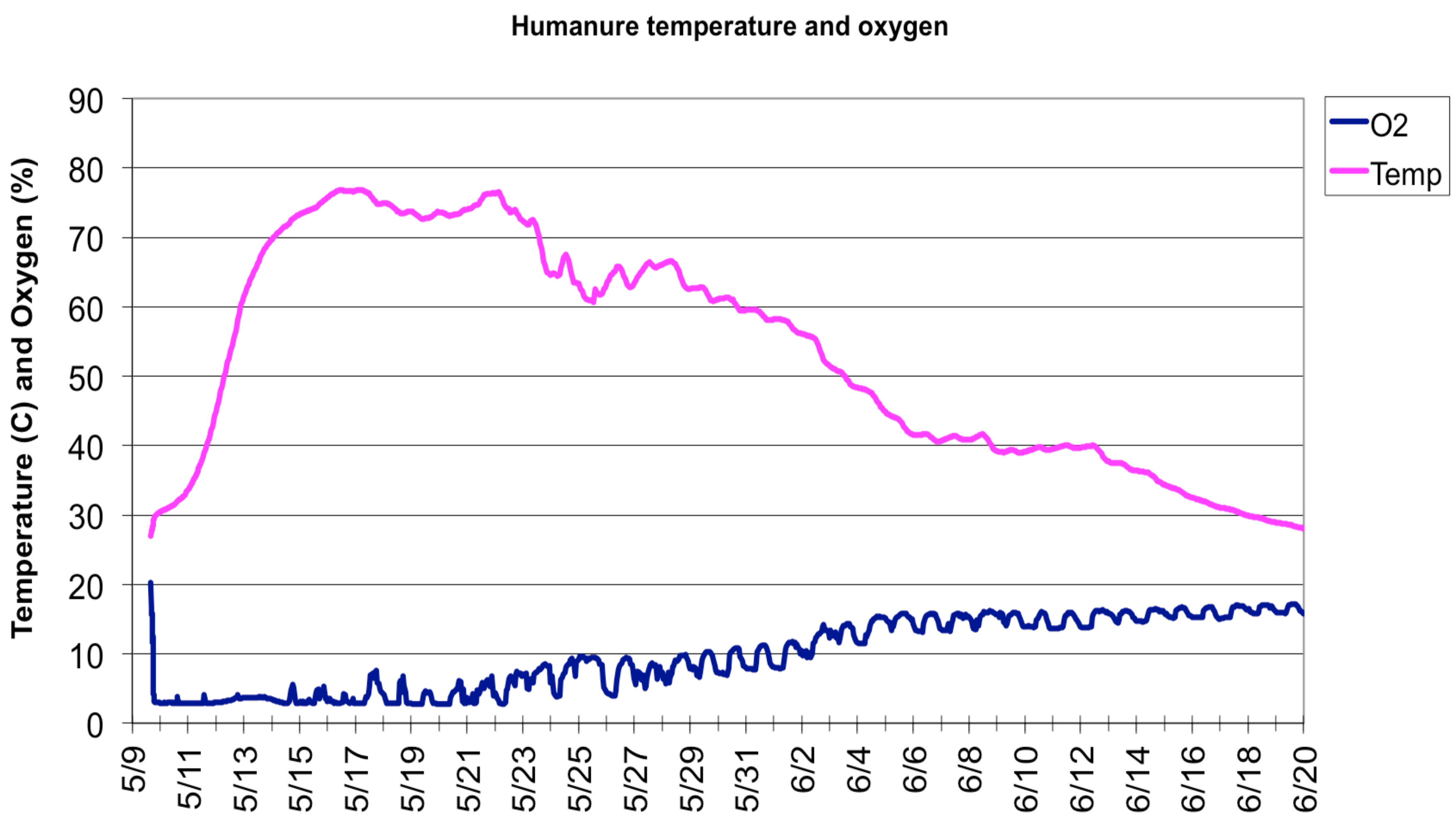
6/6/12
6/8/12
6/10/1
6/12/1


Humanure temperature and oxygen
Temperature (C) and Oxygen (%)
0
10
20
30
40
50
60
70
80
90
5/9
5/11
5/13
5/15
5/17
5/19
5/21
5/23
5/25
5/27
5/29
5/31
6/2
6/4
6/6
6/8
6/10
6/12
6/14
6/16
6/18
6/20
O2
Temp

High Pressure Liquid Chromatography

One of the key features of this device
is the extremely low amount of sampling that is needed.

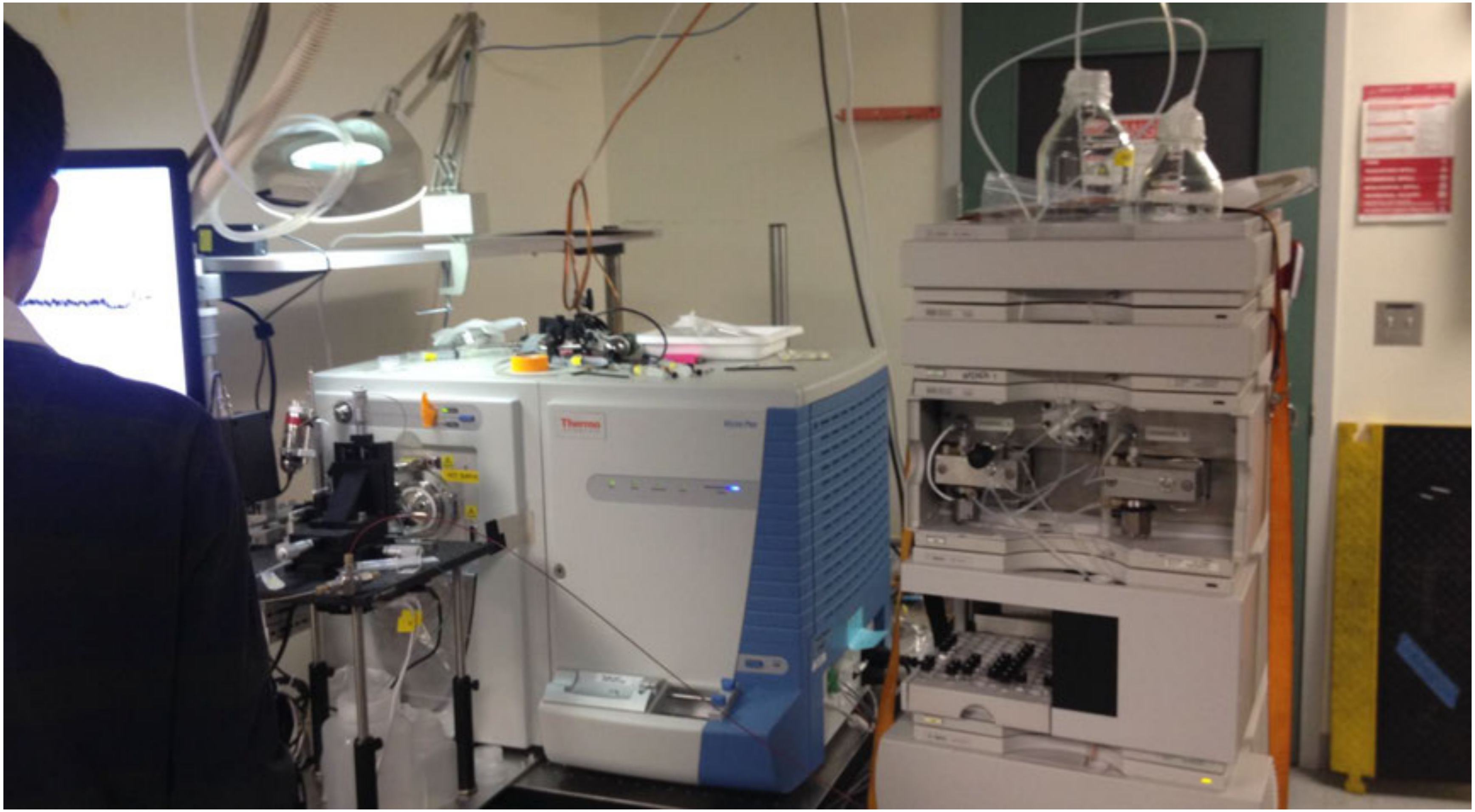
In a compost sample with hundreds of thousands of different types of molecules,
we are able to differentiate all of them.

It is not just a matter of having a very sensitive set of detectors,
our uniqueness is the expertise to look at ALL of the
chemical and biological reactions during the compost process.

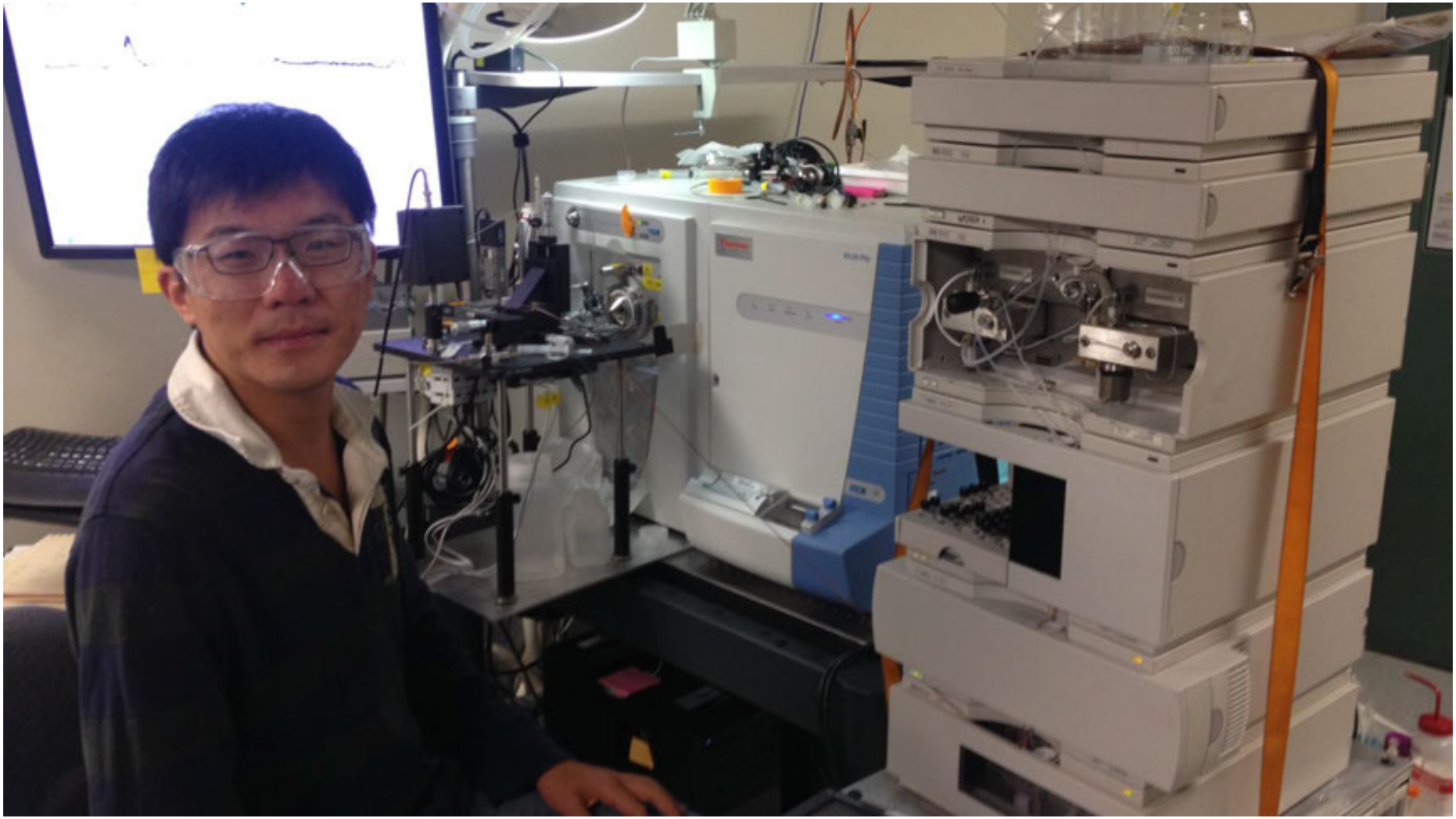
HPLC UNIT AT LBNL

In the middle of the HPLC unit you see an area that holds small,
2 ml glass vials with black screw caps on top.
It can hold up to 100 different samples. Each vial is automatically sampled, one at a time through the HPLC, it takes about 7 minutes to feed the Mass Spec the fractionated set of compounds from one sample

Nano-Electro Spray ionization (nano-ESI) mass spectrometer.

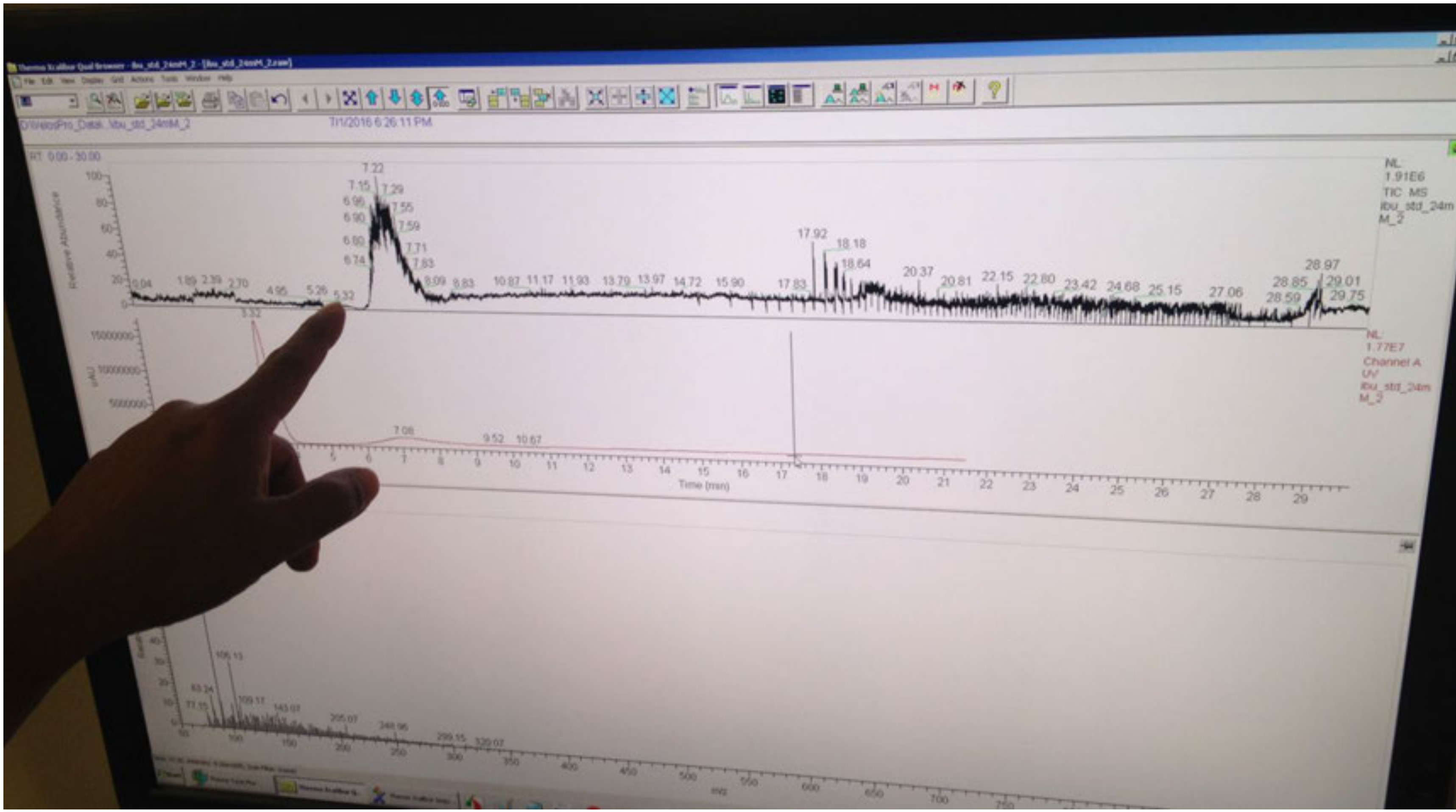


You can barely see a very thin tube crossing the front of the Thermo Mass Spec unit which is the only connection between the 2 machines.



The HPLC separates the material from the compost
into tens of thousands of different fractions based on their polarity.
Each of these fractions is sent on to the nano-electrospray ionization mass spectrometer.

Combined, we are able to separate a sample into thousands of different samples, each containing a fraction of the original number of compounds and then accurately identifying the exact mass of each compound to back-calculate the molecular structure.



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ZYMO RESEARCH
VORTEX-GENIE 2
TemPak
Insulated Shipping Container
VWR
ADAM

Compost Additions to Grazed Grasslands

The American Carbon Registry (ACR), a non-profit enterprise of Winrock International, has approved a voluntary methodology for *Greenhouse Gas Emission Reductions from Compost Additions to Grazed Grasslands*. This methodology accounts for the carbon sequestration and avoided greenhouse gas (GHG) emissions related to compost additions to grazed grasslands. The methodology was developed by Terra Global Capital with support from the Environmental Defense Fund, Silver Lab at the University of California Berkeley, and the Marin Carbon Project.

Adding compost to grazed grasslands has been demonstrated to be an effective way to increase soil carbon sequestration and avoid emissions related to the anaerobic decomposition of organic waste material in landfills. Grazed grasslands represent a large portion of agricultural working lands, and a number of recent studies have highlighted that globally grasslands are in a state of degradation.

The methodology provides a quantification framework for emissions reductions from a number of activities including avoiding anaerobic decomposition of organic material used in compost production, directly increasing soil organic carbon (SOC) content by applying compost to grazed fields, and indirectly increasing SOC sequestration through enhanced plant growth in amended fields. Apart from the economic benefit of increased forage production, applying compost to grazed grasslands also has many environmental co-benefits such as improved soil quality, decreased risk of water and wind erosion by increasing soil aggregation, and increased nutrient and water availability for vegetation.

Current approved version

- Compost Additions to Grazed Grasslands v1.0

Process documentation

- Public comment draft
- Public comments and responses
- Peer review comments and responses

Sectoral Scope
14. Agriculture, Forestry, Land Use

Filed under: Land Use Approved

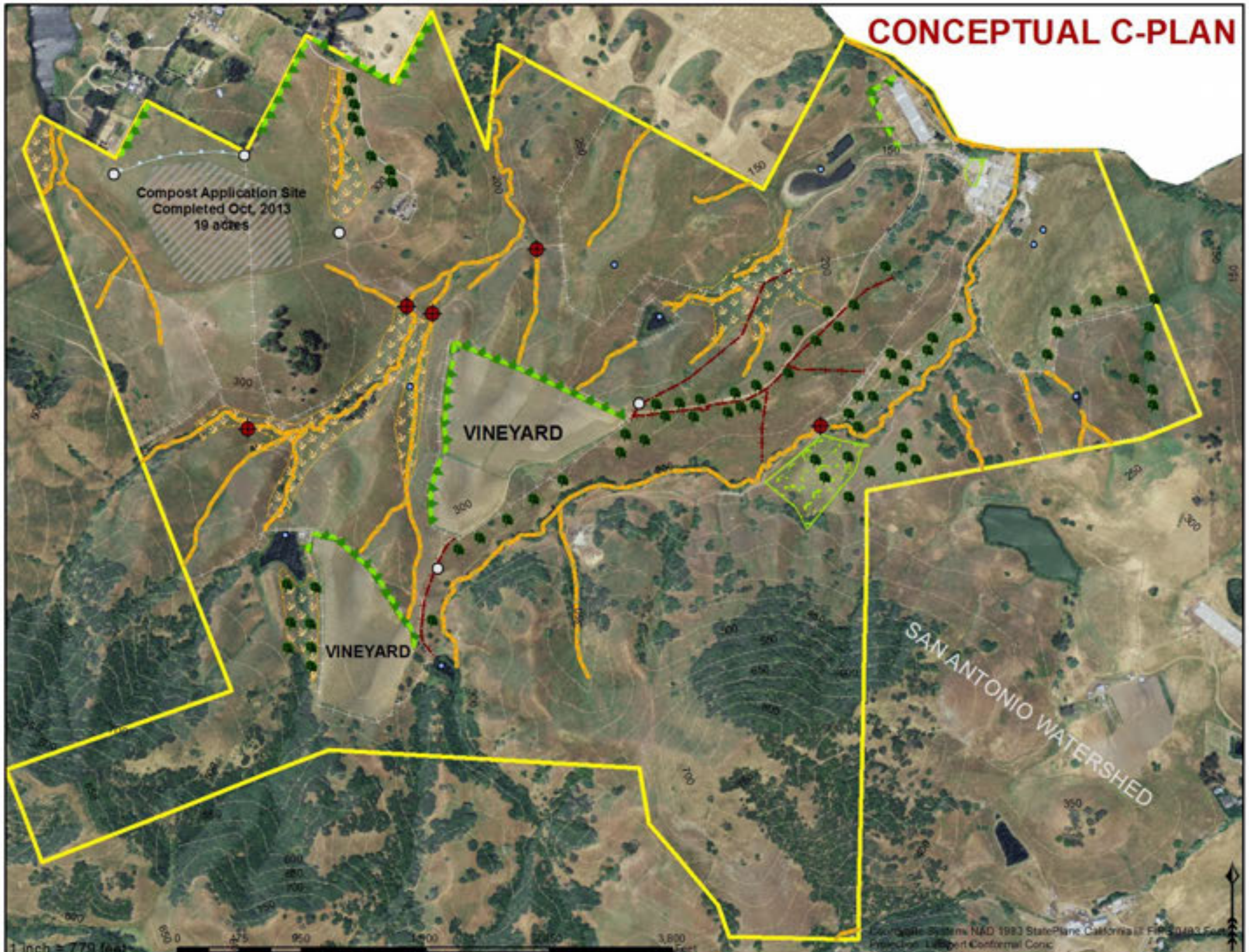
an enterprise of: WINROCK INTERNATIONAL

American Carbon Registry · c/o Winrock International
2121 Crystal Drive, Suite 500 · Arlington, VA 22202
ph 703-302-6500 · fax 703-302-6512

Marin Carbon Project
DRAFT
Carbon Farm Plan
CORDA RANCH

MARIN AGRICULTURAL LAND TRUST

MARIN RESOURCE CONSERVATION DISTRICT



Legend

Parcel Boundary

- Corda Ranch: 856 acres

Ranch Infrastructure

- Fencing, Existing
- Water Developments, Existing

Completed Practices

- Compost Application/ Mulching

Planned Practices

- Silvopasture: 6 acres
- Field/Riparian Forest Buffer: 20 acres
- Stream Crossing Repairs: 4
- Stream Restoration and/or Planting: 6.7 miles
- Riparian Buffer Planting: 34 acres
- Hedgerow/Windbreak: 7205 linear ft
- Fencing/Access Control: 6500 linear ft/ 1.2 miles

Water Development

- Pipeline: 1730 linear ft
- Troughs: 4

Proposed Conservation Practices (NRCS Practice #)

1. Compost Application/ Mulching (484) (initiated, fall 2013)
2. Critical Area Planting/Riparian Herbaceous Cover (342/390)
3. Fencing/Access Control (382/472)
4. Field Border (386)
5. Range Management Plan/ Prescribed Grazing (110/528)
6. Hedgerow Planting/ Windbreak/Shelterbelt (422/380/601)
7. Livestock Pipeline/ Water Facility (516/614)
8. Nutrient Management (590)
9. Pasture Planting (512)
10. Range Planting (550)
11. Riparian Forest Buffer (391)
12. Silvopasture: Establish Trees & Native Grasses (381/612)
13. Structure for Water Control (587)
14. Wetland Restoration (657)

Author:Lynette K Niebrugge

Date Saved: 5/20/2014 4:26:29 PM

CALIFORNIA CLIMATE STRATEGY

An Integrated Plan for Addressing Climate Change

VISION

Reducing Greenhouse Gas Emissions to 40% Below 1990 Levels by 2030

GOALS

- 50% renewable electricity
- 50% reduction in petroleum use in vehicles
- Double energy efficiency savings at existing buildings
- Carbon sequestration in the land base
- Reduce short-lived climate pollutants
- Safeguard California

USDA Natural Resources Conservation Service

California State Office, Davis, CA

Major Land Resource Areas (MLRAs)

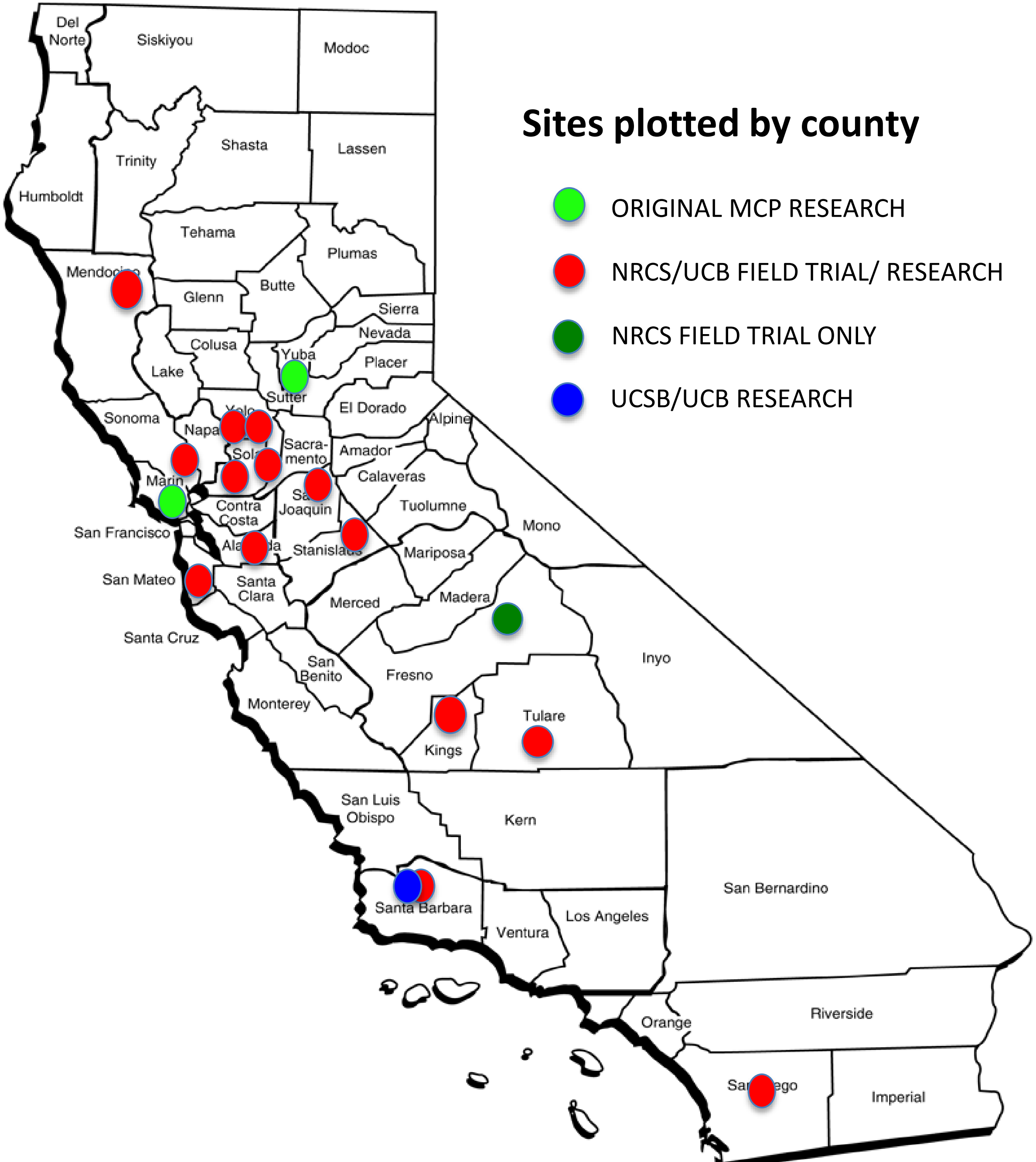
Pacific SW MLRA Office, Region 2 - Revised May, 2003

Source of Data:
USDA-NRCS, CA, Ed Tallyn, State Soil Data Quality Specialist

Map prepared using ArcView 3.2a
by Terryl Kocsis, NRCS, Davis, CA
Map ID: mlras_2003 05/15/03

NRCS
Natural Resources Conservation Service

Sites plotted by county



MLRA 4B: ***Coastal Redwood Belt*****;**
sites in Marin (compost already spread; data collection only) and San Mateo

MLRA 5: ***Siskiyou-Trinity Area*****;** site in Mendocino

MLRA 15: ***Central California Coast Range;*** sites in Alameda, Sonoma, and Yolo

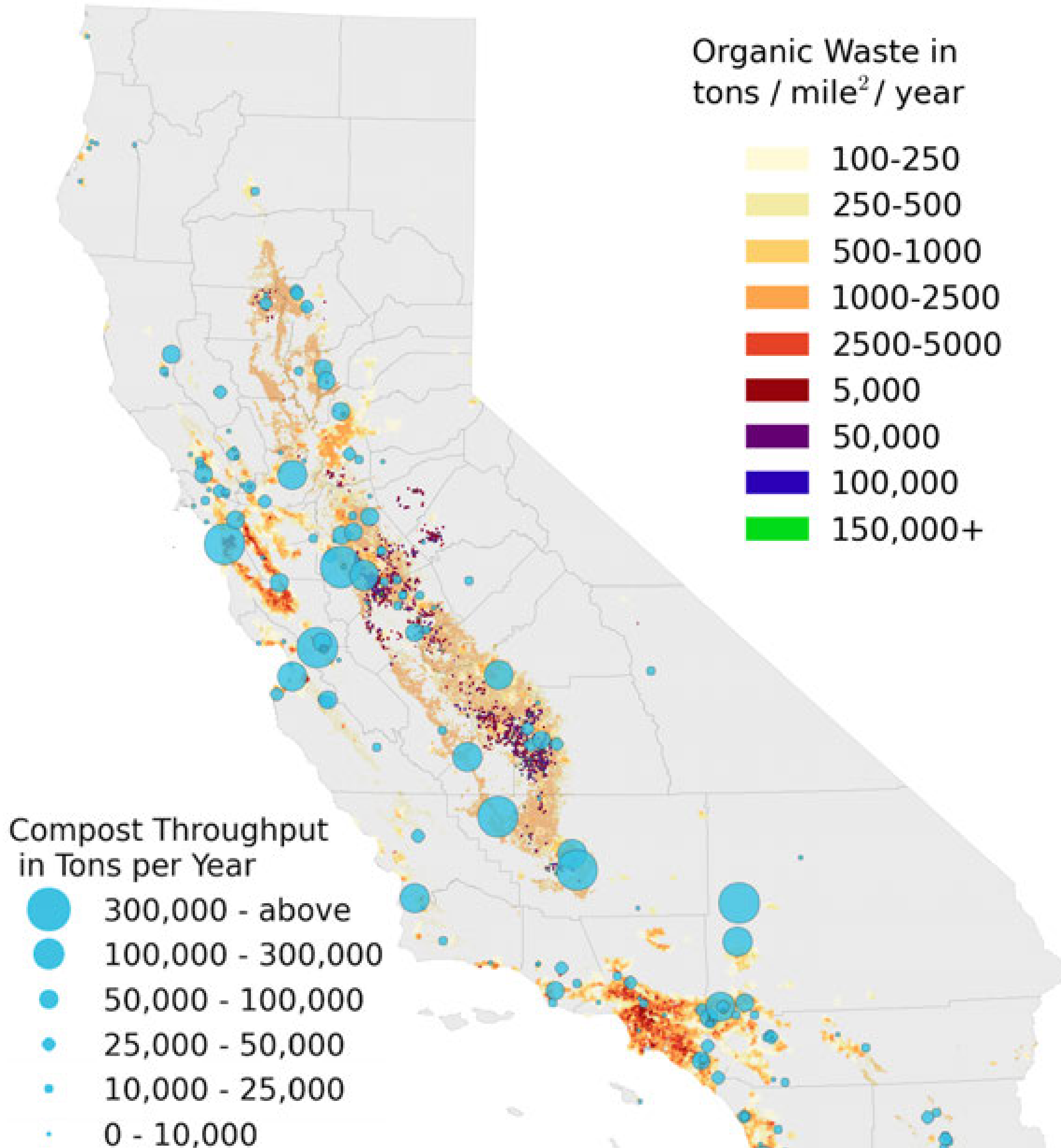
MLRA 16: ***California Delta;*** sites in Contra Costa & Solano

MLRA 17: ***Sacramento and San Joaquin Valleys;*** sites in Kettleman City,
San Joaquin (NRCS Plant Materials Center, ungrazed), Stanislaus, Tulare, and Yolo

MLRA 18: ***Sierra Nevada Foothills*****;** sites in Fresno & Yuba
(compost already spread; data collection only)

MLRA 20: ***Southern California Mountains*****;** sites in San Diego & Santa Barbara

Throughput of Compost Facilities and Organic Waste from Cities, Perennial Crops, and Dairies



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).


MICROFLEX
Evolution One

THE CALIFORNIA CARBON PROJECT

Comparative Research

Organic Sources:	Processes:	Fates:
Food Waste	Landfill	Soil Systems
Dairy Manure	Mulching	Emissions
Woody Biomass	Composting	Water
	Bio Digestion	Energy
	Reactive Processes	
	Pyrolysis	
	Incineration