JOINT STATE AGENCY PUBLIC MEETING OF THE ENVIRONMENTAL FARMING ACT SCIENCE ADVISORY PANEL (EFA SAP) CALRECYCLE AND THE CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

MEETING AGENDA
July 17, 2015
10 am to 4 pm
Byron Sher Auditorium
California Environmental Protection Agency
1001 I Street
Sacramento, CA 95814
916-654-0433

WEBCAST
http://www.calepa.ca.gov/Broadcast/

EFA SAP MEMBERSHIP
Don Cameron, Member and Chair

Mike Tollstrup, Member	Jocelyn Bridson, MSc, Member
Vacant, Natural Resources Agency	Jeff Dlott, PhD, Member

Luana Kiger, MSc, Subject Matter Expert
Doug Parker, PhD, Subject Matter Expert

1. Introductions	Don Cameron
2. Welcome address by CalRecycle and CDFA	Jenny Lester Moffitt Deputy Secretary, CDFA CalRecycle
3. Updates • Minutes from previous meeting • SWEEP	Don Cameron Amrith Gunasekara
4. Healthy Soils Initiative	Don Cameron
a. Impact of Soil Organic Matter on Nutrient Conservation and Soil Health	Dr. William Horwath, Professor of Soil Biogeochemistry, UC Davis
b. Microbial Communities, Compost and Implications for Soil Health	Dr. Gary Andersen, Senior Scientist, Lawrence Berkeley National Laboratory
c. CalRecycle – efforts to date on compost	Howard Levenson, CalRecycle
d. A tool for incentivizing soil health in agriculture (Comet-Planner)	Dr. Adam Chambers, USDA NRCS
5. Public Comment and Discussion (2 hours)	Don Cameron
6. Next meeting and location	Don Cameron

Amrith Gunasekara, PhD, CDFA Liaison to the Science Panel

All meeting facilities are accessible to persons with disabilities. If you require reasonable accommodation as defined by the American with Disabilities Act, or if you have questions regarding this public meeting, please contact Amrith Gunasekara at (916) 654-0433.
More information at: http://cdfa.ca.gov/Meetings.html and http://www.cdfa.ca.gov/EnvironmentalStewardship/Meetings_Presentations.html

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE (CDFA)
ENVIRONMENTAL FARMING ACT SCIENCE ADVISORY PANEL

Auditorium
California Department of Food and Agriculture
1220 N Street
Sacramento, CA 95814

May 14, 2015

MEETING MINUTES

Panel Members
Don Cameron, Member and Chair
Mike Tollstrup, Member
Jocelyn Bridson, MSc, Member
Jeff Dlott, Member

Subject Matter Experts
Doug Parker, PhD, Subject Matter Expert

State Agency Staff
Amrith Gunasekara, PhD (CDFA)
Jenny Lester Moffitt, Deputy Secretary (CDFA)
Karen Ross, Secretary (CDFA)

AGENDA ITEM 1
The meeting was called to order at 10:05 AM by the Chair, Mr. Don Cameron. Introductions were made. A quorum was established. Members present at the meeting included Mr. Cameron, Dr. Dlott, Mr. Tollstrup, and Mrs. Bridson.

AGENDA ITEM 2
WELCOME ADDRESS – SECRETARY ROSS
Secretary Ross welcomed the panel and audience to the meeting. Secretary Ross mentioned the importance of the Healthy Soils Initiative being discussed. She informed the group that Deputy Secretary Jenny Lester Moffitt is the policy lead on the initiative.

AGENDA ITEM 3
PREVIOUS MEETING MINUTES
CDFA staff presented the minutes from the previous December 19, 2014 meeting. The motion was made to accept the minutes as presented by Dr. Dlott, and seconded by Mr. Tollstrup. The motion was moved by all members present and was accepted without further changes.

STATE WATER EFFICIENCY AND ENHANCEMENT PROGRAM (SWEEP)
An update was provided on the State Water Efficiency and Enhancement Program (SWEEP). Senate Bill 103, signed in 2014, created the SWEEP program with $10 million appropriation. Another $10 million has been appropriated for FY 2015-2016.

AGENDA ITEM 4 - SOIL HEALTH
STATE HEALTHY SOILS INITIATIVE
Deputy Secretary Jenny Lester Moffitt provided background information on the healthy soils initiative. The initiative was introduced in the Governor's January 2015 budget proposal. CDFA will coordinate this initiative under its existing authority provided by the Environmental Farming Act. The term "healthy soils" refers to ensuring that our agricultural soils have adequate soil organic matter (SOM) or soil carbon content.

INTRODUCTION TO SOIL ORGANIC MATTER AND SOIL HEALTH
Dr. Dennis Chessman, USDA/NRCS, provided background on the new Soil Science Division created in the fall 2012 within the USDA Natural Resources Conservation Services (NRCS). Dr. Chessman spoke about Soil Organic Matter (SOM) which is the organic matter component of soil. Organic matter serves as a reservoir of nutrients and water in the soil, aids in reducing compaction, and increases water infiltration. SOM levels can be changed / increased by crop management by reducing tillage, keeping soil surfaces covered by growing plants using plant diversity. He noted that soil organic matter is 50 percent carbon and that plants are mostly water. Factors affecting SOM are mostly climate influenced.

Discussions ensued regarding the importance of organic materials and climate affects.

STRATEGIES TO INCREASE SOIL ORGANIC MATTER IN CALIFORNIA SOILS
Dr. Jeff Mitchell, UC Davis, presented strategies for improving SOM in California. Dr. Mitchell emphasized the benefits achieved by farming practices which address the core goals and principles of soil health. Organic matter serves as a reservoir of nutrients and water in the soil, aids in reducing compaction, and increases water infiltration. Dr. Mitchell noted that because of the different crops, etc., a trial and error process to finding the best technology will be a major challenge to overcome. He encouraged the Science Panel members to think of long-term goals for soil organic matter and requested a formal collaboration with the Science Panel, CDFA and/or both.

Discussions ensued regarding the strategies.

Mr. Cameron suggested changing the agenda to move the Public Comment and Discussion period to after lunch.

PUBLIC COMMENT AND DISCUSSION
Secretary Ross attended the Governor's budget revise meeting earlier in the morning, and provided an update of the items important to Greenhouse Gas Emission reduction to the group. The Secretary emphasized the importance of partnering with the Universities for collaborative solutions in these important issues.

Discussions continued for earlier presentations.

PUBLIC COMMENT
Mr. Ron Hardman: Agriculture lacks the adoption of existing technology. What about the science of adoption of the application? Understand the farmers' decision making process.

Mr. Chris Gardner: Consider the strategies to implement these practices.

Ms. Brittany Hecht, Urban Conservation District: Equipment for no-till seeder, and no-till for orchards and composting dairies. "Landsmart" program for carbon farms, vineyard crops, and compost/biochar projects

Mr. Stacey Sullivan: Improving soil health is a process using compost and dairy waste. It is important for rangelands to know the value of carbon sequestration.

Mr. Dusty Ference, California Citrus Mutual: CCM has formed working groups to look at what industries are doing for soil health. They are getting input from growers/members on farms.

Dr. Jeff Creque, Carbon Cycle Institute: He informed the group of the studies his organization has been doing, there should be a major greenhouse gas reduction by 2050.

Mr. Dan Noble, Association of Compost Producers: The website for his organization is: healthysoil.org.

Mr. Noble mentioned there are 135,000 farm acres of which 100,000 are now fallow because of the drought. To not keep those acres fallow, they should be converted to rangelands. The land should be absorbed to expand cattle herds. Compost facilities use bio-solids for rangelands. His organization in the short term is working with recycling organic producers to form an international soil/carbon coalition.

Mr. Paul Sousa, Western United Dairymen: His organization hopes this will make it easier for dairies to compost their manure.

Mr. Greg Kester, CA Sanitation Agencies: His agency is working on reclamation of fire ravaged lands by using biosolids.

Nick Lapis: Key to soil health is more compost.

Debbie Pierce, Biochar: Her organization is very involved with soil amendments. She indicated that Biochar would be very interested in partnering with other organizations in doing these studies.

Diana Rudi, Grange Lands: She would like small farmers involved in the decision making process. The USDA expects 1 million more farmers by mid-century.

Dave Runson: His organization works with all size farms. The study must look at solutions more broadly and not focus on a specific technology. Farmer to farmer groups must be included for this will happen. Farmers must be both big and small if this will work.

Adam Kotin, CalCAN: Incentivize demo projects and who is involved. Focus effort to build the program including many farmers and projects.

Torrey Estrada: There is more productivity in healthy soil. Five counties in the bay area are already involved in studies. He thinks the barriers to producers are resources or the gap for adoption, capacity on ground or the investment required by producers, and tool development.

Finian Makepeace, Kiss the Ground: Letting go of the silos is important in order to work together. An implementation gap may result because a group of people from a wide range are involved.

Diana Donlon, Center for Food Safety: Framing of the issue as a cultural issue.

Greg Suba, CA Native Plant Society: The Society preserves native habitats throughout California. The scientific gaps he sees are urban, crop/orchard/agriculture, and rangeland diversities and how to manage them. He noted that adding compost on grassland will not alter the competition of the grassland. He would like to see the inclusion of California Fish and Wildlife for studies on grazed grassland.

The sudden oak death in plants in the urban sector, becomes green waste which becomes compost. Australia has dealt with this disease.

Jessica Chardus, PhD Student, UC Davis. The complexities of plants and soil are site specific. Who is being brought into this solution? This affects us all and not enough to just include farmers. Focus also on producers and the consumer function.

Margaret Reeves, Pesticide Network: She noted that it is important to consider the human effects of pesticides and that system-change is important. Ms. Reeves encouraged the creation of farmer networks.

Neil Elder, Compost Coalition: Mr. Elder stated that the state can achieve its greenhouse gas goals by reducing waste in landfills. He also encouraged CDFA to post the speaker presentation online.

John Wick, Marine Carbon Project: Mr. Wick stressed that compost on rangelands is an important method for building carbon. He noted that there are other good feed stocks for compost such as dairy manure.

The Science Panel noted that CDFA should consider the public comments and include them in the Healthy Soils Initiative to the extent possible.

AGENDA ITEM 5 - NEXT MEETING AND LOCATION

Dr. Gunasekara noted the next meeting will be co-hosted with CalRecycle and will be focused on compost. He also noted that the Science Panel will be used to continue the discussions with the public on the Healthy Soils Initiative.

Mr. Cameron adjourned the meeting 3.52 PM.

Respectfully submitted by:

[signature]
Amrith Gunasekara, Ph.D.

7/17/15
Date

Impact of Soil Organic Matter on Nutrient Conservation and Soil Health

William R. Horwath

Dept. Land, Air and Water Resources, Univ. California, Davis, CA, USA

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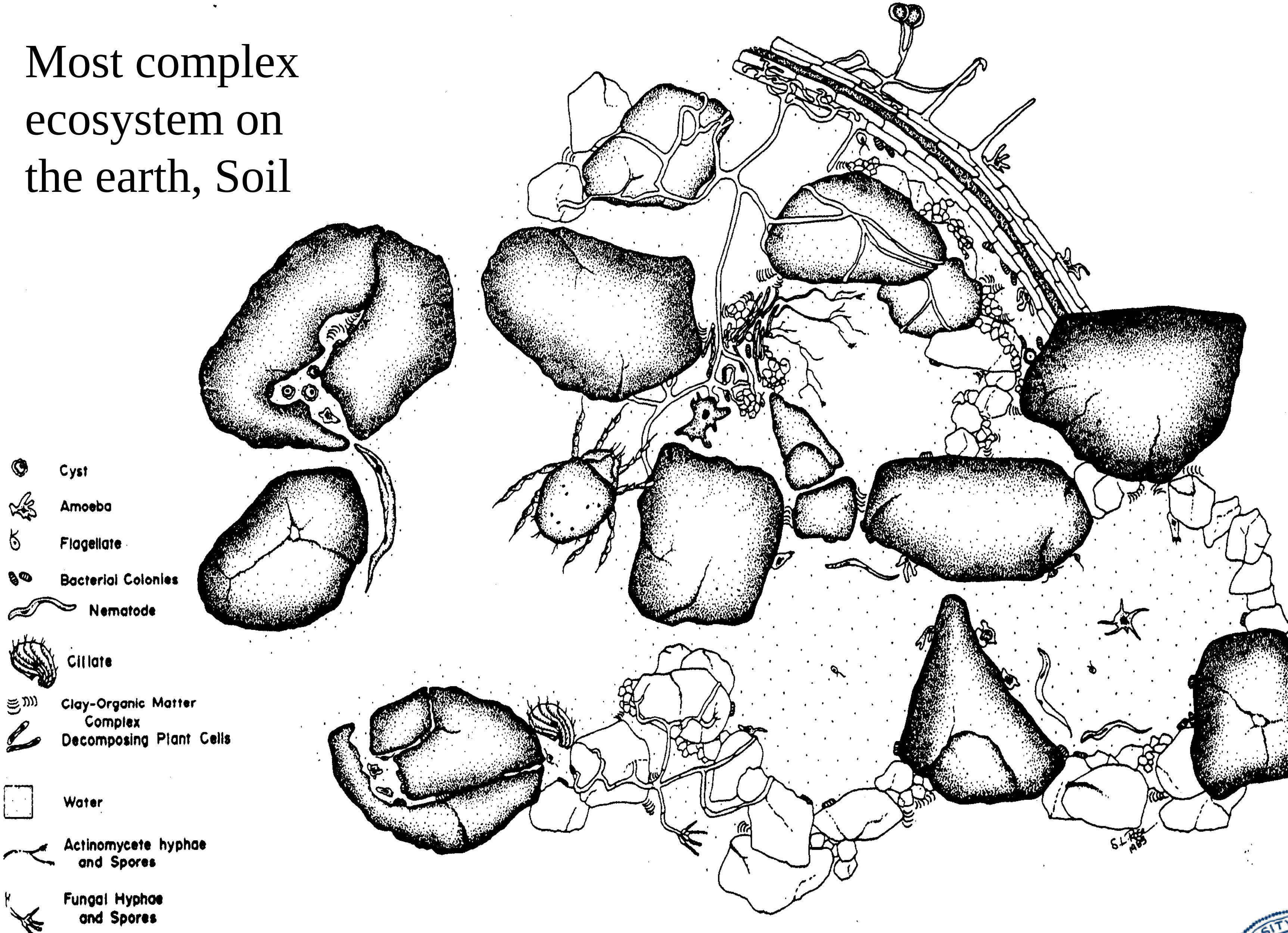
In this talk

- Background on soil C (soil organic matter)
  - What is soil organic matter?
  - Sources, theories, stabilization factors, turnover, and theories
    - Iron, moisture, temperature…..
  - Elevated CO_2 influence on soil C
  - Important fractions related to nutrient avaialbility
- Case studies
  - Role of soil organic matter in nutrient cycling.
  - Soil C sequestration potential

Most complex ecosystem on the earth, Soil



Importance of SOM

- **Cation Ion Exchange capacity**
  - **300 to 700 cmol(+)/kg**
- **Capacity to chelate metals**
- **Enhance soil physical properties**
- **Water Holding capacity**
- **Source of nutrients**
  - **C/N/S/P = 100/10/1/1**

Its easy to measure biophysical properties, but soil organic matter's influence on broad ecosystem services is often overlooked.

What is Soil Organic Matter?

Why is it Important?

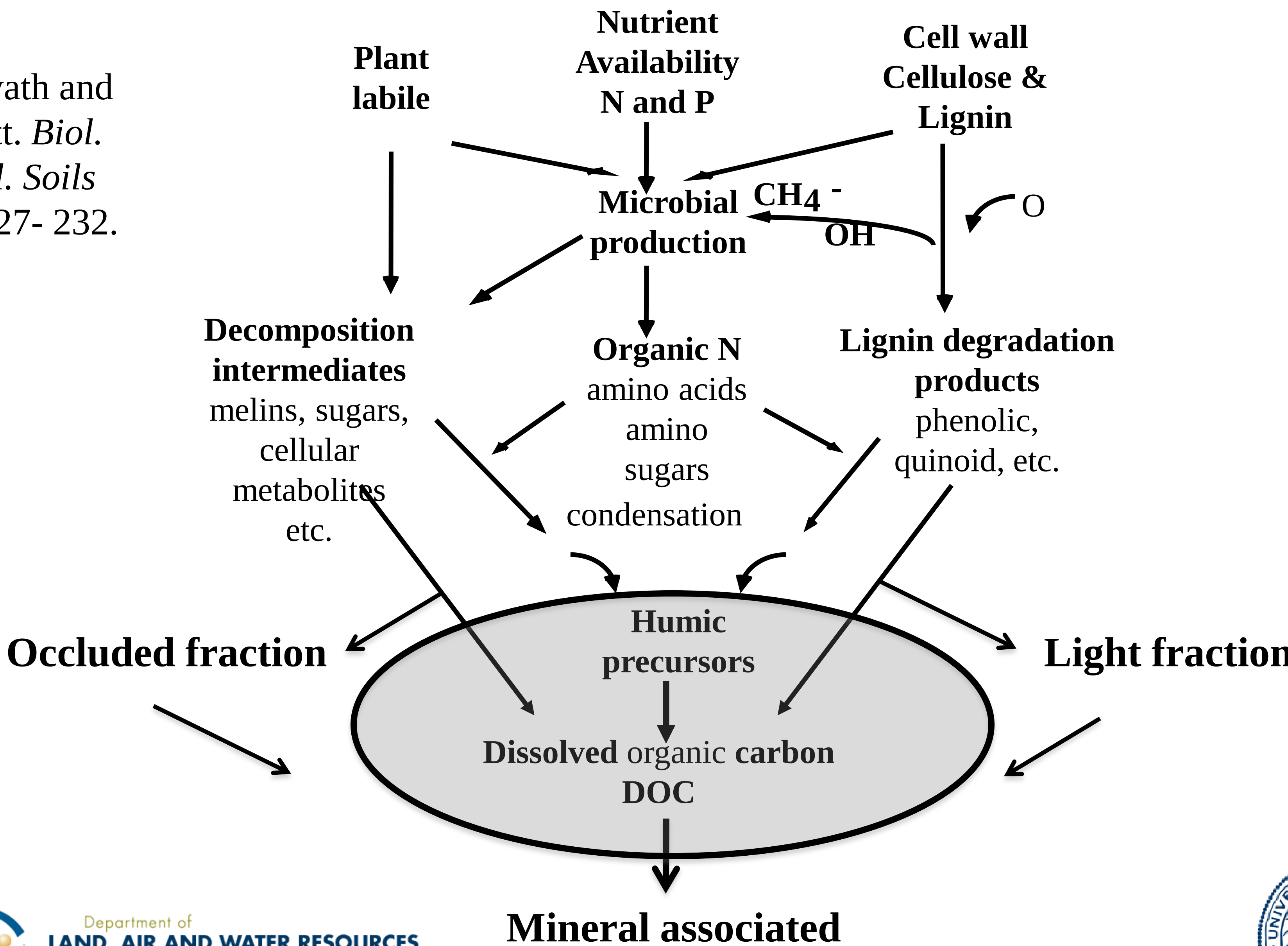
Soil Organic Matter is primarily made form microbial matter

It is a complex and recalcitrant mixture of brown and dark brown substances derived from the conversion of plant biomass into microbial products.

How is it formed?

Soil C Fractions

Horwath and Elliott. *Biol. Fertil. Soils* **21**, 227- 232.



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Soil Organic Matter

SOM is composed of:

Element %
55% C
4-6% N
0.5% P
0.5% S

Compared to other soil fractions:

Fraction	C:N Ratio
SOM	8-12:1
Plant Litter	20-400:1
Bacteria	4 to 7:1
Fungi	8 to 12:1

Living
Microbial Biomass (fungi, bacteria, fauna) 2-5%

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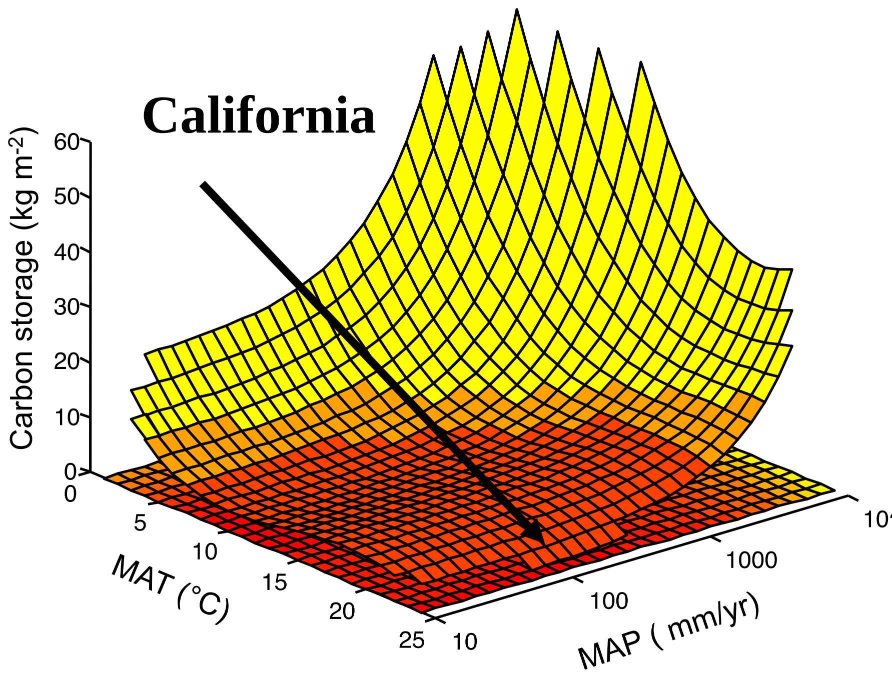
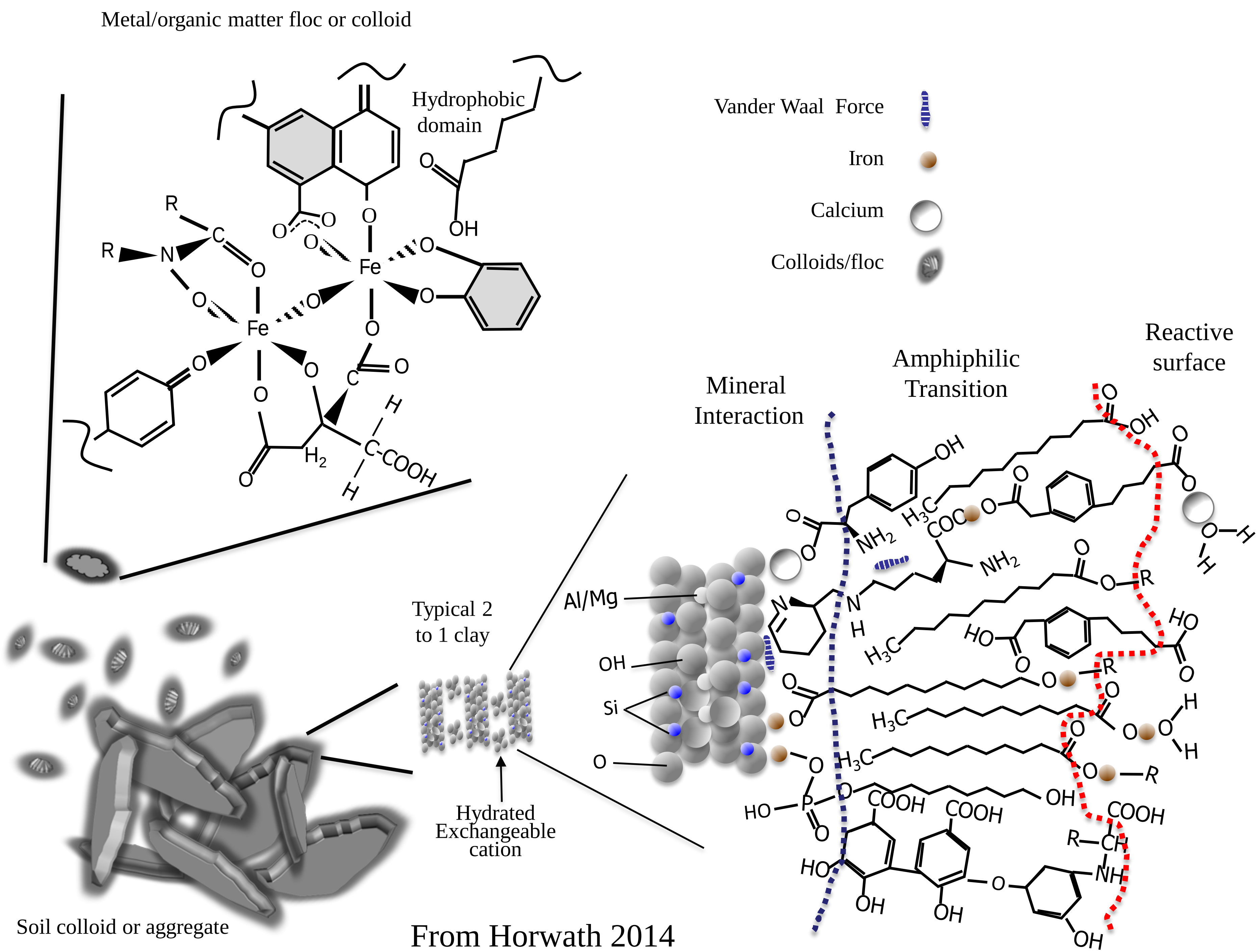
Soil C sequestration
Climate predicts

- **Climate controls potential to sequester soil C in California.**
- **High temperatures work against storing soil C.**
- **Low soil C reduces ability to sequester N**
- **High N mineralization leads to gaseous and NO_3 losses**
- **"Inputs are the key". Plant residues such as cover crops in addition to better crop residue management and other amendments (wastes) can overcome part of this limitation.**



High temperature works against soil C storage



From Horwath 2014

Unprecedented carbon accumulation in mined soils: Role of Iron stabilized biosolids: Why iron?

Time since restoration

year 0 **year 0.5** **year 3** **year 6** **year 9** **year 14**

Silva….Horwath Ecological Applications (2013)

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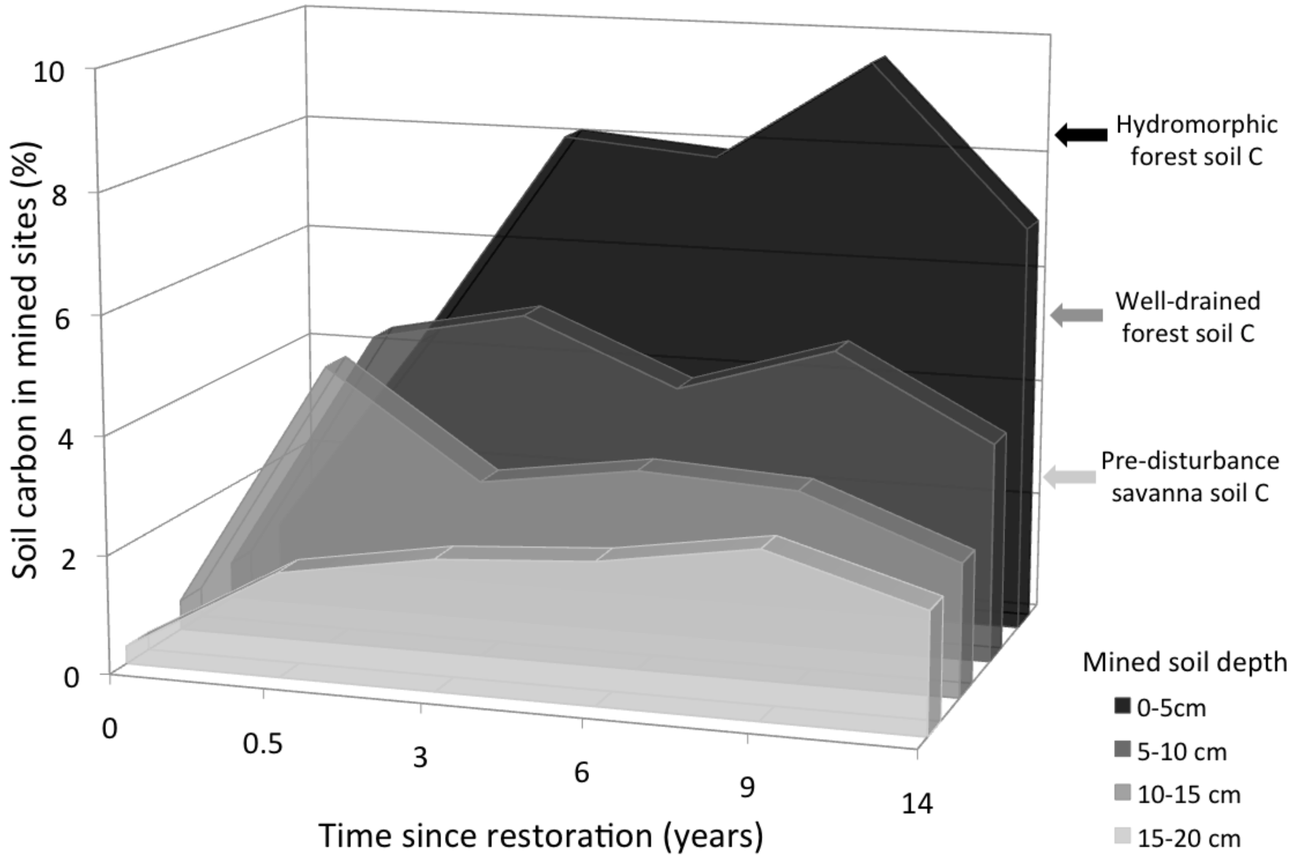
Iron stabilized biosolids addition increased soil C beyond pre-disturbance levels

Silva….Horwath Ecological Applications (2013)



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Does elevated CO_2 increase soil organic matter?

FACE experiment: Swiss Alps forage production

Van Kessel and Horwath 2000

Does elevated CO_2 increase crop production and soil C sequestration?

NO!

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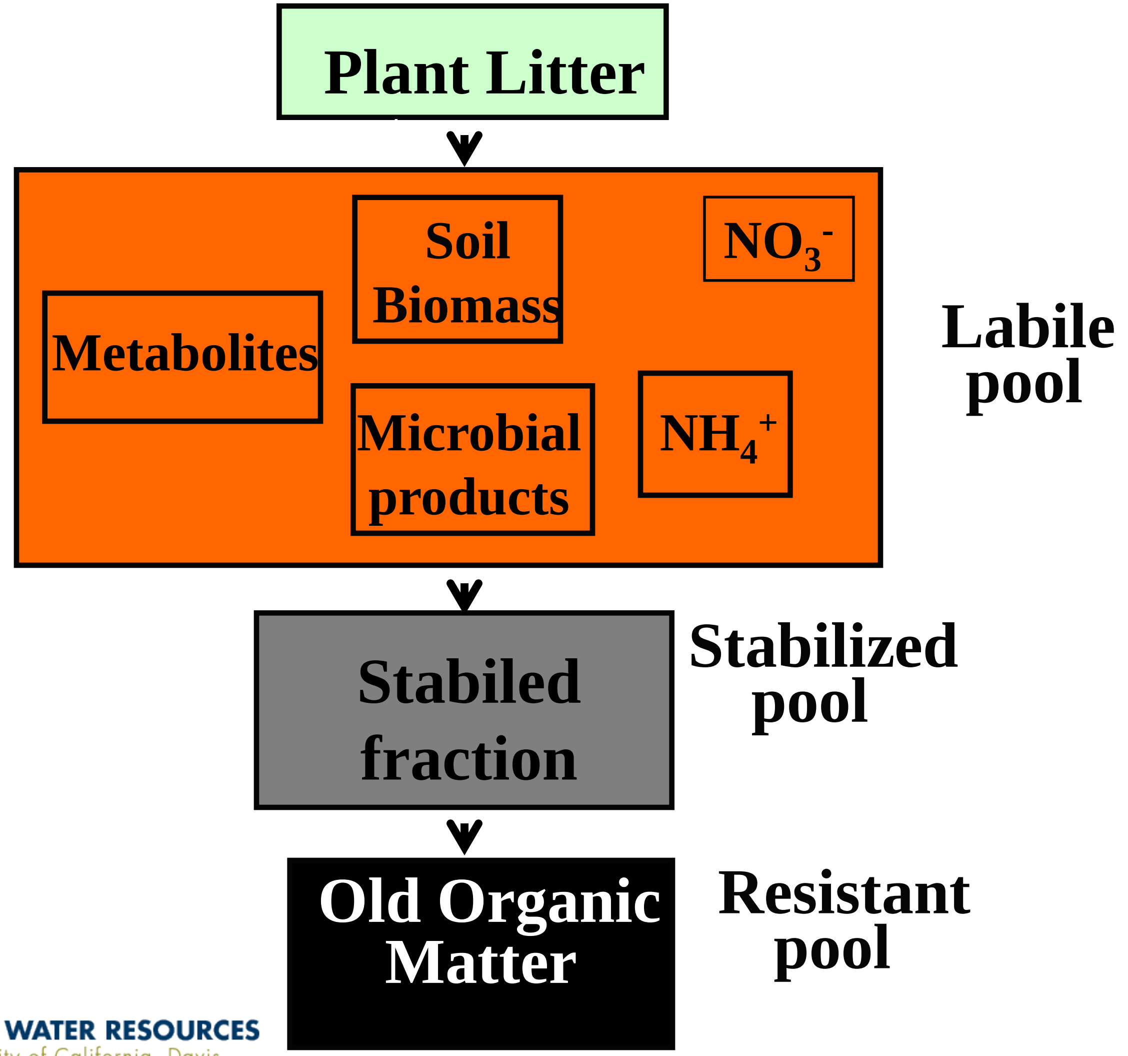
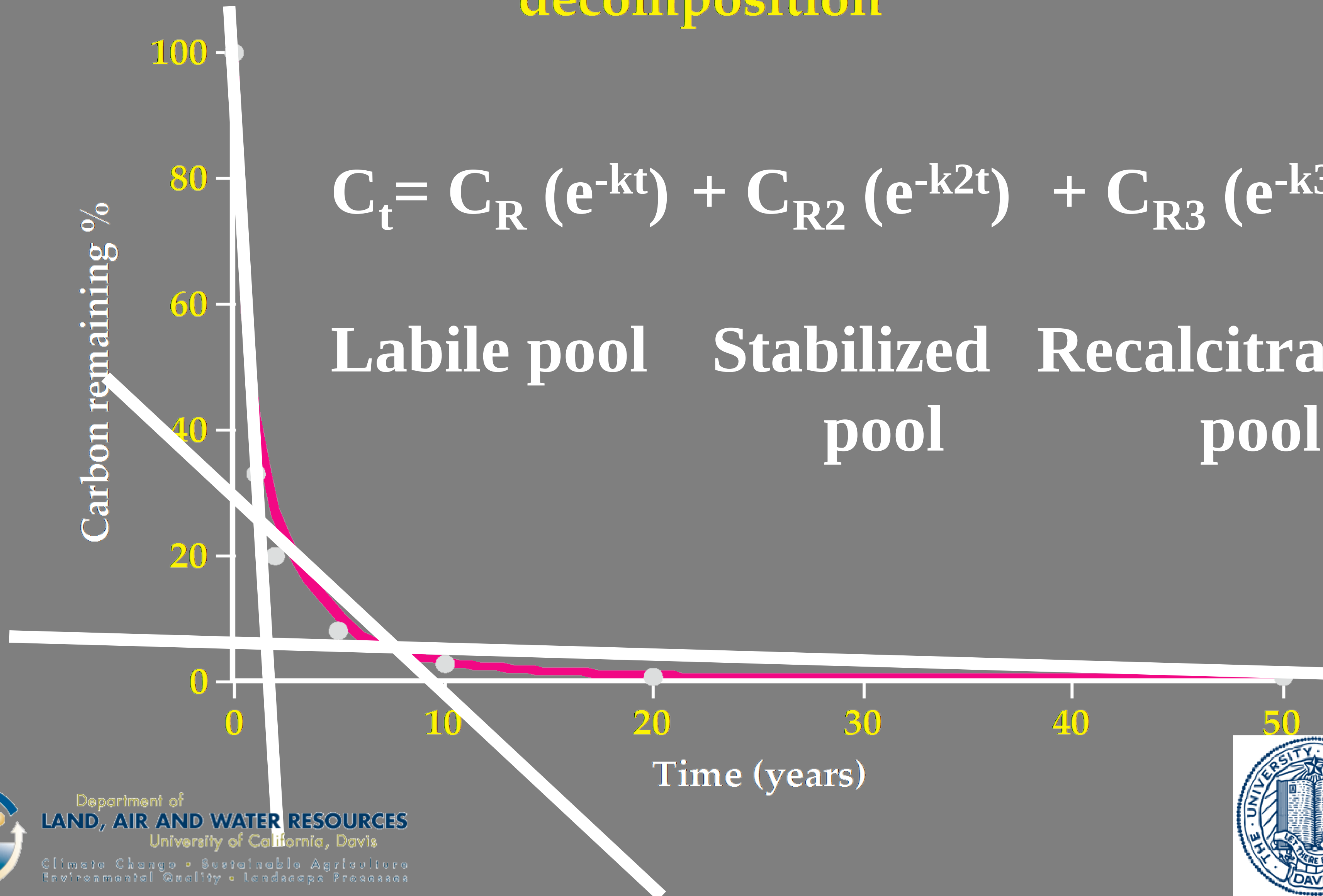
Conceptualizing Soil Organic Matter to understand its function



Plant residue carbon remaining during decomposition



$$C_t = C_R\,(e^{-kt}) + C_{R2}\,(e^{-k2t}) + C_{R3}\,(e^{-k3t})$$

Labile pool **Stabilized pool** **Recalcitrant pool**

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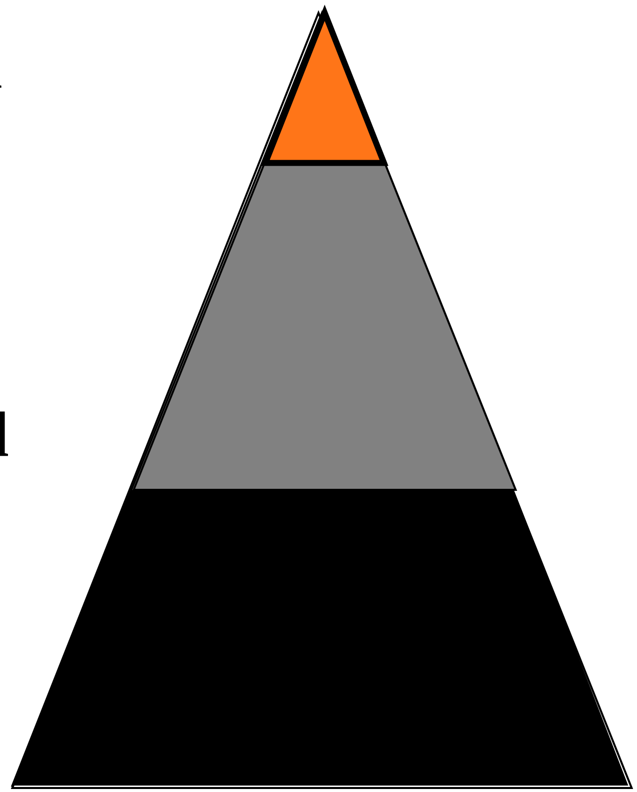
Contribution of Soil Organic Matter Fractions to available soil nitrogen

Labile SOM
Active fraction
<1 year old

Light fraction
Microbial biomass

Resistant SOM
~5 to 40 years old

Stable Organic Matter



Stable SOM
>1000 years old

Very Stable Organic Matter

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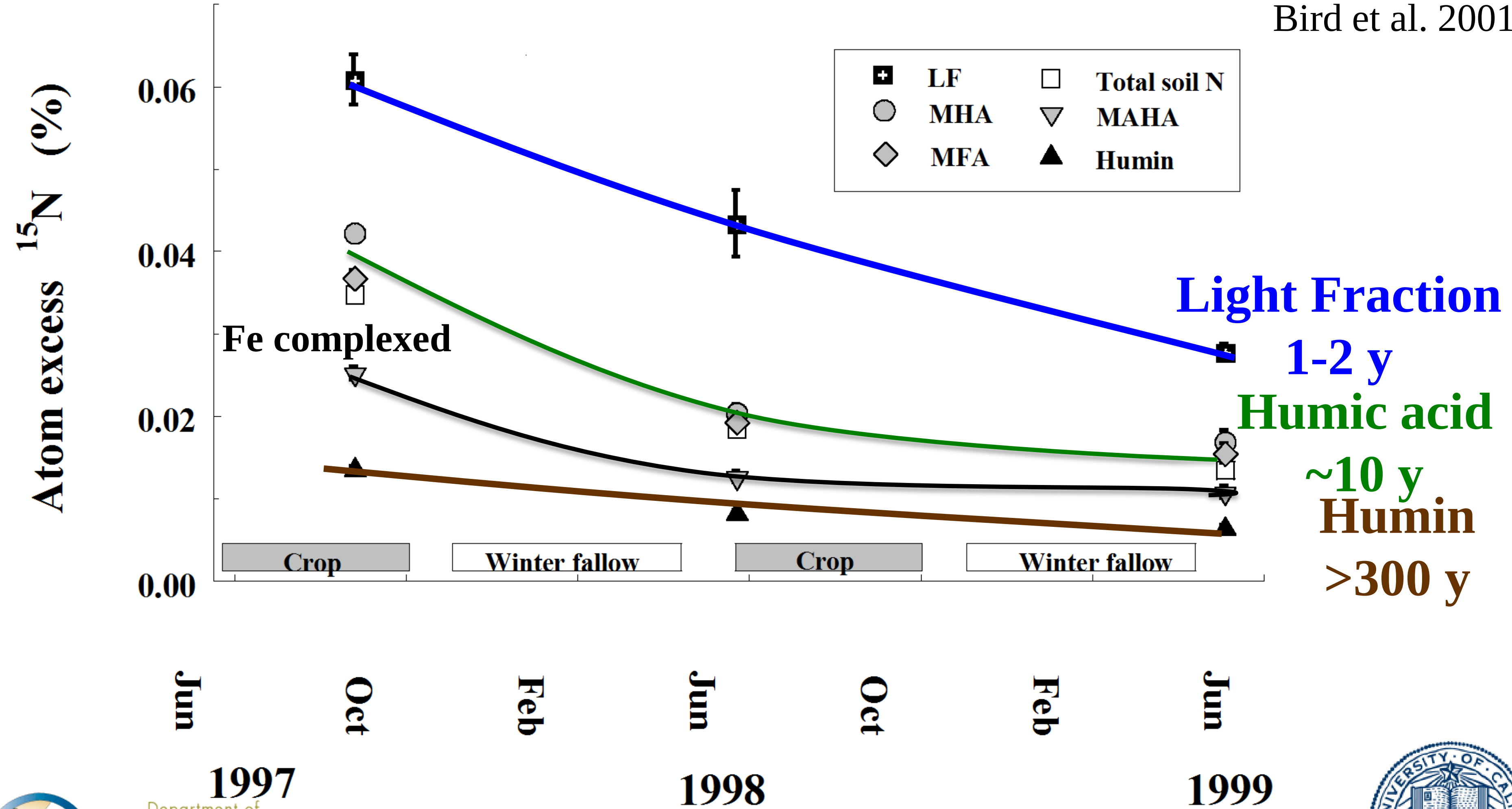
Classical Humic Fractions

Nitrogen turnover in rice through operationally defined humic fractions

Bird et al. 2001



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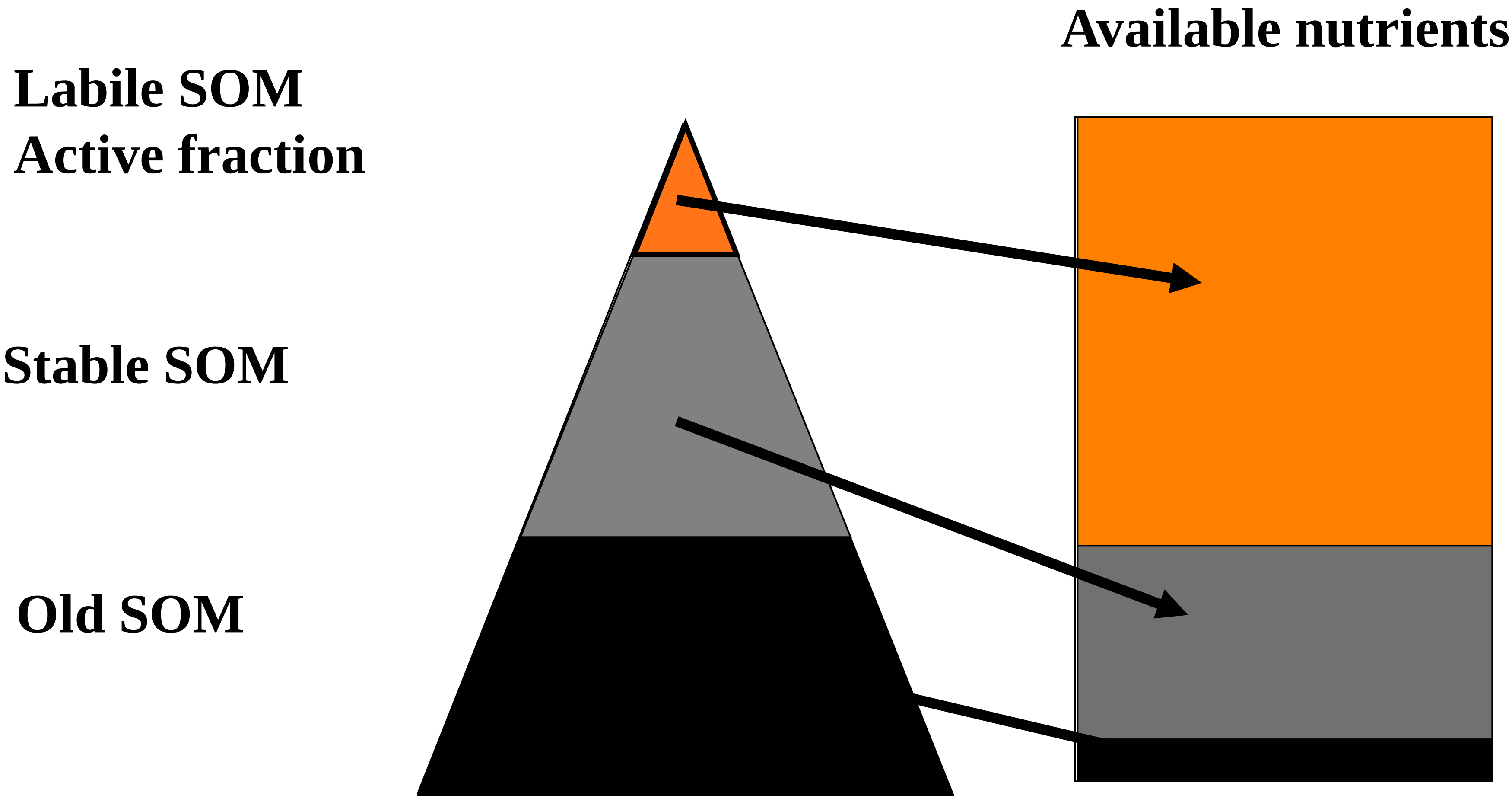
Contribution of Soil Organic Matter Fractions To available soil nitrogen



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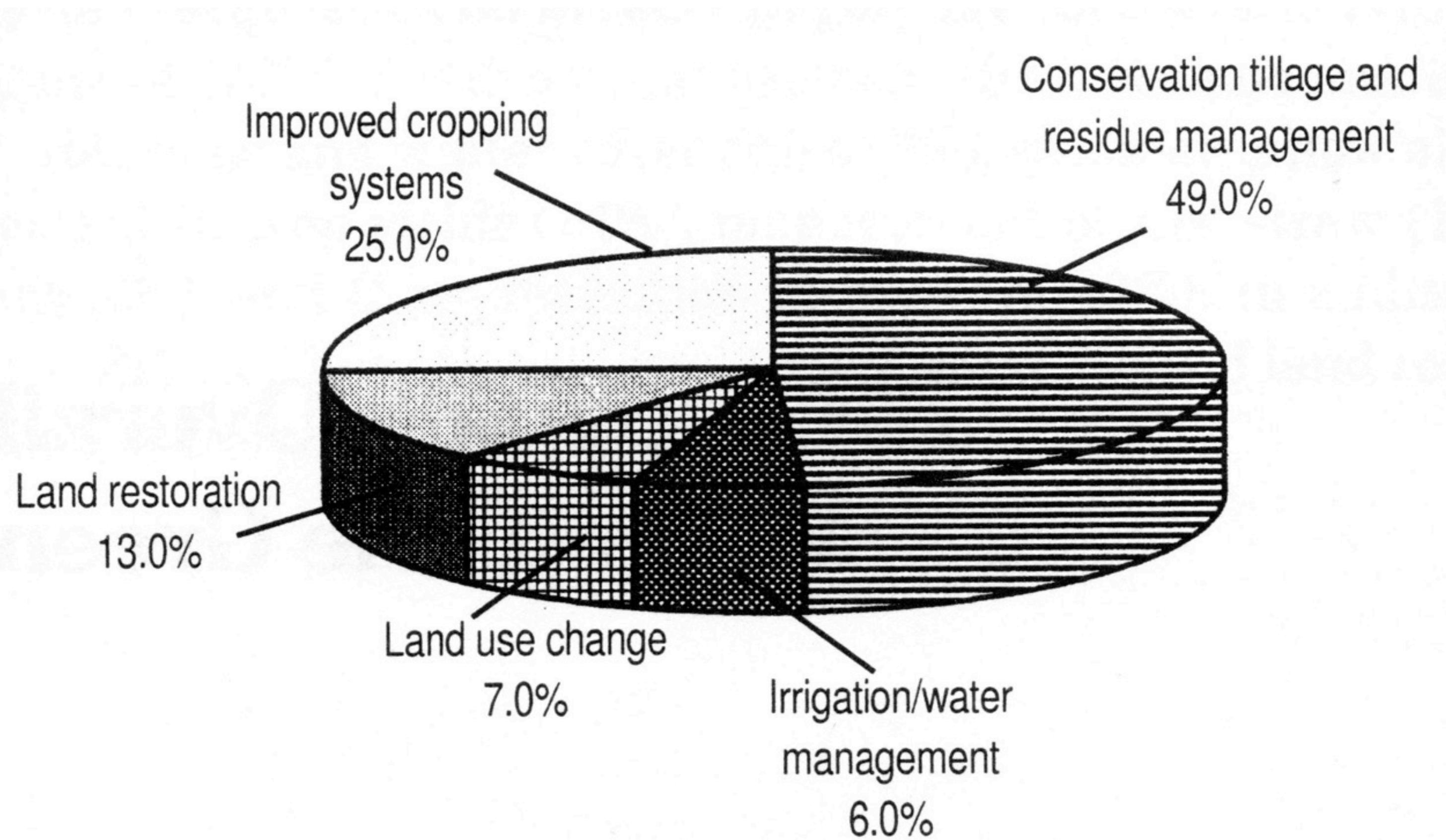
C sequestration thru improved crop management



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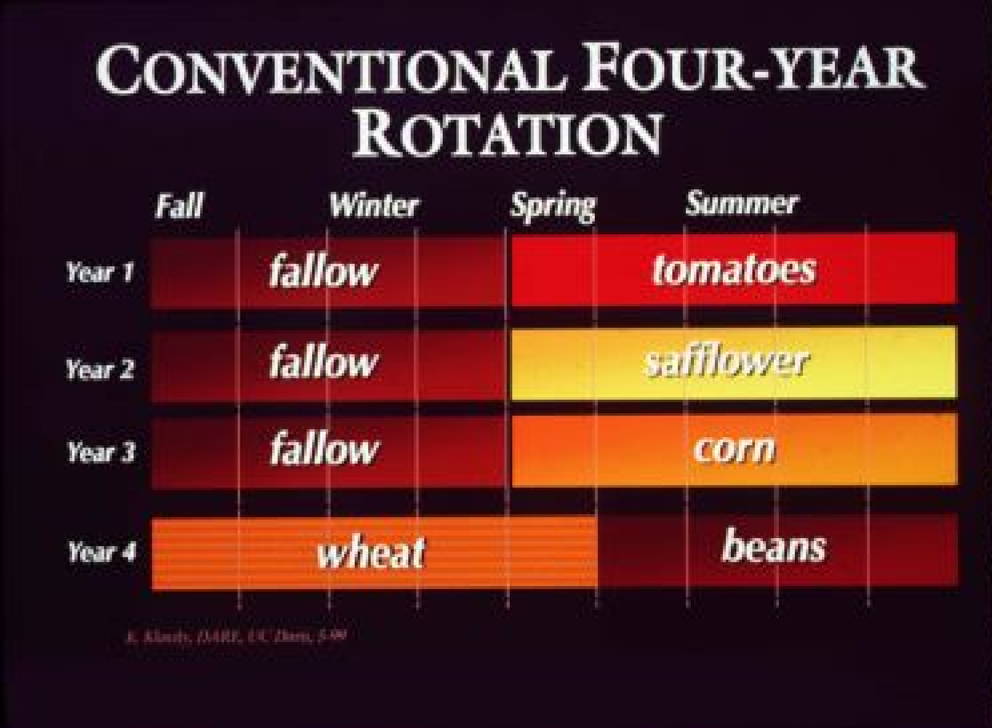
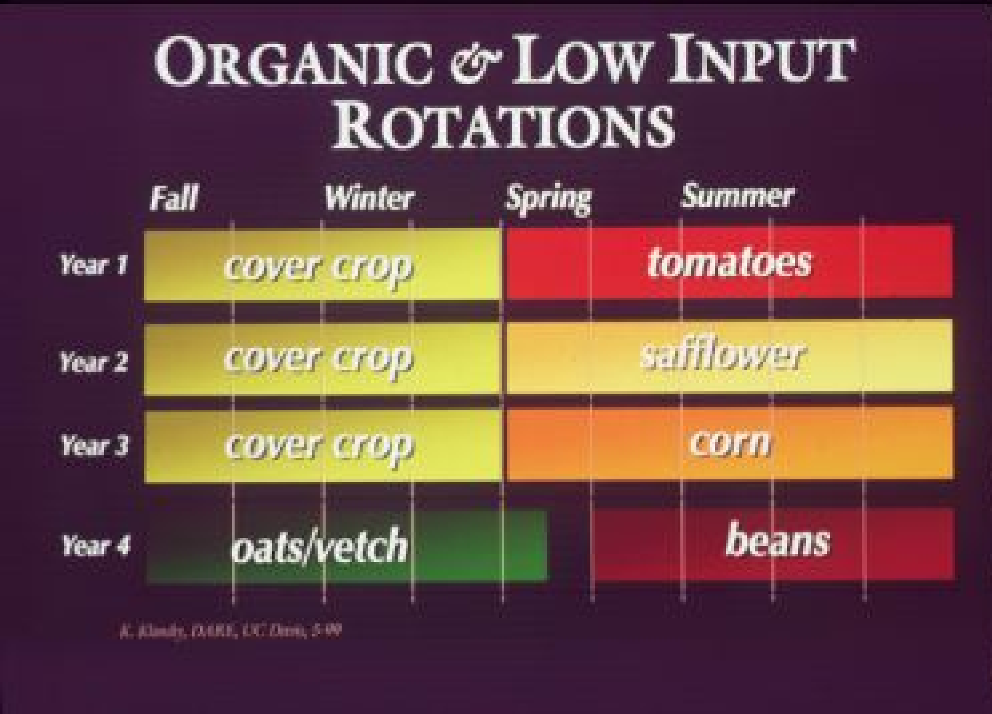
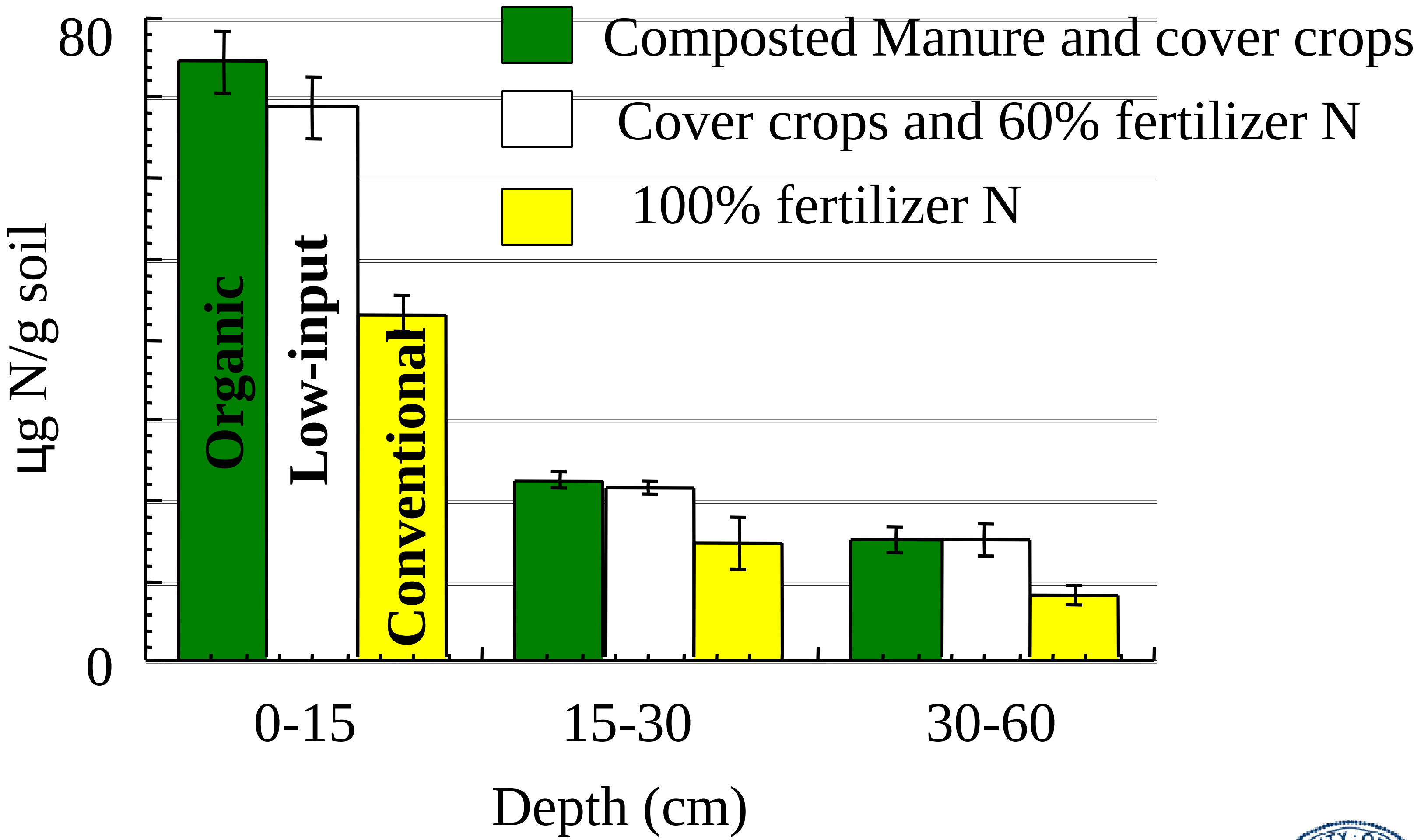

CONVENTIONAL FOUR-YEAR ROTATION
Fall
Winter
Spring
Summer
Year 1
fallow
tomatoes
Year 2
fallow
safflower
Year 3
fallow
corn
Year 4
wheat
beans


ORGANIC & LOW INPUT ROTATIONS
Fall
Winter
Spring
Summer
Year 1
cover crop
tomatoes
Year 2
cover crop
safflower
Year 3
cover crop
corn
Year 4
oats/vetch
beans


SUSTAINABLE FARMING SYSTEMS
A UC DAVIS PROJECT COMPARING CONVENTIONAL
AND LOW-INPUT SYSTEMS

Management effects on Microbial N

UCD Sustainable Agriculture Farming Systems project



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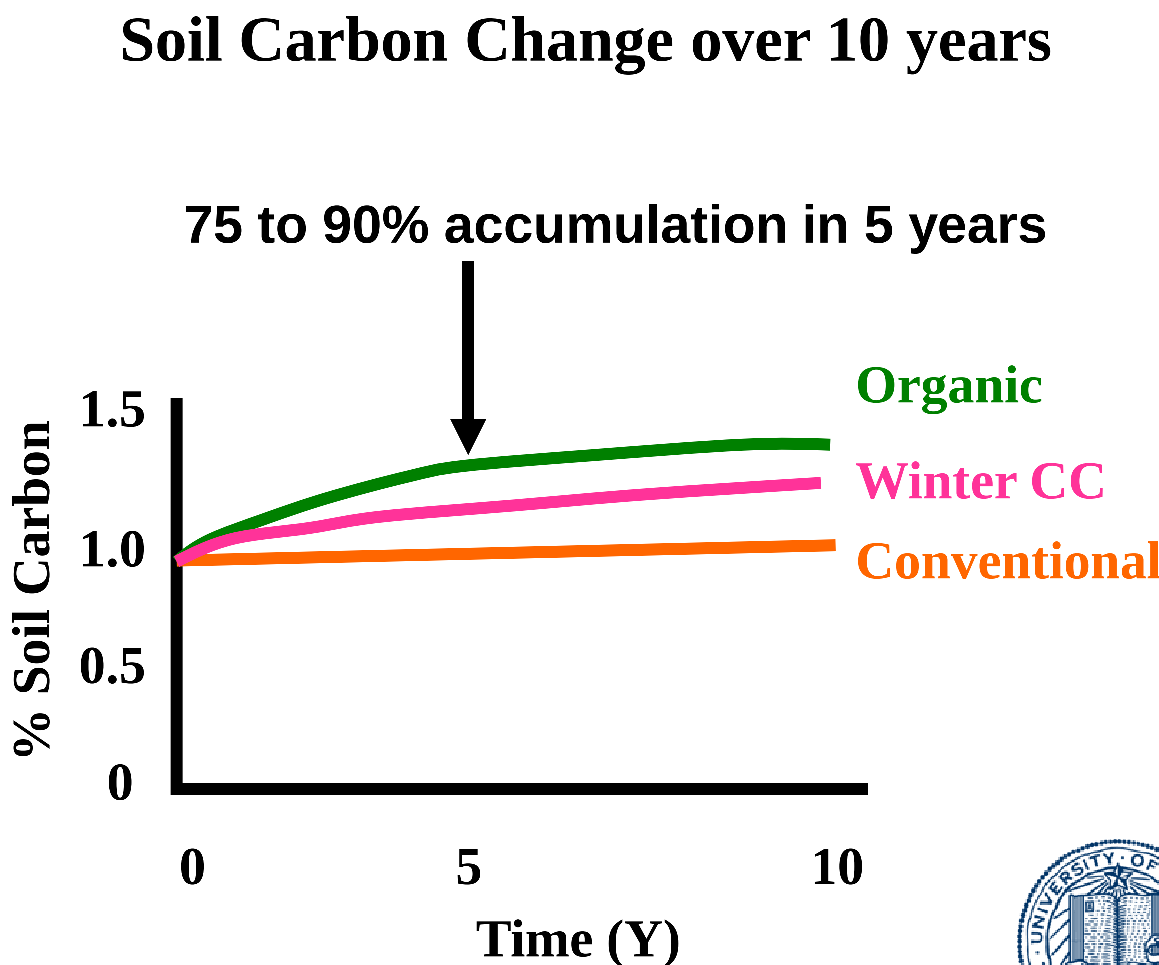
California Agriculture C Sequestration Potential (Case Studies on effect of inputs; 4 UCD studies) Harvested Irrigated Cropland

- Soil C increased 30 to 50% over 10 years with cover cropping (CC) and manure application, respectively.
- Represents 3 to 5 tons of soil C per hectare.
  - CC and or manure must be practiced annually to maintain soil C.
  - ~75% of soil C sequestration will occur as fast as 5 years.



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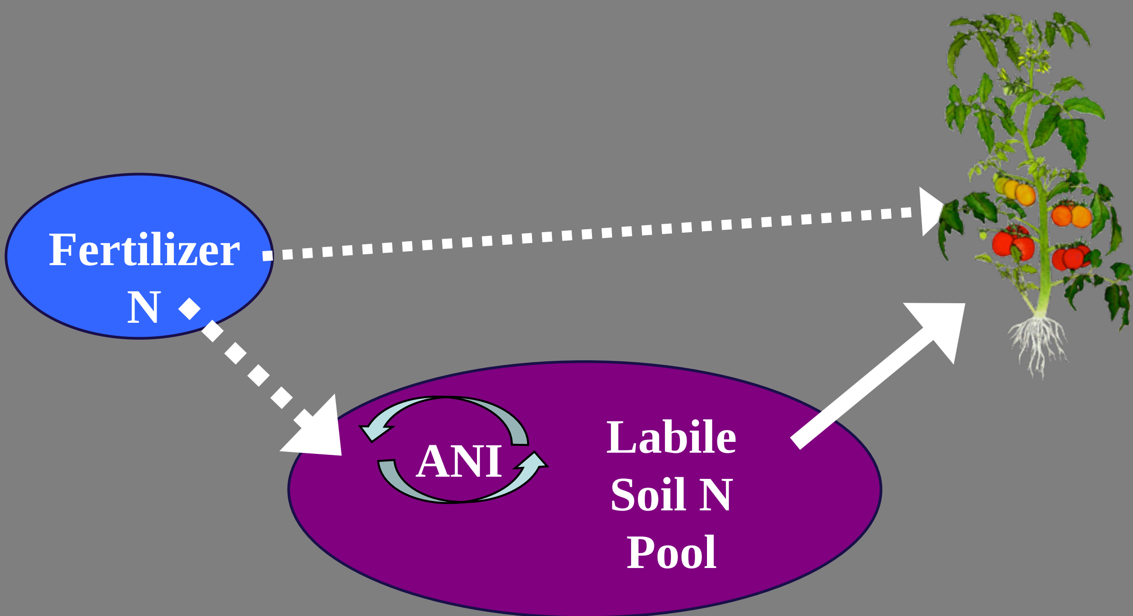
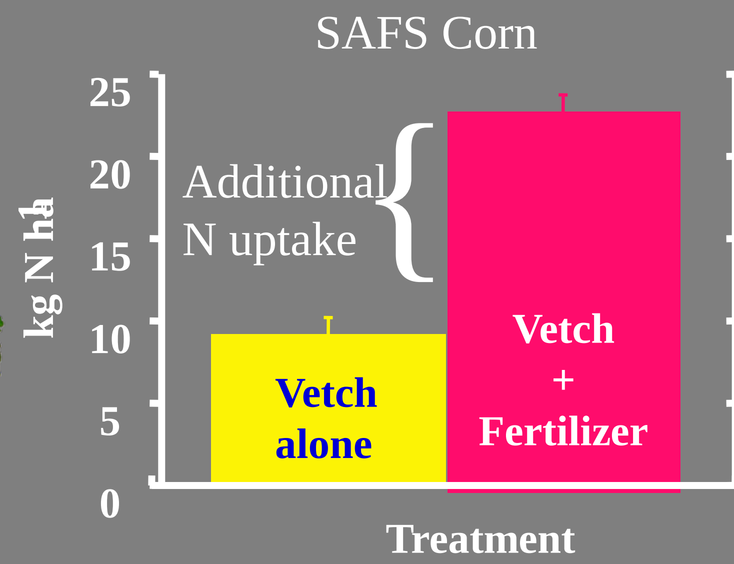
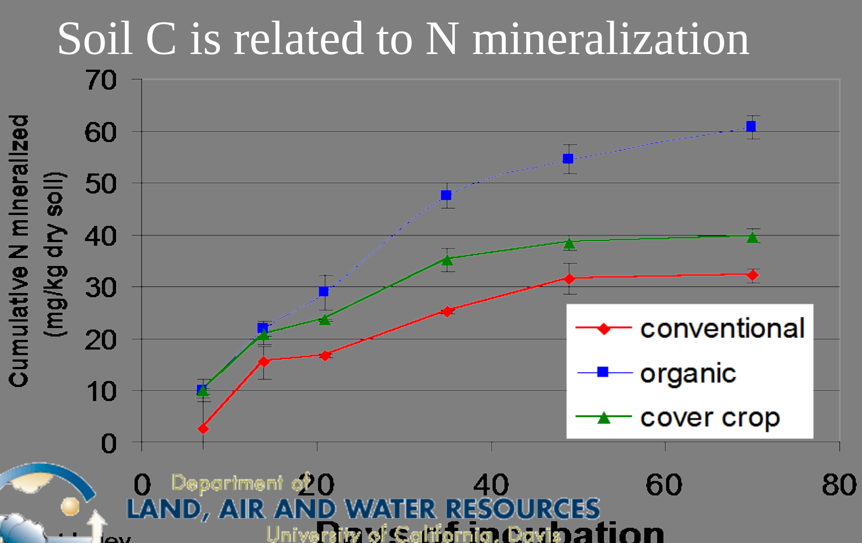
Manipulating Soil N Availability







Important finding:

Since soil C sequestration is finite, an increase in the mineralization of soil N must be achieved to manipulate N availability.

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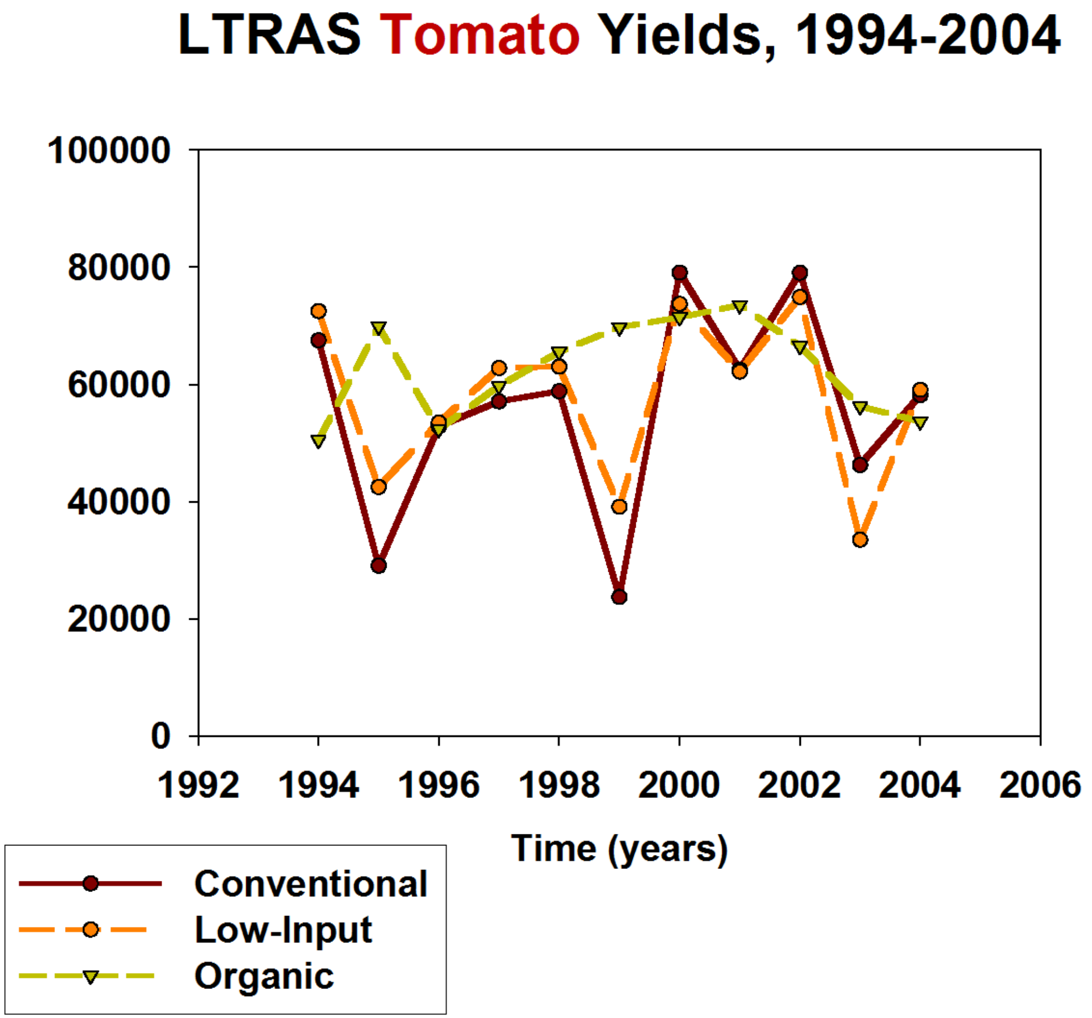
Cumulative (kg ha^{-1}) N input, N output, soil N storage and loss (%) for organic, low-input, and conventional cropping systems for SAFS & LTRAS, over 10 years

System	N input	N output	Soil N storage	Loss of Applied N
SAFS				
Organic	1924	933	901	4.6
Low-input	1550	1186	327	2.4
Conv-4	1827	1339	79	22.3
Conv-2	1584	1132	0	28.5
LTRAS				
Organic	3368	905	685	68.0
Low-input	1500	921	-329	60.5
Conv-2	2064	1288	-383	56.2

UCD Russell Ranch Sustainable Agriculture Facility Tomato Yield (kg ha^{-1}) 1994-2004



Tomato yields more consistent in organic management

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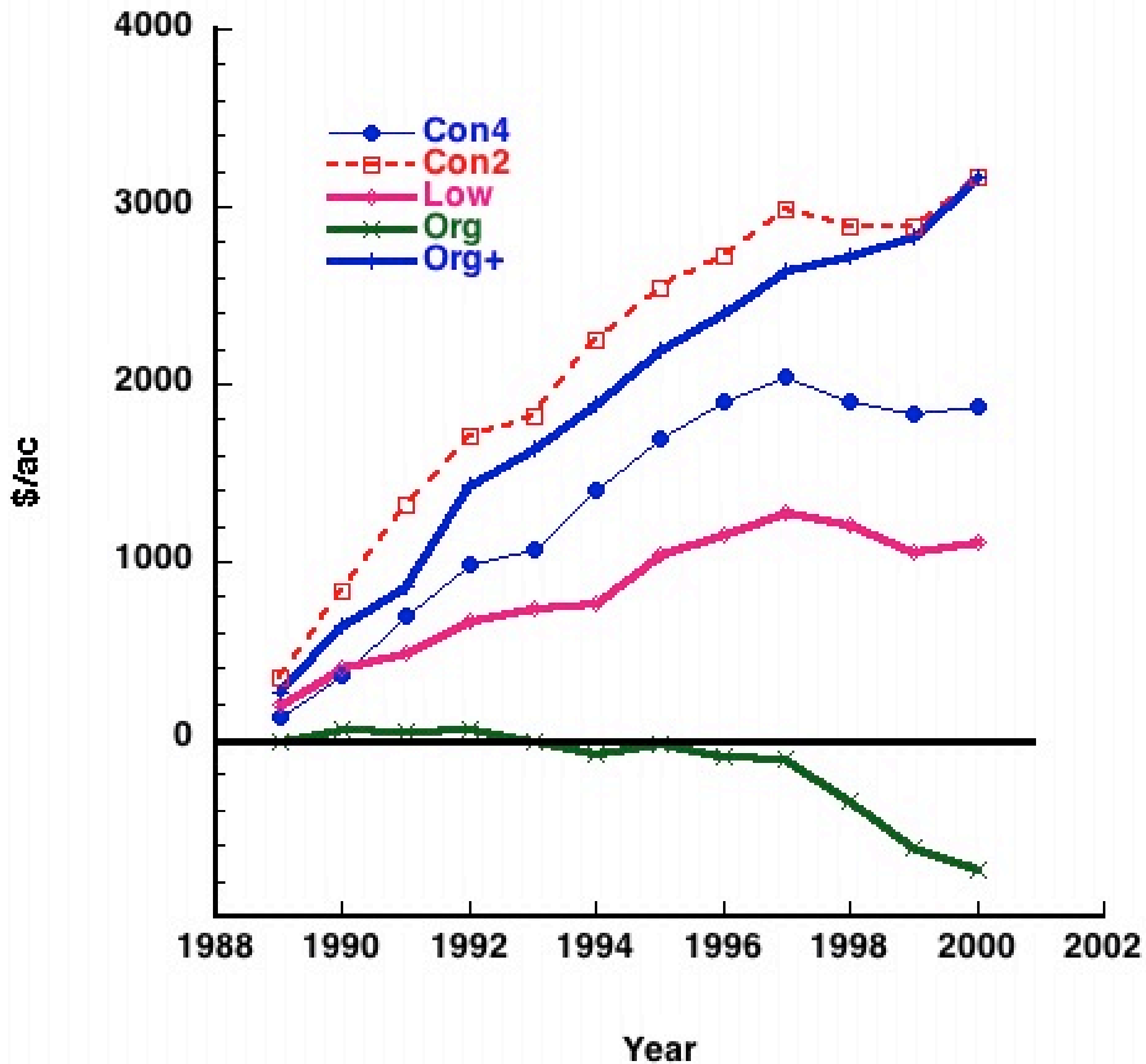
Whole Farm Cumulative Net Returns (dollars per acre)



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California Agriculture Soil C Sequestration "Big Picture"

- A potential of 11 million metric tons of soil C can be sequestered assuming composted manure or cover crops contribute to 3.0 t soil C/ha/10y for all harvested irrigated lands.
  – Need to consider differences between annual and perennial crops and different types of cover crops

- Represents 39 million metric tons of CO_2 equivalents.
  – Remember most of the sequestration occurs within a decade under consistent management, so short-term one time solution.
  – In order to realize C sequestration potential management must be practiced consistently and indefinitely.

Range of soil C sequestration will depend on consistent (annual) management (i.e., cover crops at 3 tons C/ha) (Harvestable irrigated land; 3,527,288 ha)

% of potential C sequestration	Total Soil C sequestration (total tons)	MMT CO_2 eq
25	2,645,466	10
50	5,290,932	20
75	7,936,398	29
100	10,581,864	39
125	13,227,330	49

Probable outcome

- **Consistent winter cover crop management is unlikely**
- **The addition of organic waste would help greatly but supply is limited and transportation cost would be prohibitive.**
- **Management must be done consistently and indefinetly**

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Research Needs

- Elevated CO_2 studies suggest decomposition rate increases independent of of the amount of inputs. Negative interaction?
    - Why is soil C priming increasing?
- Iron plays a key role in stabilizing soil C
    - Consider adding iron or co-compost biosolids, green waste, manure and food waste….
    - What is the optimum formulation?
- Role of enriched C amendments in affecting water relations in soils
- What factors are responsible in soils with higher C contents that maintain crop yield potential
    - Better water relations?
    - Biology?
- Increasing soil C sequestration
    - Optimum cover crop mix or mix of amendments (e.g., compost, biosolids..)
- Incentives may be needed for adoption

AndersenLab

BERKELEY LAB

The Microbiology of Compost and Healthy Soil



Compost: The Ultimate in Recycling

Returns organic nutrients back to the soil for increased plant productivity
Increases water retention in soil for drought resistance
Long term sequestration of carbon, our best hope to combat climate change

Soil is Unique to our Planet

The soil is like the Earth's skin, easy to take for granted and to damage

Soil performs many functions that are fundamental for life on Earth

In a single gram of soil there are >50,000 species and >3 billion microorganisms

45% Minerals

Sand, silt, clay

25% Water

25% Air

5% Organic matter

Dead, decaying plants, animals and other organisms

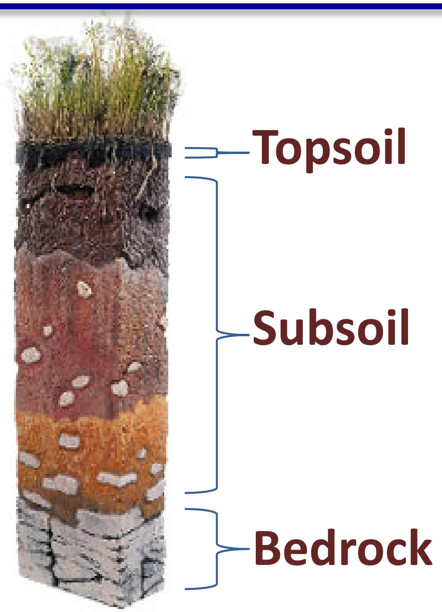
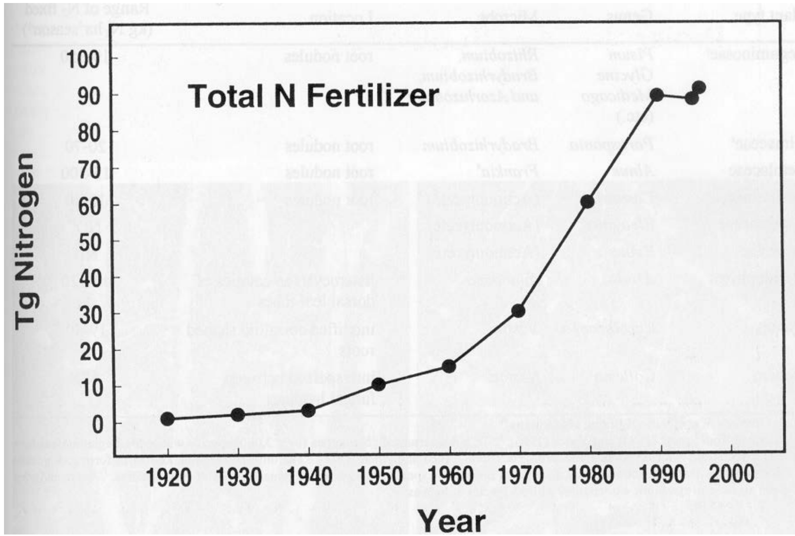


Image courtesy of USDA NRCS.

We Need to Protect our SOIL

- It is where we grow our food!
- Habitat for soil organisms
- Recycle organic matter into nutrients
- Filter and purify the water we drink and use to grow food,y resilience to drought
- Help maintain clean air
- A holding place for the Earth’s carbon

Why chemical fertilizers aren't the answer



The Haber-Bosch process

$N_2 + H_2 \longrightarrow 2NH_3$

300 to 1000 bar pressure

400 to 600 C

Catalyst

Consumes 1.4% of total fossil fuels annually

Electrical discharge

$N_2 + O_2 + \text{lightning} \longrightarrow NO_x$

$NO_x + H_2O \longrightarrow HNO_2 \text{ or } HNO_3$

- Production of nitrogenous fertilizers has "plateaued" in recent years because of high costs and pollution

- Estimated 90% of applied fertilizers never reach roots and contaminate groundwater

What is compost – why use it?

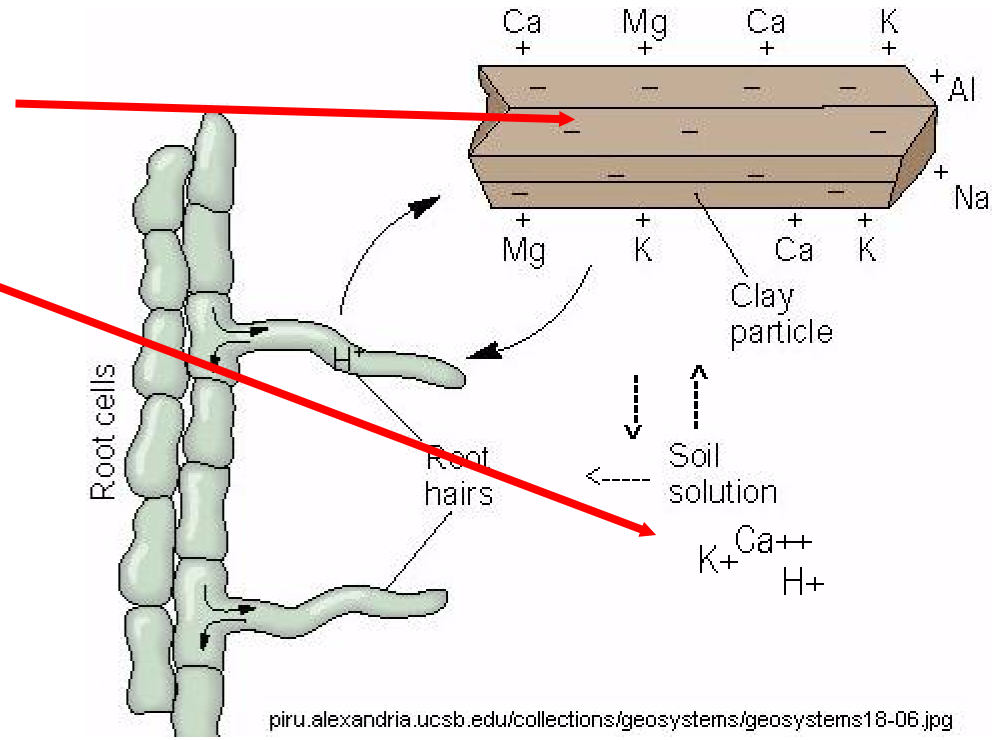
The decomposition of once-living (organic) materials to make soil amendment that is rich in nutrients.

In other words: humus!

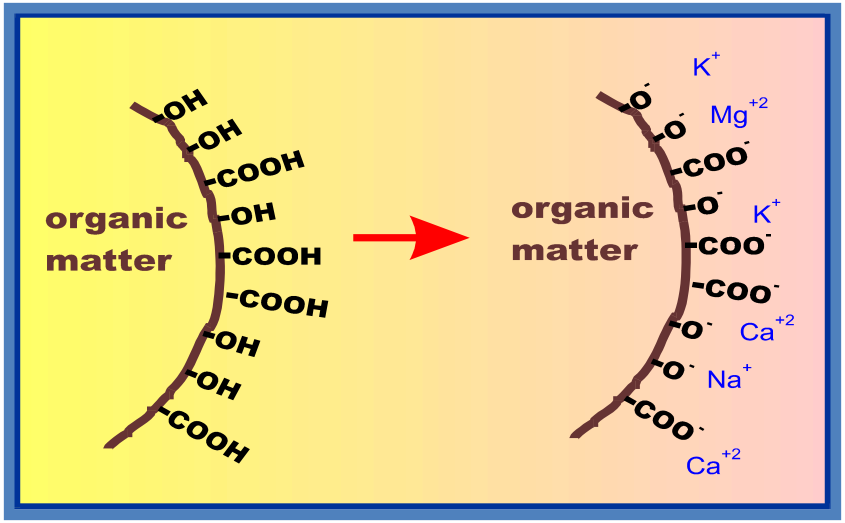
- It is the living part of the soil, slowly releases nutrients to plants.
- We manage composting so the biodegradation happens faster than in nature.
- compost improves soil structure, texture, aeration - increases the soil's water-holding capacity.

Soil Cation Exchange Capacity

- In most soils, 99% of soil cations can be found attached to micelles (clay particles & organic matter) and 1% can be found in solution.
- Cations in the soil (mainly Ca++, Mg++, K+ and Na+) maintain an equilibrium between adsorption to the negative sites and solution in the soil water.
- This equilibrium produces exchanges -- when one cation detaches from a site (leaving it free), another cation attaches to it.
- Therefore the negatively charged sites are called cation exchange sites.
- The total number of sites is the Cation Exchange Capacity or CEC



Soil nutrition from compost (humus)



-reactive functional groups:
-carboxyl, hydroxyl, phenolic

- High cation (anion) exchange capacity
- High water holding capacity
- Promotes soil aggregation

Reactive Nitrogen in Liquid Manure and Chemical Fertilizer vs. Organic Nitrogen in Compost

Nitrogen is available to plants as either ammonium (NH_4^+) or nitrate (NO_3^-)
These inorganic forms or nitrogen are commonly found in chemical fertilizer and liquid manures. Lower concentration in finished compost.

Organic nitrogen in plants and other compostable material is stable. These complex forms of nitrogen are not available to plants until they are broken down into inorganic nitrogen.

Nitrogen exists in compost and soil humus as a stable, organic nitrogen and the breakdown to inorganic nitrogen occurs over a long period of time so that the plant available nitrogen is released at about the same rate that it is taken up by plants.

Thermophilic Composting

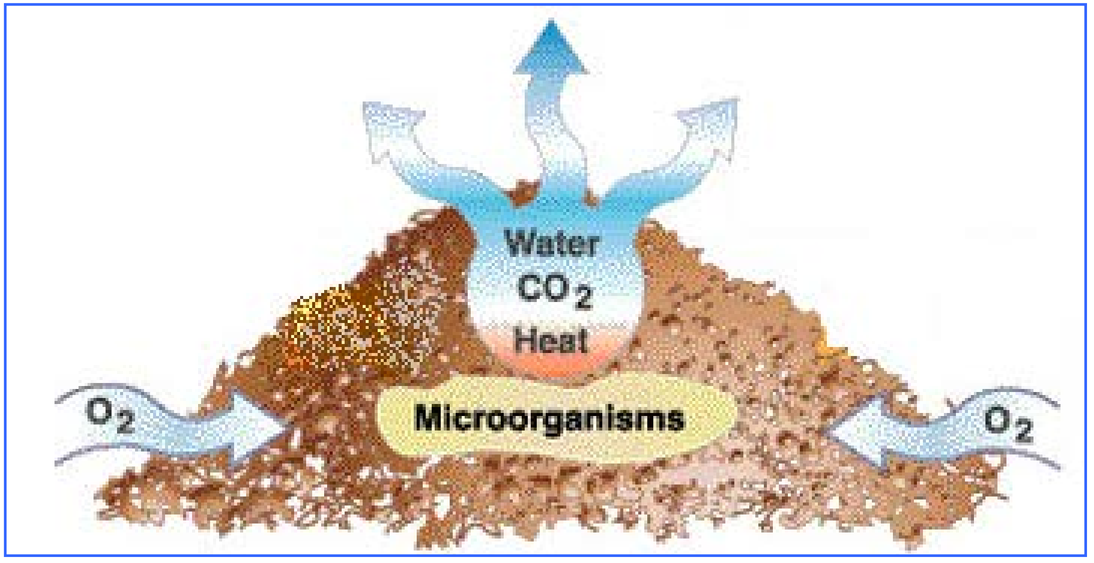
- <u>Aerobic</u>

Aerobic composting benefits from:

a) A rapid rate of degradation

b) Elevated temperature levels

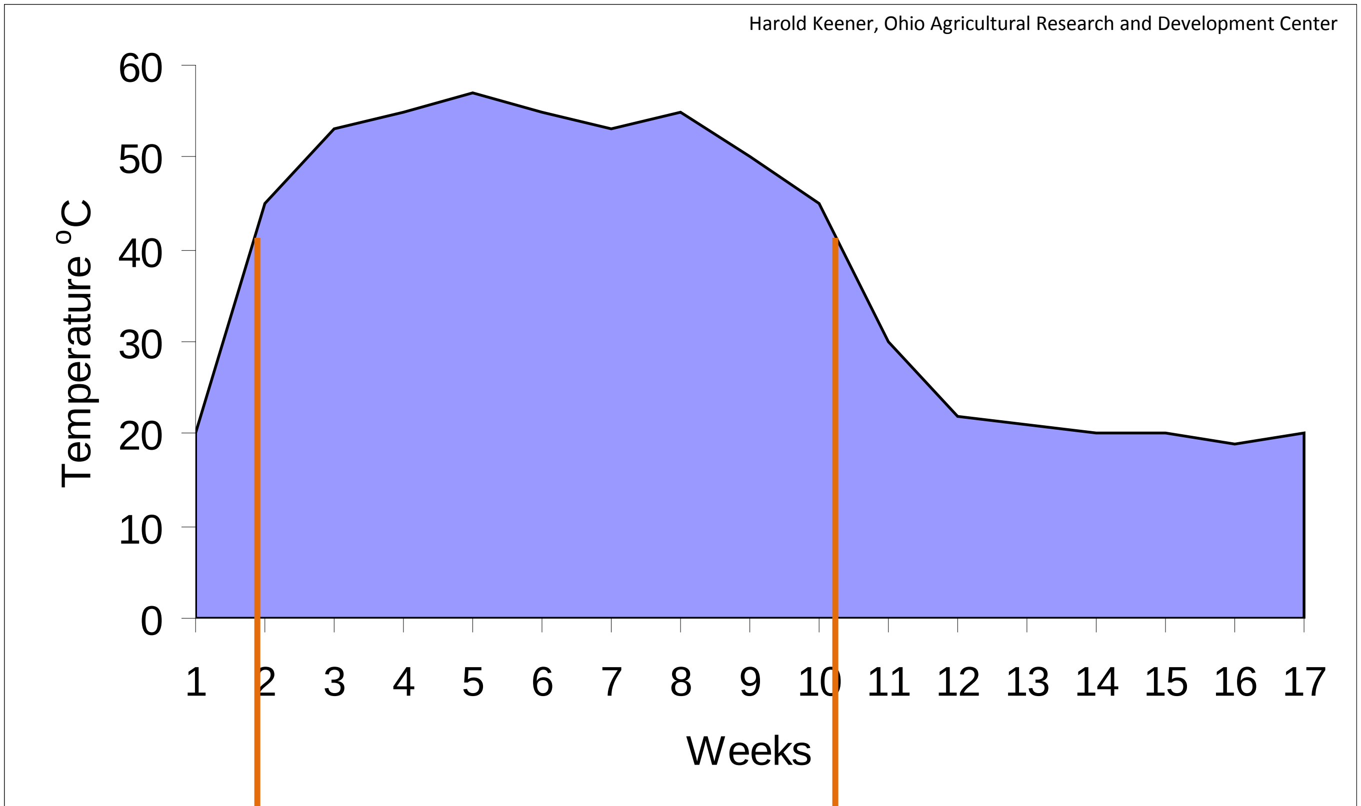
c) Very little smell



The Perfect Compost Recipe

- Carbon (C) rich materials provide energy for microbes and other decomposers
  - Leaves, wood, paper, cardboard, etc.
  - Also called “browns”
- Nitrogen (N) rich materials provide the Nitrogen needed for cell function
  - Food waste, manure, grass, etc.
  - Also called “greens”
- C:N ratio
  - Optimum is between 25:1 to 30:1
  - Or, 5 parts of browns to 1 part of greens

How Does It Work?



Ambient Temperature

Raw Material

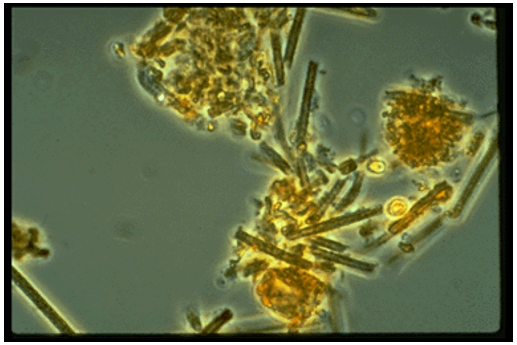
High Heat

Active Composting

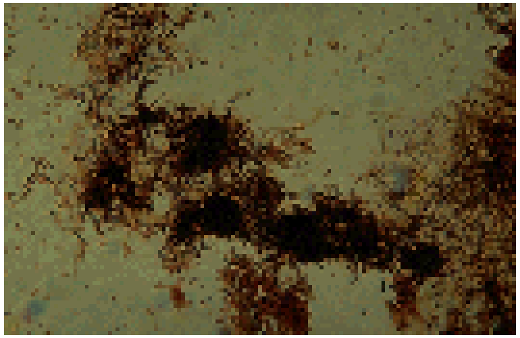
Ambient Temperature

Stabilizing/Curing

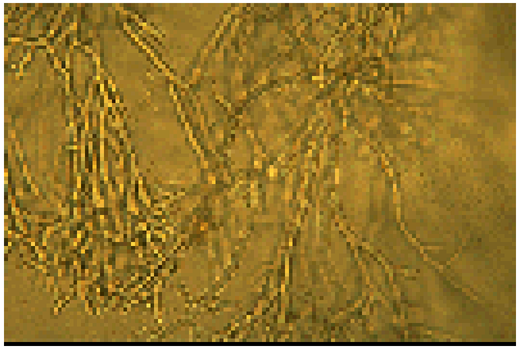
The main players



1. Bacteria:
   major decomposers, breakdown simpler forms of organic material



2. Actinomycetes:
   degrade complex organics such as cellulose, lignin, chitin, and proteins – earthy” smell, long “spider webs” filaments

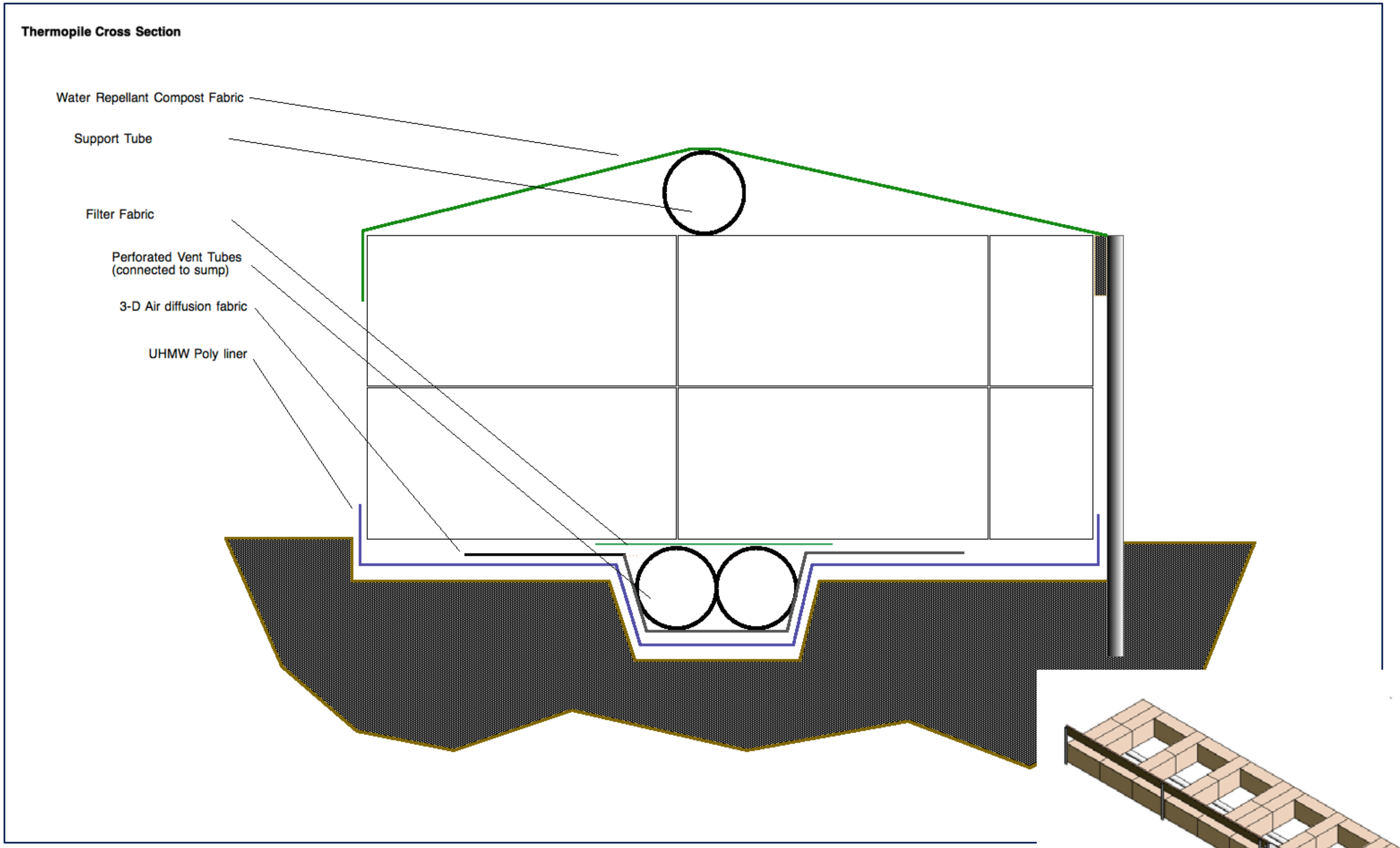


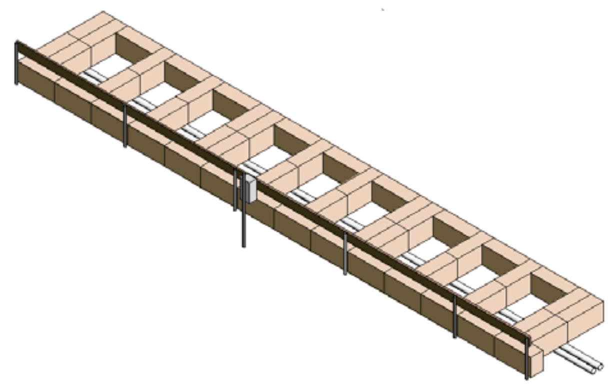
3. Fungi:
   Break down tough debris, too dry, too acidic or too low in nitrogen for bacteria to eat

Nicassio Composting Facility for Microbe Characterization

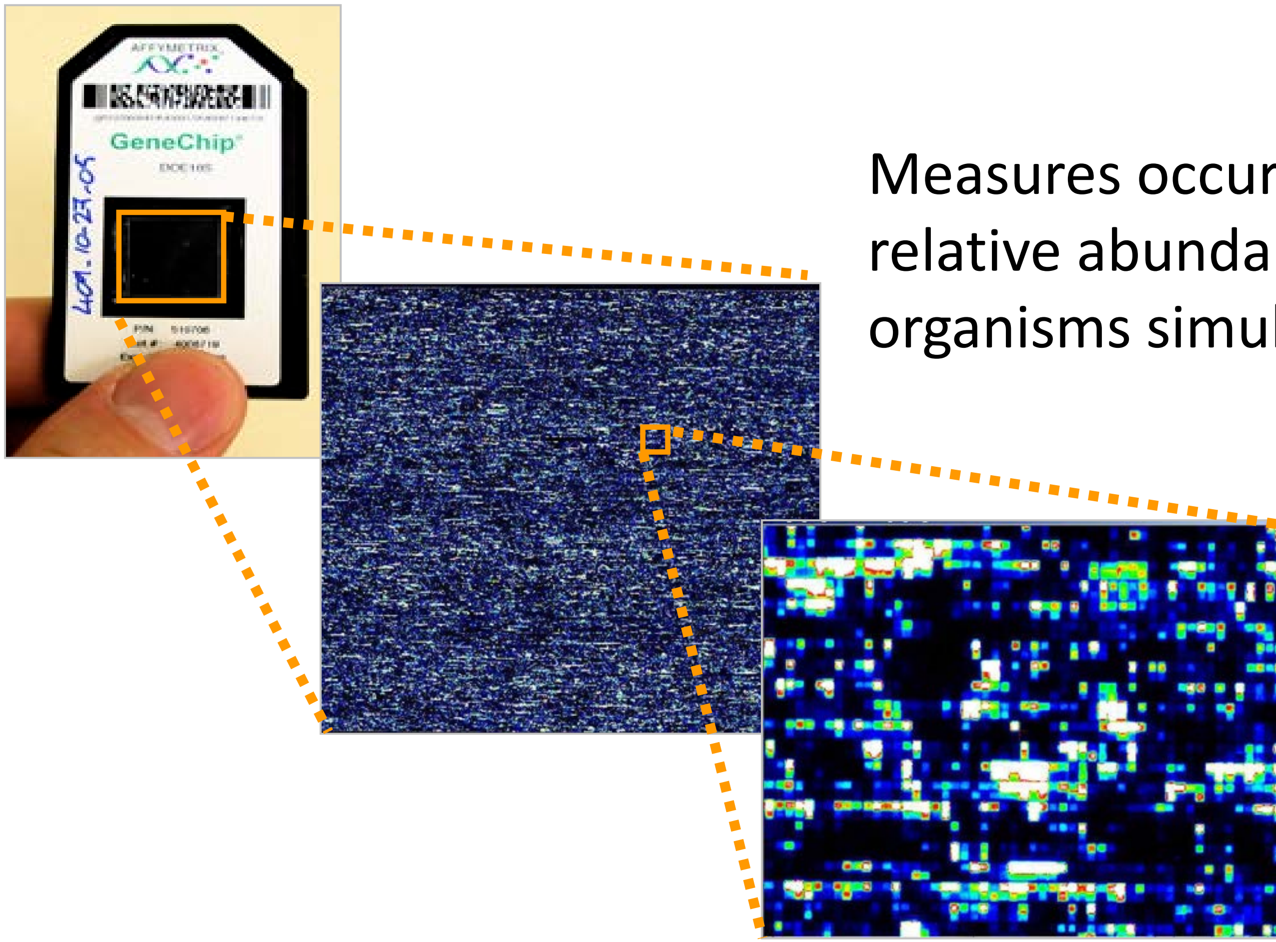
What are the microbes doing in the compost environment?

Compost Pile Design and Layout



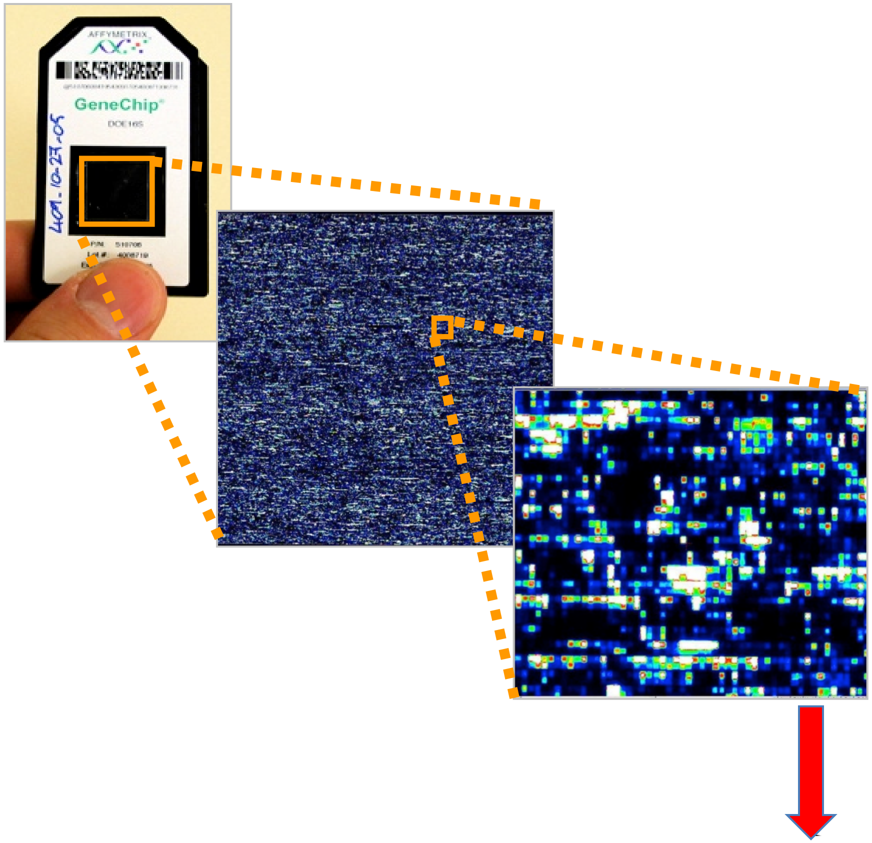


Berkeley Lab PhyloChip detects 60,000 different bacteria and archaea in one test

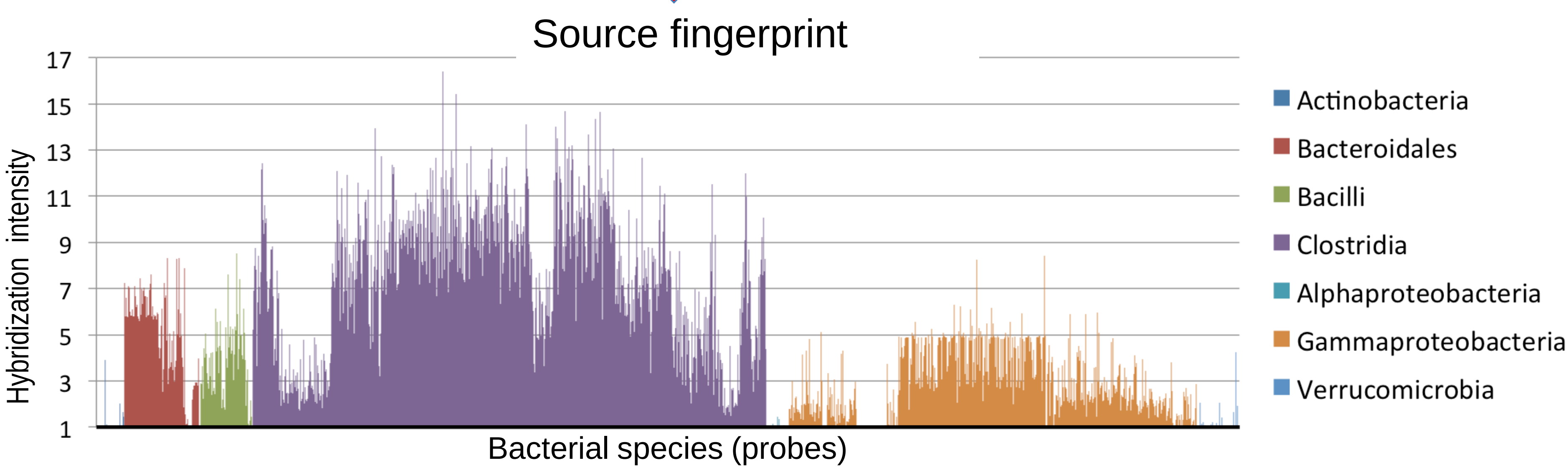


Measures occurrence and relative abundance of all organisms simultaneously

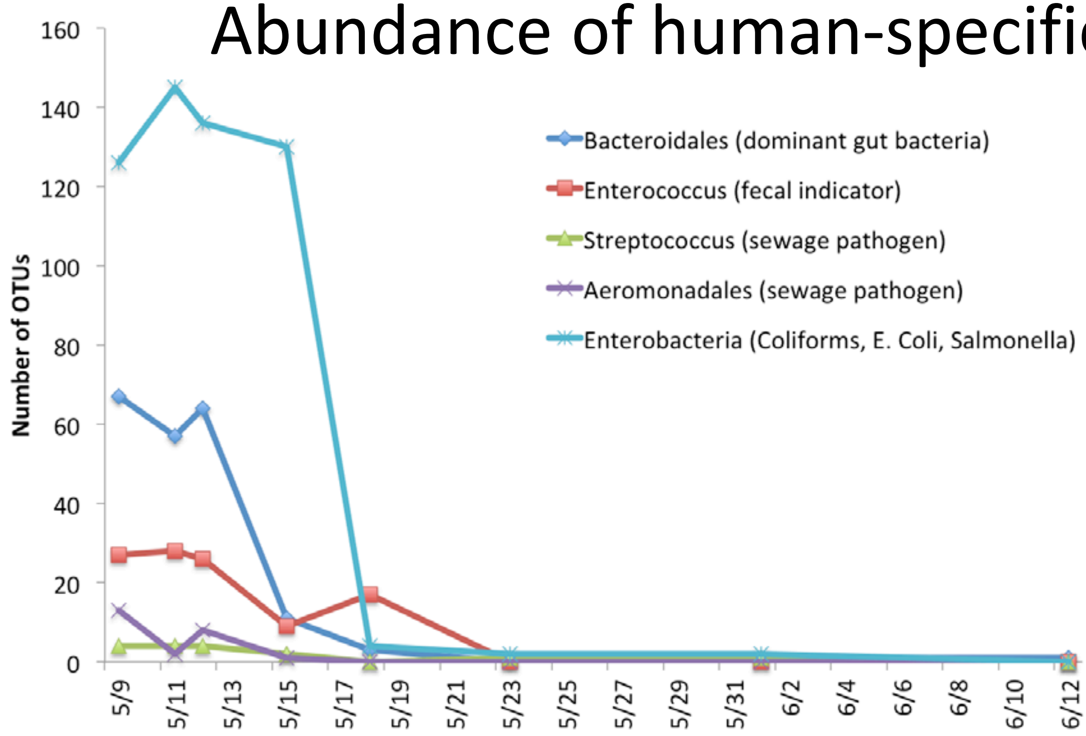
A laboratory microarray that identifies microbial species by differences in their unique DNA sequence



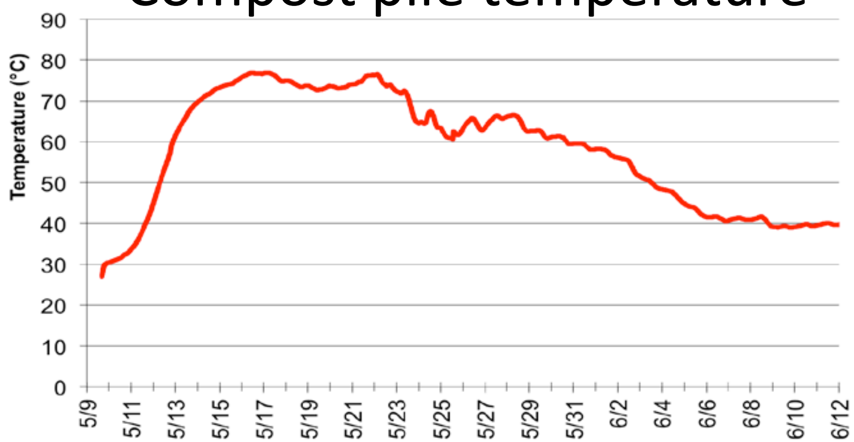
- **Analysis based on fingerprint of 1.1 million 16S rRNA gene probes**
- **Reference database of contaminated samples used to train predictive model for detection in unknowns**
- Machine learning algorithms used for predictive modeling to discriminate sources

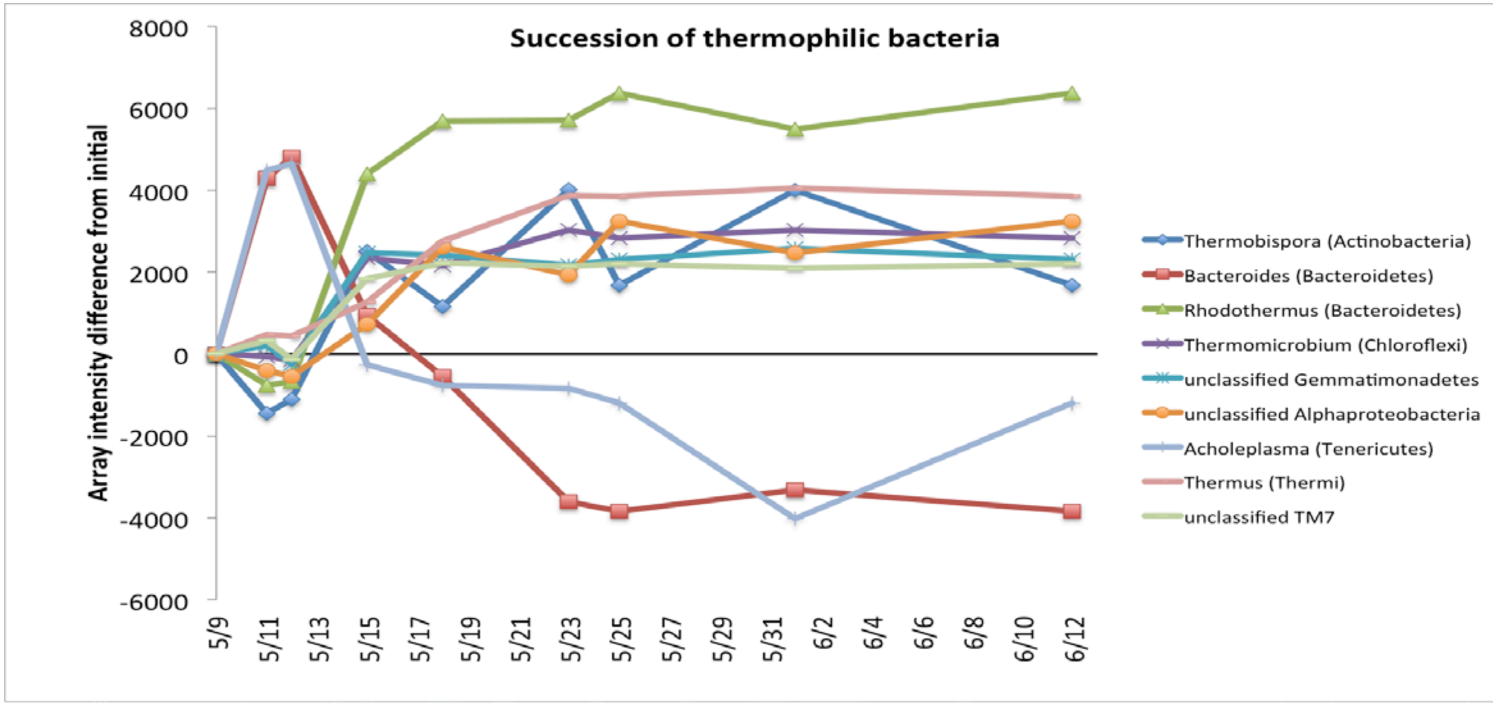


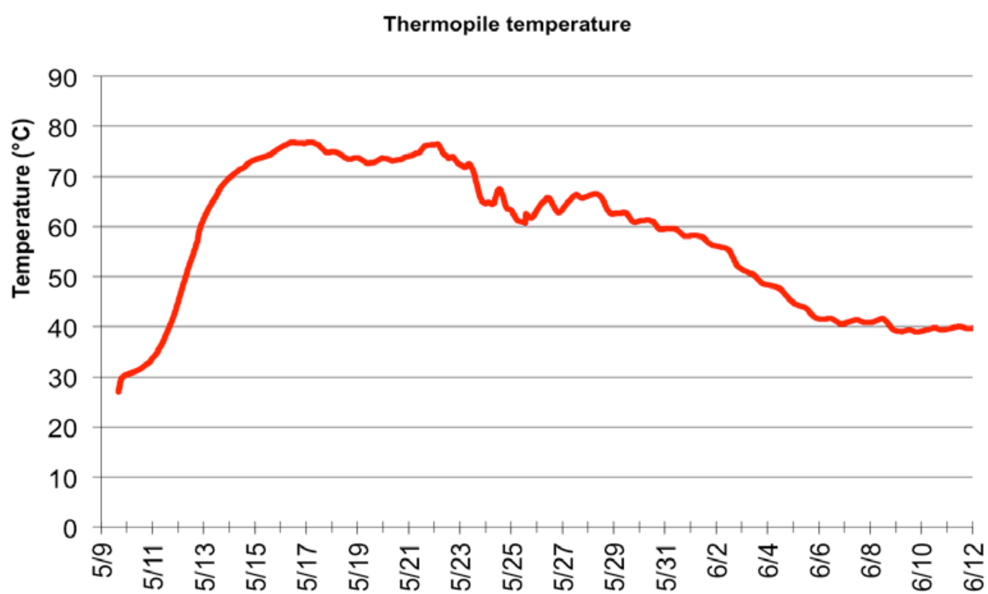
Abundance of human-specific organisms



Compost pile temperature




Succession of thermophilic bacteria
Array intensity difference from initial
8000
6000
4000
2000
0
-2000
-4000
-6000
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
Thermobispora (Actinobacteria)
Bacteroides (Bacteroidetes)
Rhodothermus (Bacteroidetes)
Thermomicrobium (Chloroflexi)
unclassified Gemmatimonadetes
unclassified Alphaproteobacteria
Acholeplasma (Tenericutes)
Thermus (Thermi)
unclassified TM7

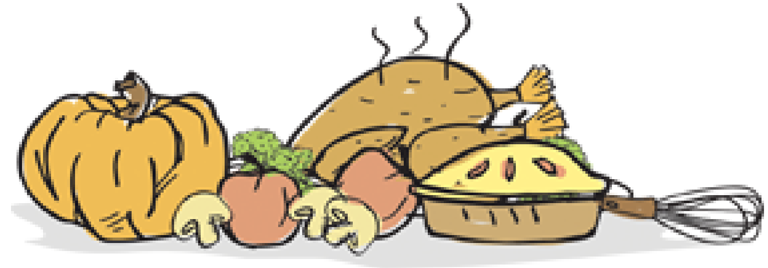

Thermopile temperature
Temperature (°C)
90
80
70
60
50
40
30
20
10
0
5/9
5/11
5/13
5/15
5/17
5/19
5/21
5/23
5/25
5/27
5/29
5/31
6/2
6/4
6/6
6/8
6/10
6/12

One time application of compost to grasslands

Prof. Whendee Silver – UC Berkeley

- Spread 1 cm compost on surface of California grasslands
- Identified a significant increase in plant productivity and water retention
- Long term carbon storage increase – 2 tonnes/hectare
- Additional 2 tonnes per year in stable, microbial resistant carbon

Food



FOOD FORWARD LET'S EAT. RIGHT. NOW

http://www.pbs.org/food/features/food-forward-season-1-sos-save-our-soil/

Search: Food Forward PBS

Episode 4: SOS: Save Our Soil

"The top six inches of soil is the most precious yet least understood ecosystem on earth, and yet we continue to treat soil like dirt. But there is a movement to restore what some say is the true wealth of nations: soil!

Episode 4

Compost and Soil Health

Special Thanks

11TH HOUR PROJECT
THE SCHMIDT FAMILY FOUNDATION

SOIL

Konpòs Lakay

MARIN CARBON PROJECT

THE UNIVERSITY OF CALIFORNIA 1868
LET THERE BE LIGHT

Berkeley
UNIVERSITY OF CALIFORNIA

Matter of Trust
Linking Ideas ✸ Sparking Action
Materializing Flourishing Systems

BERKELEY LAB
Lawrence Berkeley
National Laboratory

Policy Drivers/Research Priorities for Anaerobic Digestion & Composting

Environmental Farming Act Science Advisory Panel

July 17, 2015

Dr. Howard Levenson, Deputy Director, CalRecycle

Key Policy Drivers for CalRecycle

- 75% statewide recycling, composting, source reduction goal (AB 341, 2011)
  - No way without addressing organics
- Mandatory organics recycling for commercial waste generators (AB 1826, 2014)
  - Starts with largest generators in April, 2016
  - Ratchets down over next 3 years
- Eliminate green material alternative daily cover at landfills from counting as recycling (AB 1594, 2014)

Greenhouse Gases

- Organics in landfills - largest human-made source of methane (CH_4) in CA, US
- Multi-prong effort with ARB to get organics out of landfills and toward better uses
- Scoping Plan, Low Carbon Fuel Standard, Short-Lived Climate Pollutant Plan

>1/3 of Disposal is Organic Material

- No way to achieve 75% goal without organics
- Suitable feedstock for compost, mulch, digestion, biomass power
- Need to greatly increase processing capacity
- Siting and permitting very challenging

Additional Benefits of Compost

- Stormwater filtration
  - Filter socks, bioswales, biostrips, etc.
  - Low-impact development
- Soil carbon sequestration
- Better tilth, use less diesel
- Soil disease suppression
- Nutrient recycling, including micro-nutrients

CalRecycle – UC Cooperative Extension 1990s Ag Demo Projects

- Designed to build awareness in ag community
- Not full scientific research, but suggestive results
- Peaches, citrus, avocados, vineyards, ornamental nurseries
- One finding -- mulch effective in suppressing damage from *Phytophthora* root rot in avocado orchards

CalRecycle Research Agenda 2000-2015

- Questions from Air Pollution Control Districts about Volatile Organic Compounds
  - How many VOCs?
  - What kinds of VOCs?
  - Are there ways to mitigate those emissions?
- Understand production & prevention of composting odors
  - Comprehensive Compost Odor Response Project
- Measure and understand greenhouse gases from compost production and use

Meteorological and emissions monitoring equipment; Zamora, 2011

Flux chambers and UCD mobile ozone formation chamber; Vernalis, 2009

Solar-powered aerated static pile compost pile with biofilter cap; Tulare, 2012

Conclusions of VOC Research (multiple studies)

- Composting is source of VOCs, but these occur wherever organic material degradation occurs (farm, orchard, forest, back 40, etc.)
  - Composting produces fewer emissions than unmanaged natural degradation
  - Emissions highly variable and difficult/expensive to measure
  - Feedstock, climate and management all play major roles
- Small alcohols dominate composting VOC emissions
  - Isopropyl, ethyl and methyl alcohols; ubiquitous in the environment
  - Very low reactivity
  - Unlikely to play large role in ground-level ozone formation
- Emissions can be mitigated
  - Biofiltration – low-cost compost cap is effective
  - Engineered systems provide air and water protection - $$$

Research on Compost on Fire-scarred Lands

- Increased water holding capacity:
  - Compost reduced runoff by ~80%
- Improved water quality:
  - Sediments, total suspended solids, total dissolved solids reduced by 95%, 65%, 94% respectively
- Reduced soil erosion

Test plots at UC Riverside, 2008

Pending Research - *published in next 6 months*

- Multi-year study of GHG emissions from compost production/use
  - Lead author Dr. Horwath of UC Davis
  - Emissions factors slightly less than previous estimates
  - No measurable impact on N_2O emissions from ag lands due to compost application
- Study of potential air and water quality impacts from direct application of uncomposted green materials to ag lands
  - Lead author Dr. Green of UC Davis
  - Direct land application of uncomposted green materials does lead to emissions of VOCs and GHGs
  - Can be mitigated by tilling materials into soil

Other Research on Soil Organic Matter and Water Conservation

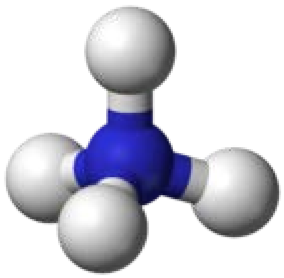
- CalRecycle staff informal review > 150 research papers
- Increased SOM improves infiltration and water holding capacity
- Water savings up to 30%, occasionally even more, depending on soil type and how much compost or mulch is used
- Field examination of ag soils with historic compost use (Brown and Cotton, 2011):
  - Soil carbon tripled, water infiltration significantly improved compared to control sites
  - Nutrient availability similar in compost-amended and conventionally managed soils
- USDA studies suggest incorporating 1% organic matter to 1-foot depth will increase plant-available water by 1.5 quarts/cubic foot

Future Research Needs

- Digestate from AD, liquids and solids
  - What is it, how to use, does it need to be composted?
  - New UC working group, led by Dr. Kafka at UCD
- Water savings from compost use
  - CA-specific research needed
- Carbon sequestration in agricultural soils from compost and digestate use
  - Marin Carbon project on rangeland
- Nutrient availability

Compost Nitrogen and Carbon Levels

- Lab analysis of more than 2000 finished compost samples from Soil Control Labs, Watsonville CA
  - Total N average ~1.6%, all feedstocks
  - Ammonium average ~ 0.1% all feedstocks
  - Nitrate average ~ 0.01% all feedstocks
  - Total organic matter average ~ 47%
  - Total carbon average ~ 25%



- Compost from urban green and food wastes slightly lower in N compounds, slightly higher in carbon
- Most compost N in organic forms, less mobile

Potential New Tools

- Map of CA soil organic matter (back wall)
- Compost cost, coverage and nutrient calculator (Excel tool)

Option 1: By compost depth			**Option 2: By cubic yards per acre**	
Input	Amount		Input	Amount
Enter the cost of compost (in $/cubic yard)	$ 10.00		Enter the cost of compost (in $/cubic yard)	$ 10.00
Enter an area to be treated (in acres)	10		Enter an amount of compost to apply per acre (in cubic yard)	13.1
Select desired thickness of compost application (in inches):	0.10		Enter an area to be treated (in acres)	10
Select the amount of total-N in compost	1.6%		Select the amount of total-N in compost	1.6%
Select the amount of ammonium-N (NH_4) in compost	0.12%		Select the amount of ammonium-N (NH4) in compost	0.12%
Select the amount of nitrate-N (NO_3) in compost	0.011%		Select the amount of nitrate-N (NO3) in compost	0.011%
Output*			Output*	
Total amount of compost needed (in cubic yards)	131		Thickness of the compost (in inches)	0.010
Total amount of compost needed (in tons)	65		Total amount of compost needed (in cubic yard)	131
Amount of total-N applied per acre (in lbs)	209		Amount of total-N applied per acre (in lbs)	210
Amount of NH_4-N applied per acre (in lbs)	16		Amount of NH_4-N applied per acre (in lbs)	16
Amount of NO_3-N applied per acre (in lbs)	1		Amount of NO_3-N applied per acre (in lbs)	1
Cost of the compost	$ 1,307		Cost of the compost	$ 1,310

Building 21st Century Organics Infrastructure

- Anaerobic Digestion for high energy, putrescible materials like food
- Composting: Mandatory protections for air and water quality
- Control of odors, good neighbor strategies
- Trash trucks running on renewable fuel, carbon-negative systems
- POTW capacity likely to be part of solution

Financing for New Infrastructure

- GGRF grants for compost and AD, first time ever
  - 5 projects funded in first cycle -- 3 AD, 2 compost
- GGRF loans
  - 2 AD loans
- RMDZ program, ongoing funding source
- CPCFA: bond funding for large projects through Treasurer
- Potential shift to incentive-type payments

Examples of Key Projects

- CR&R anaerobic digester (Riverside County)
  - *Massive scale, on-site vehicle fueling, solid and liquid products for agriculture*
- Burrtec (San Bernardino County) and Mid-Valley Disposal (Fresno County)
  - *GORE covered composting systems, full control of air and water emissions, reduced diesel-powered turning*

Digesters under construction at CR&R facility in Perris, Riverside County

Product Quality - *Key to Agriculture Acceptance*

- State mandated quality controls
  - Load inspection by facilities; facility inspections by LEAs
  - Process for Further Reduction of Pathogens -- kills weed seeds and pests
  - Product testing for 2 pathogens, 9 heavy metals
  - CDFA inspections and product labeling for Organic Input Materials
    - Issue – Composters cannot legally share lab results with clients, which means less information for farmers re: nutrients
- Voluntary quality initiatives
  - US Composting Council Seal of Testing Assurance:
    - preferred labs, pre-arranged parameters
    - CDFA-compliant version (no nutrient claims)
  - Leafy Greens Marketing Agreement
    - Beyond mandated testing to include listeria and e –coli H7:0157

Direct Land Application of Un-composted Green Materials

- Regulatory concern for CalRecycle, Water Board, CDFA, local authorities
- CalRecycle proposed regulations with limits on contaminants
- Multi-agency working group being coordinated by CalEPA
- CalRecycle research project nearly complete

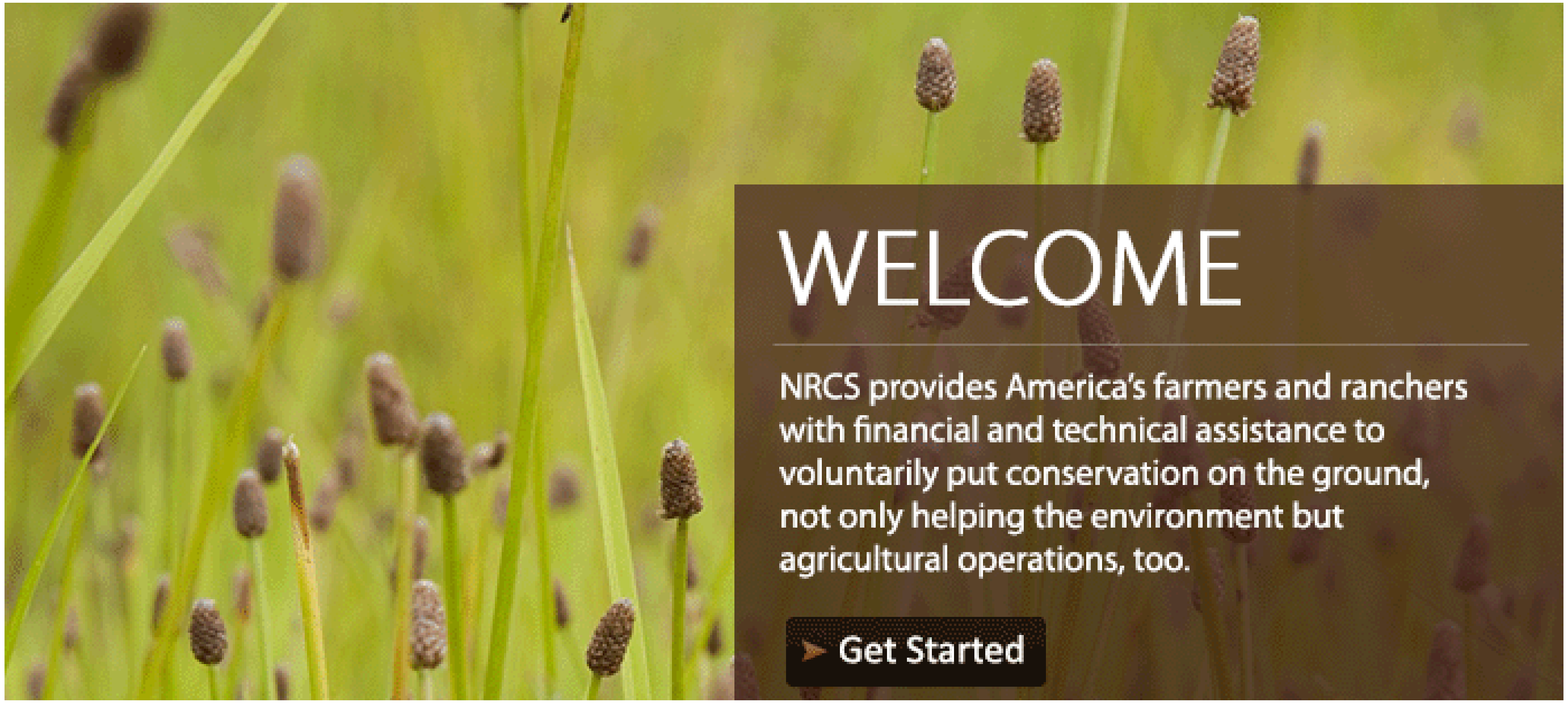
Questions?

NRCS CONSERVATION PRACTICES ~ QUANTIFYING GHG MITIGATION/CARBON SEQUESTRATION

Dr. Adam Chambers
Leader, National Energy and Environmental Markets Team
USDA Natural Resources Conservation Service (NRCS)

- NRCS, Conservation **Planning**, and Atmospheric-beneficial Conservation Practice **Implementation**
- Working with COMET-Planner
- Putting COMET-Planner to work

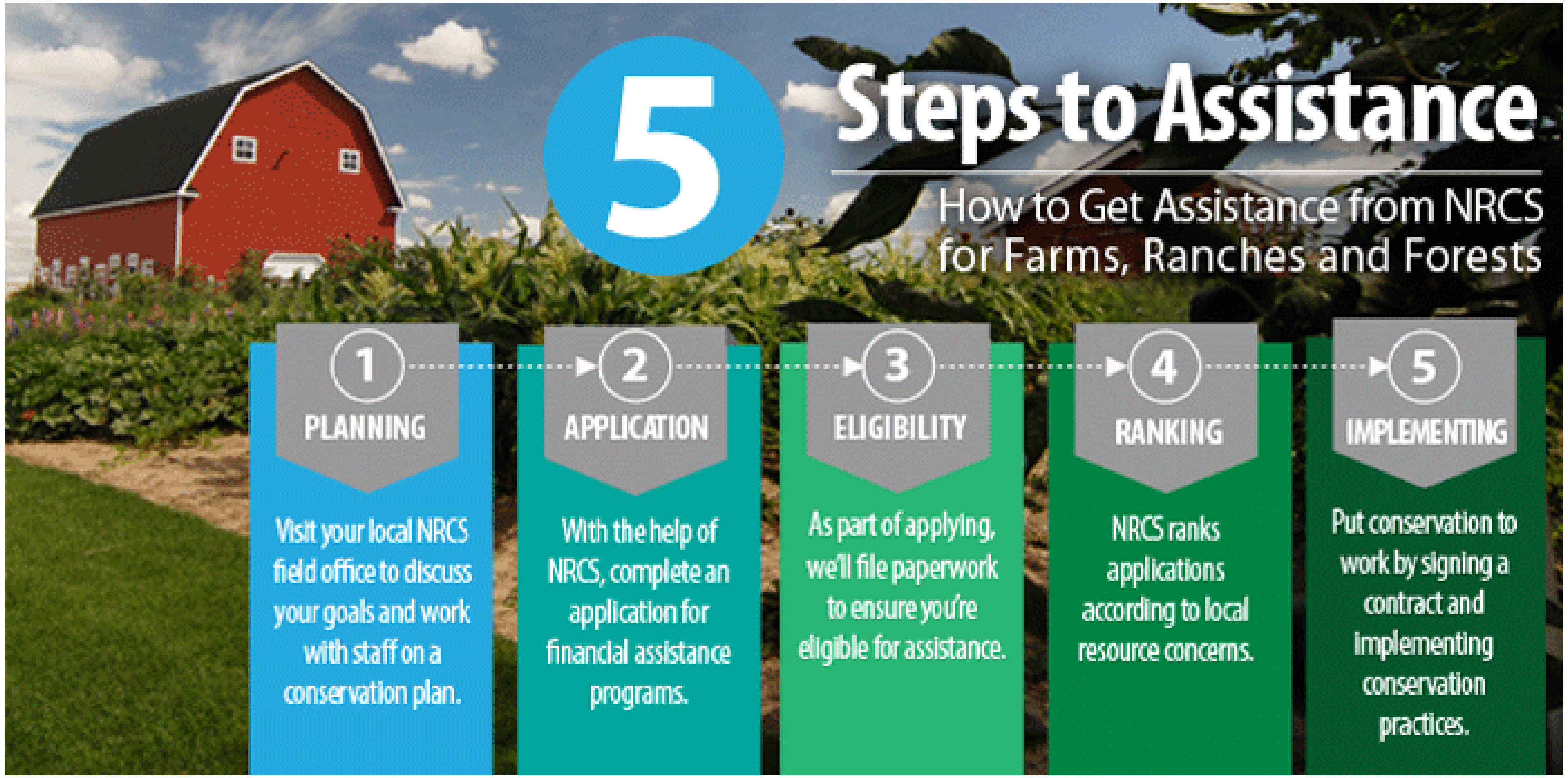
About NRCS



This **step-by-step guide** explains the process of getting started with NRCS conservation assistance.

Farmers, ranchers and forest landowners can receive financial assistance from NRCS to make improvements to their land.

Get Started with NRCS



Do you farm or ranch and want to make improvements to the land that you own or lease? NRCS offers technical and financial assistance to help farmers, ranchers and forest managers. Here's how you can get started with NRCS:

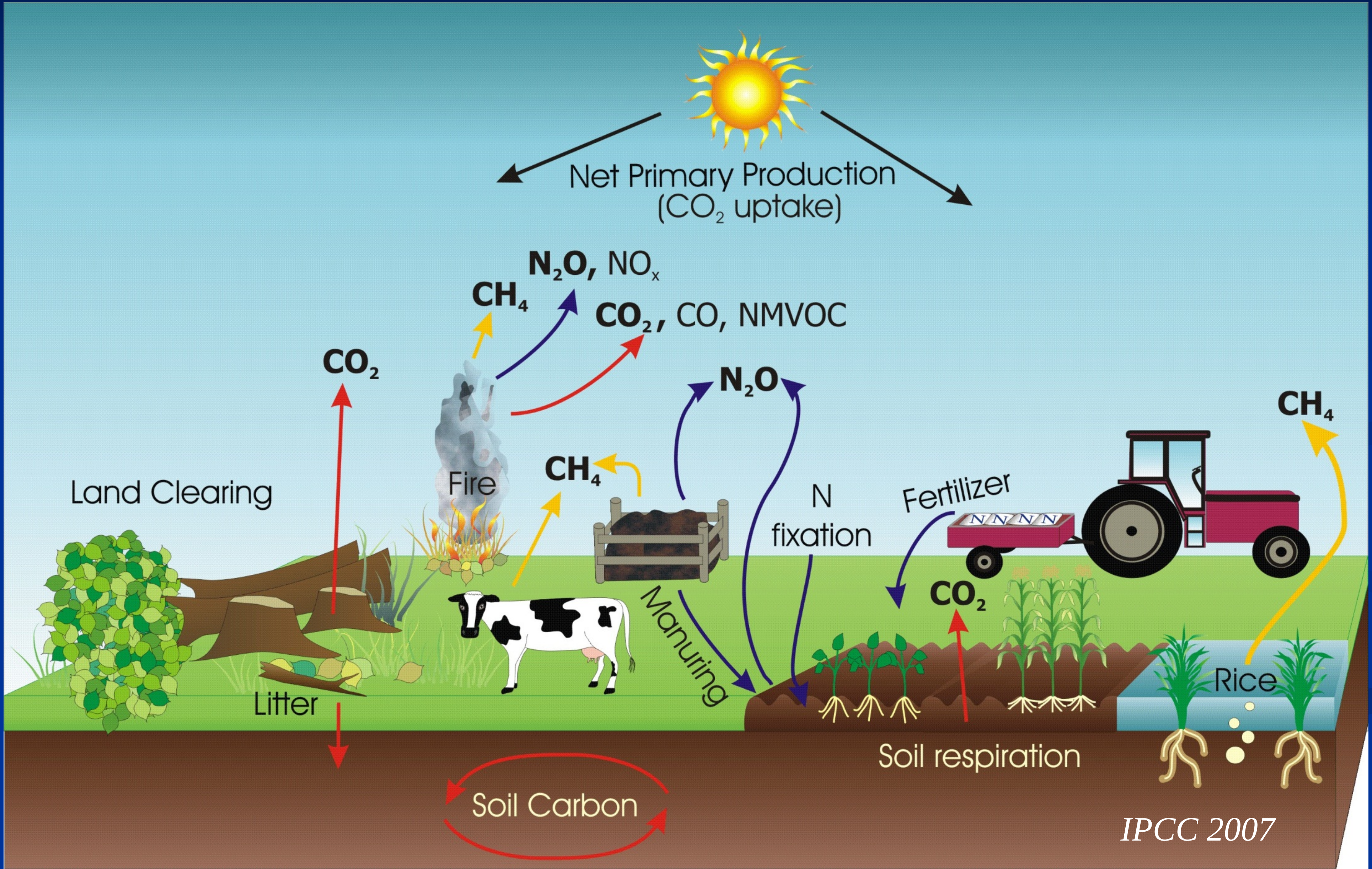
1 Planning

To get started with NRCS, we recommend you stop by your local NRCS field office. We'll discuss your vision for your land.

LET'S FOCUS OUR CONSERVATION EFFORTS ON MITIGATING THE ACCUMULATION OF GHGS IN THE ATMOSPHERE AND ADDRESS CLIMATE CHANGE?

THIS IS A DECISION PATHWAY THAT WE (SOCIETY) ARE CHOOSING

Agricultural sources and sinks of greenhouse gases

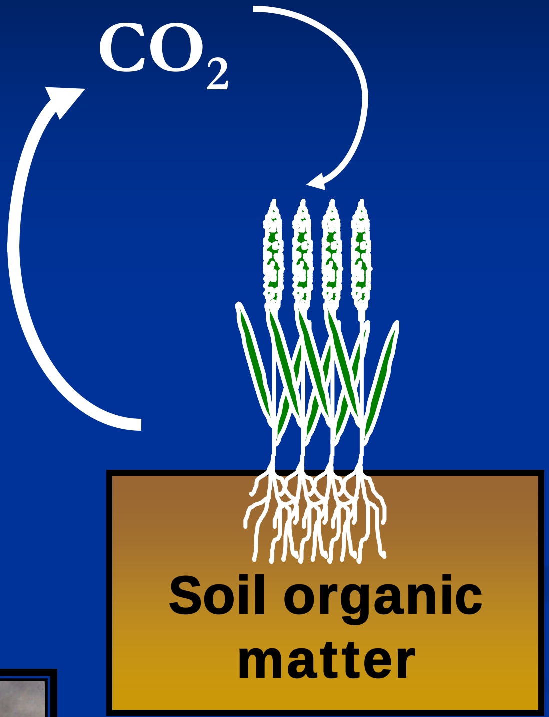


IPCC 2007

Degrading Agricultural Practices

Erosion

Intensive tillage

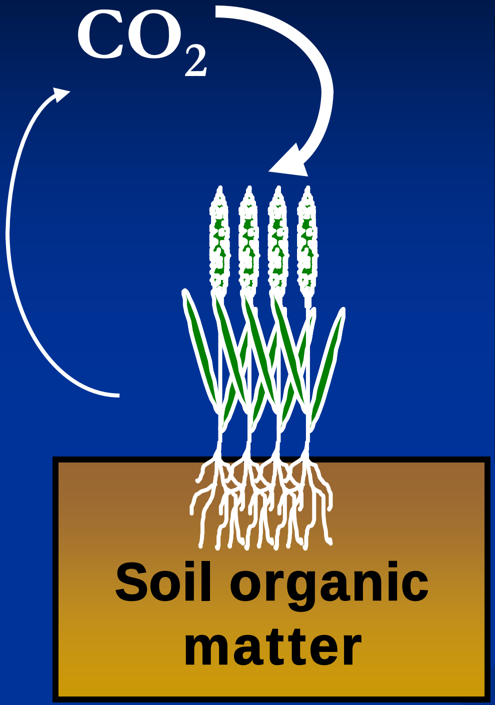


Residue removal

Low Productivity

Improved Agricultural Conservation Practices

Conservation buffers



Conservation tillage

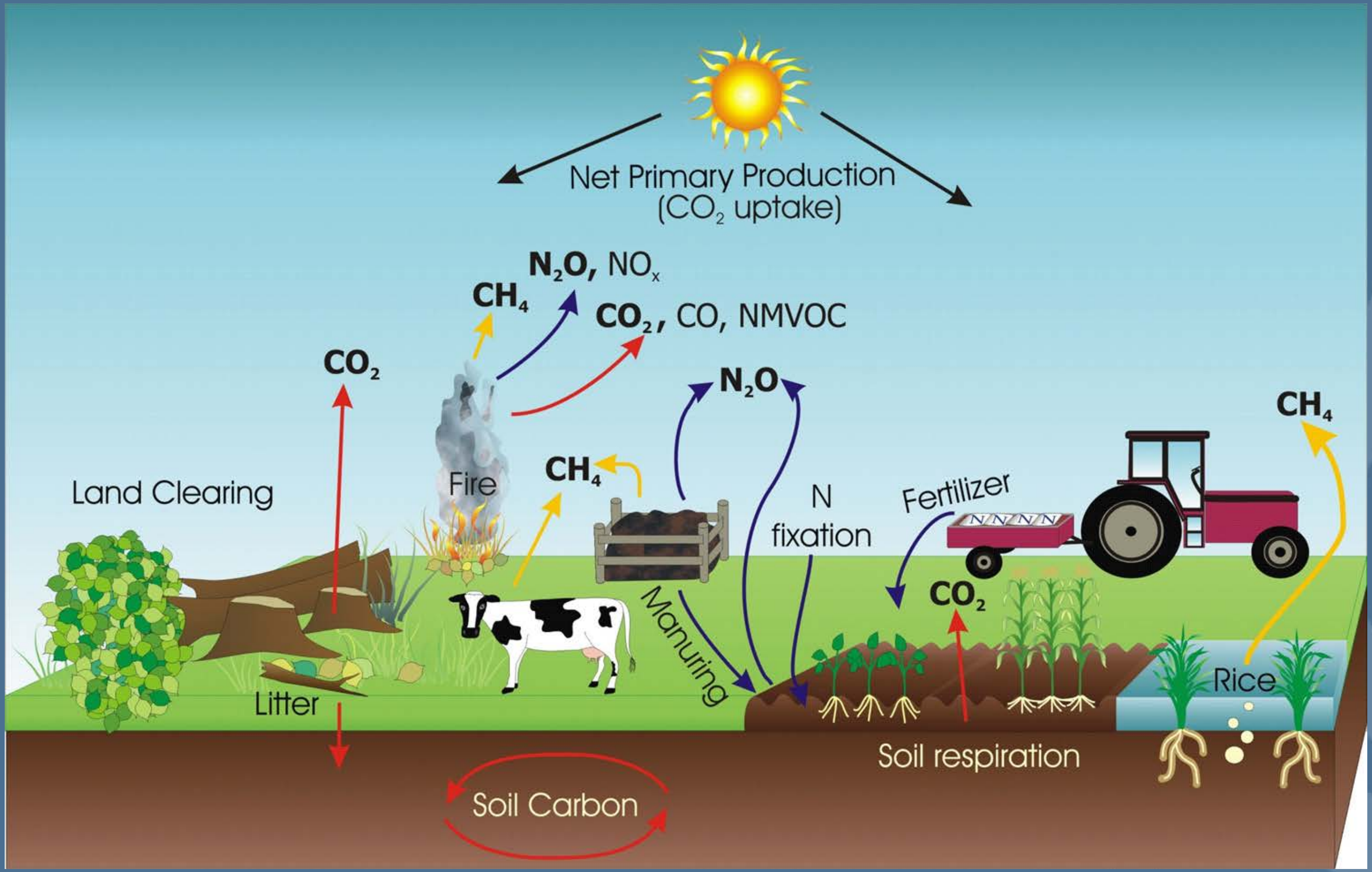
Cover crops

Improved rotations

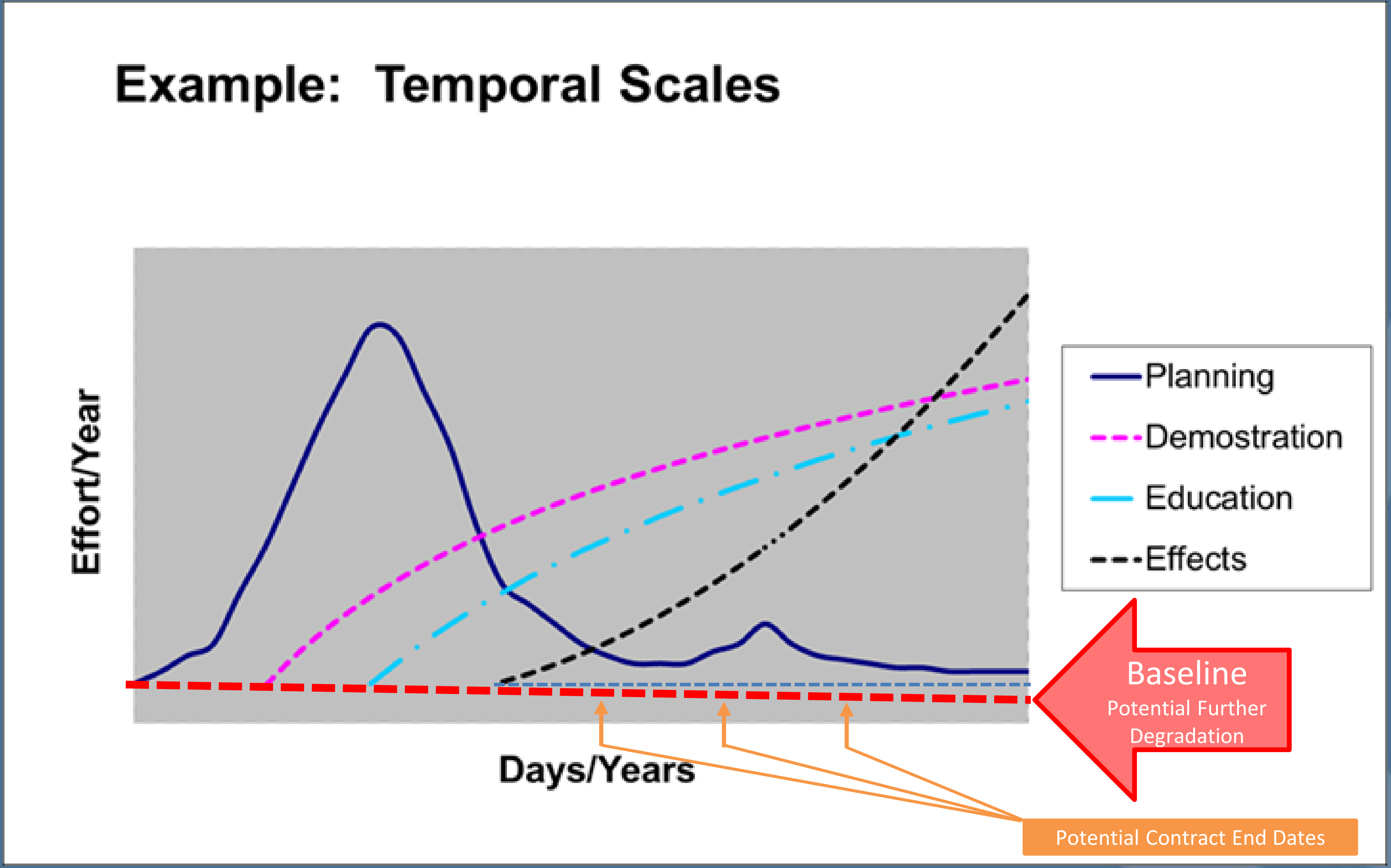
CRP

Direct Benefits of NRCS Conservation Practices on the Atmosphere

Emissions are reduced and/or carbon sequestered when Conservation Practices are Implemented, contracted, and beyond…



Conservation **Planning** and Conservation Effects



HOW DO WE KNOW WHICH NRCS CONSERVATION PRACTICES ARE ATMOSPHERIC-BENEFICIAL AND HOW DO WE QUANTIFY THE BENEFITS?

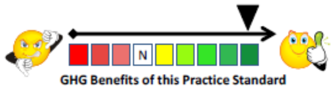
WE WERE FORTUNATE TO HAVE RAW MATERIALS AVAILABLE AT THE START.

USDA United States Department of Agriculture

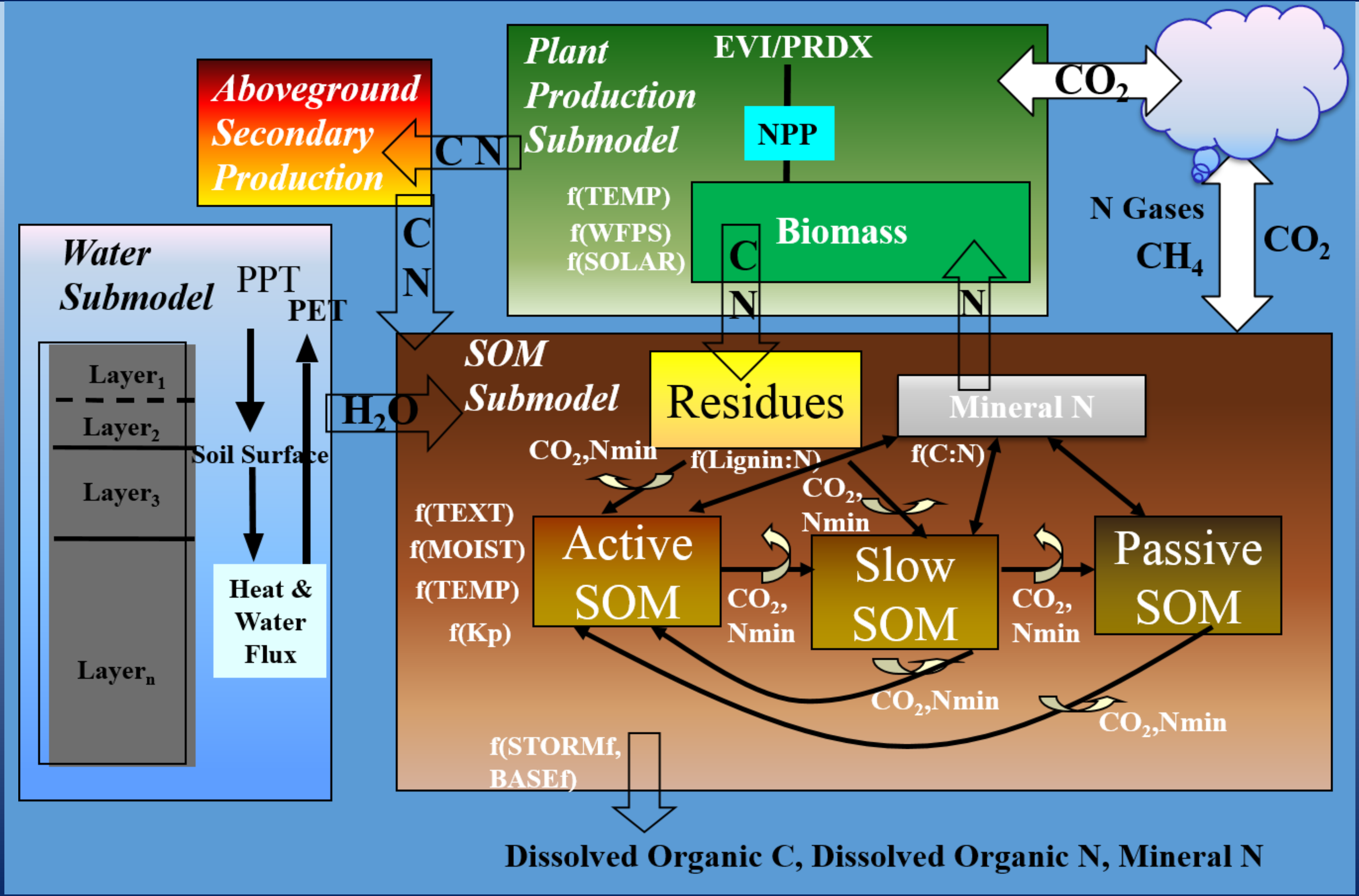
Methodology and Conservativeness:

- Of the 175 NRCS Conservation Practices
  - 35 NRCS Conservation Practices have been identified to have GHG emissions and C Sequestration Benefits
  - 34 of the practices have sufficient quantification methods to be easily quantified (initially).
- Utilized the 2011 NRCS GHG Emission Reduction and C Sequestration Qualitative Assessment as the Starting Point (emoji tool, happy world Emoji Day)

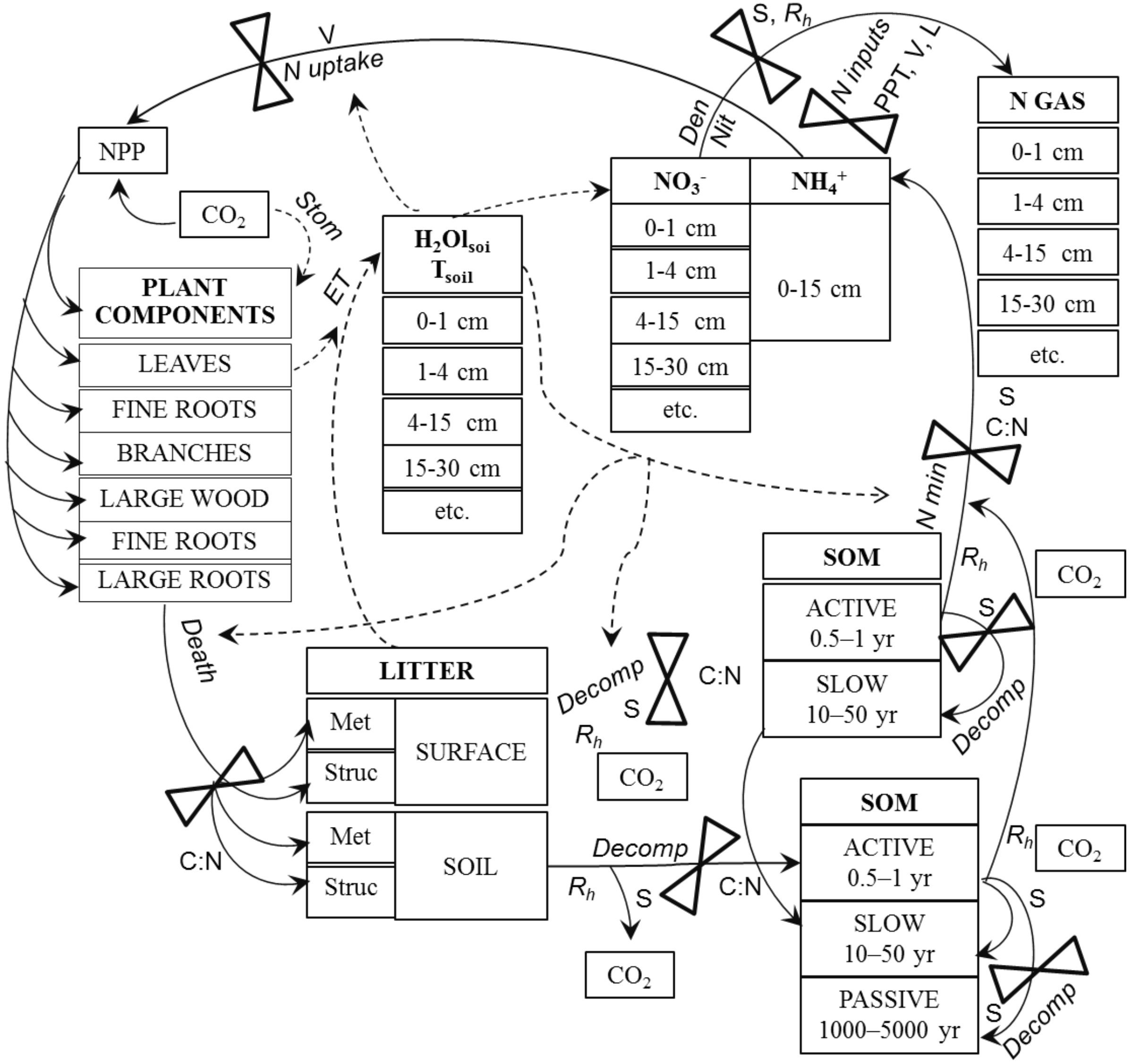
NRCS Practice Standards for Greenhouse Gas Emission Reduction and Carbon Sequestration

Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
 GHG Benefits of this Practice Standard	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.

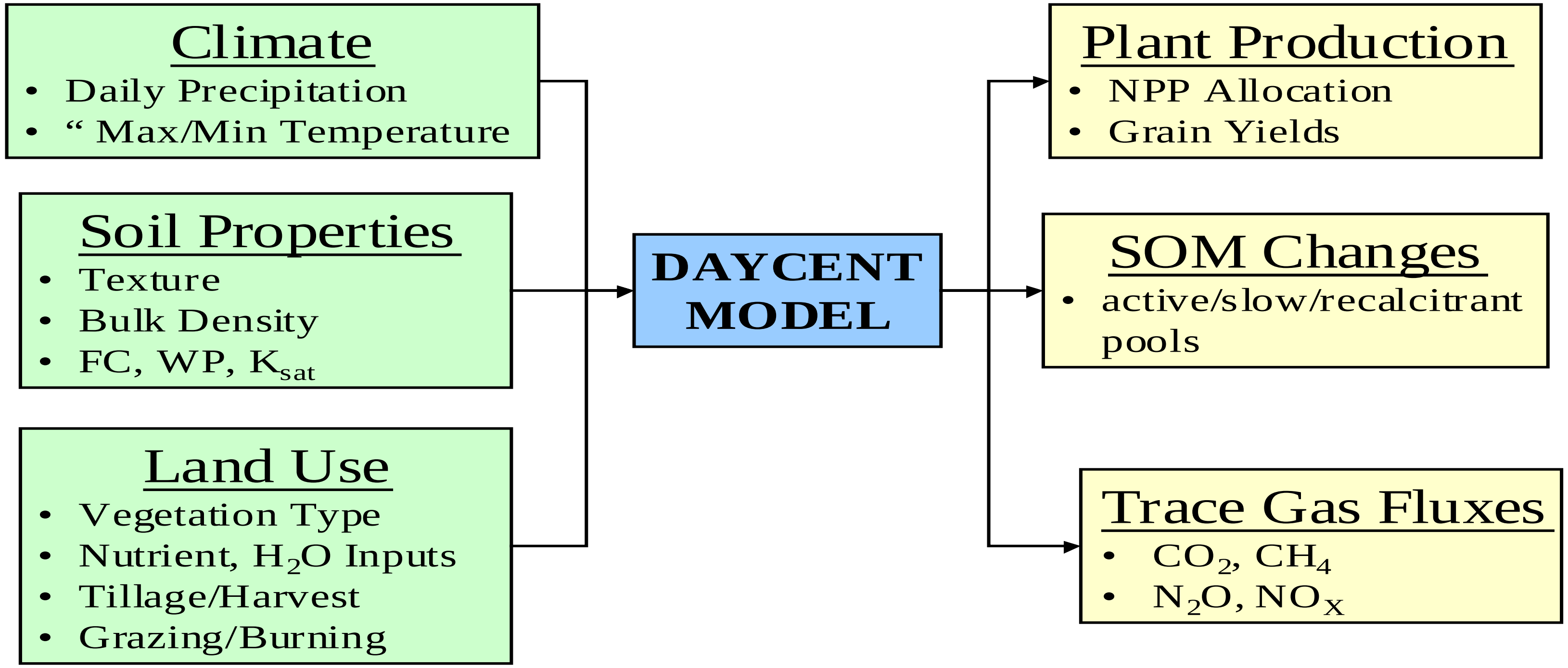
DayCent Simulation Model in US GHG Inventory



DayCent Flow Diagram



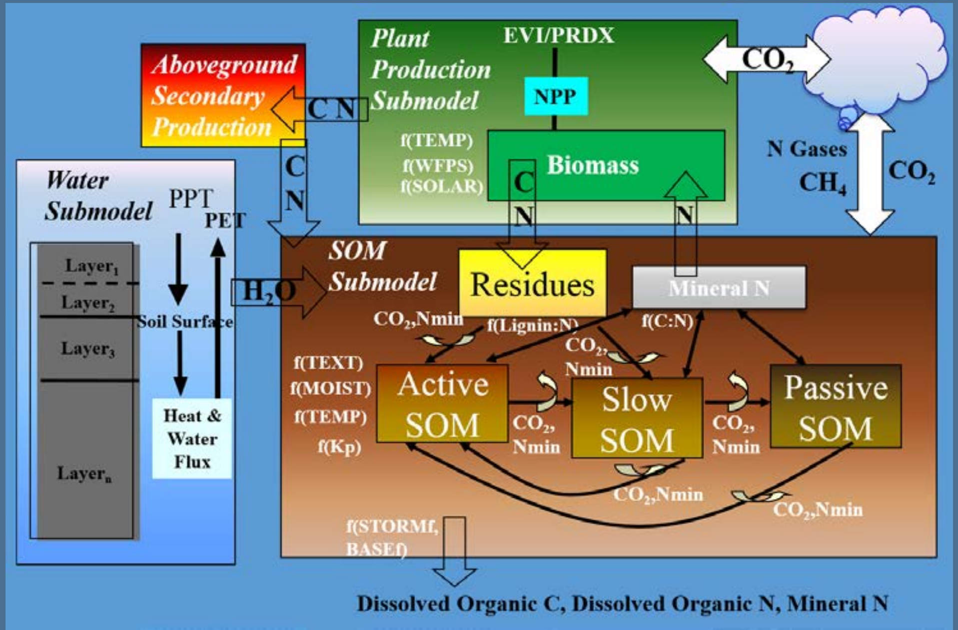
DAYCENT: Primary Inputs/Outputs



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
N GHG Benefits of this Practice Standard	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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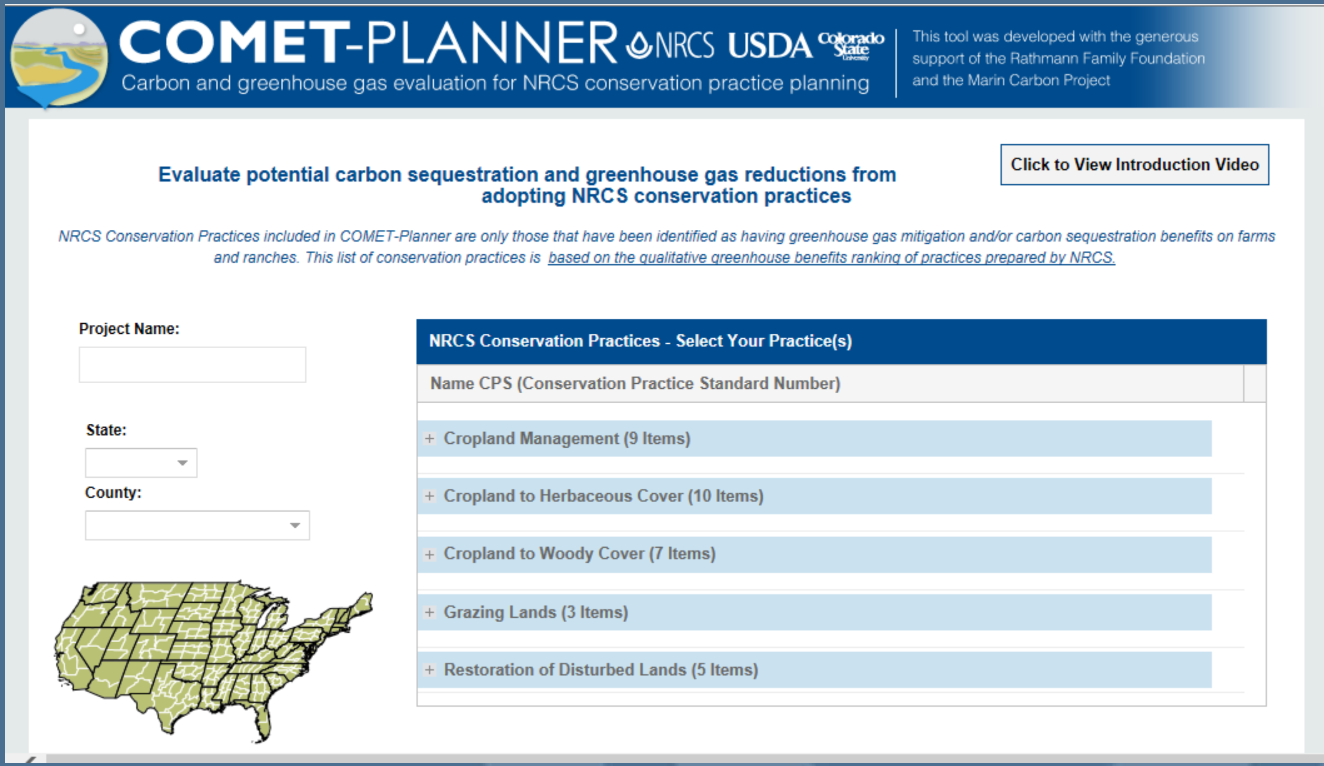
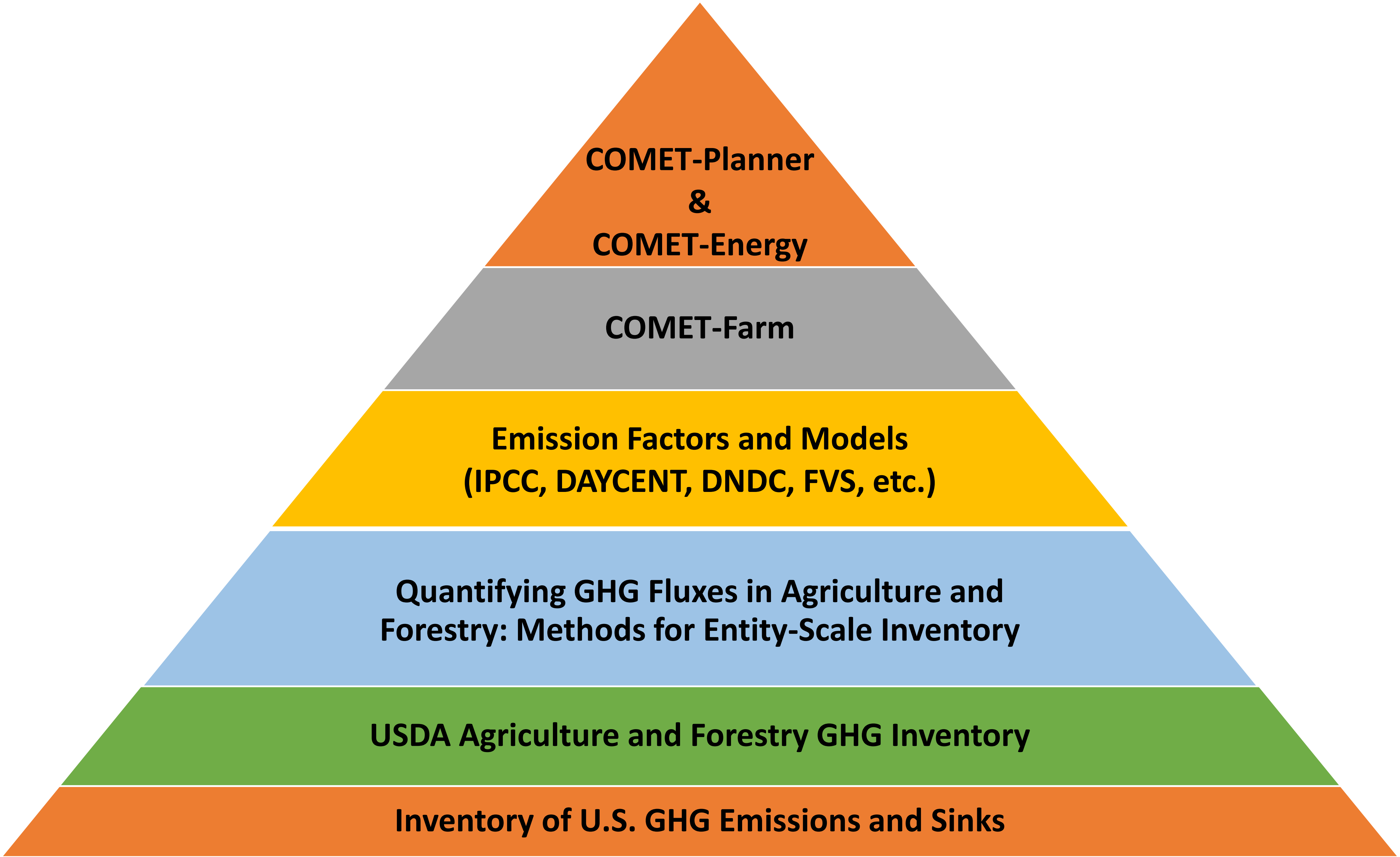
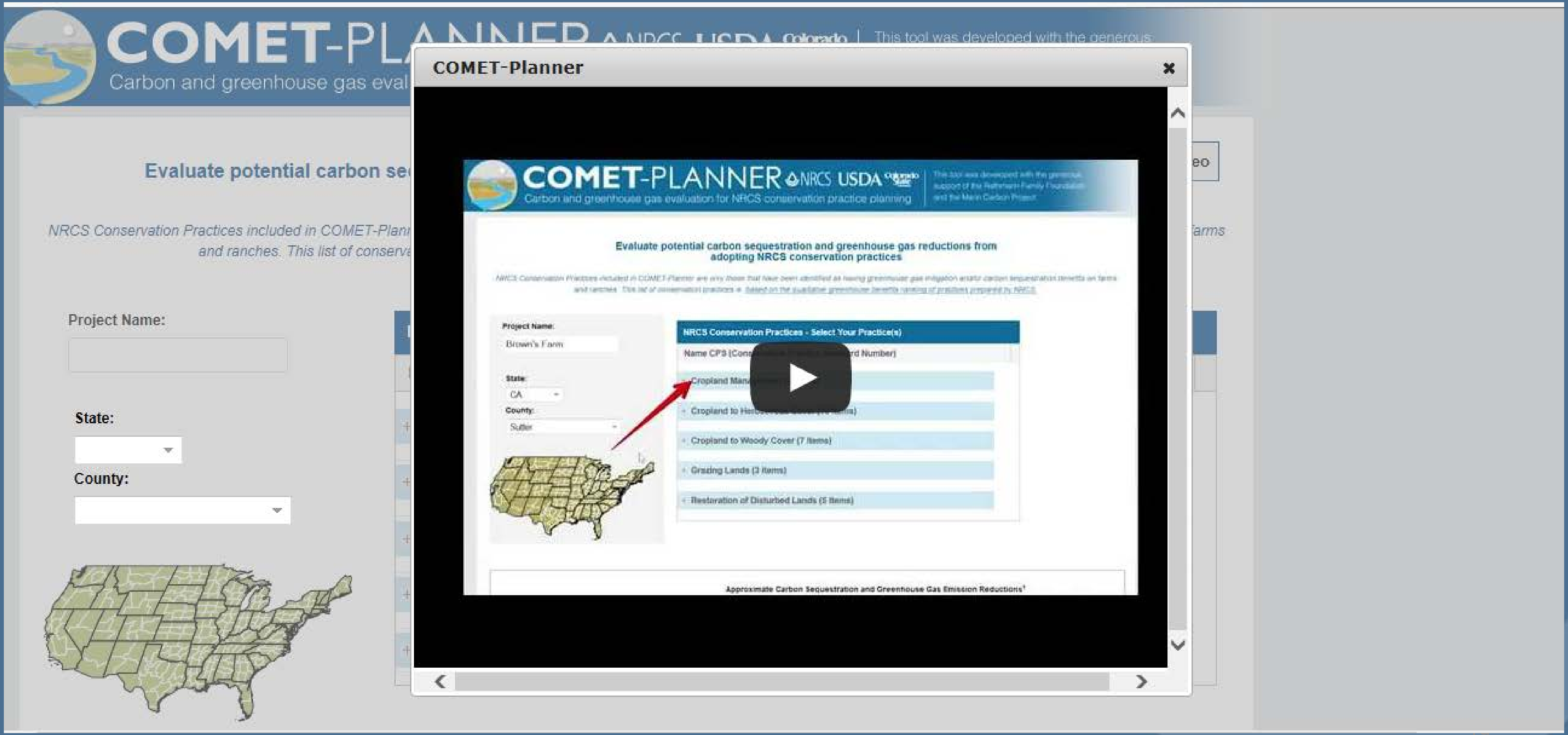


US GHG INVENTORY→USDA GHG INVENTORY→USDA METHODS REPORT→COMET-Farm→COMET-Planner



WORKING WITH COMET-PLANNER….


COMET-PLANNER
Carbon and greenhouse gas eval
This tool was developed with the generous
Evaluate potential carbon se
NRCS Conservation Practices included in COMET-Plann
and ranches. This list of conserv
Project Name:
State:
County:
COMET-Planner
COMET-PLANNER
Carbon and greenhouse gas evaluation for NRCS conservation practice planning
Evaluate potential carbon sequestration and greenhouse gas reductions from adopting NRCS conservation practices
Project Name:
Brown's Farm
State:
CA
County:
Sutter
NRCS Conservation Practices - Select Your Practice(s)
Cropland to Woody Cover (7 items)
Grazing Lands (3 items)
Restoration of Disturbed Lands (5 items)
Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions

USDA United States Department of Agriculture

COMET-PLANNER

NRCS USDA Colorado State University

Carbon and greenhouse gas evaluation for NRCS conservation practice planning

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

Click to View Introduction Video

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:

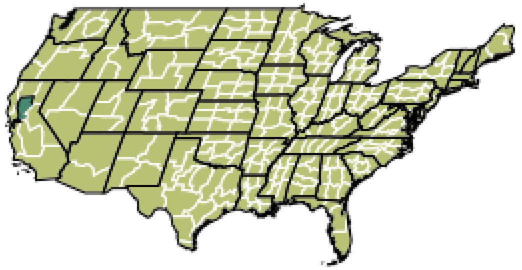
Demo

State:

CA

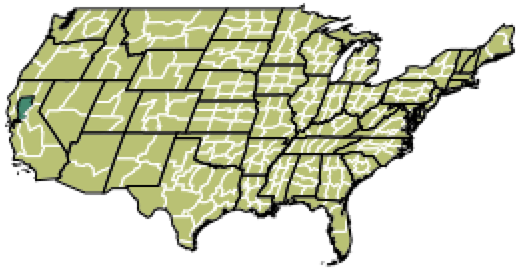
County:

Sacramento



NRCS Conservation Practices - Select Your Practice(s)

Name CPS (Conservation Practice Standard Number)
+ Cropland to Herbaceous Cover (10 Items)
– Cropland to Woody Cover (7 Items)
Tree/Shrub Establishment - Farm Woodlot (CPS 612)
Windbreak/Shelterbelt Establishment (CPS 380)
Windbreak/Shelterbelt Renovation (CPS 650)
Riparian Forest Buffer (CPS 391)



Windbreak/Shelterbelt Establishment (CPS 380)

Windbreak/Shelterbelt Renovation (CPS 650)

Riparian Forest Buffer (CPS 391)

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
Riparian Forest Buffer (CPS 391) [delete]	30 ac	30	2	N.E.[2]	32
	Total	**30**	**2**	**0**	**32**

[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. Emissions estimates represent field emissions only, including those associated with soils and woody biomass as appropriate, and do not include off-site emissions, such as those from transportation, manufacturing, processing, etc More information on quantification methods can be found in the COMET-Planner Report .

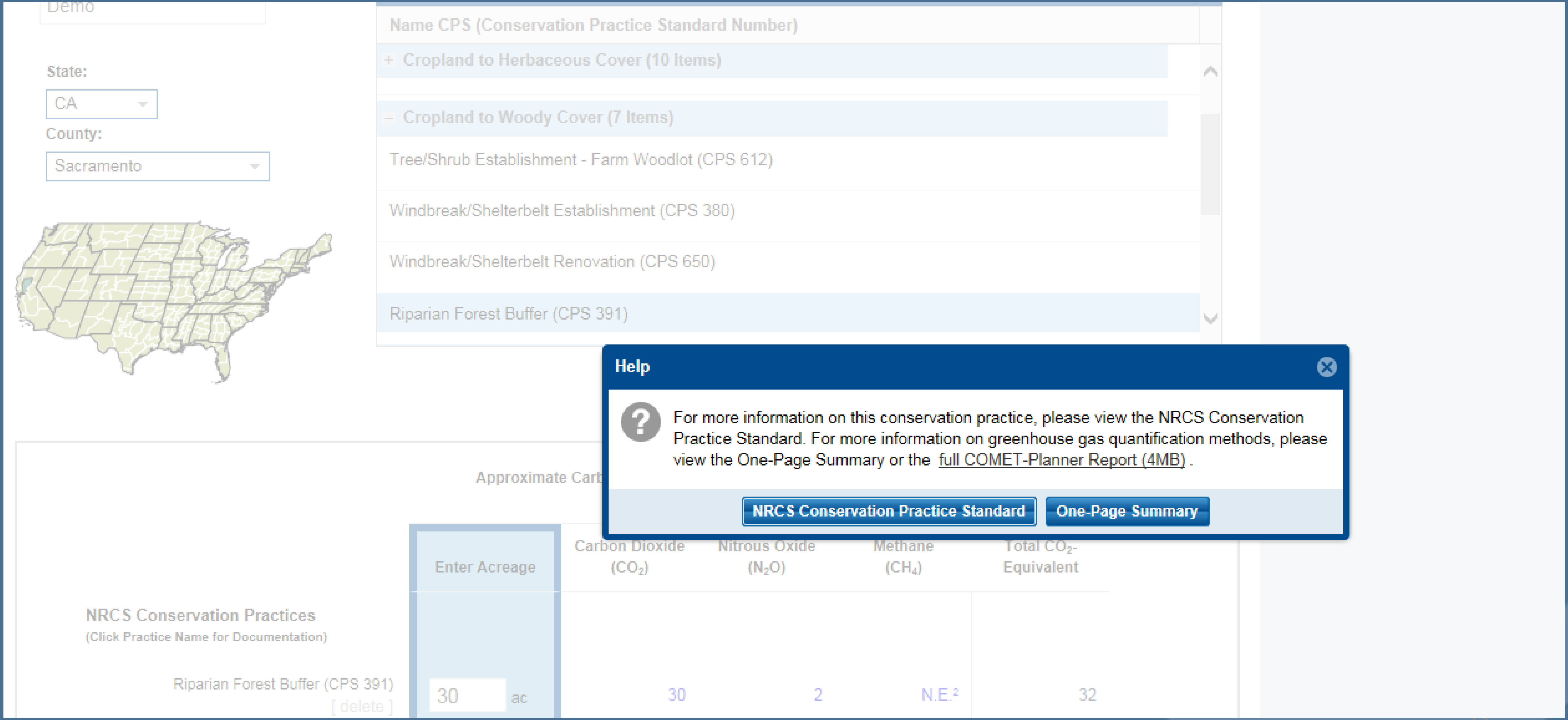
Each emission reduction is calculated using the following equation:

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

	Emission Reduction Coefficients (ERC) (tonnes CO_2 equivalent per acre per year)		
	Greenhouse Gases		
	Carbon Dioxide (CO_2)	Nitrous Oxide (N_2O)	Methane (CH_4)
NRCS Conservation Practices			
Riparian Forest Buffer (CPS 391)	1.00	0.08	N.E.[2]

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.


Demo
State:
CA
County:
Sacramento
Name CPS (Conservation Practice Standard Number)
+ Cropland to Herbaceous Cover (10 Items)
– Cropland to Woody Cover (7 Items)
Tree/Shrub Establishment - Farm Woodlot (CPS 612)
Windbreak/Shelterbelt Establishment (CPS 380)
Windbreak/Shelterbelt Renovation (CPS 650)
Riparian Forest Buffer (CPS 391)
Help
For more information on this conservation practice, please view the NRCS Conservation Practice Standard. For more information on greenhouse gas quantification methods, please view the One-Page Summary or the full COMET-Planner Report (4MB) .
NRCS Conservation Practice Standard
One-Page Summary
Approximate Carb
Enter Acreage
Carbon Dioxide (CO_2)
Nitrous Oxide (N_2O)
Methane (CH_4)
Total CO_2-Equivalent
NRCS Conservation Practices
(Click Practice Name for Documentation)
Riparian Forest Buffer (CPS 391)
[delete]
30 ac
30
2
N.E.[2]
32

Riparian Forest Buffer Establishment
(Conservation Practice Standard 391)

NRCS Practice Information

DEFINITION: An area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

PURPOSE:
- Increase carbon storage in plant biomass and soils
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow
- Create or improve riparian habitat and provide a source of detritus and large woody debris
- Reduce pesticide drift entering the water body
- Restore riparian plant communities

CONDITIONS WHERE PRACTICE APPLIES:
Riparian forest buffers are applied on areas adjacent to permanent or intermittent streams, lakes, ponds, and wetlands. They are not applied to stabilize stream banks or shorelines.


Photo by USDA NRCS

COMET-Planner Practice Information

COMET-Planner estimates for Riparian Forest Buffer establishment are constructed from a scenario of replacing conventionally managed and fertilized cropland with unfertilized, woody plants. Impacts on greenhouse gases include woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from synthetic fertilizer.

Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions*				
Practice	*Climate zone*	Carbon Dioxide ($Mg\ CO_2\ eq\ ac^{-1}\ y^{-1}$) Average (Range)	Nitrous Oxide ($Mg\ CO_2\ eq\ ac^{-1}\ y^{-1}$) Average (Range)	Methane ($Mg\ CO_2\ eq\ ac^{-1}\ y^{-1}$) Average (Range)
Riparian Forest Buffer Establishment (CPS 391)	Dry/semiarid	1.00 (0.38 – 1.63)	0.08 (0 – 0.15)	Not estimated
	Moist/humid	2.19 (0.96 – 3.26)	0.28 (0 – 0.50)	Not estimated

*Positive values indicate reductions in greenhouse gas emissions and negative values indicate increases in greenhouse gas emissions. Woody biomass carbon estimates were derived from empirical models of woody biomass carbon accumulation in NRCS agroforestry prescriptions that used tree growth increment data from the U.S. Forest Service Forest Inventory and Analysis (FIA) program and allometric equations to allocate biomass

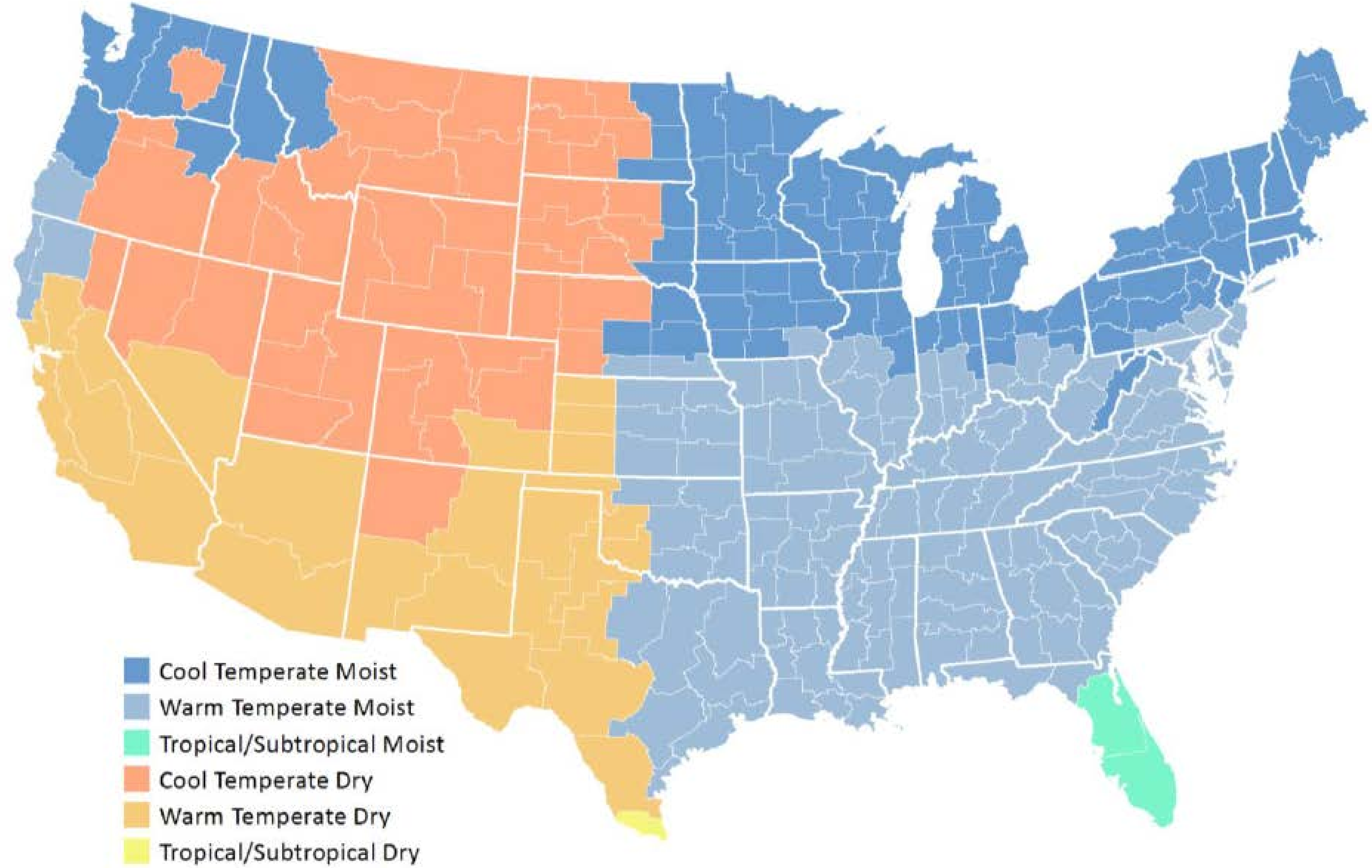


Figure 1. Broad climate categories for the U.S (IPCC 2006).

PUTTING COMET-PLANNER TO WORK…

CLIMATE

The USDA Is Taking On Agriculture's Huge Contribution To Climate Change

BY NATASHA GEILING APR 23, 2015 11:33AM

U.S. Agriculture Secretary Tom Vilsack.

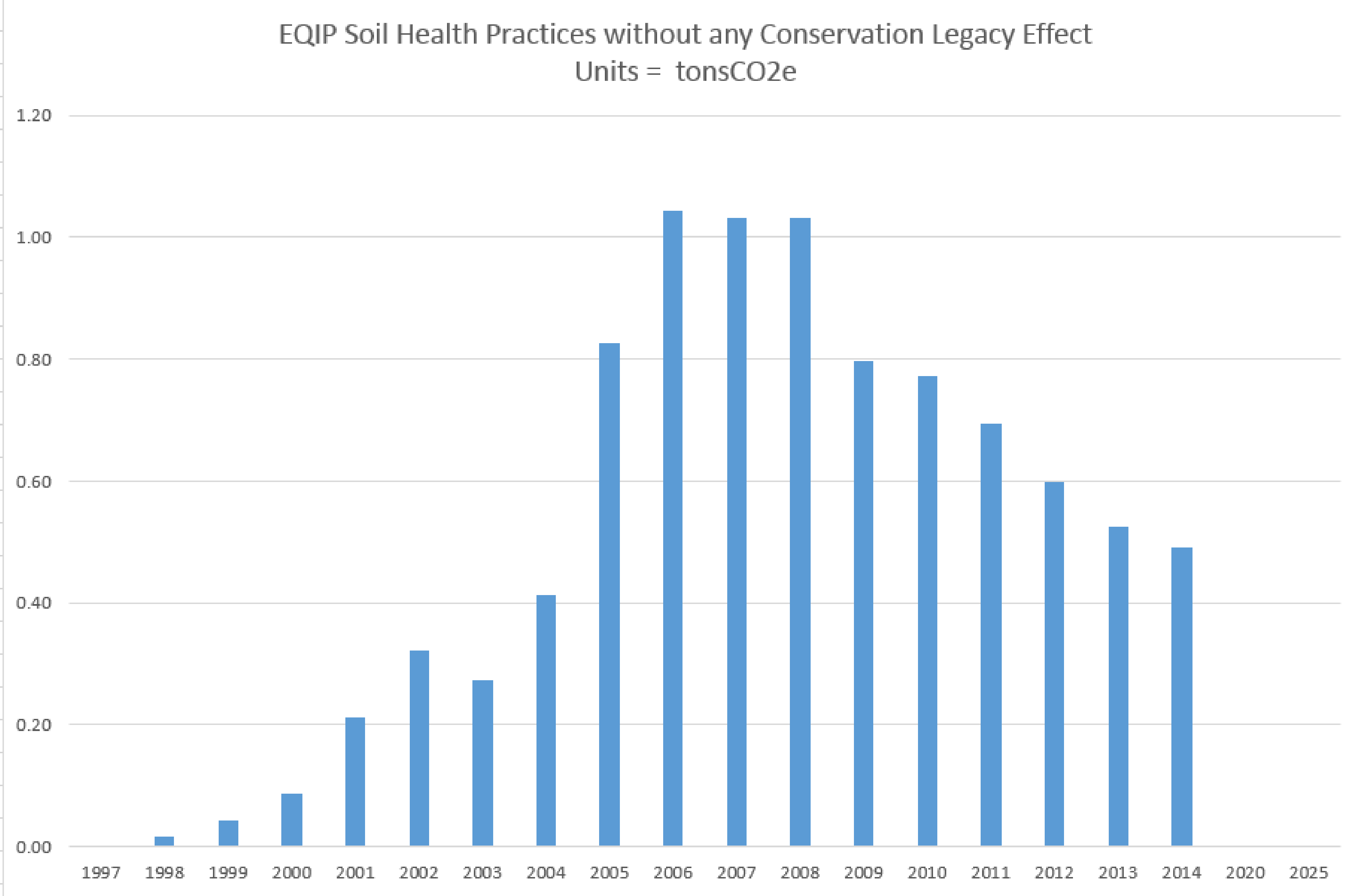
Secretary Vilsack’s Mitigation Building Blocks

DECISION MEMORANDUM FOR THE SECRETARY
Page 4

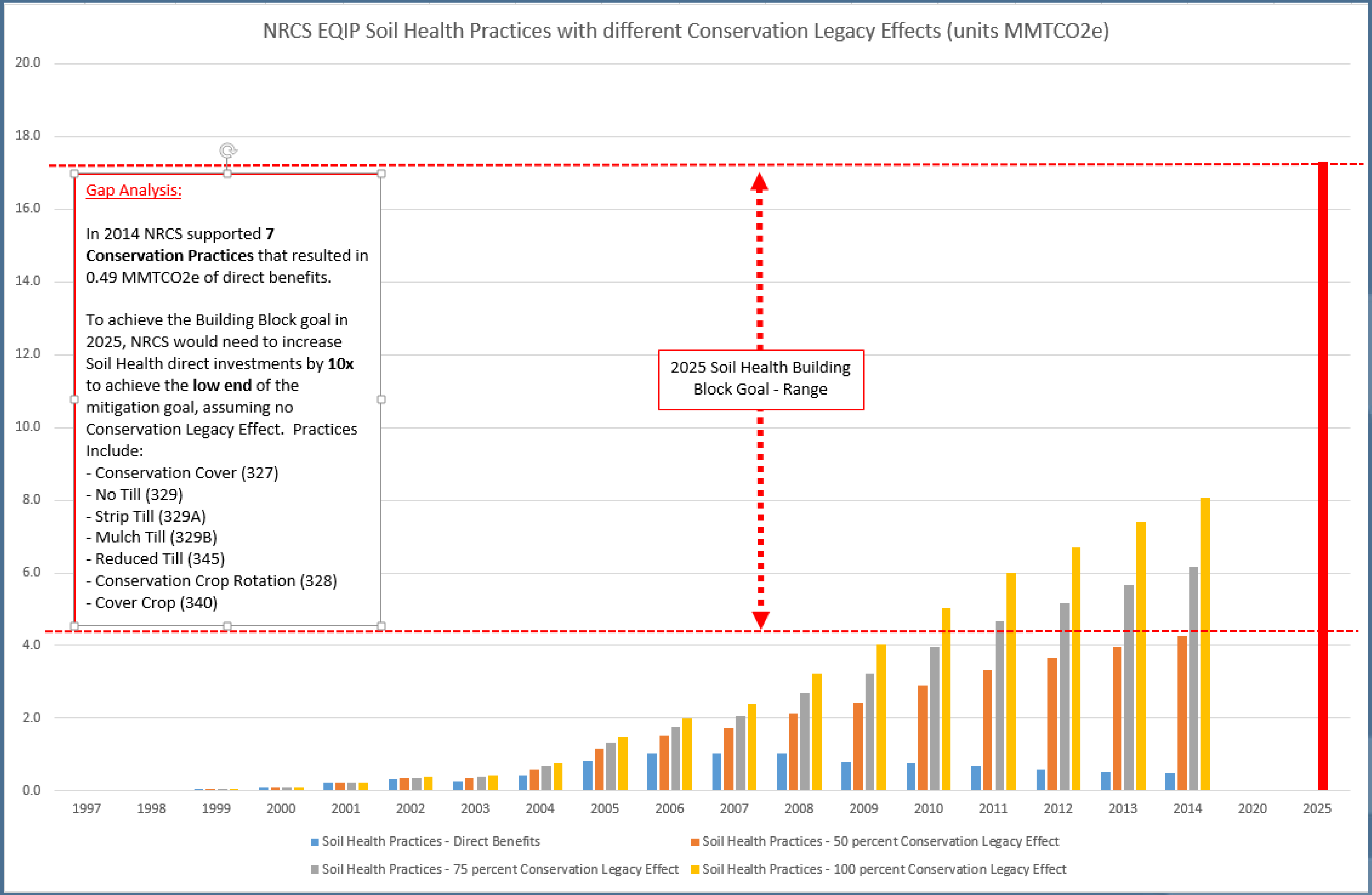
NRCS

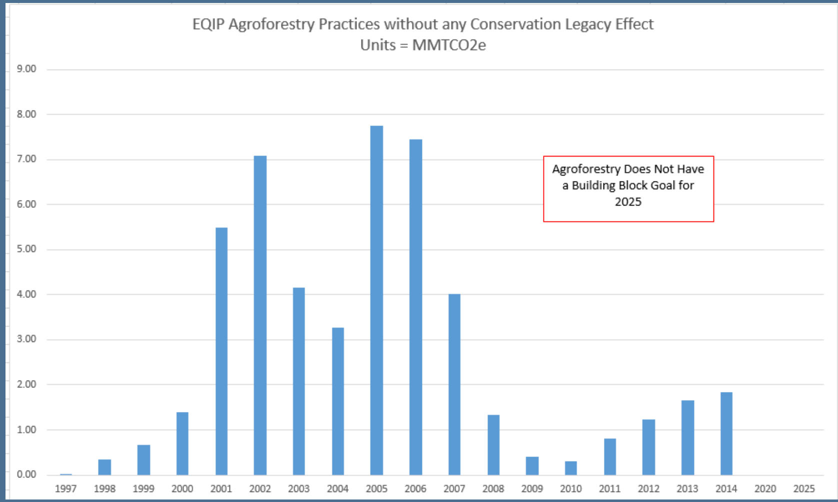
Building Block	Estimated Annual GHG Reduction by 2025 ($MMTCO_2e$)
Soil Health	4.3 – 17.3
Nitrogen Stewardship	7.0
Livestock Partnerships	18.7
Conservation of Sensitive Lands	3.0 – 3.2
Grazing and Pasture Lands	0.4
Private Forest Growth and Retention	4.8
Stewardship of Federal Forests	0.03
Promotion of Wood Products	5.9
Urban Forests	0.02
Energy Generation and Efficiency	67.0
Total	**111.2 – 124.4**

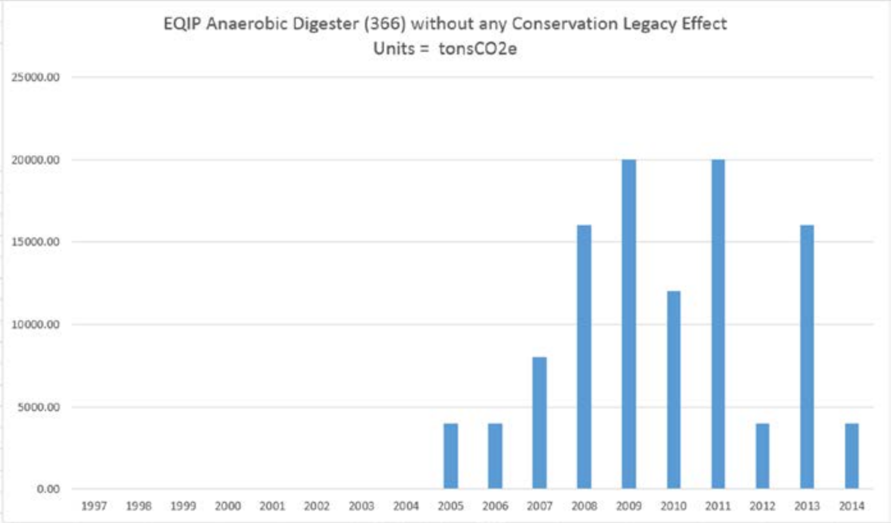
NRCS Total Contribution: 100.4 – 113.6

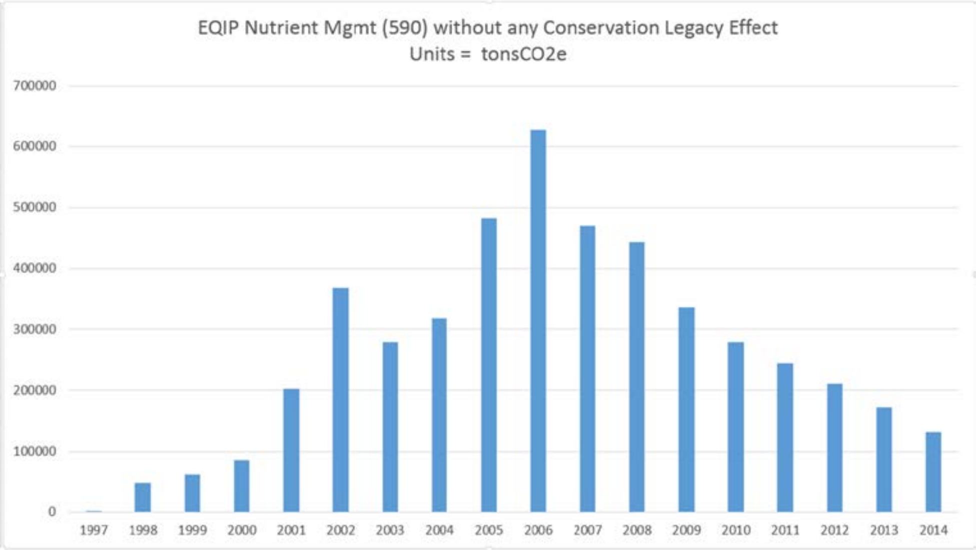

EQIP Soil Health Practices without any Conservation Legacy Effect
Units = tonsCO2e
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2020
2025

Soil Health


NRCS EQIP Soil Health Practices with different Conservation Legacy Effects (units MMTCO2e)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Gap Analysis:
In 2014 NRCS supported 7 Conservation Practices that resulted in 0.49 MMTCO2e of direct benefits.
To achieve the Building Block goal in 2025, NRCS would need to increase Soil Health direct investments by 10x to achieve the low end of the mitigation goal, assuming no Conservation Legacy Effect. Practices Include:
- Conservation Cover (327)
- No Till (329)
- Strip Till (329A)
- Mulch Till (329B)
- Reduced Till (345)
- Conservation Crop Rotation (328)
- Cover Crop (340)
2025 Soil Health Building Block Goal - Range
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2020
2025
Soil Health Practices - Direct Benefits
Soil Health Practices - 50 percent Conservation Legacy Effect
Soil Health Practices - 75 percent Conservation Legacy Effect
Soil Health Practices - 100 percent Conservation Legacy Effect


EQIP Agroforestry Practices without any Conservation Legacy Effect
Units = MMTCO2e
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Agroforestry Does Not Have a Building Block Goal for 2025
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2020 2025


EQIP Anaerobic Digester (366) without any Conservation Legacy Effect
Units = tonsCO2e
25000.00
20000.00
15000.00
10000.00
5000.00
0.00
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014


EQIP Nutrient Mgmt (590) without any Conservation Legacy Effect
Units = tonsCO2e
700000
600000
500000
400000
300000
200000
100000
0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

Wrap-up

All tools have limits, limits of COMET-Planner:

- **Conservation Legacy Effect in Time – annual benefits tool**
- **Conservation also has a Ripple Effect in Space – farmer to farmer**
- **Region-specific ex-ante quantification of implementing conservation practices**
- **Limited suite of NRCS conservation practices**
- **Site-specific soils, weather, management history and practices – visit COMET-Farm (www.comet-farm.com)**

Image Source: http://bariatricexperience.com/content/ripple-effect

End

Nutrient Management – Replacing Synthetic Nitrogen Fertilizer with Soil Amendments (Conservation Practice Standard 590)

NRCS Practice Information

DEFINITION: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

CONDITIONS WHERE PRACTICE APPLIES: This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

COMET-Planner Practice Information

COMET-Planner estimates assume a full or partial replacement of synthetic nitrogen fertilizer with soil organic matter amendments, such as manure or other organic by-products. It is assumed that total nitrogen addition rates will not change and therefore nitrous oxide emissions will not be significantly different with soil amendments. Emission reductions are associated with soil carbon sequestration from increased inputs of carbon from manure or organic by-products.

Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions*				
Practice	***Climate zone***	**Carbon Dioxide ($Mg\ CO_2\ eq\ ac^{-1}\ y^{-1}$) Average (Range)**	**Nitrous Oxide ($Mg\ CO_2\ eq\ ac^{-1}\ y^{-1}$) Average (Range)**	**Methane ($Mg\ CO_2\ eq\ ac^{-1}\ y^{-1}$) Average (Range)**
Nutrient Management – Replacing Synthetic Nitrogen Fertilizer with Soil Amendments (CPS 590)	Dry/semiarid	1.00 (0.40 – 2.17)	Not estimated	Not estimated
	Moist/humid	1.75 (0.85 – 2.51)	Not estimated	Not estimated

*Positive values indicate reductions in greenhouse gas emissions and negative values indicate increases in greenhouse gas emissions. Emissions reductions for soil carbon were estimated using the Intergovernmental Panel