2024 NORTH AMERICAN

# BIOCHAR CONFERENCE

— USBI —

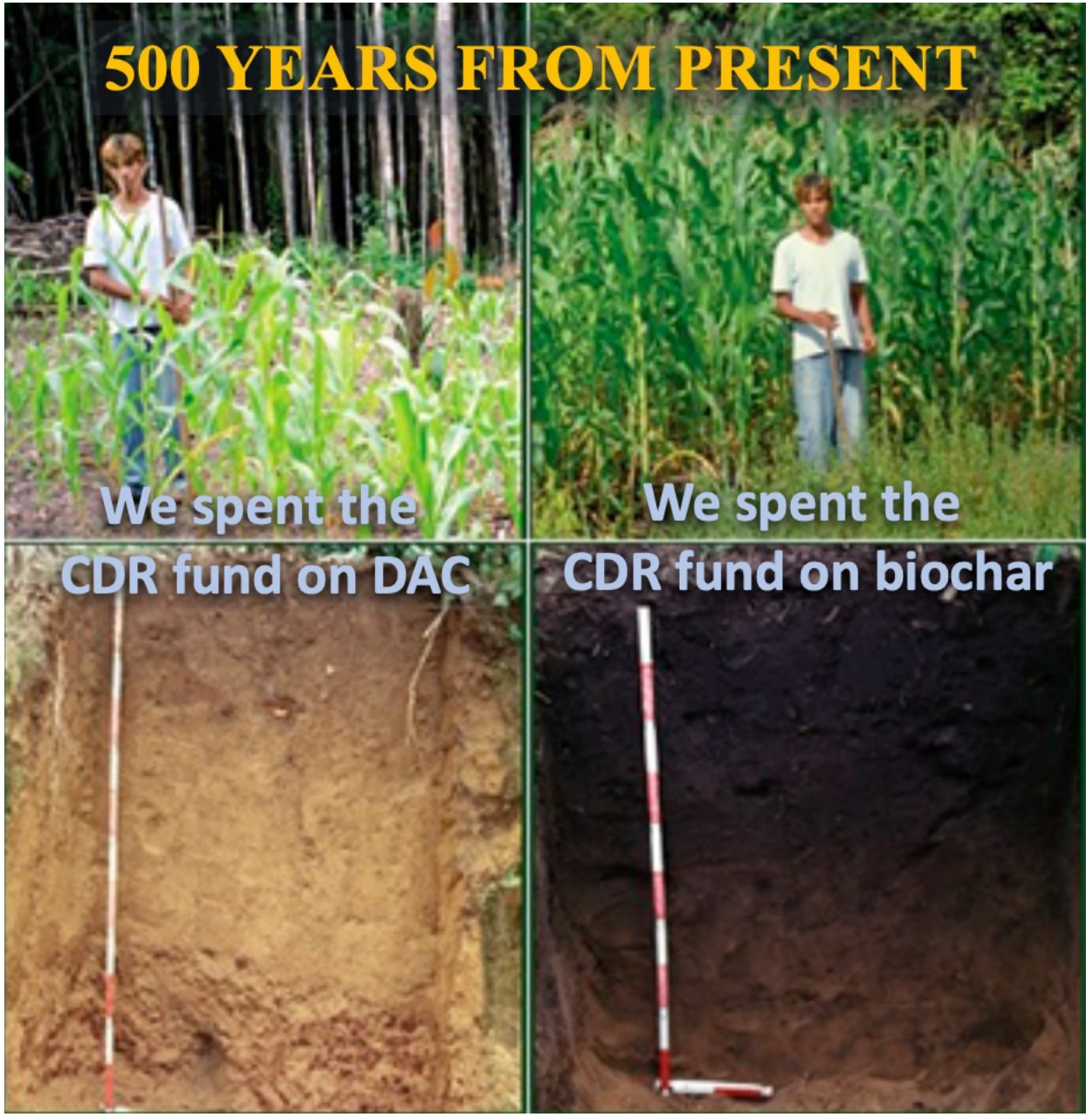
CALIFORNIA, USA

PACIFIC BIOCHAR

# Intergenerational Benefits of Farmland Applied Biochar

By
Josiah Hunt
CEO, Pacific Biochar Benefit Corporation
2/12/24

PACIFIC BIOCHAR



# CDR with Co-Benefits

## >25,000 research articles

Received: 22 May 2021 | Revised: 11 August 2021 | Accepted: 12 August 2021

DOI: 10.1111/gcbb.12889

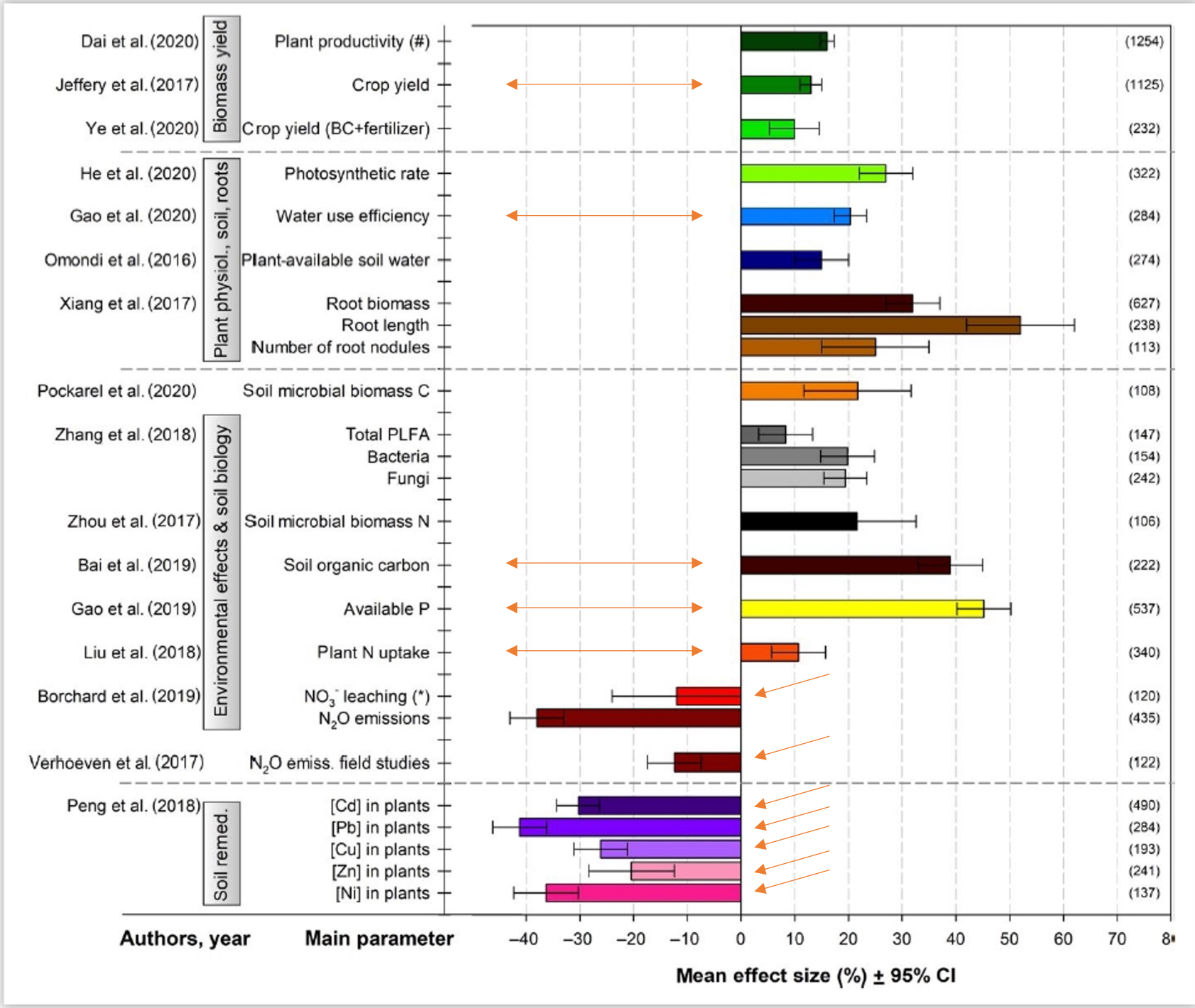
RESEARCH REVIEW

GCB BIOENERGY | WILEY

**Biochar in agriculture – A systematic review of 26 global meta-analyses**

Hans-Peter Schmidt[1] | Claudia Kammann[2] | Nikolas Hagemann[3,4] | Jens Leifeld[4] | Thomas D. Bucheli[4] | Miguel Angel Sánchez Monedero[5] | Maria Luz Cayuela[5]

**FIGURE 2** Selected parameters with highest agronomic relevance that were investigated in the 26 reviewed meta-analyses. The mean overall effect size (% change) and 95% confidence intervals are given as reported in the original studies. The numbers in parentheses indicate the number of pairwise comparisons used for that specific parameter



# Key concepts

1. When farmland applied, some benefits will result, but, with intention, we could improve intergenerational outcomes
2. The potential for intergenerational benefit is dramatic
3. A system of financial reward for intergenerational outcomes is possible and would drive action

We modify biomass power plants to produce biochar

PACIFIC BIOCHAR

The product ships with standard trucks

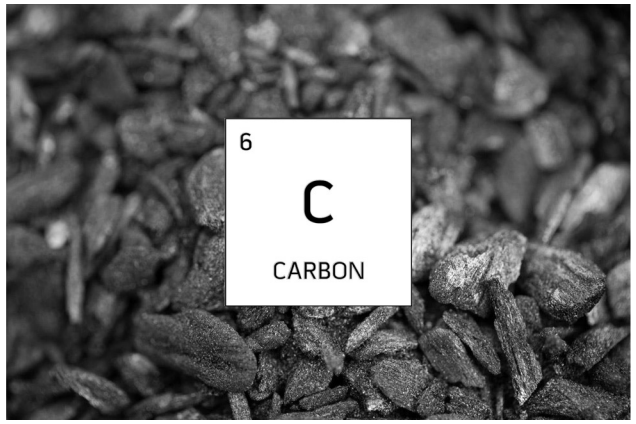
We often co-locate with compost yards for processing and distribution

PACIFIC BIOCHAR

With >6yrs of field trials, our biochar has shown improved crop yield in the farmlands of major ag companies

We’ve been doing this since 2016

*“When the carbon is worth more in the ground than it is in the furnace…”*




Vs

*“…a business we might have”*

From June 2016 till November 2020, Pacific Biochar survived (barely) on revenue from ag sales alone

PACIFIC BIOCHAR

$

Farmland Improvement,
Potting Media, etc.

In 2020, Pacific Biochar registered the first carbon removal credits for biochar. Now that we can get compensated for carbon removal, this is a viable business for growth

$ $

6
C
CARBON

Carbon Dioxide Removal,
Voluntary Markets

Farmland Improvement,
Potting Media, etc.

In 2024, we are already experiencing the reality that biochar must sometimes be deployed at cost in order to deliver CDR supply

$ ↓ ↓ $

6
C
CARBON

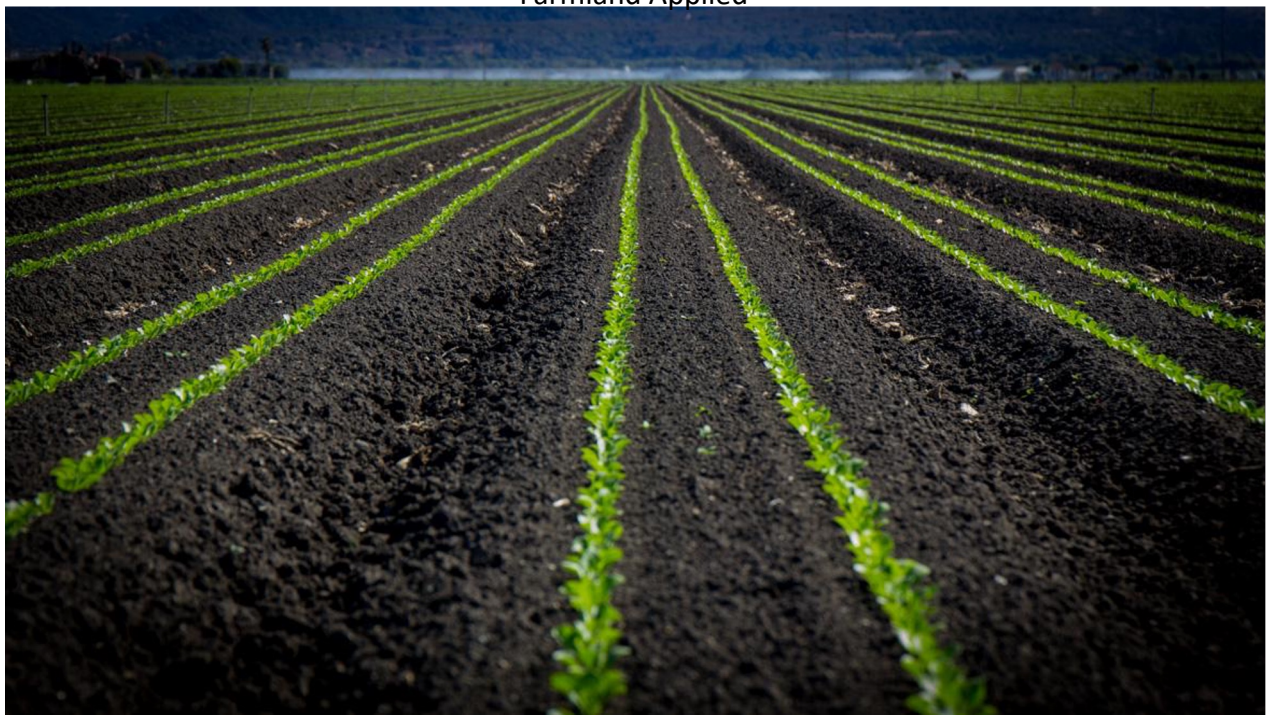
Carbon Credit Sales
Global -
Rapid Growth -
“need to have” -

Carbon Dioxide Removal,
Voluntary Markets

Farmland Improvement,
Potting Media, etc.

Biochar Sales
- Regional
- Slow adoption
- ”want to have”

Farmland Applied



≠

Landfill Applied, Alternative Daily Cover

CDR requirements:

- ☑ Must be sequestered
- ☑ Do no harm

CDR preferences:

- ☑ Co-benefits please

CDR requirements:

- ☑ Must be sequestered
- ☑ Do no harm

CDR preferences:

- ☑ Co-benefits please

While each scenario can technically provide co-benefits, the scale of benefit if not equal

PACIFIC BIOCHAR

# CDR with Co-Benefits

## >25,000 research articles

Received: 22 May 2021 | Revised: 11 August 2021 | Accepted: 12 August 2021

DOI: 10.1111/gcbb.12889

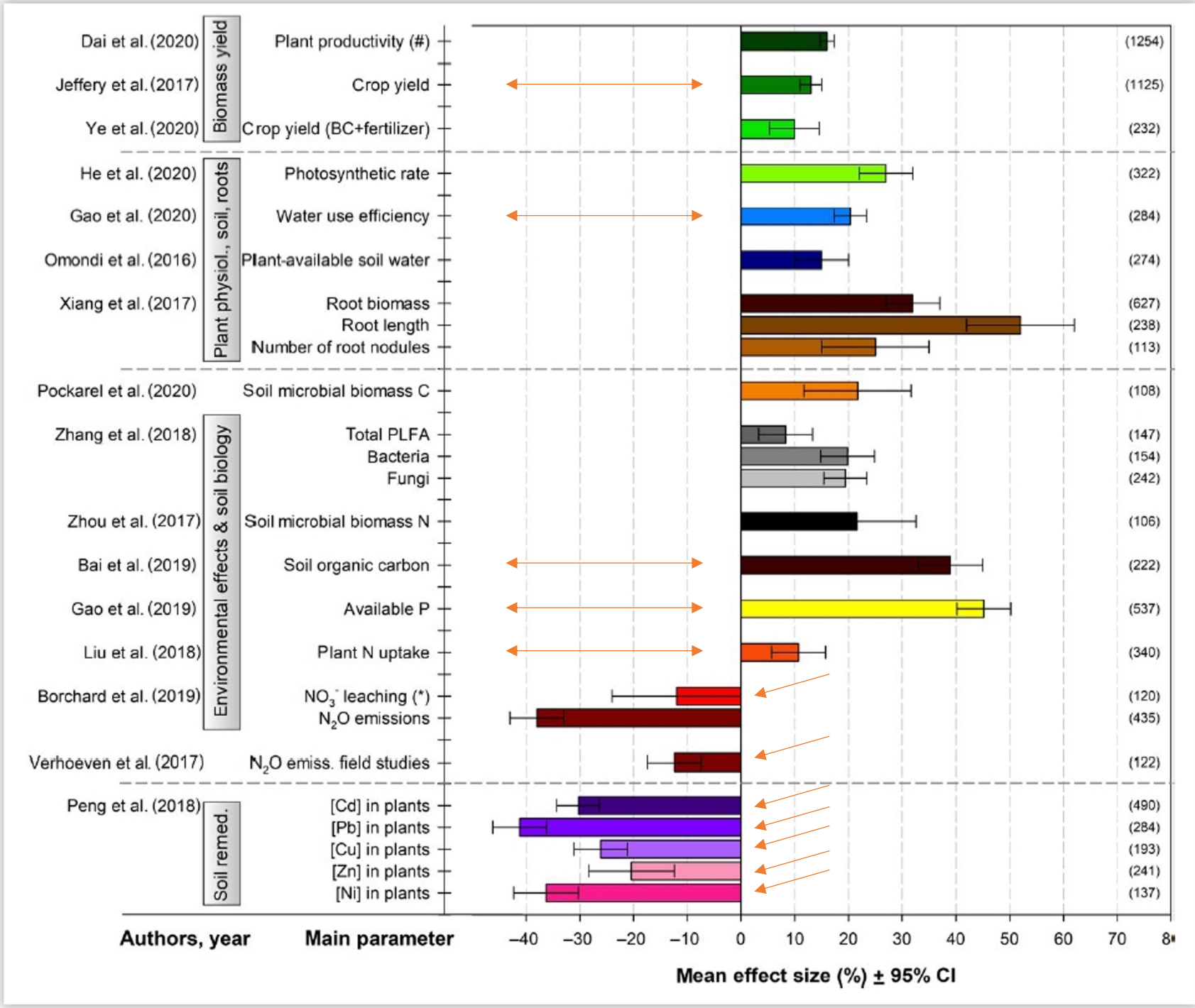
RESEARCH REVIEW

GCB BIOENERGY | WILEY

**Biochar in agriculture – A systematic review of 26 global meta-analyses**

Hans-Peter Schmidt[1] | Claudia Kammann[2] | Nikolas Hagemann[3,4] | Jens Leifeld[4] | Thomas D. Bucheli[4] | Miguel Angel Sánchez Monedero[5] | Maria Luz Cayuela[5]

**FIGURE 2** Selected parameters with highest agronomic relevance that were investigated in the 26 reviewed meta-analyses. The mean overall effect size (% change) and 95% confidence intervals are given as reported in the original studies. The numbers in parentheses indicate the number of pairwise comparisons used for that specific parameter



# What's that worth?

- Metric: **Crop Yield Value**
- Assumptions:
  - Crop – Almonds (statewide average, 2021 data)
  - Yield increase – 10% (Ye et al. 2020)
  - Application rate – 4.5 t/a (10 t/ha, ~0.5% OM in top 6")
  - Permanence factor – 90%

@ 2% discount rate

| | per application | per ton biochar |
|---|---|---|
| NPV (20 year) | **$7,998.85** | **$1,777.52** |
| NPV (1000 year) | **$23,455.58** | **$5,212.35** |

@ 0% discount rate

| | per application | per ton biochar |
|---|---|---|
| NPV (20 year) | **$9,776.92** | **$2,172.65** |
| NPV (1000 year) | **$305,941.27** | **$67,986.95** |

# What's that worth?

- Metric: **Crop Yield Value**
- Assumptions:
  - Crop – Wine Grapes (statewide average, 2020 data)
  - Yield increase – 10% (Ye et al. 2020)
  - Application rate – 4.5 t/a (10 t/ha, ~0.5% OM in top 6")
  - Permanence factor – 90%

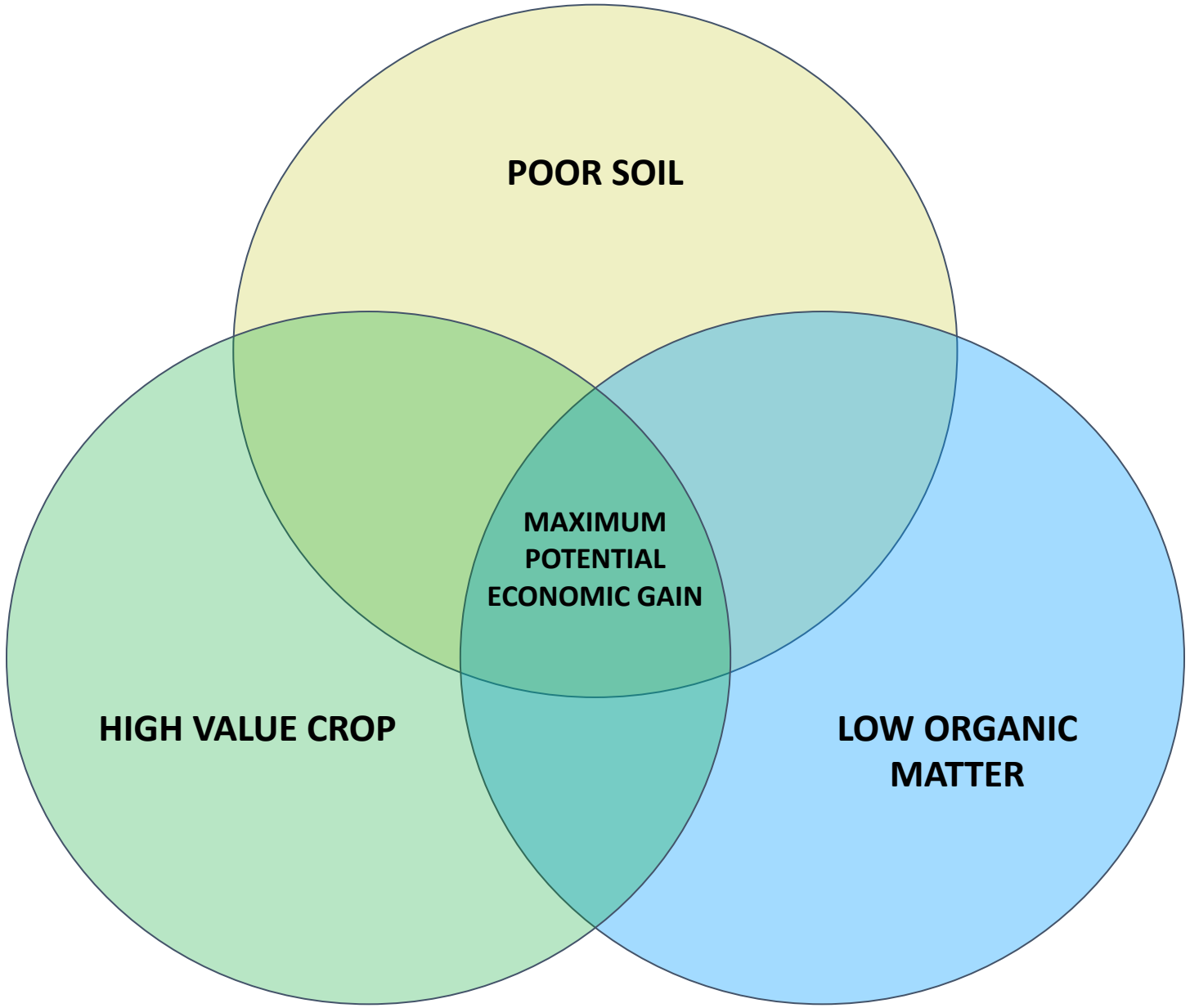
@ 2% discount rate

| | per application | per ton biochar |
|---|---|---|
| NPV (20 year) | **$8,429.79** | **$1,873.29** |
| NPV (1000 year) | **$24,719.27** | **$5,493.17** |

@ 0% discount rate

| | per application | per ton biochar |
|---|---|---|
| NPV (20 year) | **$10,303.66** | **$2,289.70** |
| NPV (1000 year) | **$322,424.14** | **$71,649.81** |

PACIFIC BIOCHAR



# What's that worth?

- Metric: **Crop Yield Value**
- Assumptions:
  - Crop – Wine Grapes (MPI field trial, 5th harvest report)
  - Yield increase – 25% (MPI field trial, 5th harvest report)
  - Application rate – 5.5 t/a (10 t/ha, ~0.5% OM in top 6")
  - Permanence factor – 90%

@ 2% discount rate

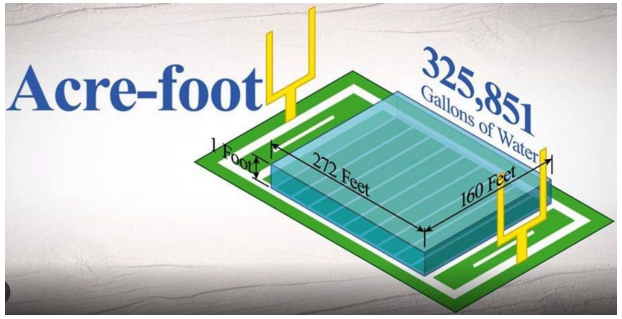
| | per application | per ton biochar |
|---|---|---|
| NPV (20 year) | **$38,577.49** | **$7,014.09** |
| NPV (1000 year) | **$113,123.52** | **$20,567.91** |

@ 0% discount rate

| | per application | per ton biochar |
|---|---|---|
| NPV (20 year) | **$47,152.92** | **$8,573.26** |
| NPV (1000 year) | **$1,475,518.81** | **$268,276.15** |

# What's that worth?

- Metric: **Water Conservation**
- Assumptions:
  - Crop – Almonds (statewide average, 2021 data)
  - Water Use Efficiency improvement – 18.8% (Gao et al. 2020)
  - Application rate – 4.5 t/a (10 t/ha, ~0.5% OM in top 6")
  - Permanence factor – 90%
  - Price of water - $60 per acre foot




@ 2% discount rate

| | per application | per ton biochar | |
|---|---|---|---|
| Water Conservation (20 yr) | **11.17** | **2.48** | Acre Feet |
| Water Conservation (1000 yr) | **32.75** | **7.28** | Acre Feet |

| | per application | per ton biochar | |
|---|---|---|---|
| Water Conservation (20 yr) | **$ 670** | **$ 149** | $ |
| Water Conservation (1000 yr) | **$ 1,965** | **$ 437** | $ |

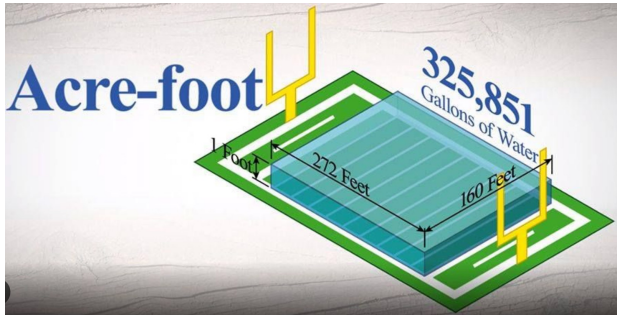
@ 0% discount rate

| | per application | per ton biochar | |
|---|---|---|---|
| Water Conservation (20 yr) | **13.65** | **3.03** | Acre Feet |
| Water Conservation (1000 yr) | **427.14** | **94.92** | Acre Feet |

| | per application | per ton biochar | |
|---|---|---|---|
| Water Conservation (20 yr) | **$ 819** | **$ 182** | $ |
| Water Conservation (1000 yr) | **$ 25,628** | **$ 5,695** | $ |

# What's that worth?

- Metric: **Water Conservation**
- Assumptions:
  - Crop – Almonds (statewide average, 2021 data)
  - Water Use Efficiency improvement – 18.8% (Gao et al. 2020)
  - Application rate – 4.5 t/a (10 t/ha, ~0.5% OM in top 6")
  - Permanence factor – 90%
  - Price of water - $521 per acre foot




@ 2% discount rate

| | per application | per ton biochar | |
|---|---|---|---|
| Water Conservation (20 yr) | **11.17** | **2.48** | Acre Feet |
| Water Conservation (1000 yr) | **32.75** | **7.28** | Acre Feet |

| | per application | per ton biochar | |
|---|---|---|---|
| Water Conservation (20 yr) | **$ 5,818** | **$ 1,293** | $ |
| Water Conservation (1000 yr) | **$ 17,061** | **$ 3,791** | $ |

@ 0% discount rate

| | per application | per ton biochar | |
|---|---|---|---|
| Water Conservation (20 yr) | **13.65** | **3.03** | Acre Feet |
| Water Conservation (1000 yr) | **427.14** | **94.92** | Acre Feet |

| | per application | per ton biochar | |
|---|---|---|---|
| Water Conservation (20 yr) | **$ 7,112** | **$ 1,580** | $ |
| Water Conservation (1000 yr) | **$ 222,539** | **$ 49,453** | $ |

# What's that worth?

- Metric: **Nitrogen Conservation**
- Assumptions:
  - Crop – Almonds (statewide average, 2021 data)
  - Nitrogen Use Efficiency improvement – 13.97% (Han et al. 2023)
  - Application rate – 4.5 t/a (10 t/ha, ~0.5% OM in top 6")
  - Permanence factor – 90%
  - Price of N (Urea N) - $0.60 per lb

@ 2% discount rate

| | per application | per ton biochar | |
|---|---|---|---|
| N Conservation (20 yr) | 0.23 | 0.05 | Tons N |
| N Conservation (1000 yr) | 0.66 | 0.15 | Tons N |

| | per application | per ton biochar | |
|---|---|---|---|
| N Conservation (20 yr) | $ 272 | $ 60 | $ |
| N Conservation (1000 yr) | $ 796 | $ 177 | $ |

@ 0% discount rate

| | per application | per ton biochar | |
|---|---|---|---|
| N Conservation (20 yr) | 0.28 | 0.06 | Tons N |
| N Conservation (1000 yr) | 8.66 | 1.92 | Tons N |

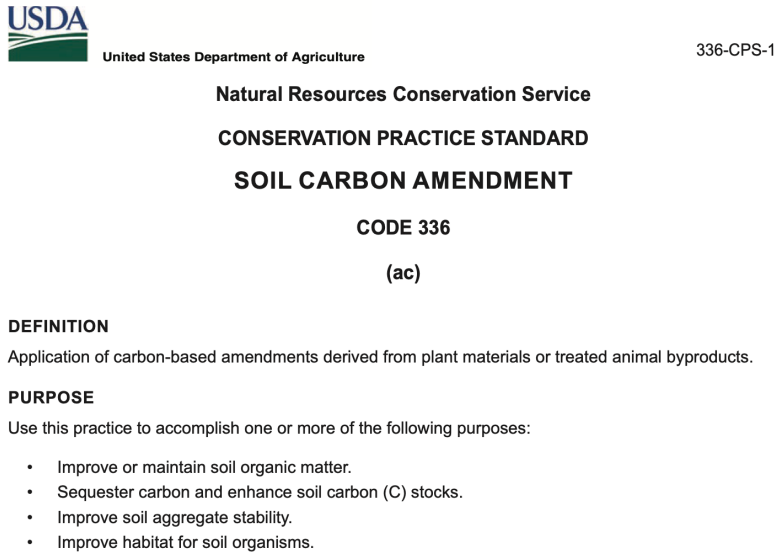
| | per application | per ton biochar | |
|---|---|---|---|
| N Conservation (20 yr) | $ 332 | $ 74 | $ |
| N Conservation (1000 yr) | $ 10,388 | $ 2,308 | $ |

# What's that worth?

- Metric: **Food Security**
- Assumptions:

*"Them belly full, but we're hungry,*
*A hungry mob is a angry mob*
*A rain a-fall, but the dirt, it tough*
*A yet I yoke, but the yield no nuff"*
- Bob Marley, born February 6, 1945

The Soil Conservation Act was passed April 27, 1935 amid the Dust Bowl, leading to the creation of the Soil Conservation Service, now NRCS.



USDA United States Department of Agriculture

336-CPS-1

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

SOIL CARBON AMENDMENT

CODE 336

(ac)

DEFINITION

Application of carbon-based amendments derived from plant materials or treated animal byproducts.

PURPOSE

Use this practice to accomplish one or more of the following purposes:

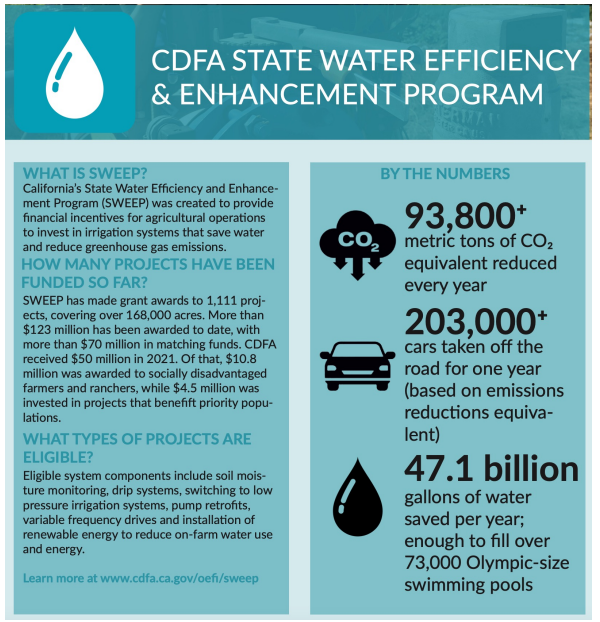
- Improve or maintain soil organic matter.
- Sequester carbon and enhance soil carbon (C) stocks.
- Improve soil aggregate stability.
- Improve habitat for soil organisms.

*"The nation that destroys its soil destroys itself."*
- President Theodore Roosevelt, 1937

*"The truth is **soil is literally at the root of many pressing national security challenges that we face**…without good soil, crops fail, prices rise, people go hungry. "*
Secretary Blinken – World Economic Forum, January 16, 2024

*"We're tackling a lot of challenges around the world**, but if we don't get this right, I actually don't think anything else really matters.**"*
Secretary Blinken – UNGA 78, September 20, 2023

# What's that worth?



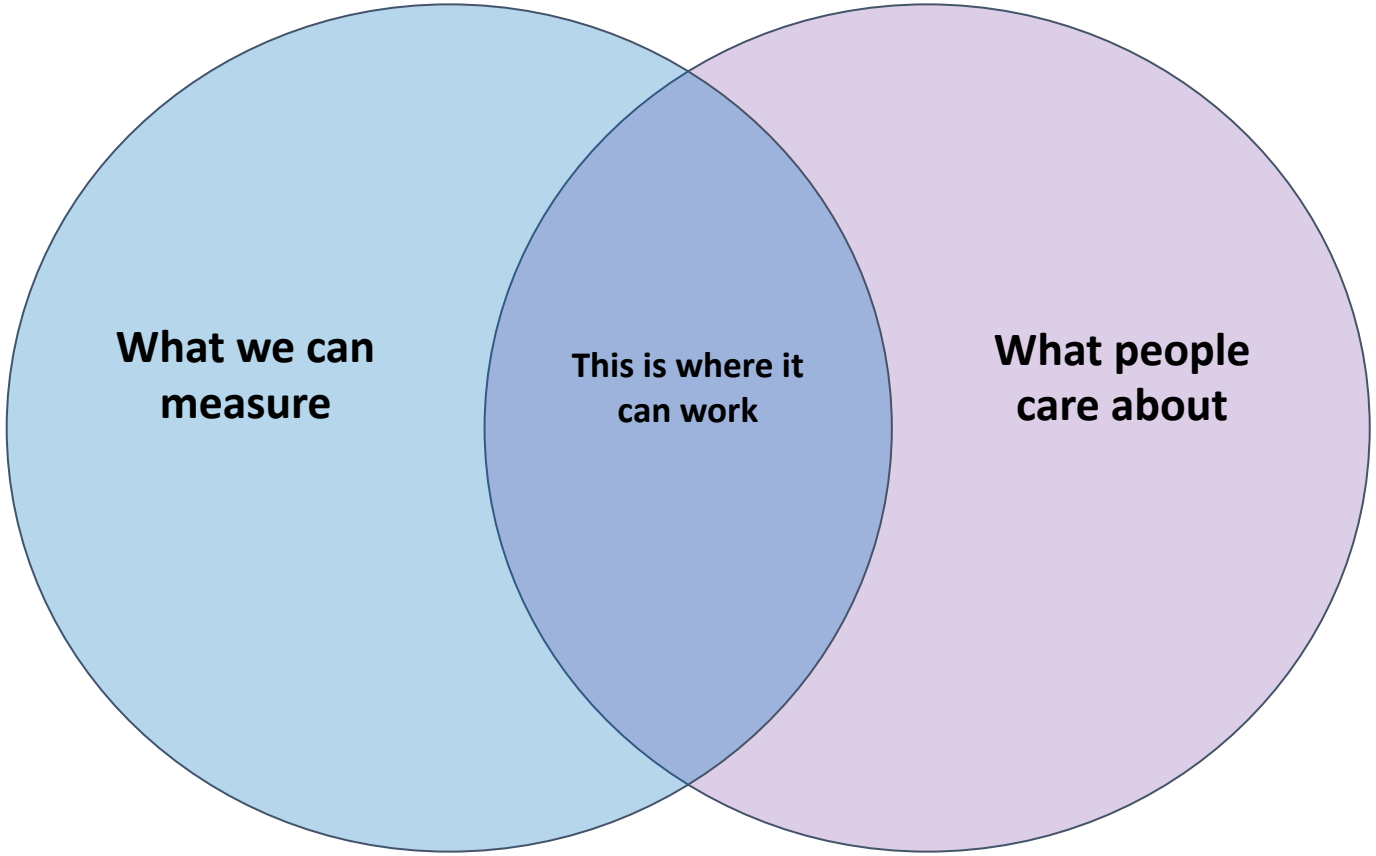

- Metric: **Drought Resilience**
- Assumptions:

*"Water is life"*
- universal saying

*"**On average, agriculture accounts for 70 percent of global freshwater withdrawals**. In the last 30 years, food production has increased by more than 100 percent. FAO estimates that about 60 percent more food will be needed by 2050 to meet the food requirements of a growing global population.*
- Food and Agriculture Organization of the United Nations, 2017

*"And it never failed that during the dry years the people forgot about the rich years, and during the wet years they lost all memory of the dry years. It was always that way."*
- John Steinbeck, East of Eden, 1952

PACIFIC BIOCHAR



# How do we make it work?!

1. If we wait until we can measure the end-result before we initiate the program…
2. We must employ predictive modeling

PACIFIC BIOCHAR

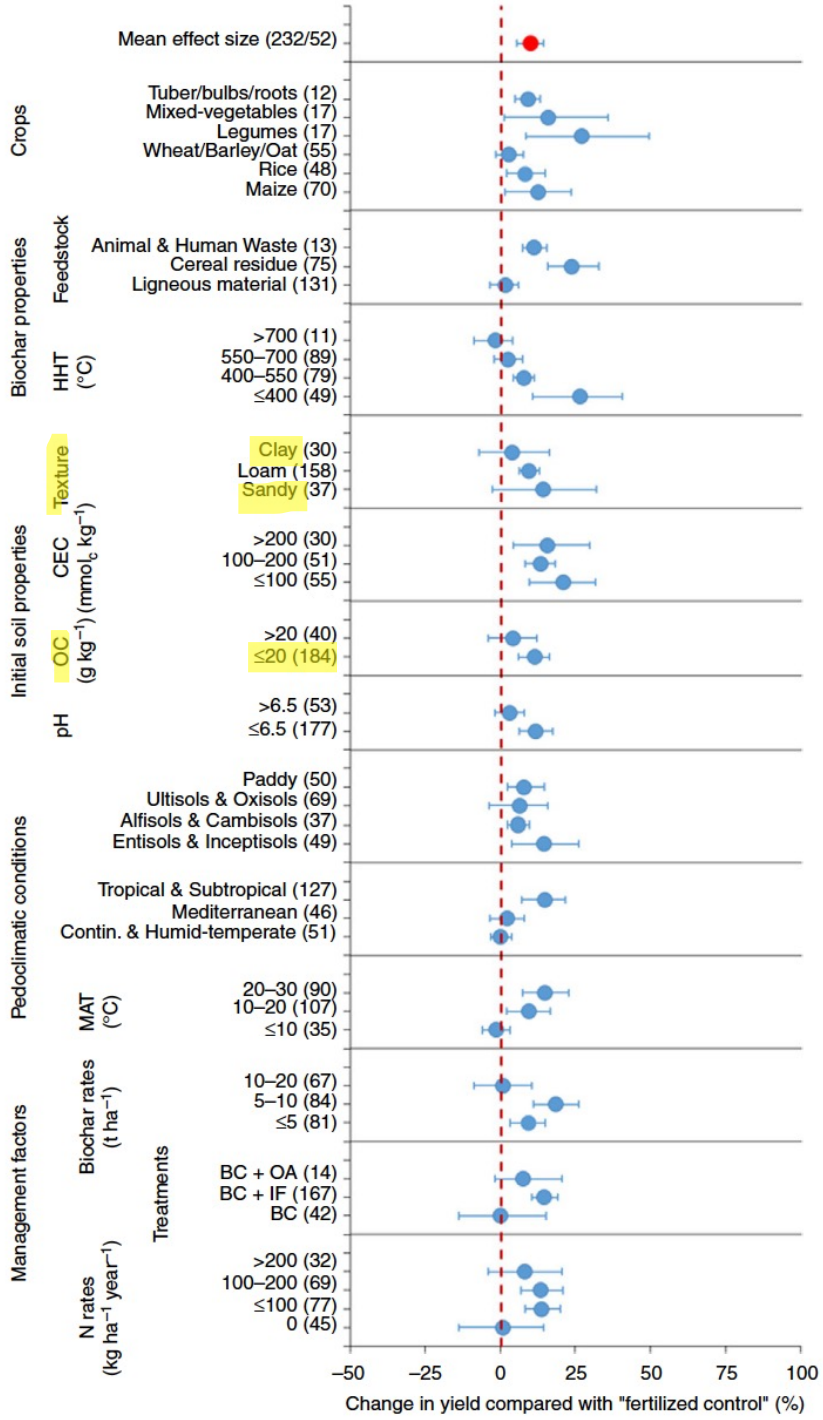
# We have tools optimize for outcomes

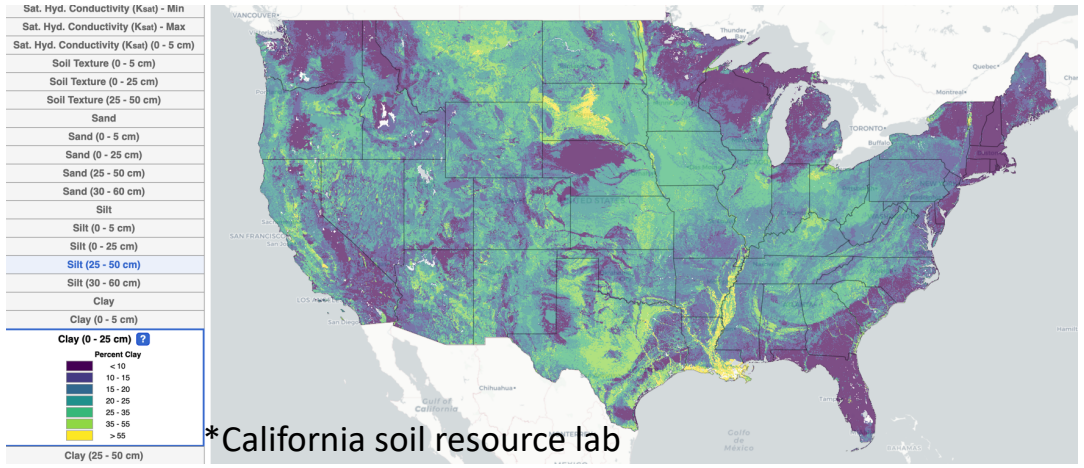
INVITED REVIEW

Soil Use and Management

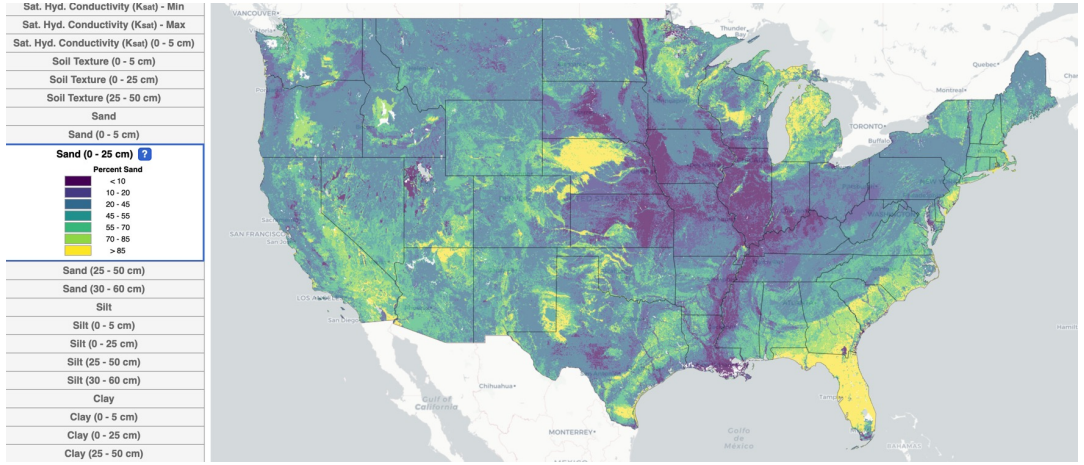
## Biochar effects on crop yields with and without fertilizer: meta-analysis of field studies using separate controls

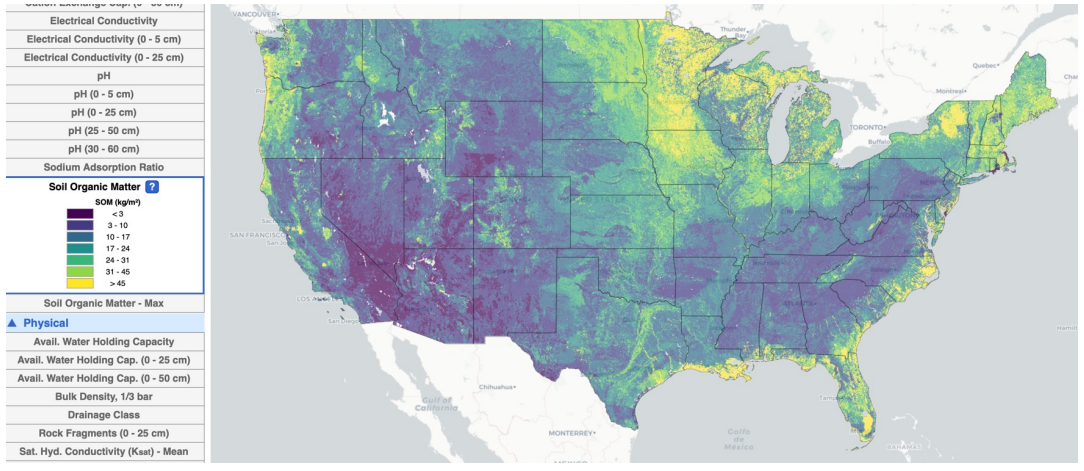
Lili Ye[1,2] | Marta Camps-Arbestain[1] | Qinhua Shen[1] | Johannes Lehmann[3,4,5]
Balwant Singh[6] | Muhammad Sabir[7]




*California soil resource lab

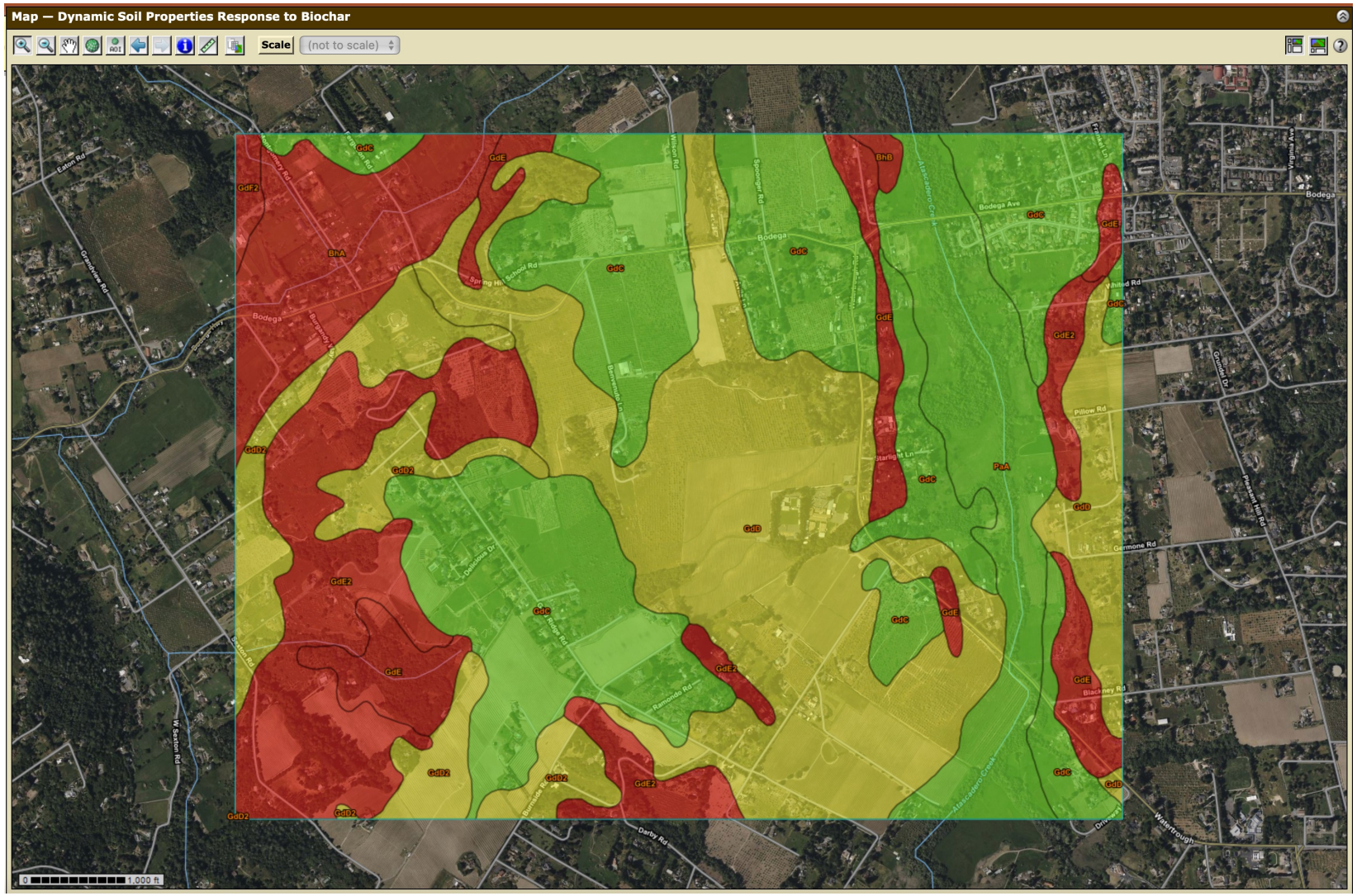


PACIFIC BIOCHAR

We even have modeling tools specific to biochar, which can both be used in predictive modeling and reporting!

(*super rudimentary, but a reasonable example)



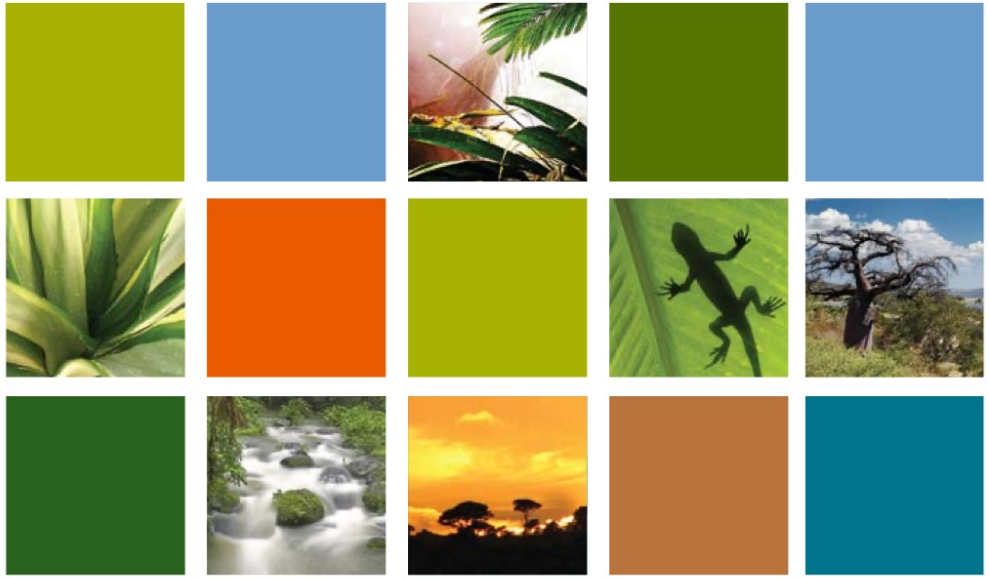

*Web soil survey, dynamic soil properties response to biochar

PACIFIC BIOCHAR

There is precedence

# Payments for Ecosystem Services: Getting Started

## *A Primer*



the katoomba group

UNEP

FOREST TRENDS

2008

PACIFIC BIOCHAR

And proxies

WORLD ECONOMIC FORUM

# The Biodiversity Credits Initiative

In 2022, the World Economic Forum launched an initiative to explore the potential of biodiversity credits to unlock new financing for measurable positive outcomes for nature and its stewards.

**The Biodiversity Credits Initiative has been building the business case fo the development of this market, bringing forth integrity both in project development and the supply of credits, and also across demand and related claims.**

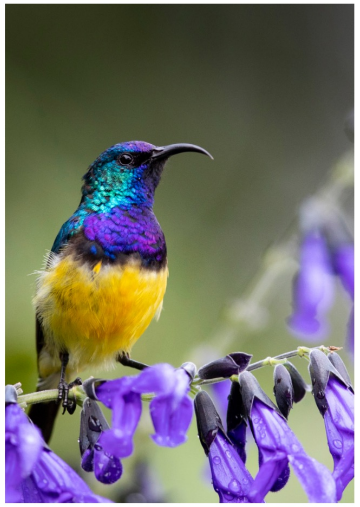
UN environment programme

Who we are | Where we work | What we do | Publications & data

19 DECEMBER 2022 | REPORT

# Kunming-Montreal Global Biodiversity Framework

**Authors:** CONVENTION ON BIOLOGICAL DIVERSITY (CBD)



The conclusion of the 15th Conference of Parties to the UN Convention on Biological Diversity saw the adoption of the Kunming-Montreal Global Biodiversity Framework (GBF).

Amidst a dangerous decline in nature threatening the survival of 1 million species and impacting the lives of billions of people, the GBF aims to halt and reverse nature loss. The framework consists of global targets to be achieved by 2030 and beyond to safeguard and sustainably use biodiversity.

READ THE FRAMEWORK

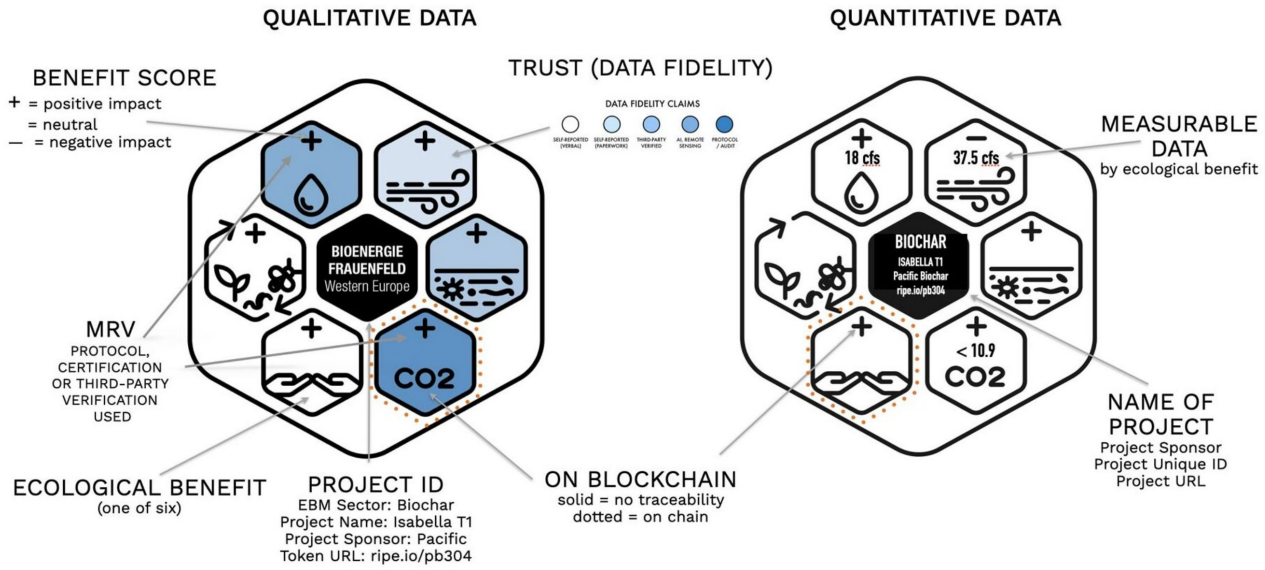
FURTHER RESOURCES

- Download the framework
- 2023: The year of implementation for climate, nature and pollution reduction
- Resource: Assessment Report on Sustainable Use of Wild Species
- Resource: Assessment Report on Diverse Values and Valuation of Nature
- Resource: A Multi-Billion-Dollar Opportunity: Repurposing agricultural support to transform food systems
- Resource: The Global Biodiversity

PACIFIC BIOCHAR

And we have early-stage frameworks to enable value communications and transactions

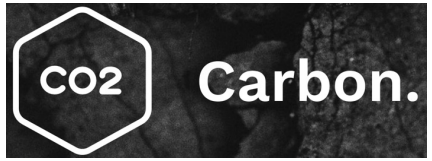
# ECOLOGICAL BENEFITS FRAMEWORK









PACIFIC BIOCHAR

Some potential marketplaces

ECOLOGICAL CREDITS IN THE DIGITAL VOLUNTARY CARBON MARKET

## Regen Marketplace allows project developers to sell their ecological credits to buyers around the world.

PROJECT DEVELOPERS

### Enroll with Regen Registry

Finance your ecological regeneration project by enrolling in a crediting program and access demand

EXPLORE REGEN REGISTRY

BUYERS

### Purchase innovative ecocredits

Seamlessly purchase, trade, and retire digital ecological assets with transparency & accountability

LEARN ABOUT BUYING

# The grant program approach

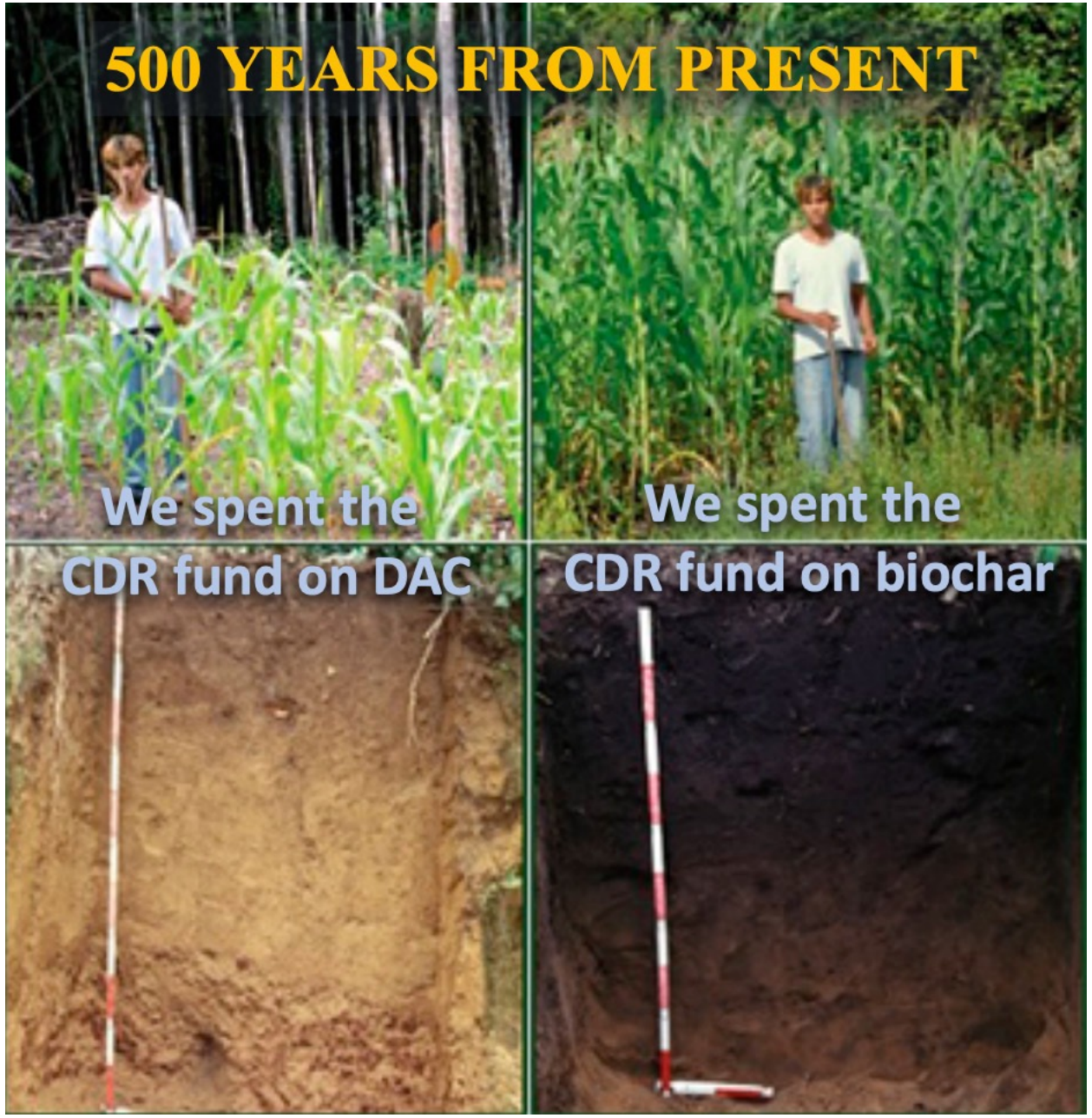
(the Pacific Biochar concept as it stands today)

- Deploy biochar in a grant-style program
  - Instead of providing cash, we provide biochar
  - Recipients would be judged on criteria
    - designed to maximize intergenerational ecological benefit, such as:
    - water conservation,
    - nutrient conservation,
    - SOM,
    - historically important farmland, etc.
    - And bonus points for research/data collection to iteratively improve process

# The grant program approach

(where Pacific Biochar is at today)

- Beginning to deploy biochar now!
- Establishing criteria for “how to not cannibalize sales”
  - And working out synergies of research and development to support sales
- Practicing outreach and communications for deployment
- Practicing logistics of a different nature
- Stakeholder discussions on:
  - What is valued?
  - Who values it?
  - How to transact?




*It's not just whether we use biochar, it's also how we use biochar*

# Key concepts

1. When farmland applied, some benefits will result, but, with intention, we could improve intergenerational outcomes
2. The potential for intergenerational benefit is dramatic
3. A system of financial reward for intergenerational outcomes is possible and would drive action


PACIFIC
BIOCHAR
Thank you

# Appendix

PACIFIC BIOCHAR

An untapped data resource: 100’s of thousands of acres in CA alone have received land applications of high carbon fly ash over several decades, with carbon stocks still visible to the naked eye, and with some measure of record keeping.

# Premise:

- Biochar can provide profound benefits on a multi-generational timescale
- The benefits realized across future generations depend upon on how the biochar is applied in this one
- We lack tools to incentivize intergenerational benefit
- Massive amounts of biochar will be produced and applied in the coming decades, posing an immense opportunity to optimize for intergenerational benefit – a legacy of fertile soil
- Therefore, a system of financial reward for optimizing intergenerational outcomes should be developed

- In other words: Climate change MITIGATION will drive massive biochar production, based on carbon alone.  Climate change ADAPTATION outcomes may be immense and will vary depending on what we do today.