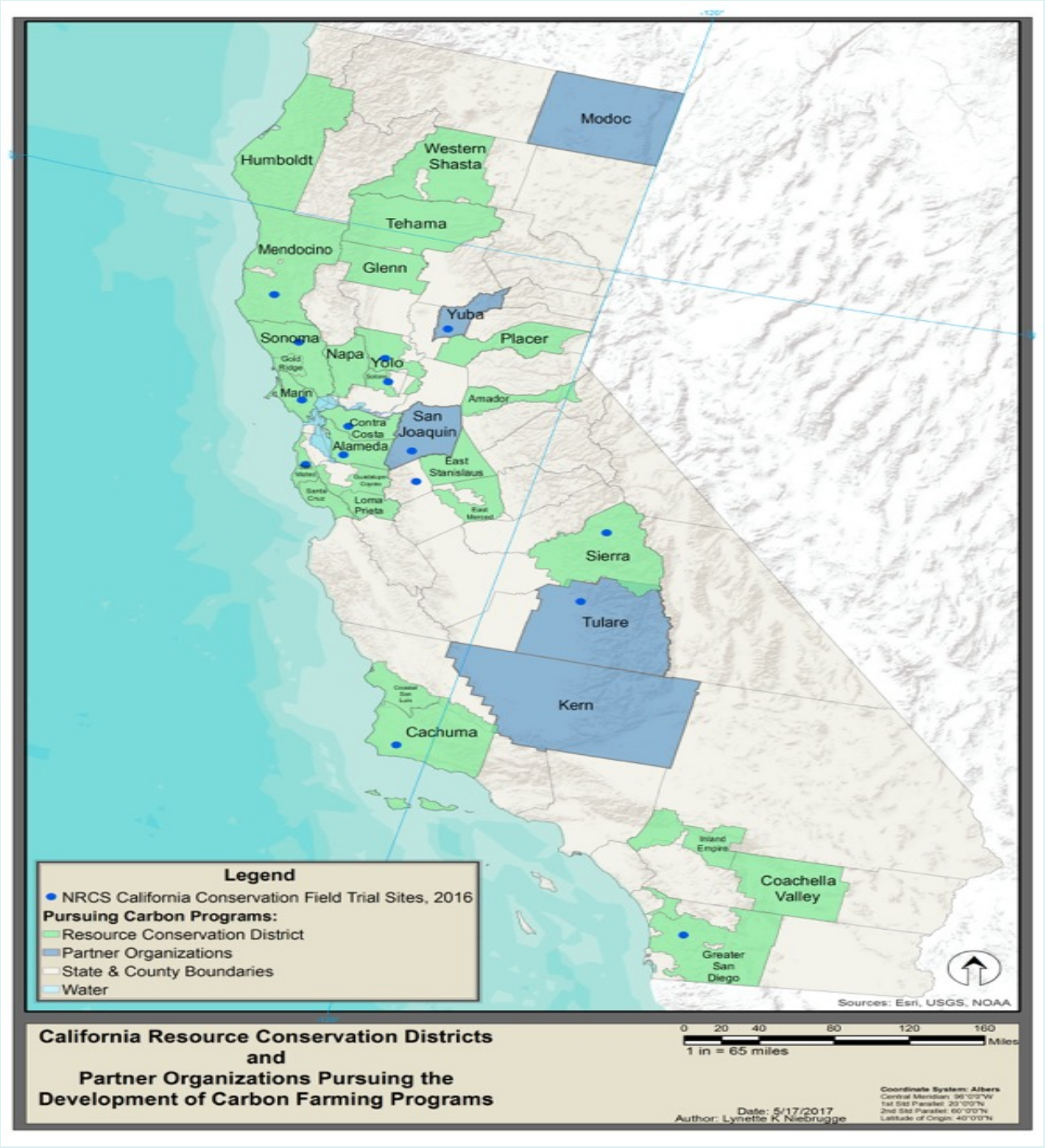
CARBON FARMING

Increasing Carbon Capture on California's Working Lands

Carbon Cycle Institute

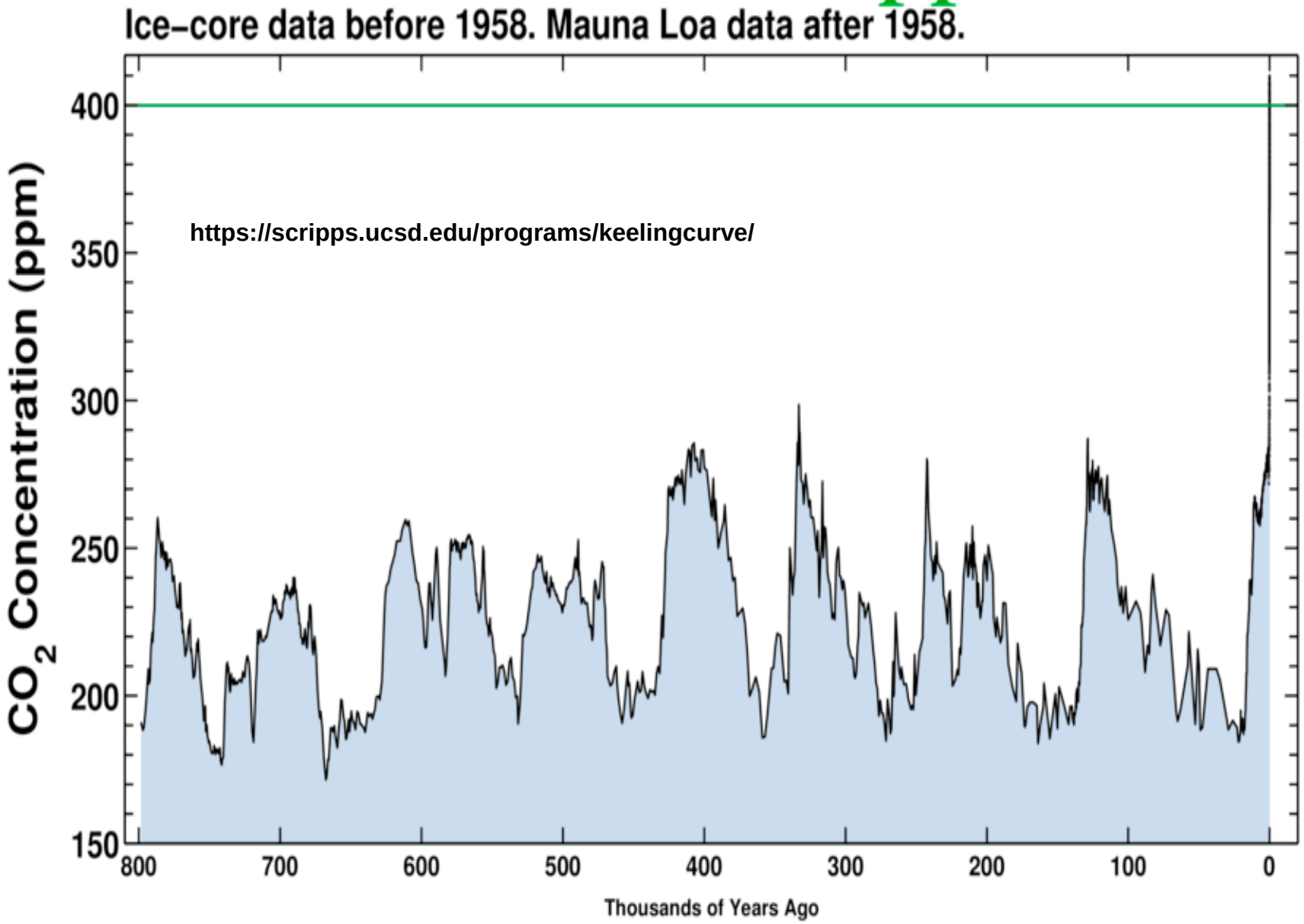
www.carboncycle.org

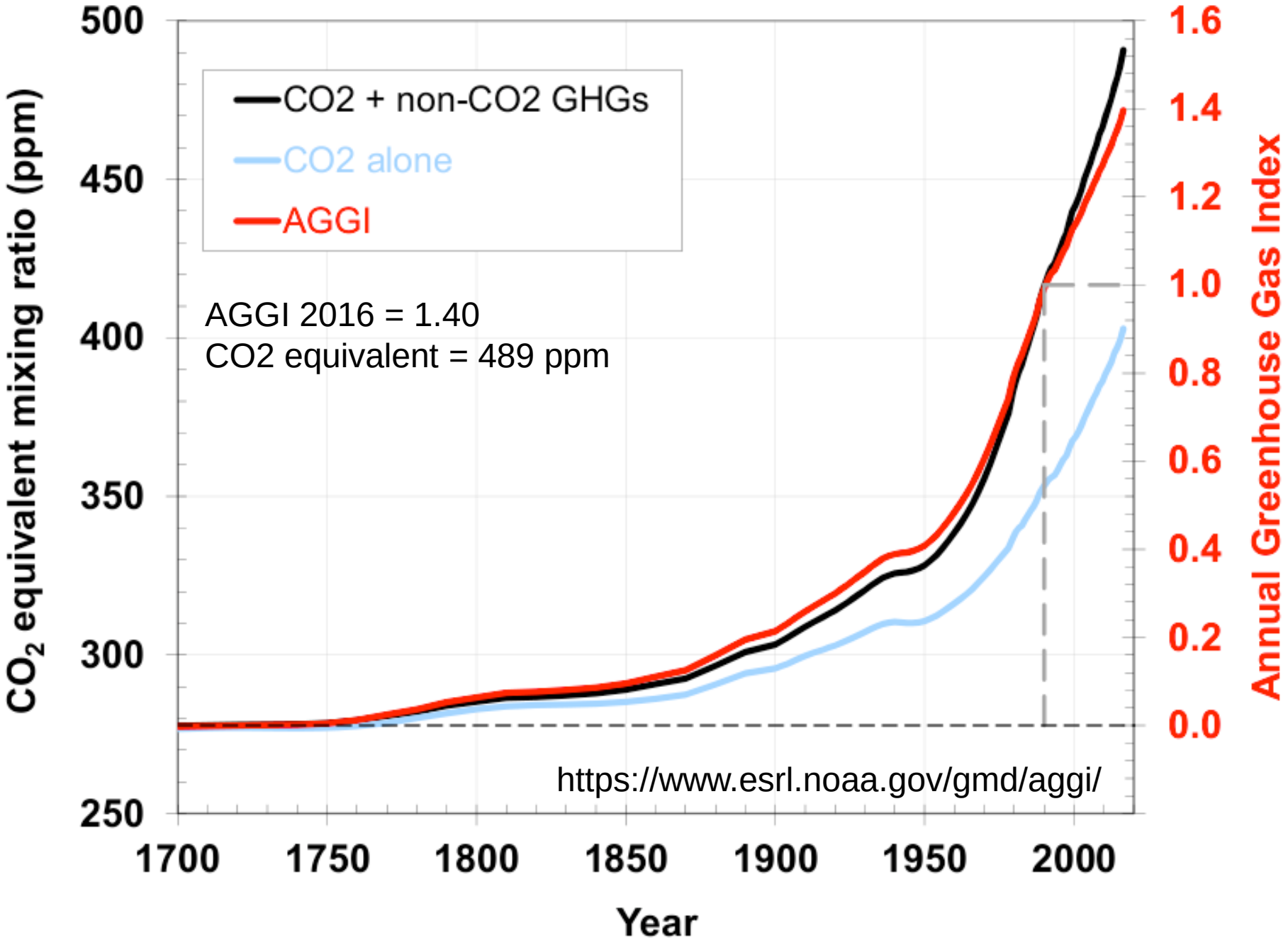
Scaling Up: Carbon Farming with Resource Conservation Districts

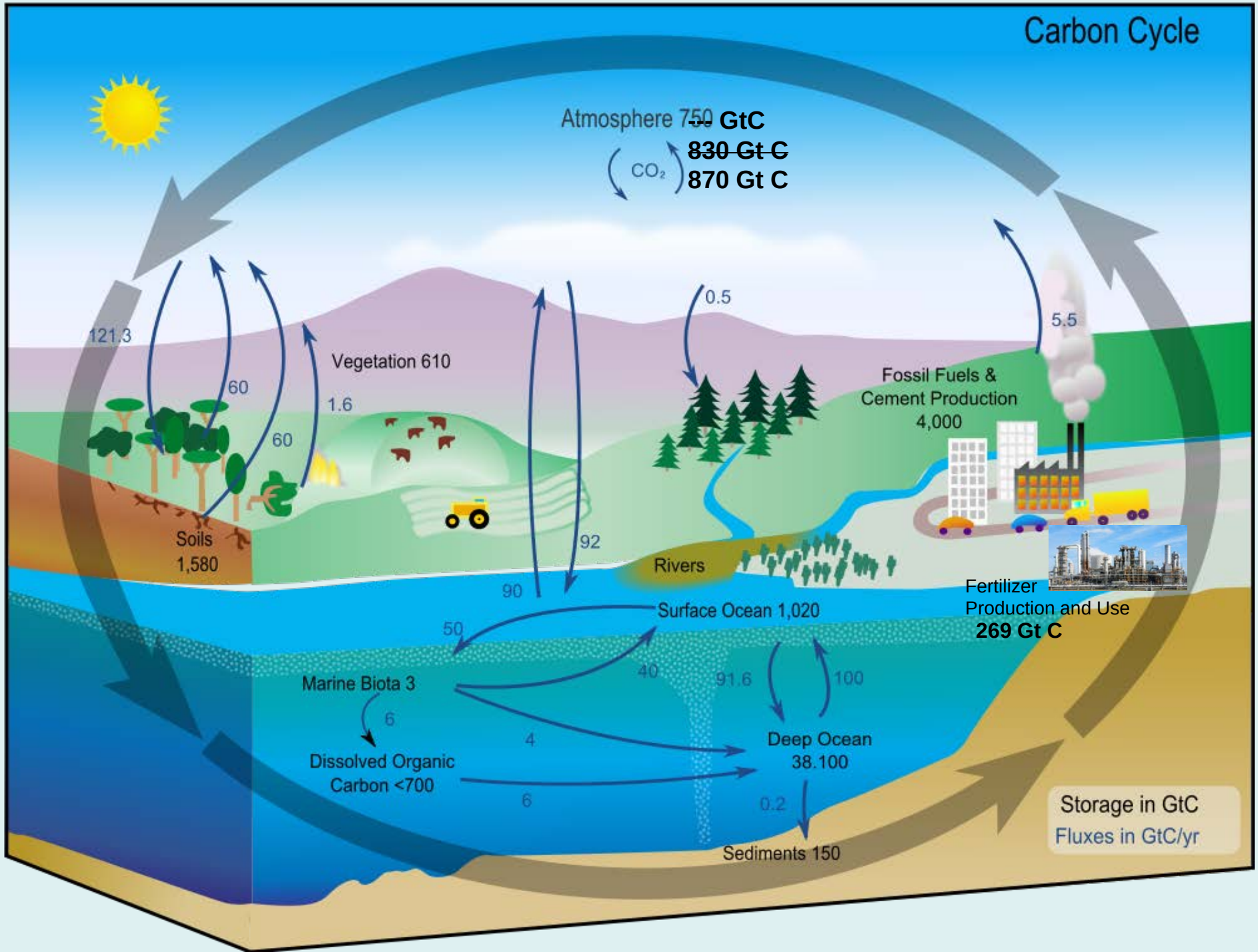


Latest CO_2 reading
February 04, 2018

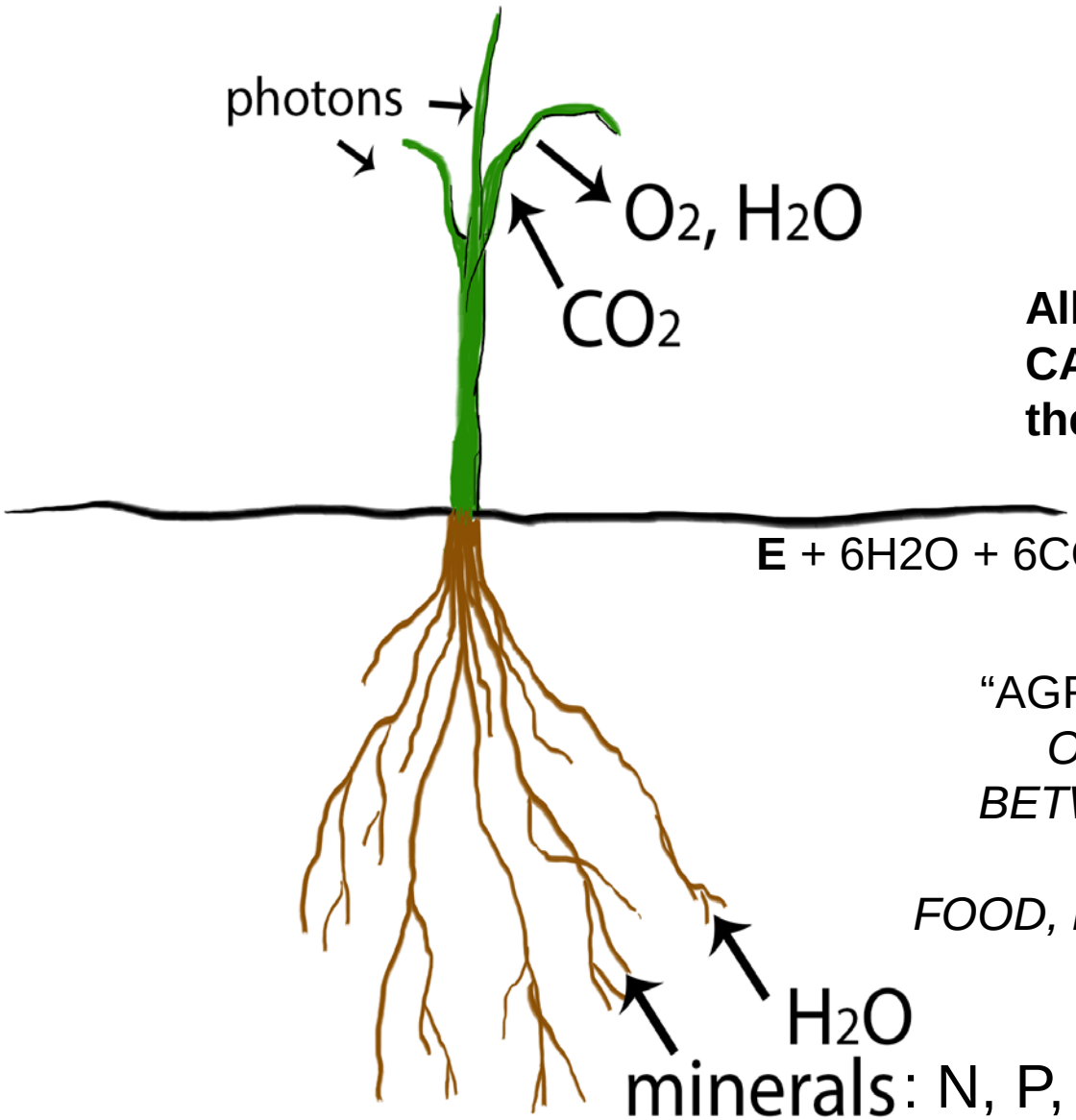
407.51 ppm




CO2 + non-CO2 GHGs
CO2 alone
AGGI
AGGI 2016 = 1.40
CO2 equivalent = 489 ppm
https://www.esrl.noaa.gov/gmd/aggi/
CO2 equivalent mixing ratio (ppm)
Annual Greenhouse Gas Index
Year
500
450
400
350
300
250
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1700
1750
1800
1850
1900
1950
2000


Carbon Cycle
Atmosphere 750 GtC
~~830 Gt C~~
870 Gt C
CO_2
121.3
60
60
Vegetation 610
1.6
Soils
1,580
0.5
5.5
Fossil Fuels &
Cement Production
4,000
92
Rivers
90
Surface Ocean 1,020
50
Marine Biota 3
6
Dissolved Organic
Carbon <700
40
4
6
91.6
100
Deep Ocean
38.100
0.2
Sediments 150
Fertilizer
Production and Use
269 Gt C
Storage in GtC
Fluxes in GtC/yr

Photosynthesis:
the *synthesis* of carbohydrates from *sunlight,* carbon dioxide and water



All the CARBON in CARBOhydrates comes from the AIR

E + 6H2O + 6CO2 ------> C6H12O6+ 6O2

"AGRICULTURE IS *THE ART OF MOVING CARBON BETWEEN CARBON POOLS TO PRODUCE FOOD, FUEL, FIBER, AND FLORA"*

John Wick
Marin Carbon Project

Farmland after rain (right): waterlogging due to poor structure resulting from cultivation, compaction and lack of soil cover (and roots!). Different management, including denser groundcover, on the adjacent paddock (left) results in higher soil carbon, better structure and improved water absorbing and holding capacity.

Patrick Francis, Australian Farm Journal

Same Mendocino soil: different input and management histories

Photo: G. Batist, 2017

Can Soil Carbon Sequestration Stop Global Warming?

The 4 per Thousand Initiative:

French Ministry of Agriculture, Agrifood and Forestry **Increasing global Soil Organic Carbon by 0.4% annually would offset *all* global CO2 emissions**

- the "*4‰ Initiative: soils for food security and climate*" aims to show that
- **food security and combating climate change are complementary** and to ensure that
- ***agriculture provides solutions to climate change***.

- ***Will California join the Initiative?***
  - http://agriculture.gouv.fr/agriculture-et-foret/environnement-et-climat

…enhancing soil carbon is the only viable option to achieve negative emissions….

-Celine Charveriat, Executive Director, Institute for European Environmental Policy. COP 22, 2016.

Marin Carbon Project 2008
H1: Management can increase soil carbon
and: we can measure it

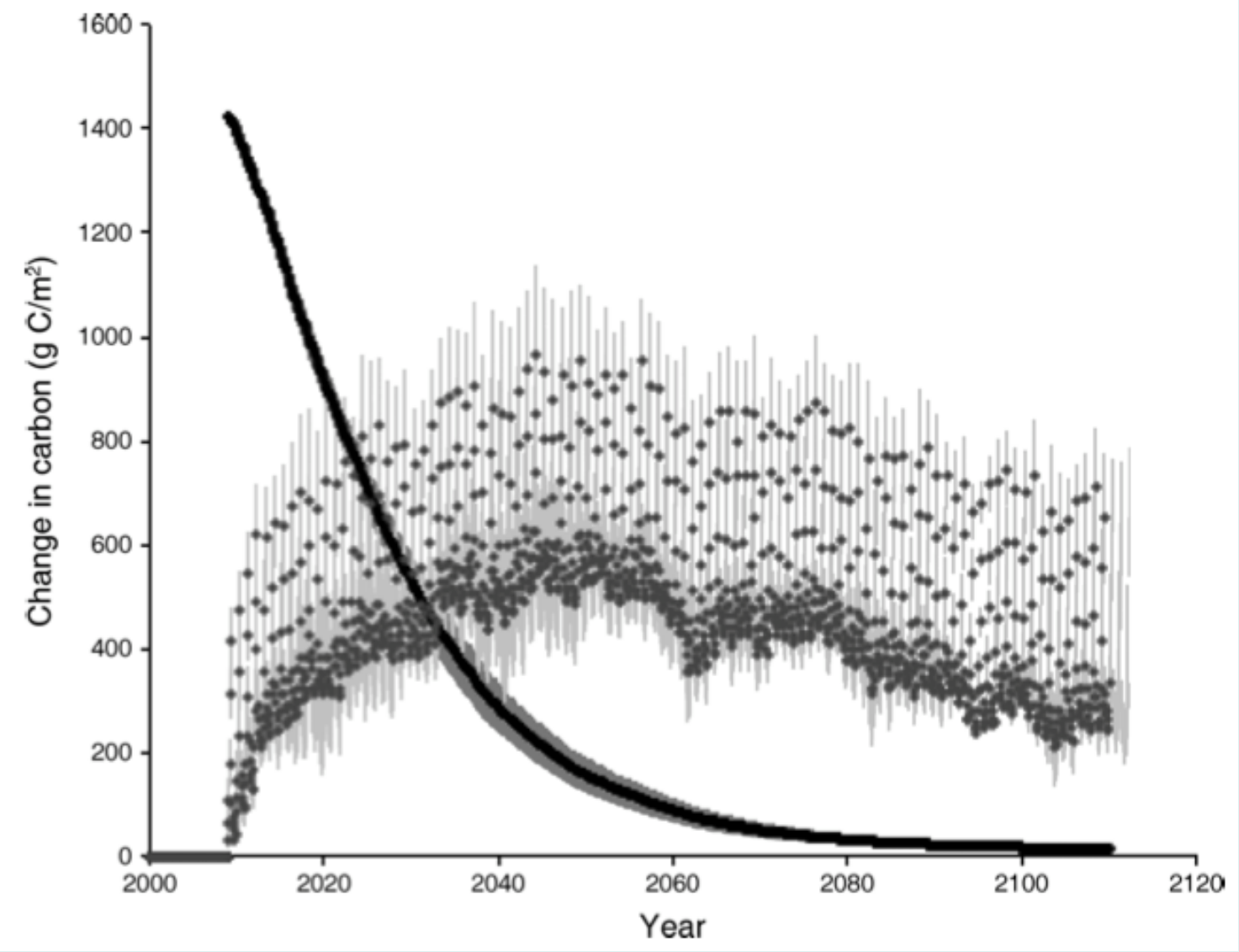
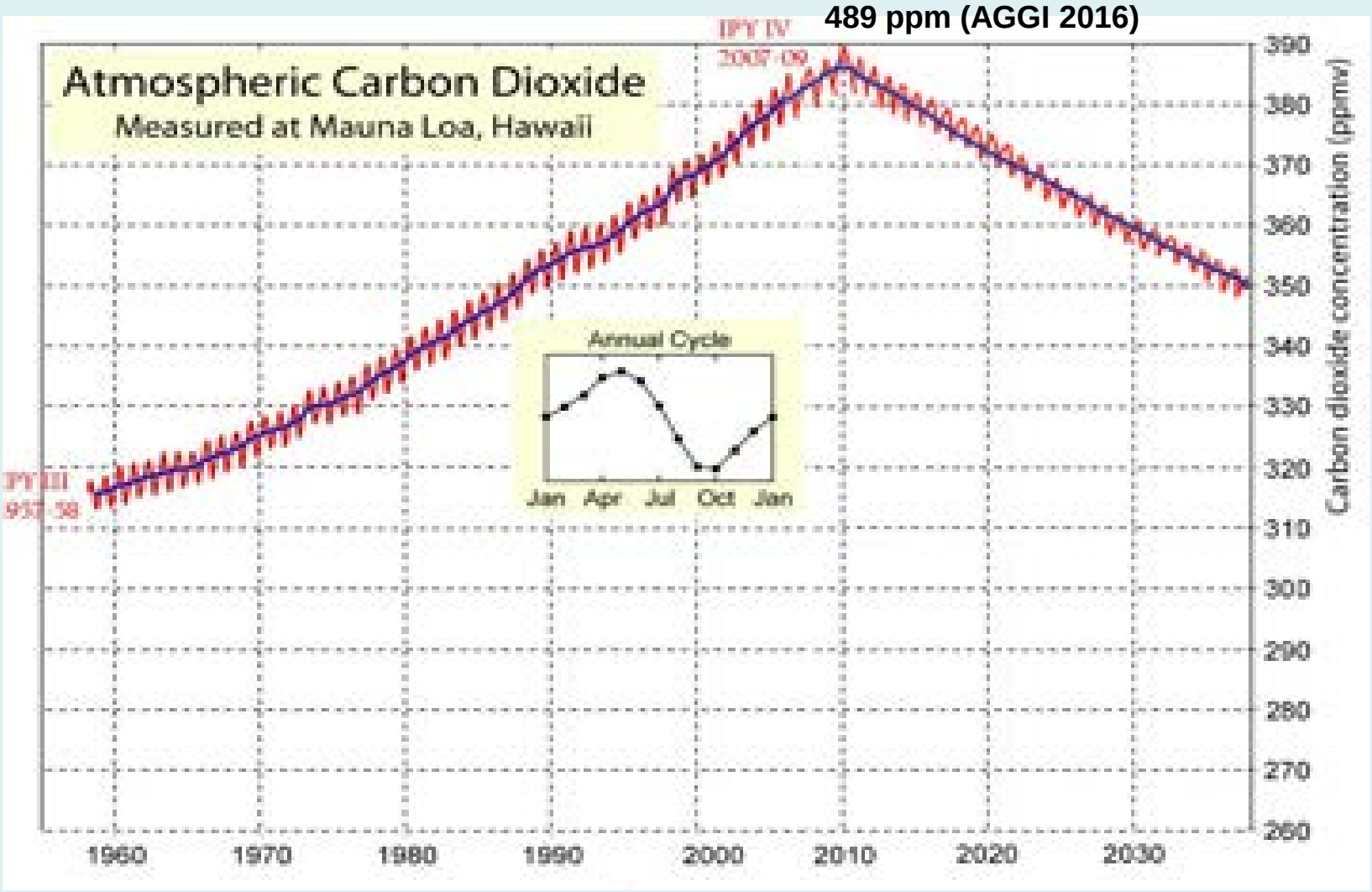


FIG. 3. The black line shows simulated decomposition of the compost following application to grassland soils. Gray circles show the monthly change in total ecosystem carbon, not including compost carbon. Values are averages across site characterizations, with standard error bars in light gray. Ryals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

Measured effect of anthropogenic forcing of atmospheric C, with hypothetical effect of anthropogenic forcing of soil organic C at global scale



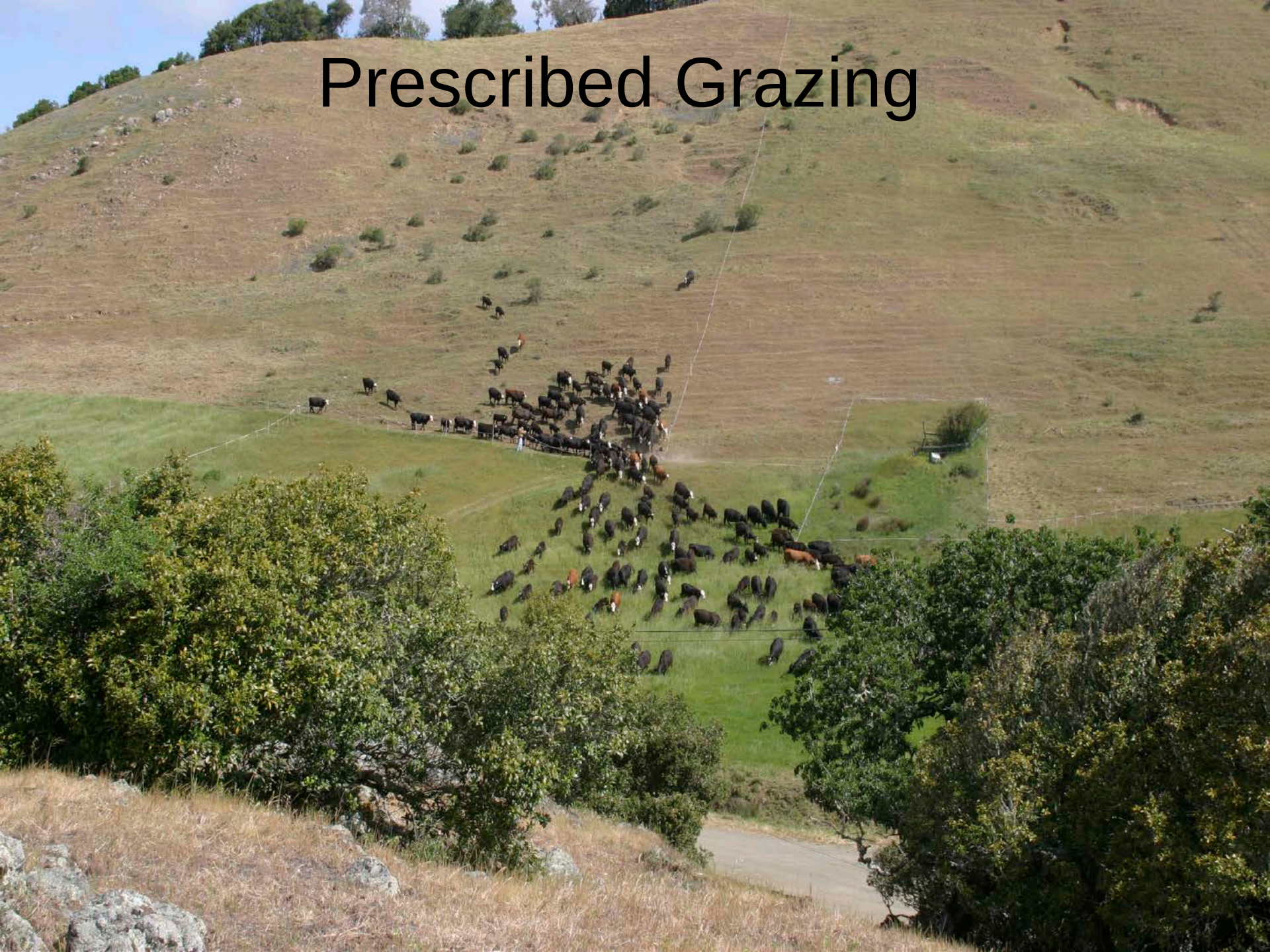
GHG Implications of Riparian Restoration in Coastal California

David Lewis, Michael Lennox, Anthony O'Geen, Valerie Eviner, Jeff Creque, Kenneth Tate

UC CE | University of California
Agriculture and Natural Resources | Cooperative Extension

Hedgerows

Prescribed Grazing



Conventional Tillage to No-Till

Cover Cropping

Nutrient Management – Replacing Synthetic Nitrogen with Organic Matter Amendments

Bare Ranch

CARBON FARM PLAN

Spring 2016

Carbon Cycle Institute

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and

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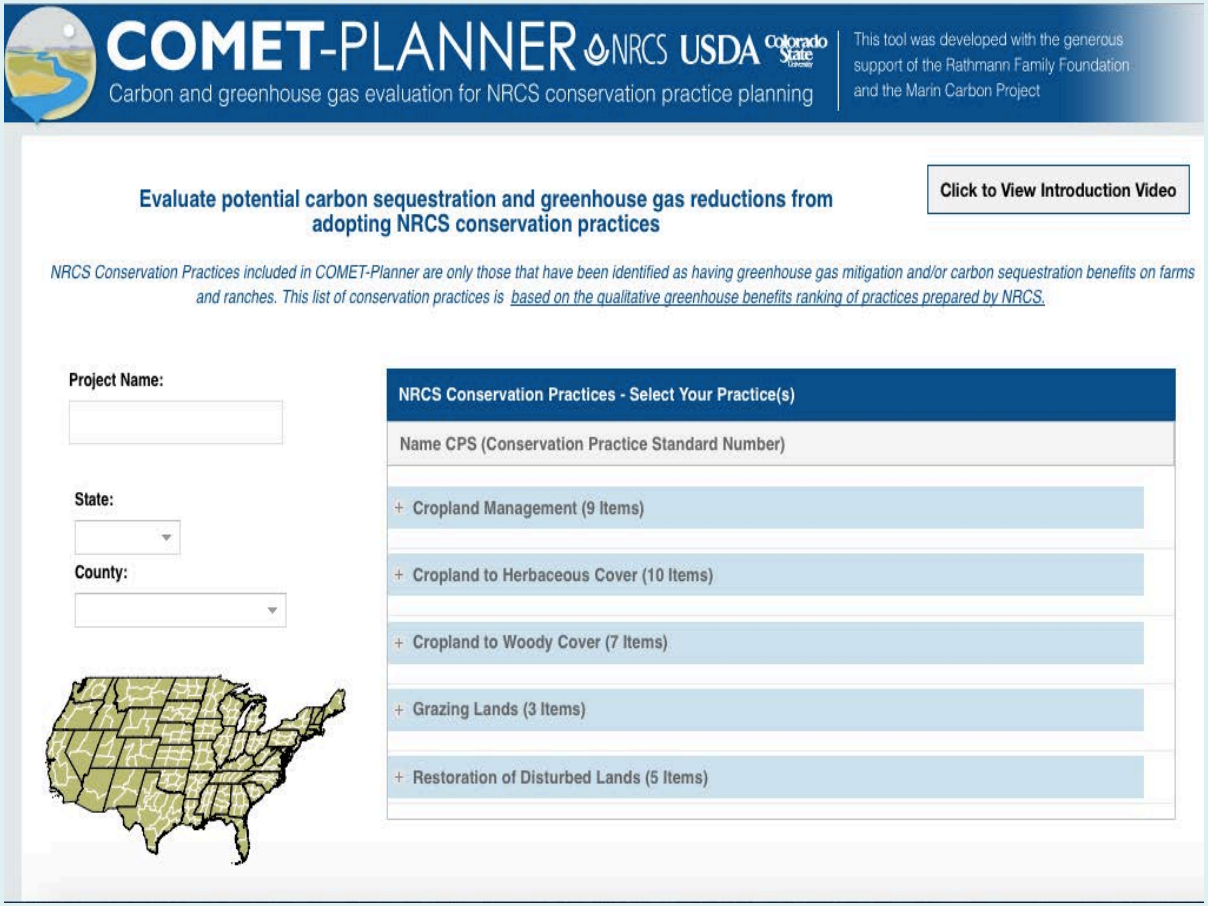
Carbon Farming:
Quantifying On-farm Carbon Capture Potential



And LOCAL DATA, where available…
COMPOST: Ryals et al 2013; DeLonge et al 2013
CREEK CARBON: Lewis et al 2015

Estimated CO2e Reduction/Sequestration Potential, Bare Ranch, 2016

Practice	Average Annual CO2e Sequestration (Mg)	20 yr CO2e Sequestration
Rangeland Compost	167	31,826
Cropland Compost (590)	1,097	21,938
Shelterbelts (380)	20	404
Riparian Restoration*	368*	7353*
Prescribed Grazing (528)	790	15,800
Range Planting (550)	720	14,400
Minimum-Tillage (345)	104	2,080
Silvopasture (381)	94	1,880
Irrigation System (443)	780	15,600
Totals	**4,140**	**111,581**

Carbon Farming:
Climate-Beneficial Agriculture

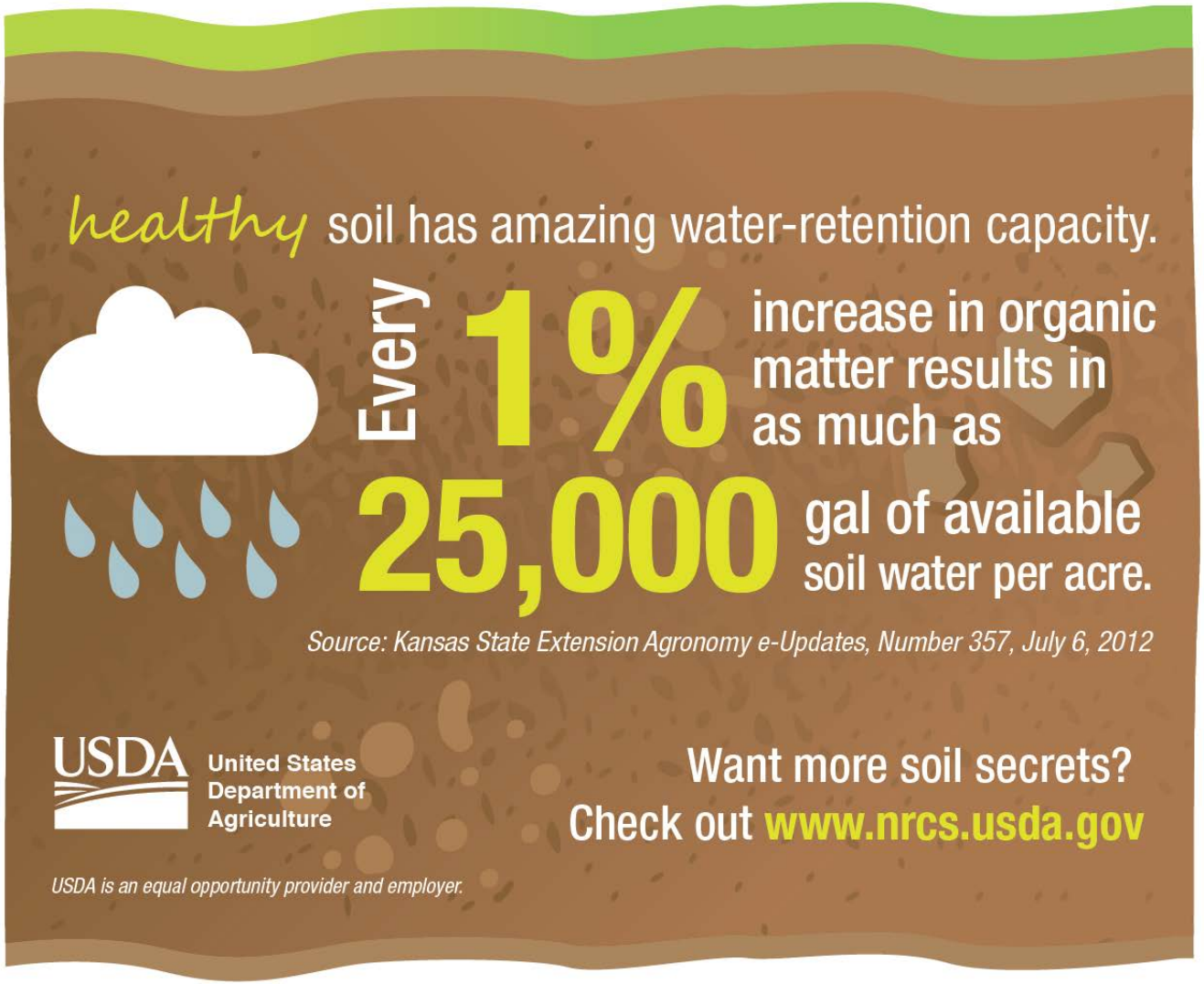
Using published (Wiedemann et al 2015) on-farm GHG emission values for wool production, implementation of this Ranch's Carbon Plan would offset 6 to 9.5 times the GHG emissions associated with its wool production each year.

Carbon Farming provides a robust framework for a 'Climate-Beneficial' agriculture.

USDA-NRCS SOIL HEALTH INFOGRAPHIC SERIES #002

unlock the SECRETS IN THE SOIL

what's underneath



Estimated Additional Annual Soil Water Holding Capacity, Bare Ranch, With Carbon Farm Plan Implementation, Year 20

PRACTICE	DESCRIPTION	20 YEAR SOM INCREASE (Mg)	ANNUAL WHC INCREASE BY YEAR 20 (AF)
Compost application on Rangeland (NRCS practice standard in development)	Application of 1/4" of compost to 1600 acres of permanent pasture.	17344.09	158.99
Compost application on Cropland (590)	Application of compost to 537 acres of cropland to 5% SOM	11,955.00	109.59
Shelterbelts (380)	6.78 miles (16.44 acres) of 20' wide shelterbelts	98.35*	0.90*
Prescribed Grazing (528)	Grazing management to favor perennials and improve production on 4411 acres	8,610	78.93
Riparian Restoration	32.36 acres of riparian system along 4.45 miles	1,048.00*	9.60
Minimum-Tillage (345)	Conversion of tilled crop fields to minimum tillage on	1,134	10.39
Silvopasture (381)	Establish trees on approximately 134 acres of pasture	270**	2.35
Conversion of flood irrigation to pipe irrigation (443)	Conversion of flood to pipe irrigation on 1,000 acres permanent pasture	8,501.00	77.93
Range Planting (550)	No-till interseeding of forage species in irrigated pasture within the Saline Bottom ecological site (2,107 acres)	7,847.00	71.93
TOTAL		64,274.44	521.63

Synthetic fertilizer: the largest import (519 Gg N yr^{-1}) of N into California
(UCD, CNA 2015)

- Every metric ton of nitrogen spread in the form of fertilizer is responsible for emissions of 10.5 t CO2e in the field and 5.1 t CO2e during its production.
    - -Foucherot and Bellassen, Climate Report No. 31, December, 2011

- Excess ecosystem N is driven by the ***intentional anthropogenic forcing*** of the N cycle through the manufacture and use of synthetic fertilizers.

- ***69% of the N added annually to cropland statewide is derived from synthetic fixation*** *(CNA 2015).*

Mass Balance for CA N, 2005

(CA N Assessment, UCD 2016)

1000 Kg = 1 Mg; 1000 Mg = 1Gg; 1000 Gg = 1 Tg; 1Tg = 1 million Mg.

Leaching from cropland (333 Gg/yr) is the predominant (88%) input of N to groundwater. Many wells in California have nitrate concentrations > Maximum Contaminant Level (10 mg NO_3^--N/L).

An amount of reactive N equivalent to 71% (333/466 Gg/yr) of the synthetic N applied to CA croplands each year ends up in the State's groundwater.

Nitrogen oxide (NOx = NO + NO2) gases are among the most important components of air pollution, which, according to the World Health Organization, is responsible for one in eight premature deaths worldwide…. Global studies have pointed to similarities in the magnitude of NOx emissions from fossil fuel combustion and soil, with the largest soil emissions from regions with heavy N fertilizer applications.

Where agriculture is an important source of NOx, strategies to reduce nonpoint emissions will need to incorporate soil management approaches and policies.….

(CA)…results indicate ***fertilized croplands account for 20 to 32% of total NOx-N emissions from all sectors of the state,*** (natural soils account for 5 to 9%). The model predicts local maxima in the Sacramento Delta region, the Salinas Valley, and the San Joaquin Valley.

NOx uptake by vegetation can cut atmospheric NOx emissions in half.

Almaraz et al 2018, Sci Adv 4(1) DOI: 10.1126/sciadv.aao3477

Good News: We- ***can*** meet our GHG reduction goals ***if*** we ***dramatically reduce*** emissions ***and seriously invest*** in our **soils and working lands** as major ***-beneficial-*** sinks for atmospheric GHGs

Bad News:, ***the carbon budget for 1.5˚ C will be exceeded in 3 years*** (2021), and the carbon budget for 2˚ C will be exceeded in 18 years (2036) if we do not ***act now.***

Photo: Abe Collins, CarbonFarmersofAmerica.org

Opportunities for Connecting Healthy Soils and Community Health

Integrating Carbon Farming and Health into Local Climate and Community Development Plans

Agriculture missing from climate plans, including most TCC proposals (Fresno, Coachella)

Model for Carbon Farming and Healthy Soils for Health-Impacted Communities

Local food access and agriculture: Huerta del Valle Carbon

Coachella RCD: working with small-scale Latino farmers to develop a model of carbon farming in Coachella Valley

Job Training and Employment

At scale, Healthy Soils will require a large labor force with technical training and education in agroecosystems, soils, climate and land management/restoration