

Climate solutions, justice, and the rise of a trillion dollar industry

Penn Regenerative Ag Alliance Workshop
March 24, 2023

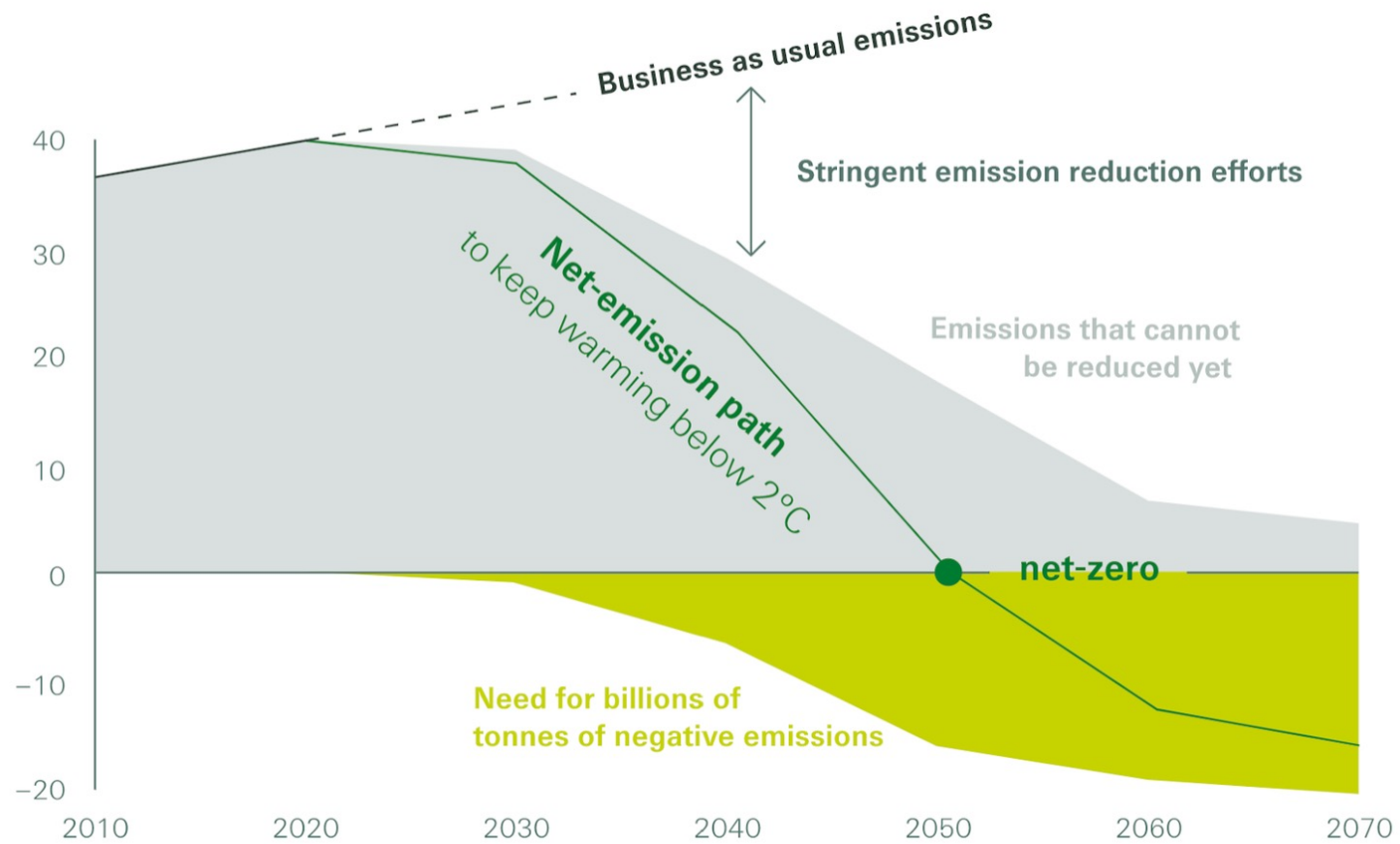
Dr. Jane Zelikova

Director
Soil Carbon Solutions Center
Colorado State University

Carbon removal is now “essential”

Global CO₂ emissions

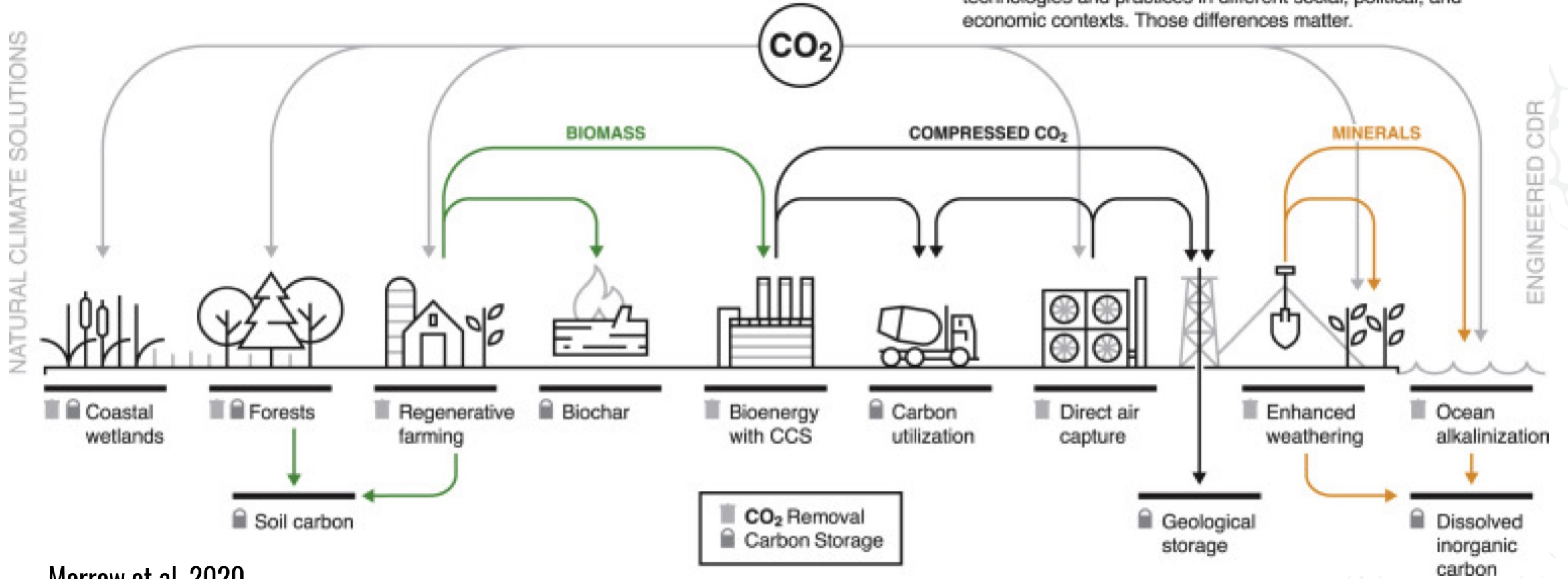
Billion tonnes per year



Source: *Swiss Re*, based on IPCC data

Carbon removal is now “essential”

All of these approaches can be implemented using different technologies and practices in different social, political, and economic contexts. Those differences matter.



Agricultural systems both contribute to and are particularly sensitive to the impacts of climate change

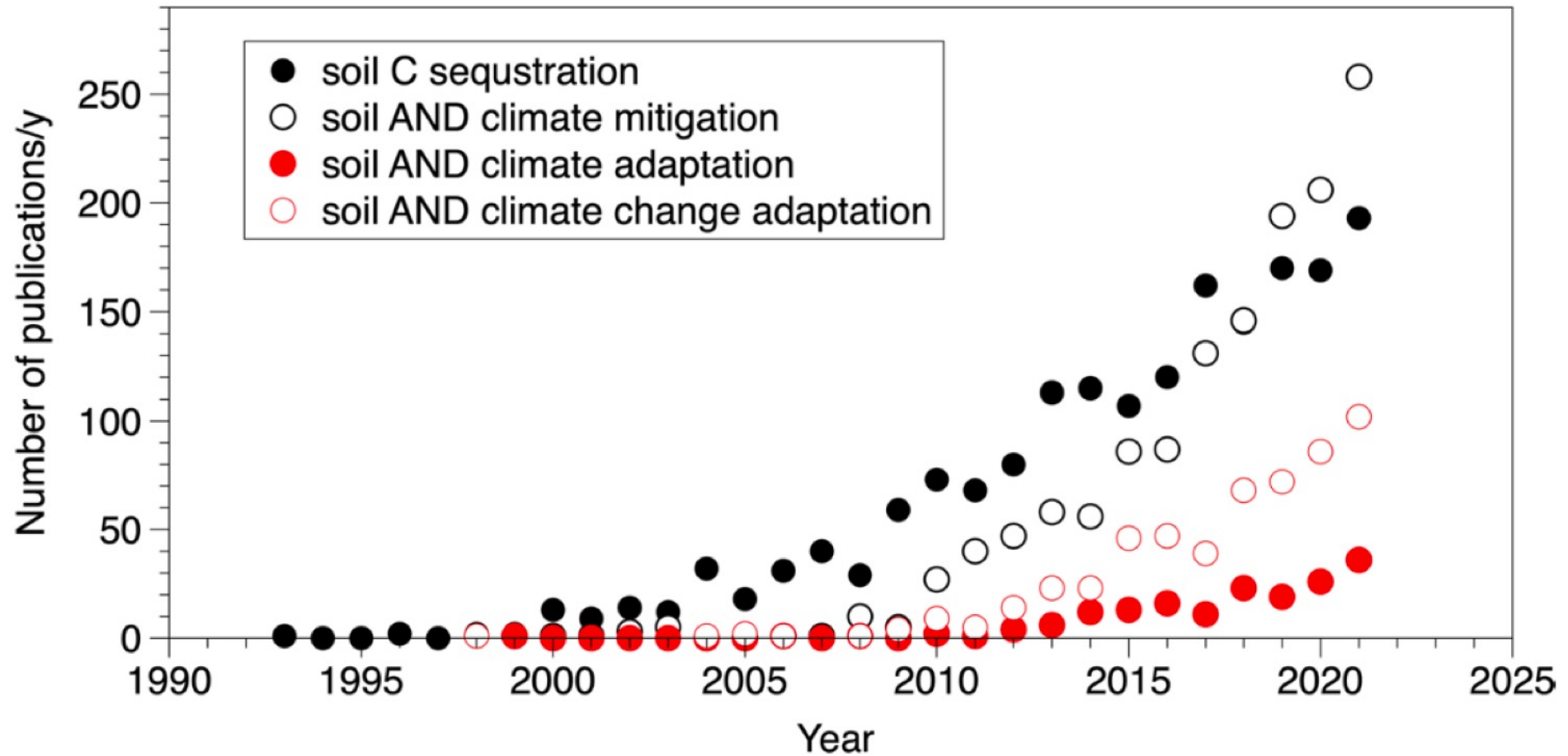
They also offer opportunities for climate mitigation



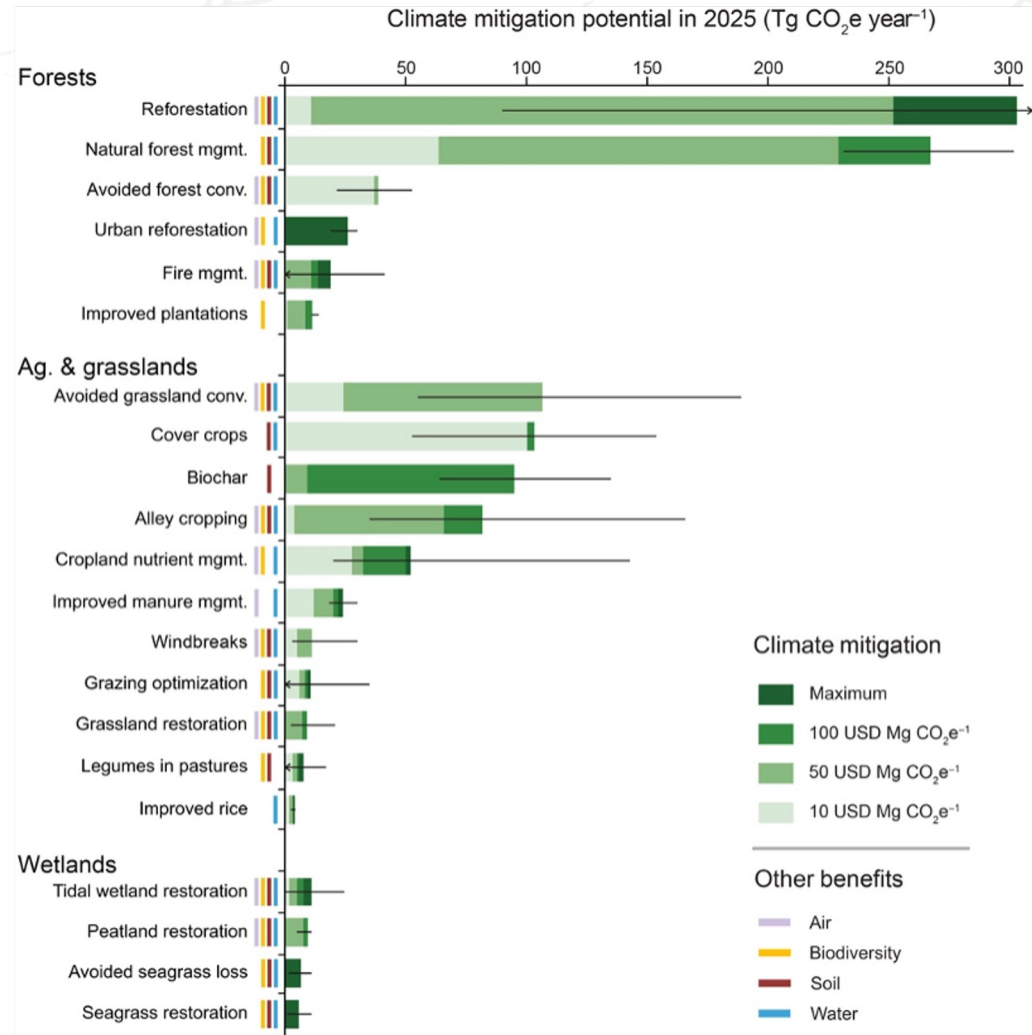
This is soil's moment

Interest in agricultural soil carbon and soil health more broadly is rapidly gaining traction with producers, companies, policy makers, C markets, and civil society.

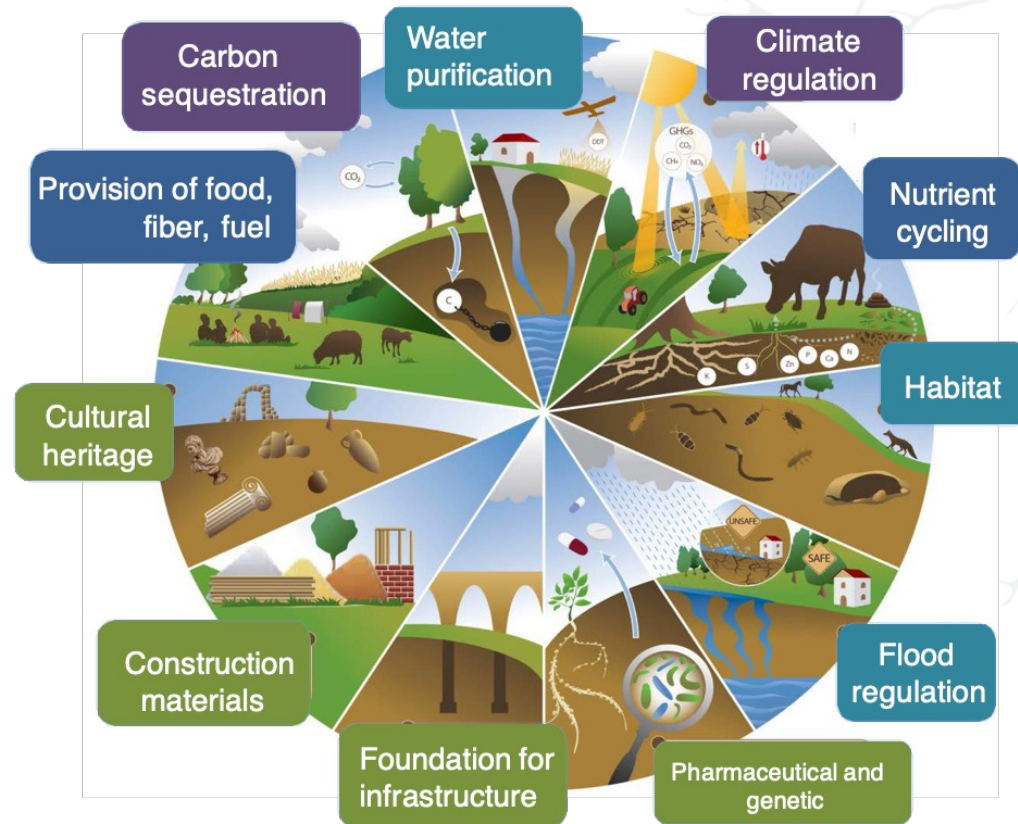
Interest in soil carbon is growing



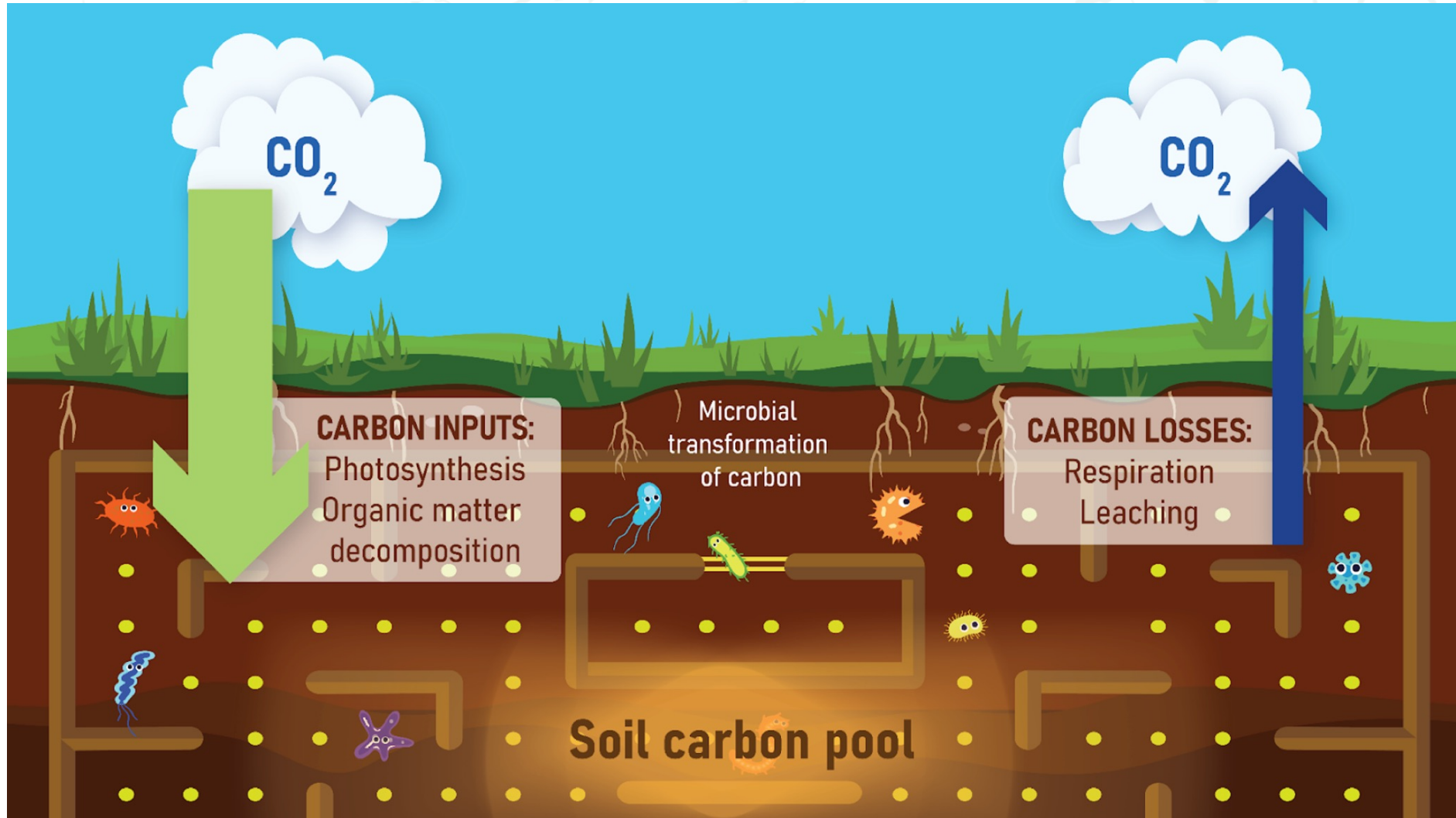
A “win win” solution under our feet



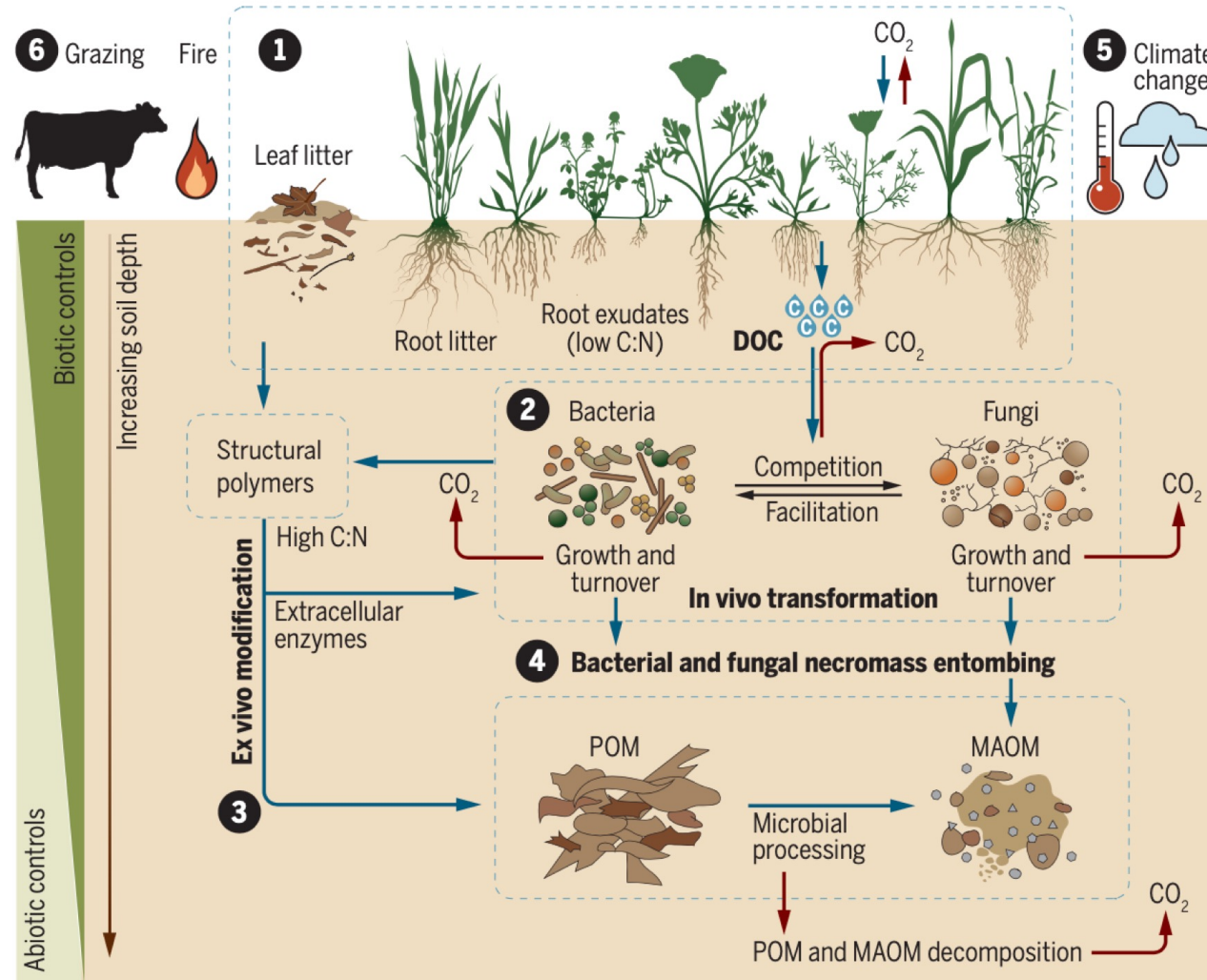
Soils are at the nexus of many concurring and reinforcing challenges



How do soils sequester carbon?



How do soils sequester carbon?





Sampling + lab analyses

To Stratify or not to stratify



Fluxes

Towers towers everywhere



Spectra and satellites

Can we measure soil carbon from space?



Models

Daycent, DNDC, SNAP, RothC, MEMS, MIMICS, the list goes on and on and on

You can't value what you can't measure

All the ways we measure soil carbon

A key barrier to implementing programs that incentivize increases in soil C at large scales is the need for credible and reliable MRV (for NDCs, emissions trading, supply chain, etc)

We can't value what we can't measure

Measuring soil C

We need to take a LOT of samples

There are no one-size-fits-all sampling strategies

We can't "measure" soil carbon from space

We don't have rapidly deployable field instruments *yet*

Valid inferences about soil carbon in heterogeneous landscapes

Paige Stanley ^{a,*}, Jacob Spertus ^b, Jessica Chiartas ^c, Philip B. Stark ^b, Timothy Bowles ^a

^a Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA, USA

^b Department of Statistics, University of California, Berkeley, Berkeley, CA, USA

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Article

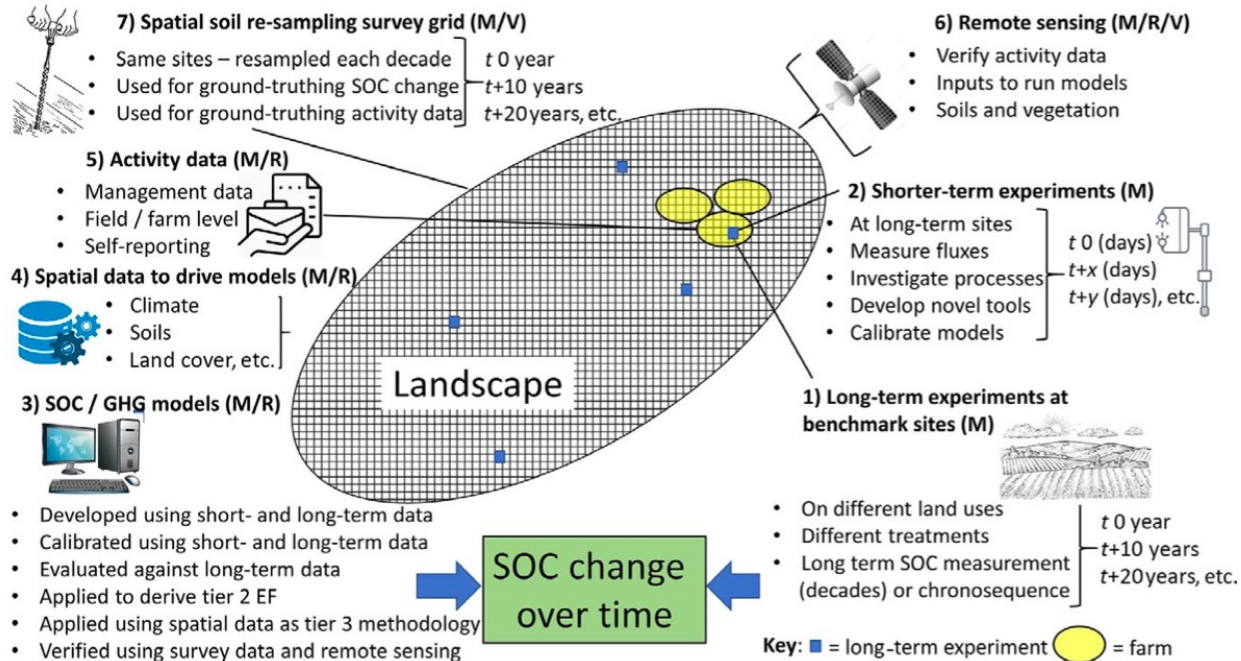
Optimizing Sampling Strategies for Near-Surface Soil Carbon Inventory: One Size Doesn't Fit All

Charles Bettigole ^{1,*}, Juliana Hanle ², Daniel A. Kane ³ , Zoe Pagliaro ¹, Shaylan Kolodney ^{1,4}, Sylvana Szuhay ¹, Miles Chandler ¹, Eli Hersh ¹, Stephen A. Wood ^{3,5}, Bruno Basso ² , Douglas Jeffrey Goodwin ⁶ , Shane Hardy ⁷, Zachary Wolf ⁴ and Kristofer R. Covey ¹

Research article

Carbon farming: Are soil carbon certificates a suitable tool for climate change mitigation?

Carsten Paul ^a  , Bartosz Bartkowski ^b, Cenk Dönmez ^{a i}, Axel Don ^c, Stefanie Mayer ^d, Markus Steffens ^e, Sebastian Weigl ^a, Martin Wiesmeier ^{d f}, André Wolf ^g, Katharina Helming ^{a h}



Smith et al. 2019

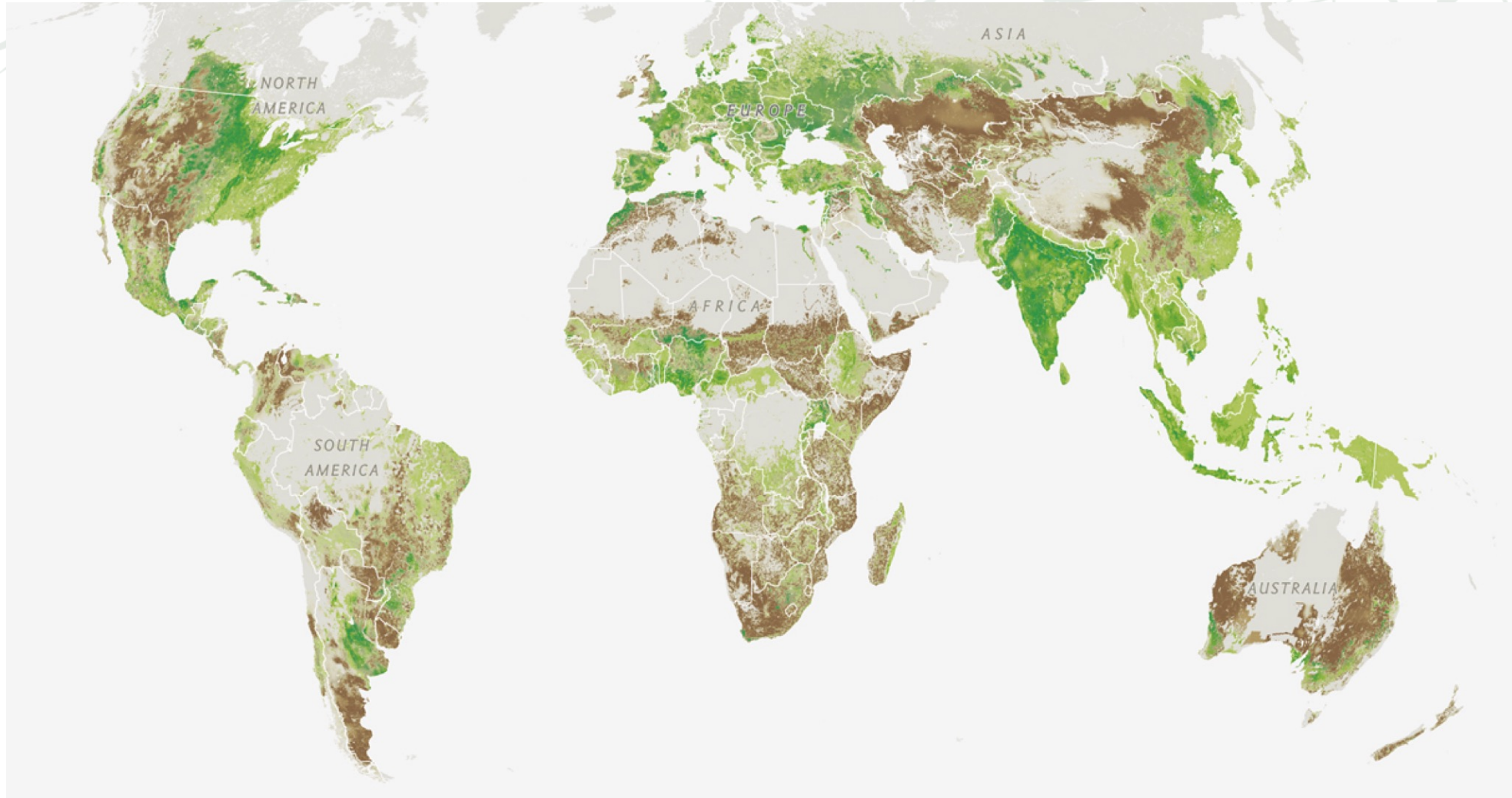
We can't value what we can't measure

Integration across scales of measurement

No one method is perfect

Integration across scales (space and time) is a promising and much needed next step

Where is the potential?



Where we grow food, fiber, fuel

Where there is high technical sequestration potential

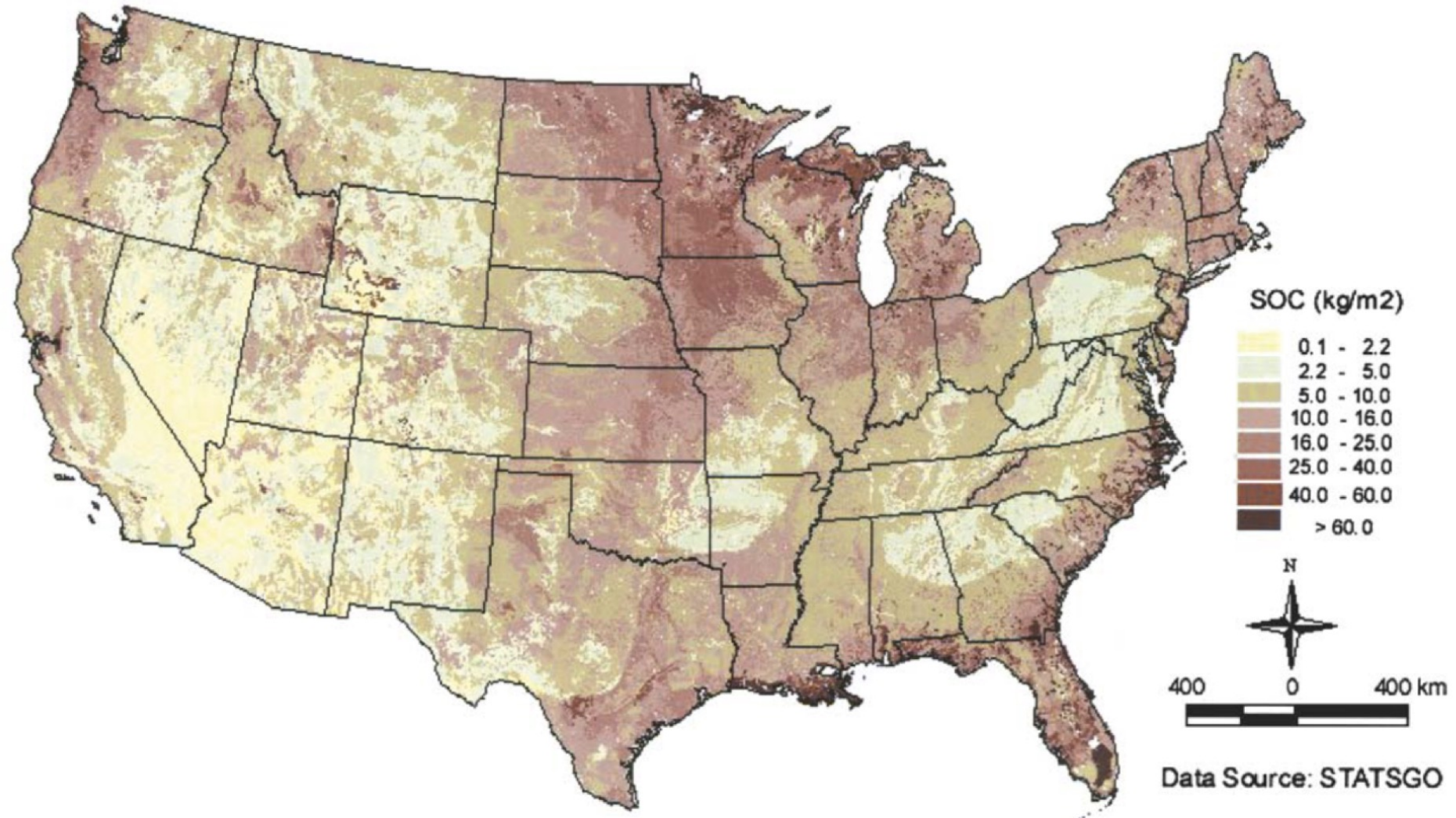
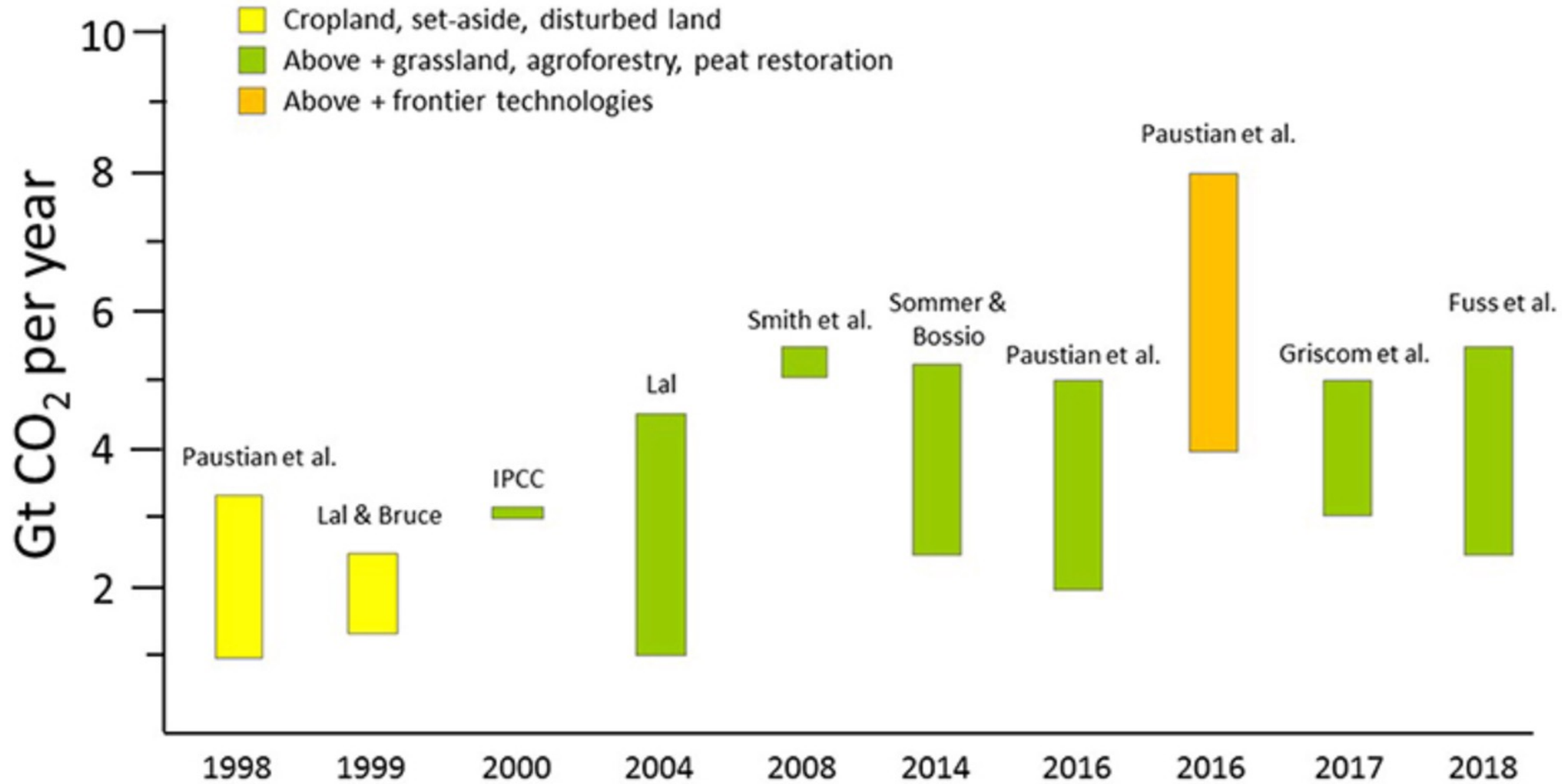


Fig. 1. Spatial distribution of soil organic C (SOC) content to 2-m soil depths in the conterminous USA (midpoint method).

What is the potential?



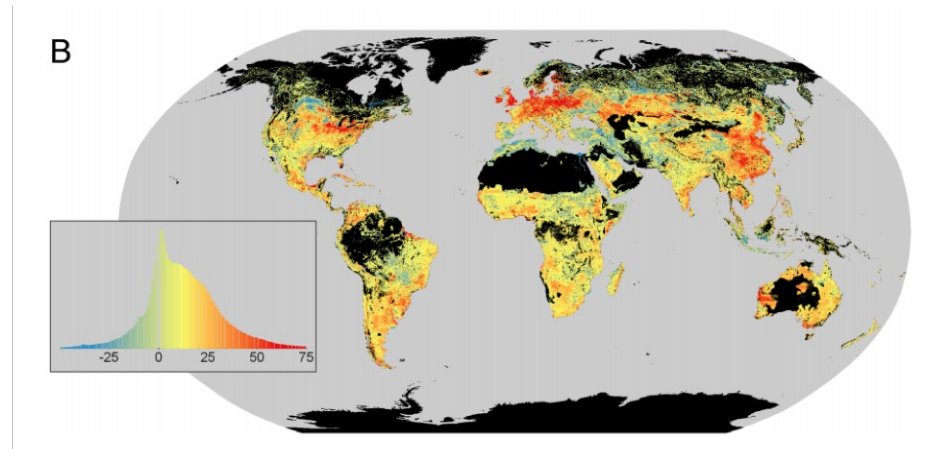
~ 10% of annual emissions

Where we have lost a lot of carbon

RESEARCH

MIDWESTERN US HAS LOST 57.6 BILLION METRIC TONS OF SOIL DUE TO AGRICULTURAL PRACTICES

New research, led by UMass Amherst, shows that human-caused erosion in America's Breadbasket is far greater than previously thought



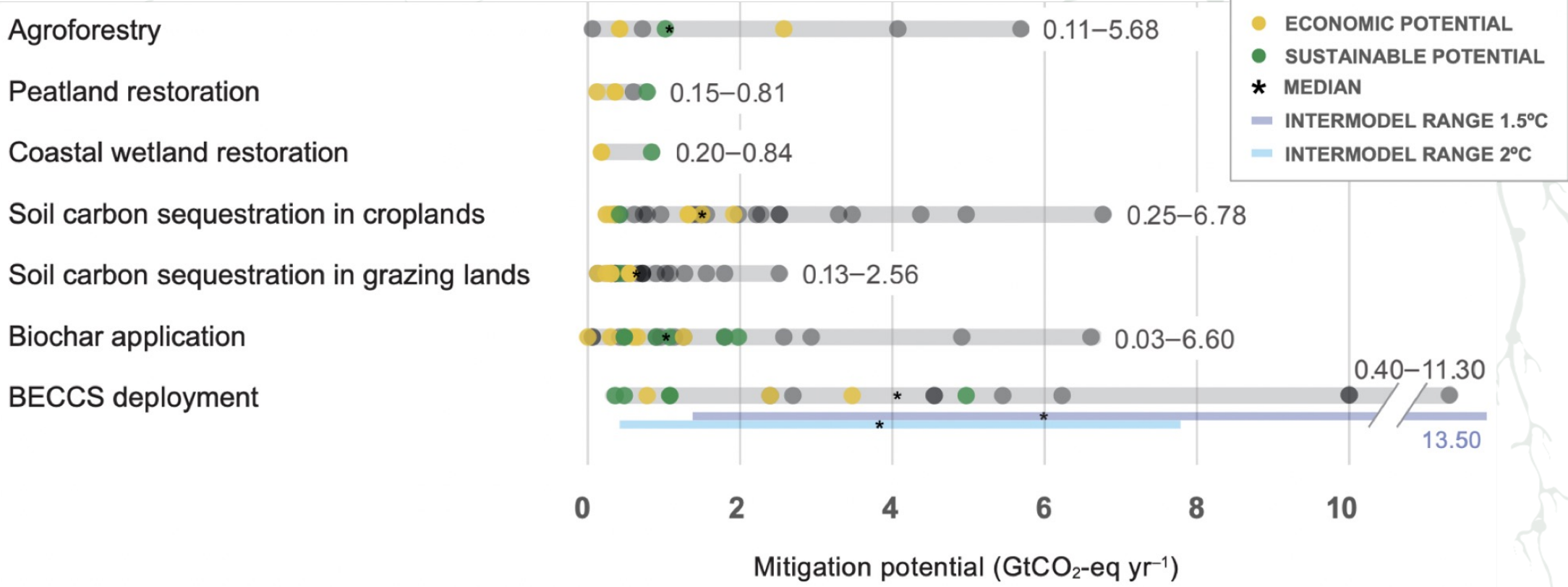
Sanderman et al. 2017

Agricultural land uses have resulted in the loss of **133 Pg C** from the soil. Maps indicate hotspots of soil carbon loss, often associated with major cropping regions and degraded grazing lands, suggesting that there are identifiable regions that should be targets for soil carbon restoration efforts.

Where we can shift management practices



Just < Economic < Technical sequestration potential

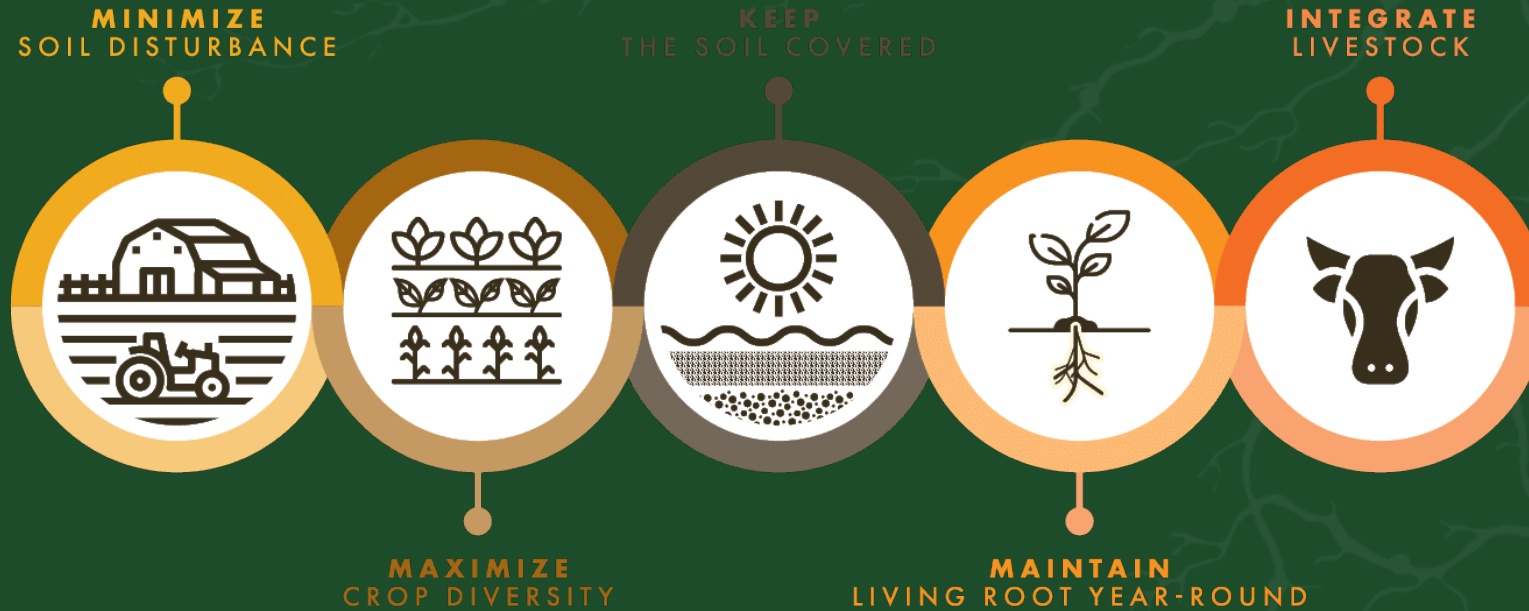


Shifting to regenerative agriculture is hard

Soil carbon is only one dimension of the transition to regenerative agriculture

Soil and Climate

Enabling a shift toward regenerative ag



Markets

Carbon markets, price premiums

Policy

Federal, state, local
Corporate, procurement, climate
commitments

Vision

Internal transformation

Soil carbon markets



2023 market map of the „new“ voluntary carbon market

Buy-side

Sales-side

Supply-side

Corporates:
Buy and retire credits to achieve climate commitments, e.g., net-zero pledges

Governmental Institutions and NGOs:

Decarbonization Platforms:
Offer offsetting in addition to their core business, e.g., carbon accounting or green fintech

Individuals and Subscription-Based Mobile Offsetting:

Insurance:
Insure projects, credits, or buyers against key risks, either as a broker or insurer

Brokers:
Procure and transfer or retire credits from a trader on behalf of a client. Charge a commission and do not necessarily take credit ownership

Marketplaces and API Providers:
Enable credit transactions by hosting a marketplace and/or API services to directly bridge end-buyers to registered credits

Advance Market Commitments:
Enter or offer pre-purchase/ offtake agreements to mobilize capital toward projects at pre-credit stage

Tokenized Credits:
An entire ecosystem for credits moved onto the blockchain has arisen

Market Research and Data Platforms:
Gather, analyze, interpret, and publish data on the VCM

Exchanges:
Provide trading infrastructure

Meta-Registries:
Integrate multiple registry systems and display credits through a decentralized and shared metadata layer

Governance and Accreditation:
Provide guidance through principle frameworks and endorse compliant Standards or corporates with quality labels

Third-Party Auditors (also known as VVBs):
Independently verify a project's climate impact against a Standard's methodology

Credit Ratings:
Provide carbon credit ratings based on project data

Traders:
Buy large credit batches from suppliers and sell them in bundled portfolios, usually for a commission

Standards and Registries:
Provide a set of independent methodologies to certify projects and issue credits, which are hosted and/or displayed in a registry

Direct Sales:
Host and sell credits without an intermediary

Measurement, Reporting, and Verification (MRV):
Collect emissions monitoring data for project developers such as through remote sensing, satellite imagery, and machine learning

Project Proponents:
Own and operate an emissions avoidance, reduction, or removal project

Project Developers and Aggregators:
Have the legal right to carry out an owner's project and claim carbon credits

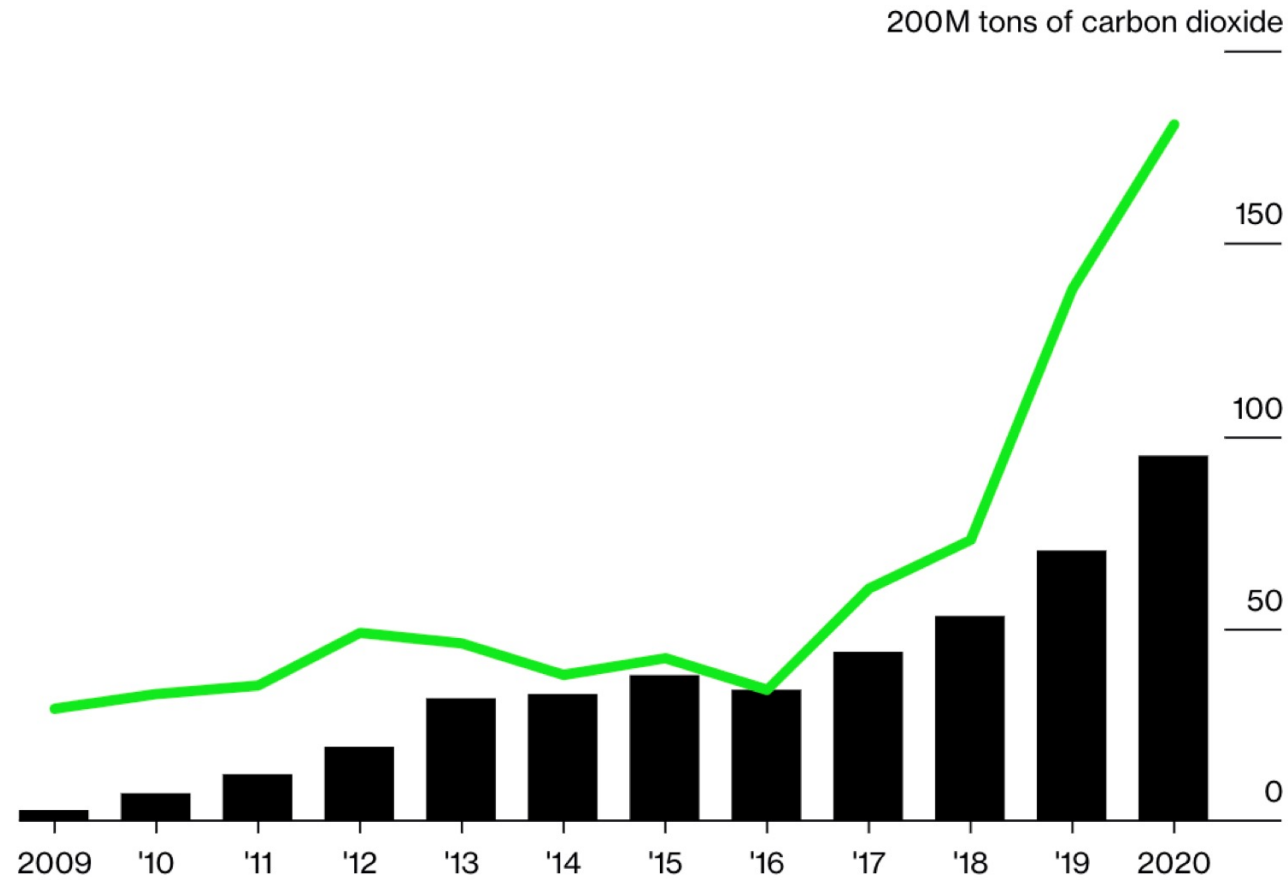
Financing and Advisory:
Deploy resources to projects; at times with brokering and development arms

Soil carbon markets

Compensating Carbon

The number of offsets sold has doubled in the past two years

■ Bought ▲ Issued



Source: Taksforce on Scaling Voluntary Carbon Markets

Note: One carbon credit represents one ton of carbon dioxide equivalent avoided or sequestered

		Perspective			Comments
		Soil Science	Agricultural Management	Governance	
1	Quantification of SOC changes	Precision of SOC measurement/ modelling		Costly	Strong spatial heterogeneities and temporal fluctuations limit precision. Long- time monitoring based on field measurements is economically unviable.
2	Additionality			Difficult to prove	Proving that measures would not have been implemented without certificates is difficult. Accounting for future market and policy changes is not feasible.
3	Permanence	Uncertain	Requires indefinite continuation of carbon farming measures	Difficult to ensure	The build up of SOC is fully reversible and typically slow in / fast out. To achieve permanence, carbon farming measures need to be continued indefinitely. Guaranteeing this is not feasible.
4	Additional reduced emissions caused by carbon farming measures	Assesing soil-related emissions	Management data needs to be disclosed to certifying agency	Difficult to assess	Additional emissions need to be considered. It is not clear how emissions should be treated that are already covered by other governance instruments, such as the European ESD.
5	Leakage Effects		Whole farm needs to be considered	Difficult to exclude	Crop rotations, inputs of carbon sources and export of agricultural products need to be monitored for the whole farm. Leakage effects from any changes need to be assessed. This is difficult due to the non-static nature of agricultural management.
6	Transparency, Legitimacy & Accountability		Management data needs to be disclosed to certifying agency	Accountability difficult over climate-relevant time span	Accounting methods are usually publicly available. Certificates can easily be linked to the fields where the sequestration occurred. Typically no accountability in case sequestered carbon is re-emitted after end of certification process (typically $\leq 10y$).
7	Synergies & Trade- Offs	Improved soil health	Many synergies		Synergies dominate, in particular with climate change adaptation and biodiversity preservation. Adopting carbon farming measures and increasing SOC levels is highly desirable.

No significant challenges
 Minor challenges
 Problematic

We can't value what we can't measure

Criticisms

Crediting protocols lack rigor across all measures (Carbon Plan 2021)

Soil carbon projects deepening existing inequities

- Unequal distribution of benefits
- Non-additionality, leakage
- Another dimension of commoditization

	Rigor	Additionality	Durability	Safeguards	Rating
ACR C	██████	██████	██████	██████	✓✓✓✓✓
ACR G	██████	██████	██████	██████	✓✓✓✓✓
Alb Cr*	██████	██████	██████	██████	✓✓✓✓✓
Aus Est*	██████	██████	██████	██████	✓✓✓✓✓
Aus Meas*	██████	██████	██████	██████	✓✓✓✓✓
BCarbon	██████	██████	██████	██████	✓✓✓✓✓
CAR Soil	██████	██████	██████	██████	✓✓✓✓✓
FAO	██████	██████	██████	██████	✓✓✓✓✓
Gold Std	██████	██████	██████	██████	✓✓✓✓✓
Nori	██████	██████	██████	██████	✓✓✓✓✓
Plan Vivo	██████	██████	██████	██████	✓✓✓✓✓
Regen	██████	██████	██████	██████	✓✓✓✓✓
Verra FG	██████	██████	██████	██████	✓✓✓✓✓
Verra IA	██████	██████	██████	██████	✓✓✓✓✓
Verra Soil	██████	██████	██████	██████	✓✓✓✓✓
Verra SA	██████	██████	██████	██████	✓✓✓✓✓
Verra SG	██████	██████	██████	██████	✓✓✓✓✓

Carbon Plan, Zelikova et al. 2021

Scaling soil carbon

What do farmers think?



90% are aware of C markets



3% currently participating

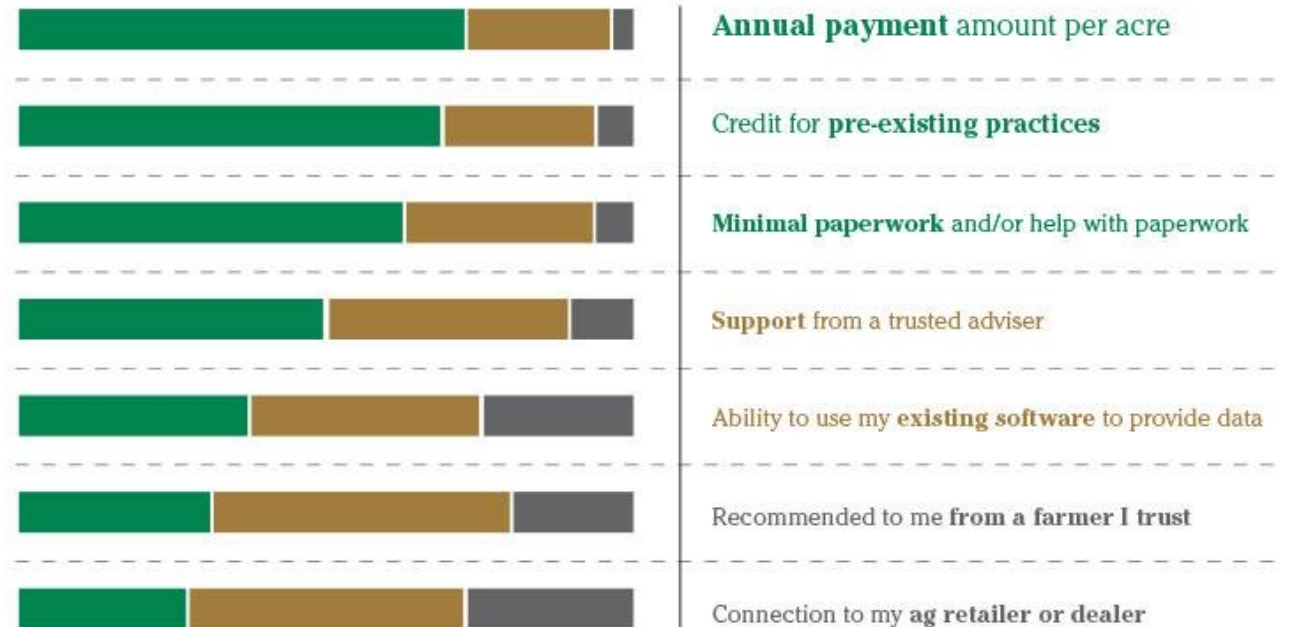


59% won't participate without changes

500 FARMER INSIGHTS

How important are the following criteria to you in evaluating what carbon market you might choose to participate in?

VERY IMPORTANT SOMEWHAT IMPORTANT NOT IMPORTANT



SOURCE: TRUST IN FOOD

“The trouble the enthusiasm about high technical potentials of soils to remove carbon is that these potentials are going to be constrained by social factors, including whether farmers want to change what they do day-to-day to offer a sink for the world’s emissions.”

Buck and Palumbo-Compton 2022

Here is a subtitle

Producer considerations

Transitioning to regenerative agriculture isn't just about climate-smart practices that are adopted via education, innovation, and policy support. Rather, "it involves subjective, nonmaterial factors associated with culture, values, ethics, identity, and emotion that operate at individual, household, and community scales and interact with regional, national, and global processes."

Gosnell et al. 2019

Co-benefits

Environmental, social
(financial benefits less important)

Educational barriers

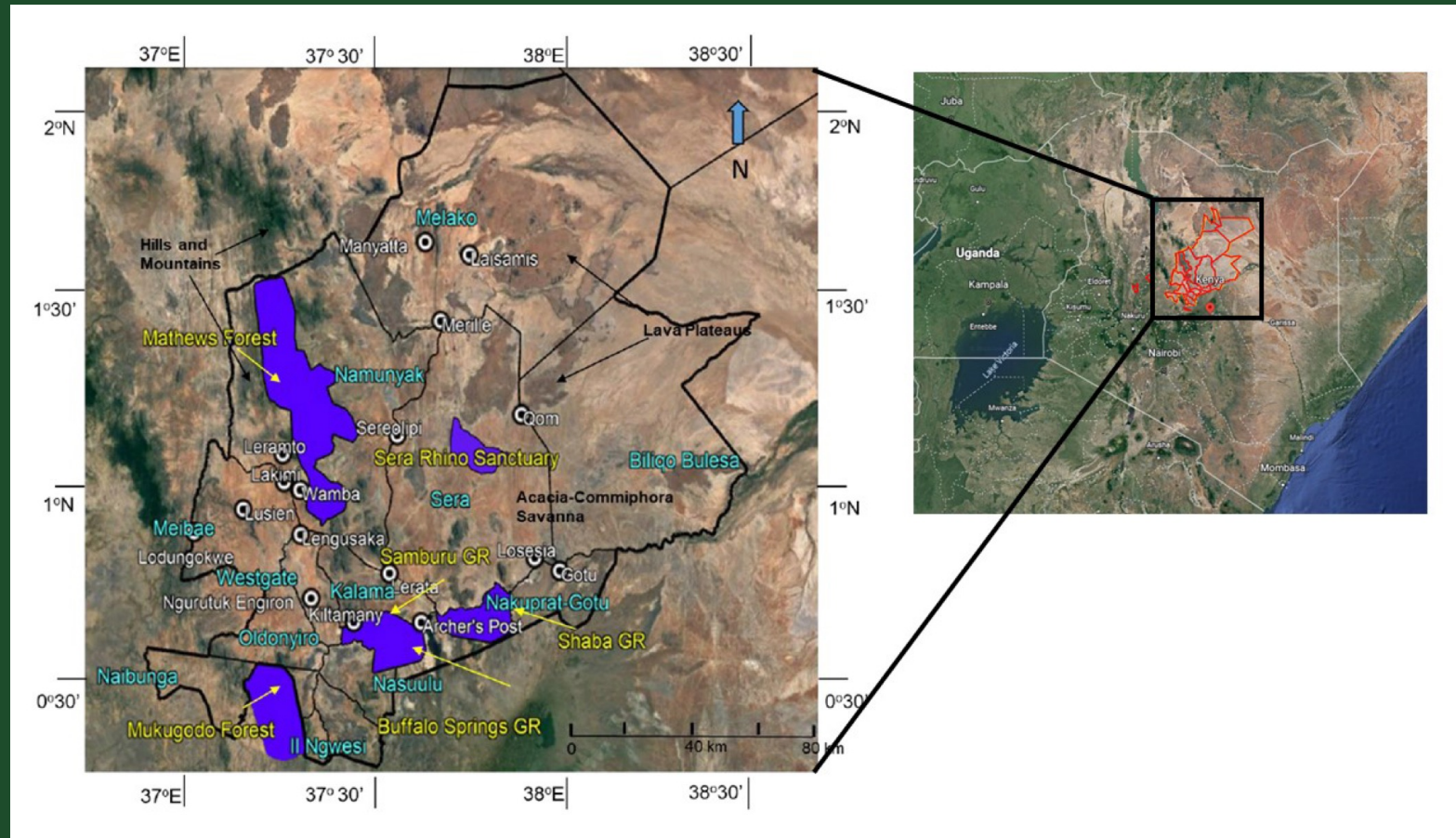
De-risking practice adoption

Economics

Policy relevance, enabling financial benefits

What if we do this poorly?

Northern Kenya Grassland Carbon Project



What if we do this poorly?

Lessons from forestry

Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows

Investigation into Verra carbon standard finds most are 'phantom credits' and may worsen global heating

Guardian reporting

Based on a new analysis at least 90% of Verra's rainforest carbon credits do not represent real emission reductions

Each credit is equal to one metric tonne of CO₂ equivalent

94.9m
carbon credits
claimed

5.5m
real emissions
reductions



Guardian graphic. Source: The Guardian analysis based on a significant percentage of the projects as looked by West et al studies and Verra registry (accessed in August 2022). All figures are estimates. West et al 2023 is a pre-print. Note: Verra's claims versus analysis of independent scientific studies

What if we do this poorly?

Lessons from forestry

OVER-CREDITING PERCENT

29.4%

(20.1-37.8%)

OVER-CREDITING VALUE

\$410M

(\$280-528M)

ANALYZED CREDITS

102M

OVER-CREDITING

30M (20-39M)

CREDIT VALUE

\$13.67

FIGURE 1 / Summary of results from our analysis of crediting error, in terms of net over-crediting, percentage relative to the projects we analyzed, and value in dollars assuming a credit value of \$13.67. Each credit represents 1 tCO₂e. Ranges report 5th and 95th percentiles of a bootstrapped distribution forming a 90% confidence interval.

Carbon Plan
Badgley et al. 2021

PROPUBLICA

Environment

The Climate Solution Actually Adding Millions of Tons of CO₂ Into the Atmosphere

by Lisa Song, ProPublica, and James Temple,
MIT Technology Review

April 29, 2021, 5 a.m. EDT



Are Carbon Offsets the Labradoodle of Climate Solutions?

“It’s too easy to do it wrong,” says Mark Trexler, who helped create the first carbon offset project, on the latest episode of *Zero*.

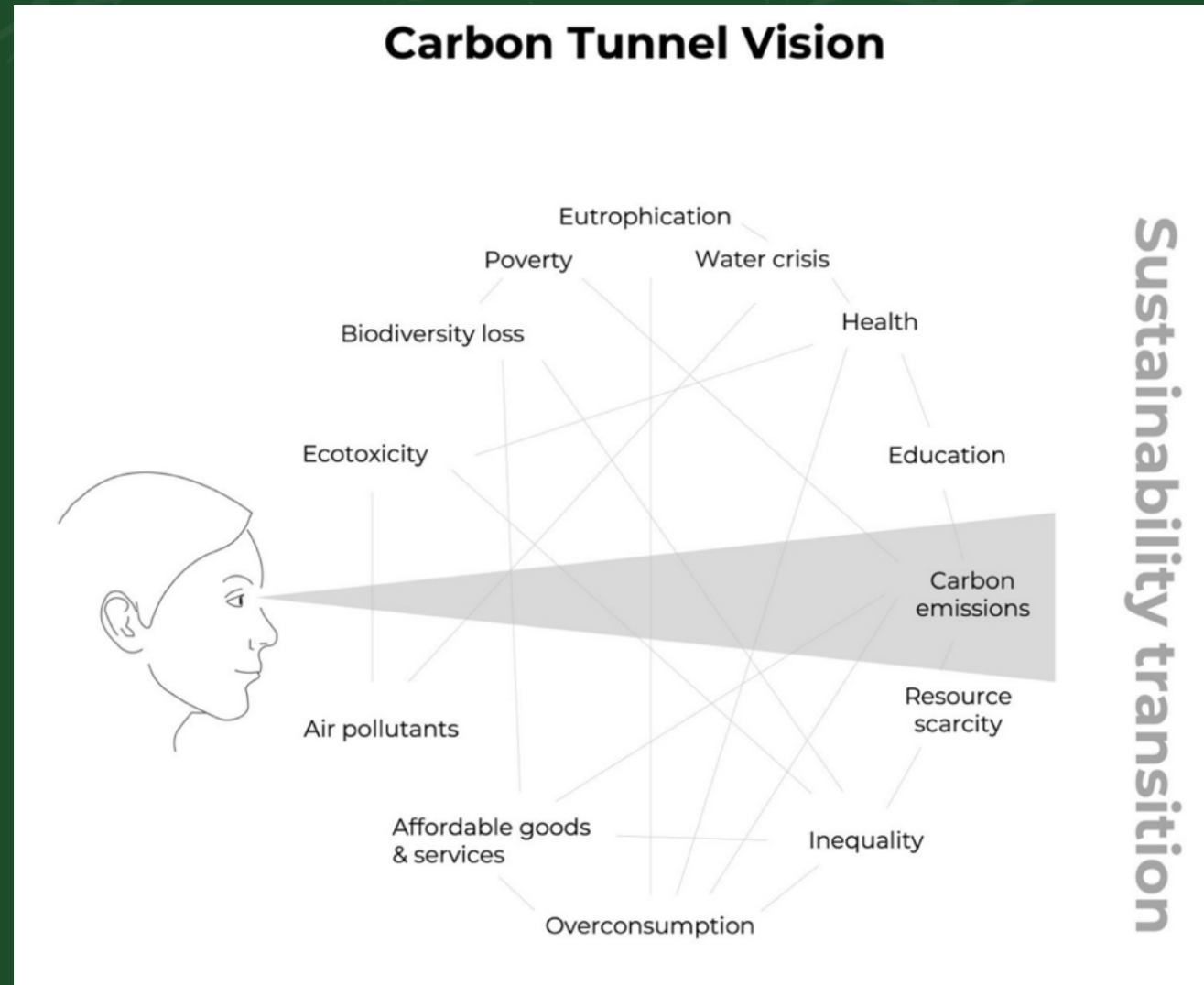
<https://www.bloomberg.com/news/articles/2022-12-01/are-carbon-offsets-the-labradoodle-of-climate-solutions#xj4y7vzkg>

What if we get this right?

Vision for regeneration and a just ag system



Its not just about the carbon



A justice framework

What would embedding justice principles entail?



Procedural justice = fairness in decision making



Distributive Justice = equitable allocation of risks, benefits, and impacts



Reparative Justice = regressing past harms

Here is a subtitle

Scaling soil carbon justly

“When we talk about environmentally just CDR technologies, we have to make sure that we are thinking about everything and everyone that goes into the project. This includes, but is not limited to: the people, policies, processes, communication, transparency, impacts (environmental, health, economic, and more), and decision-making.”

--- Jasmine Davenport

From the Ground Up: Recommendations for Building an Environmentally Just Carbon Removal Industry

Community engagement

Continued, not one-off
Soil C projects take place within a community

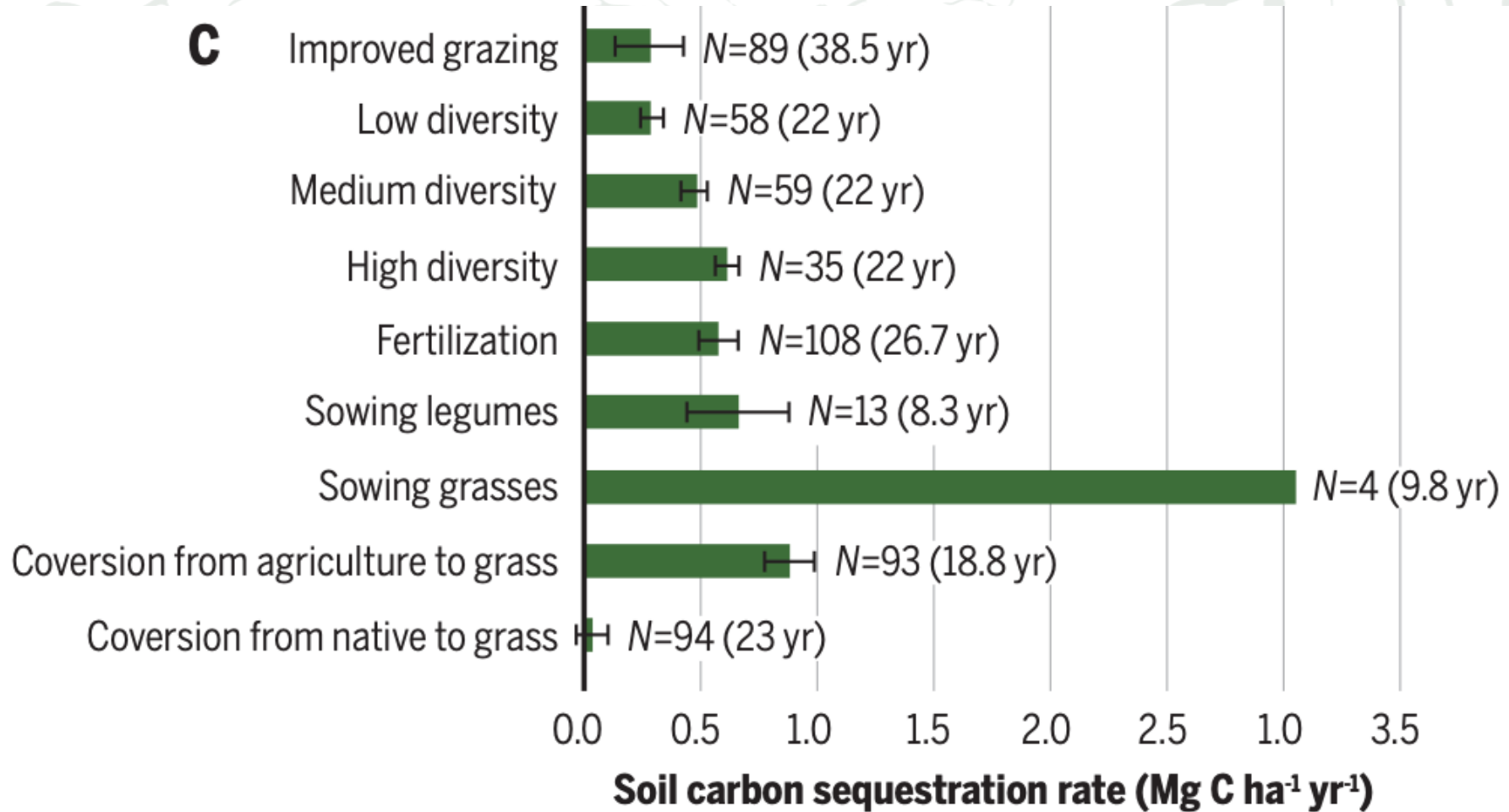
Transparency

Risks, benefits
Contracting

Address harms

Acknowledge past harms

Where we can shift management practices



Soil solutions with impact

How to make this moment count

01.

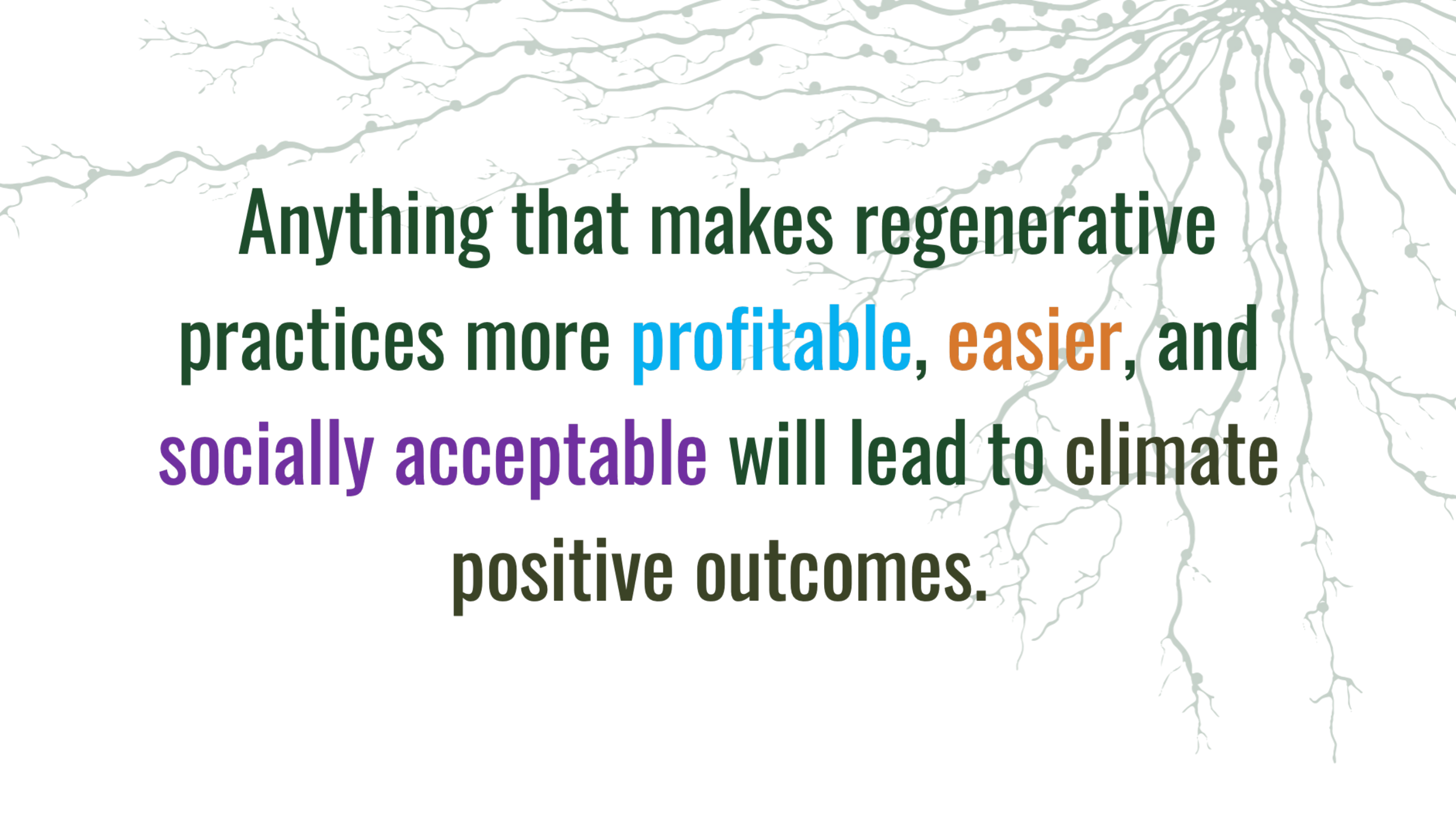
A focus on producers and regenerative production systems

02.

Create incentives that are fostering just outcomes and solving actual problems

03.

Scientific rigor to ensure climate benefits are real



Anything that makes regenerative practices more profitable, easier, and socially acceptable will lead to climate positive outcomes.

Regenerative agriculture at scale

Question for you

Would you support regenerative agriculture if it was fully embraced and implemented by a large agricultural company?



Let's keep the conversation going...

Thank you



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<https://www.soilcarbonsolutionscenter.com>

Instagram @soilcarbon_csu



CSU's Soil Carbon Solutions Center leverages world-class expertise to **build** the tools needed to **accelerate** the deployment of credible soil-based climate solutions, **measure** their impact, and bring them to **scale**.

Soil Carbon Solutions Center

Interdisciplinary research

Soil Ecology
Biogeochemistry
Energy Sector
Engineering
Crop genetics
Climate Science

Economics
Extension and outreach
Business development
Humanities
Policy
IT/Tech development



Unlocking the potential of soil for a more sustainable planet

Our work

Research



Tools



Implementation

