# Regenerative Agriculture, Renovation and Rehabilitation of Oil Palm

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# Different crops: different histories

- Cocoa – expanded in the early 20th Century as a smallholder crop in West Africa – settl… plantations failed
- Coffee and tea were plan… smallholders prohi… …ya
- Major ex… …e and tea after indepe… …s and 70s
- Oil palm … …lholder crop in West Africa – massive smallholder expansion since the 1980s in SE Asia

A huge proportion of the smallholder crops is at the end of its productive cycle

# Rehabilitation & renovation

- Rehabilitation
  - Closing yield gaps on existing plantations
  - Bringing plantations back into production
- Renovation
  - Replanting/interplanting

- What does replanting mean for smallholders?
  - No income from the cash crop for 3 years or more
  - Need to diversify income

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For quality of life

# What to (re)plant and how?

- Genetics - use the best new varieties (pest and disea... ...e, yield potential)
- Planting material – good nursery condi...
- Agronomy - planting method... ...gement, irrigation, pruning, pest and dise...

Good establishment phase gives better yields for 20 years or more

# Where not to invest?

- On problem soils (shallow soils, too acid, toxicity, peat)
- Heavily eroded or steep slopes
- Waterlogged areas without drainage
- Risky climates (and watch out for climate change)
- With the poorest farmers?

- Options
  - Intercropping (vegetables, cocoa, coffee)
  - Farmer organisations (farmer groups, cooperatives etc)

Perspective

Outlook on AGRICULTURE

Outlook on Agriculture
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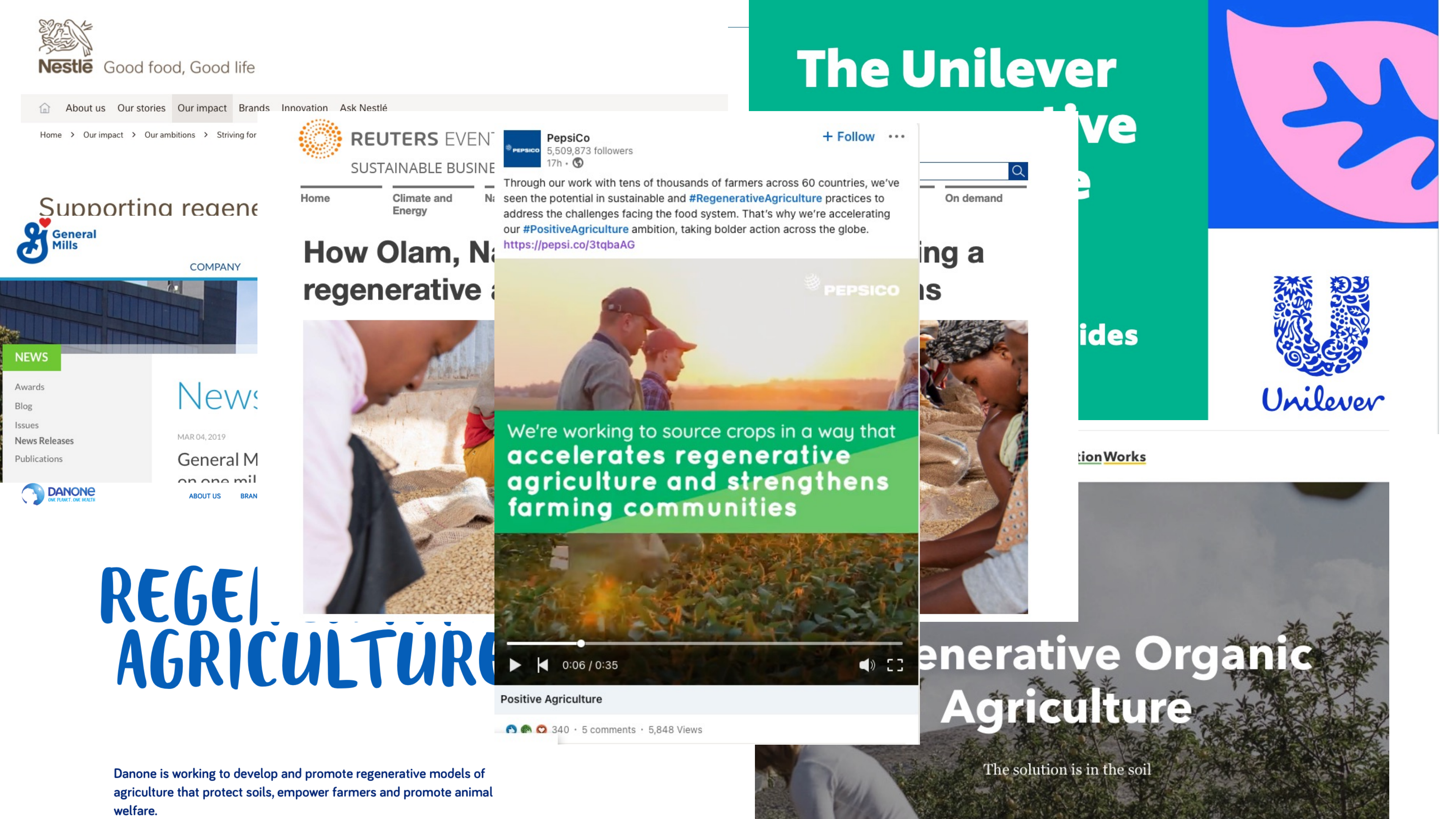
# Regenerative Agriculture: An agronomic perspective

**Ken E Giller[1], Renske Hijbeek[1], Jens A Andersson[1] and James Sumberg[2]**

**Abstract**

Agriculture is in crisis. Soil health is collapsing. Biodiversity faces the sixth mass extinction. Crop yields are plateauing. Against this crisis narrative swells a clarion call for Regenerative Agriculture. But what is Regenerative Agriculture, and why is it gaining such prominence? Which problems does it solve, and how? Here we address these questions from an agronomic perspective. The term Regenerative Agriculture has actually been in use for some time, but there has been a resurgence of interest over the past 5 years. It is supported from what are often considered opposite poles of the debate on agriculture and food. Regenerative Agriculture has been promoted strongly by civil society and NGOs as well as by many of the major multi-national food companies. Many practices promoted as regenerative, including crop residue retention, cover cropping and reduced tillage are central to the canon of 'good agricultural practices', while others are contested and at best niche (e.g. permaculture, holistic grazing). Worryingly, these practices are generally promoted with little regard to context. Practices most often encouraged (such as no tillage, no pesticides or no external nutrient inputs) are unlikely to lead to the benefits claimed in all places. We argue that the resurgence of interest in Regenerative Agriculture represents a re-framing of what have been considered to be two contrasting approaches to agricultural futures, namely agroecology and sustainable intensification, under the same banner. This is more likely to confuse than to clarify the public debate. More importantly, it draws attention away from more fundamental challenges. We conclude by providing guidance for research agronomists who want to engage with Regenerative Agriculture.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Danone is working to develop and promote regenerative models of agriculture that protect soils, empower farmers and promote animal welfare.
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Through our work with tens of thousands of farmers across 60 countries, we've seen the potential in sustainable and #RegenerativeAgriculture practices to address the challenges facing the food system. That's why we're accelerating our #PositiveAgriculture ambition, taking bolder action across the globe.
https://pepsi.co/3tqbaAG
PEPSICO
We're working to source crops in a way that accelerates regenerative agriculture and strengthens farming communities
0:06 / 0:35
Positive Agriculture
340 · 5 comments · 5,848 Views
The Unilever
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enerative Organic Agriculture
The solution is in the soil

# Regenerative Agriculture Practices

**Table 1.** Agronomic principles and practices considered to be part of Regenerative Agriculture and their potential impacts on restoration of soil health and reversal of biodiversity loss.

| Principles | Practices | Restoration of soil health | Reversal of biodiversity loss |
|---|---|---|---|
| Minimize tillage | Zero-till, reduced tillage, conservation agriculture, controlled traffic | *** | – |
| Maintain soil cover | Mulch, cover crops, permaculture | *** | * |
| Build soil C | Biochar, compost, green manures, animal manures | *** | – |
| Sequester carbon | Agroforestry, silvopasture, tree crops | *** | ** |
| Relying more on biological nutrient cycles | Animal manures, compost, compost tea, green manures and cover crops, maintain living roots in soil, inoculation of soils and composts, reduce reliance on mineral fertilizers, organic agriculture, permaculture | *** | – |
| Foster plant diversity | Diverse crop rotations, multi-species cover crops, agroforestry | ** | *** |
| Integrate livestock | Rotational grazing, holistic [Savory] grazing, pasture cropping, silvopasture | ** | ? |
| Avoid pesticides | Diverse crop rotations, multi-species cover crops, agroforestry | * | *** |
| Encouraging water percolation | Biochar, compost, green manures, animal manures, holistic [Savory] grazing | *** | – |

Based on McGuire (2018), Burgess et al. (2019) and Merfield (2019).

# Types of principles in agricultural discourse

- Explanatory
- Directive
- Normative

| Principle type | Sub-type | Example | Context & reference |
| --- | --- | --- | --- |
| **Explanatory** | --- | 'Vegetative vigor and reproductive vigor are mutually antagonistic' | General (Piper, 1914) |
| | --- | 'Yield and the quality of products from crops are strongly linked to the supply of nutrients' | General (Black and Batten, 2017) |
| **Directive** | **Should do** | 'Keep the soil surface covered' | Regenerative agriculture (groundswell.org) |
| | | 'Do everything reasonably possible to build internal strengths into the agricultural ecosystem' | Ecological agriculture (Magdoff, 2007) |
| | **Must do** | 'Crop rotations' | Conservation agriculture (Hobbs et al., 2008; FAO, 2016) |
| | **Don't do** | 'to minimize the use of non-renewable resources and off-farm inputs'<br>'to exclude the use of soluble mineral fertilisers' | Organic agriculture (The Soil Association, 2023) |
| **Normative** | **Vision** | 'an agricultural sector that ensures land use is appropriate given the characteristics of the terrain, maintains soil fertility and health, prevents damage and provides benefits to the surrounding environment, and ensures the land acts a significant greenhouse gas sink' | Sustainable agriculture (SAI Platform, 2021) |
| | **Value** | 'Fairness' | Agroecology (agroecology-europe.org) |

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# Evolving meanings of ‘principles’

- Alternative agricultures define themselves through a set of (directive and/or normative) principles
- These do not challenge or undermine the scientific principles that underpin mainstream agronomy
- To articulate and proclaim principles is to exert authority, bolster legitimacy and claim a place in a crowded and contested marketplace



Sumberg, Giller & Glover (2023) Evolving meanings of ‘principles’ in agronomic discourse. *Outlook on Agriculture* **52**, 363–370.

# The Carbon Underground



**Join the growing list of organizations supporting a new definition for agriculture that's better for the planet, people, and profitability.**

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Global Change Biology WILEY

OPINION



# Carbon for soils, not soils for carbon

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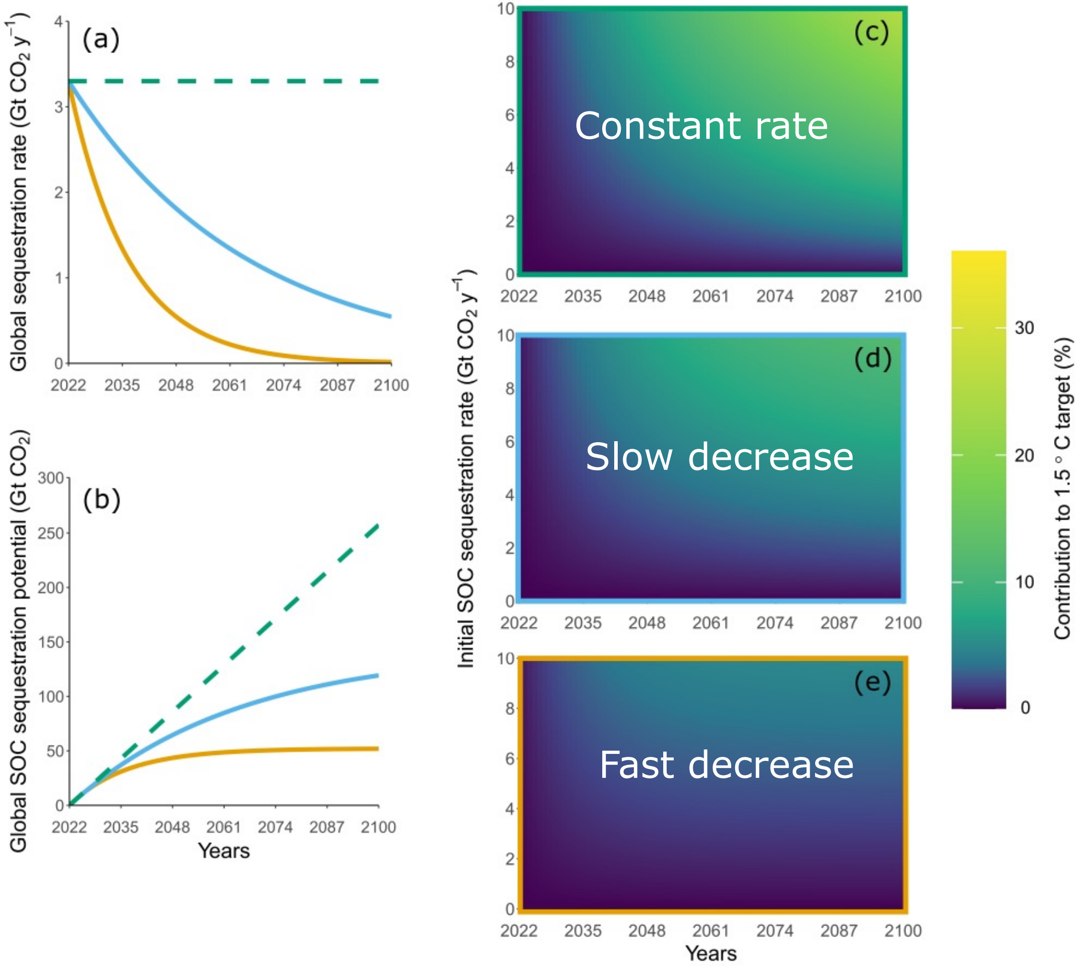
## Abstract

The role of soil organic carbon (SOC) sequestration as a 'win-win' solution to both climate change and food insecurity receives an increasing promotion. The opportunity may be too good to be missed! Yet the tremendous complexity of the two issues at stake calls for a detailed and nuanced examination of any potential solution, no matter how appealing. Here, we critically re-examine the benefits of global SOC sequestration strategies on both climate change mitigation and food production. While estimated contributions of SOC sequestration to climate change vary, almost none take SOC saturation into account. Here, we show that including saturation in estimations decreases any potential contribution of SOC sequestration to climate change mitigation by 53%–81% towards 2100. In addition, reviewing more than 21 meta-analyses,

# Carbon for soils, not soils for carbon

Three scenarios:

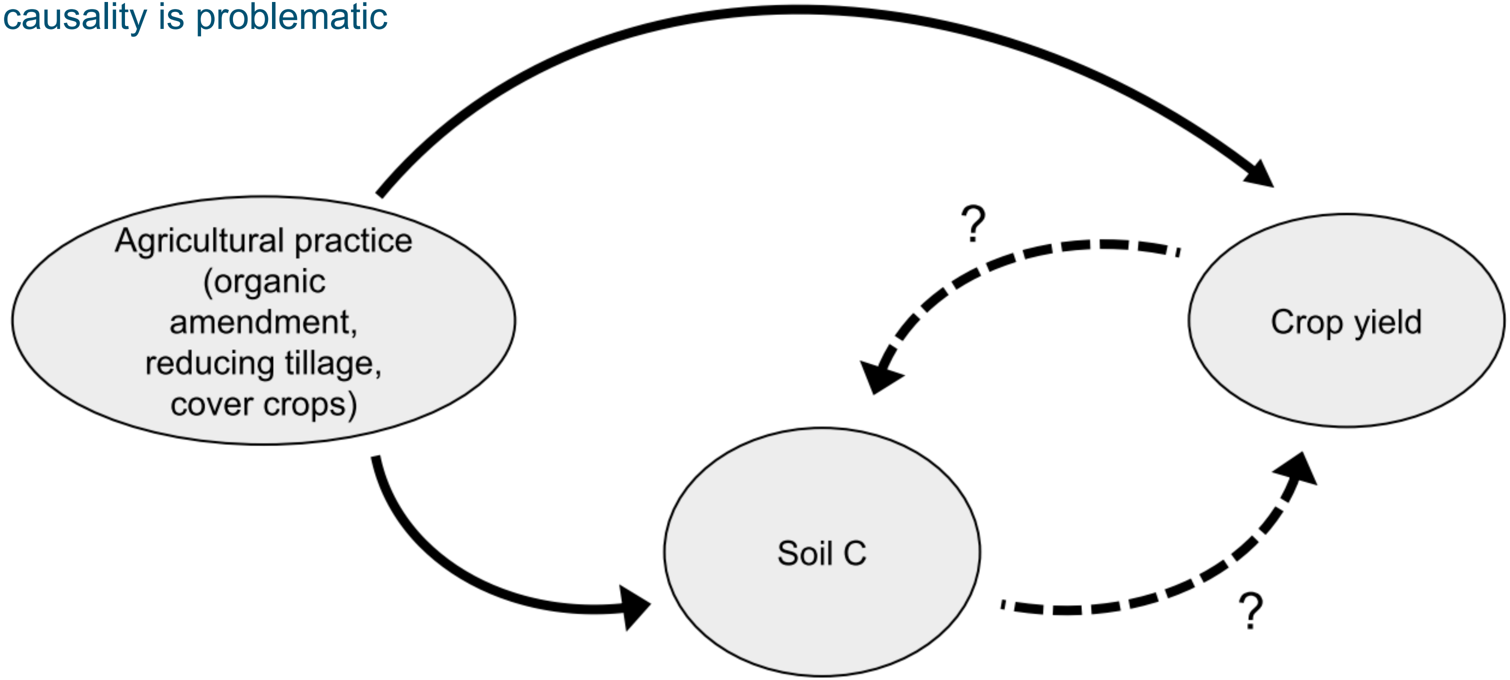
1. Unrealistic constant sequestration rate (green dashed lines and frame)
2. Slow exponential decrease in sequestration rates (blue lines and frame)
3. Fast exponential decrease in sequestration rates (orange lines and frame)




Moinet, Hijbeek, van Vuuren, Giller (2023) Carbon for soils, not soils for carbon. Global Change Biology https://doi.org/10.1111/gcb.16570

# Which comes first? The chicken or the egg?

Establishing causality is problematic

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Moinet, Hijbeek, van Vuuren, Giller (2023) Carbon for soils, not soils for carbon. Global Change Biology https://doi.org/10.1111/gcb.16570

# Many claims of alternative nitrogen fixing bacteria don't stand up to scrutiny



# Serious doubts about **biological alternatives** to **fertiliser**

Agro-multinationals are eagerly jumping into biological alternatives to fertilisers: bacterial preparations that supposedly fix nitrogen from the air in a form that can be absorbed by plants. Independent experts have serious doubts about the sustainability of those claims and are calling for regulation.

You could call it the holy grail of agronomy. Crops that are not or much less dependent on artificial fertilisers and animal manure, because they manage to extract nitrogen from the air themselves, with or without the help of bacteria. Some plants can do that, leguminous plants such as beans, clover and lupins manage to entice the soil bacterium Rhizobium to 'move in' with them in the plant cell of a root nodule. In exchange for providing absorbable nitrogen, they receive energy-rich carbohydrates from their host.

However, major crops such as maize, rice, wheat and potatoes still depend on external sources of nitrogen. That supply is problematic, both because of the high price of fertilisers and because of the greenhouse gases emitted in their production and use. Hence the growing focus of agro-multinationals on biological nitrogen fixation.

In the Netherlands, both Corteva Agriscience and Syngenta have launched a bio stimulant that enables non-leguminous crops to fix nitrogen from the air. Corteva's product is Methylobacterium symbioticum under the brand name BlueN® and Syngenta works with Azotobacter salinestris, brand name Vixeran. With both products, a grower could supposedly save 30 to 50 kilograms of nitrogen per hectare, equivalent to over 100 kilograms of nitrogen fertiliser.

**EXCITEMENT**

This is not the first time this form of biological nitrogen fixation has set hearts racing. Soil scientist Ken Giller, professor of production ecology in Wageningen, refers to an article he wrote 20 years ago with his Flemish colleague Roel Merckx about the repeating cycles of excitement and disappointment since the early 1960s.

In those days, crops in the former Soviet Union were widely treated with Azotobacterin, a nitrogen-fixing soil bacterium. With less fertiliser, higher yields would be possible. It later turned out that the higher yields were mainly due to the production of indole acetic acid (IAA), a plant growth hormone. Disappointment all round, but that did nothing to prevent that ten years later there were again high expectations, this time from free-living soil bacteria of the genus Azospirillum spp. Again, however, the observed effects could be attributed to the increased production of indole acetic acid and other growth hormones. In the late 1980s, it was the same story again, this time around Gluconacetobacter diazotrophicus. This bacterium was also found to mainly stimulate the production of indole acetic acid while it also improved plant uptake of zinc and phosphorus.

**FOURTH WAVE**

So, we are currently experiencing the fourth wave of excitement about biological nitrogen fixation. Once again, it seems to be heading for disappointment. For instance, independent research by a number of cooperating US universities showed that, with a few exceptions, the bacterial varieties on the market there have no effect on growth yields, even with lower rates of fertiliser application.

The researchers conducted a combined 61 years of field trials across 10 US states and with various crops, including, maize, sugar beet and oilseed rape.

Embr

## What is Utrish

Utrisha N is a **nutrie**
bacteria, *methylob*
from the air and co

## How Utrisha™ N

1. Utrisha N enters
colonizes in the l
2. It then converts
in a constant sup

**No plant energy is**

## Enhances Nitro

Utrisha N provides
nitrogen that redu
the soil and ensure
**season long,** witho
or releasing additio


TEVA

# Regenerative practices to maintain/improve soil health

- **Maximize soil cover:**
  - Leguminous cover crops at planting
  - Use oil palm residues as mulch (cover)
  - Weeding of circles & path, leaving soft weed cover
  - Integrating cattle grazing in oil palm to recycle nutrients → reduce herbicide and fertilizer use

- **Effects:**
  - prevent erosion and run off & add nutrients to the soil, reduce fertilizer needs
  - reduce soil compaction and acidification, add soil carbon
  - increases infiltration e.g. under frond stacks

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# Measuring and monitoring

Unilever

SUSTAINABLE AGRICULTURE
CODE 2017

- Very wide-ranging
- Focused on continuous improvement

# Selecting meaningful indicators

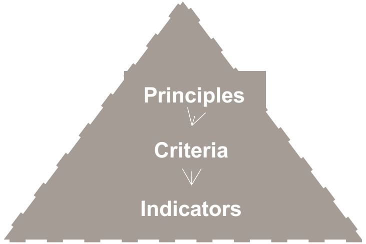
- Hierarchical frameworks help with indicator selection
- Provide logical linkages between indicators and abstract concepts

# Soil health

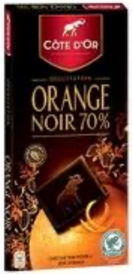
Principle: Enhance soil health

Criterion: Increase soil organic matter

Indicators: Soil C content







# Ground Zero? Let's Get Real on Regeneration!

Report 1: State of the Art and Indicator Selection

# The Regeneration Agenda

- Zero C commitments
- Enhance Soil Health
- Safeguard and enhance Biodiversity

Alongside commitments to ensure all smallholder producers receive a living income and avoid child labour

and ensuring sustainable supply

# Greenhouse gases



## The Cool Farm Tool quantifies on-farm greenhouse gas emissions and soil carbon sequestration

### DEMONSTRATE GOOD PRACTICE

Farmers manage for cost, productivity and soil health. The Cool Farm Tool can show how these management decisions sequester carbon or reduce greenhouse gas emissions – an issue customers care about.

### QUICK AND EASY

It takes just 10-15 minutes to get a rough estimate, and the calculations are based on information you will have on hand or easily accessible.

### STIMULATES THINKING

The Cool Farm Tool isn't just a calculator. It stimulates thinking about management, by showing hotspots and helping to develop action plans.

### RESULTS TAILORED TO YOUR FIELD

Reducing tillage and adding cover crops can reduce and offset problem emissions while building soil health. But each farm and field responds differently. The Cool Farm Tool allows farmers to find out how their fields respond to the management options of interest.

### ENCOURAGE GOOD AGRICULTURE PRACTICE

With an interactive interface designed to be simple to use, but scientifically robust in the complex arena of carbon accounting, the Cool Farm Tool encourages, motivates and rewards good agricultural practice.

### TESTED AND ADOPTED

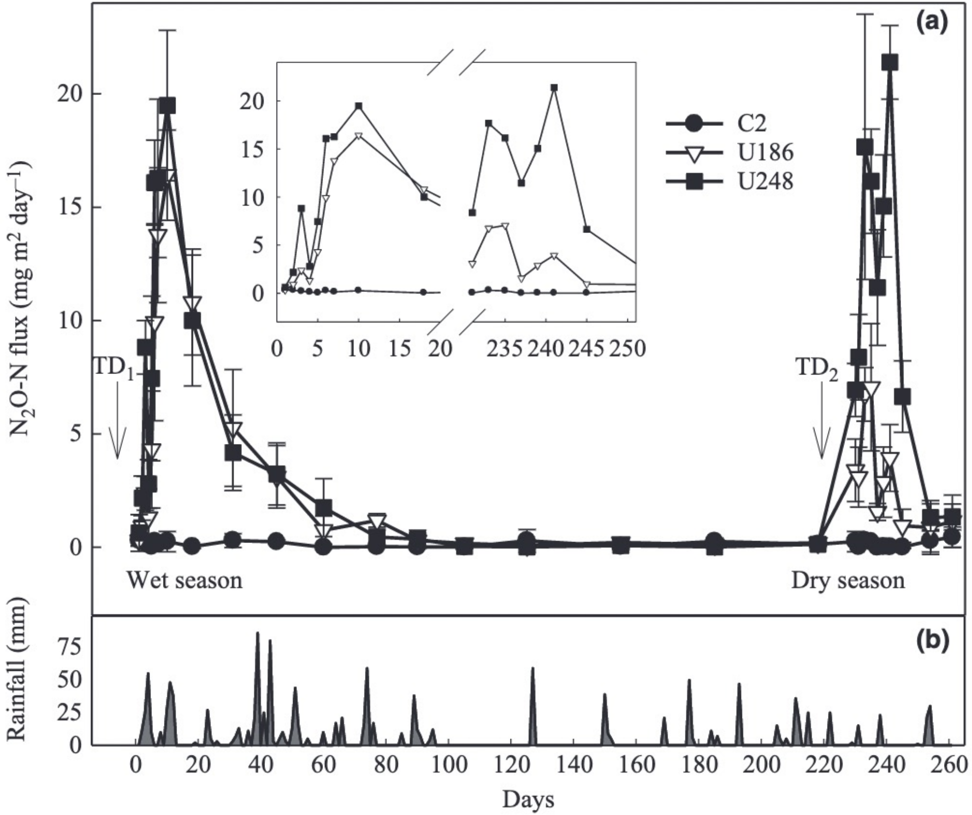
The Cool Farm Tool has been tested and adopted by a range of multinational companies who are working with their suppliers to measure, manage, and reduce greenhouse gas emissions in the effort to mitigate global climate change.

# Carbon Footprints

- Deploy and improve the Cool Farm Tool
  - Measure GHG emissions – focus on N ($N_2O$ emissions)
  - Assess relative importance of input parameters
  - Biomass production (inc. prunings, litter, root turnover)
  - Management of fertilizer N
  - Integrated Soil Fertility Management (ISFM)
  - Use of nitrification inhibitors
  - Composting and waste management

# Nitrous oxide emissions in oil palm

- High temperatures, moist soil, C-rich substrates ideal conditions for $N_2O$ losses
- Emission factors in oil palm 2.5-2.7% of N added as fertilizer

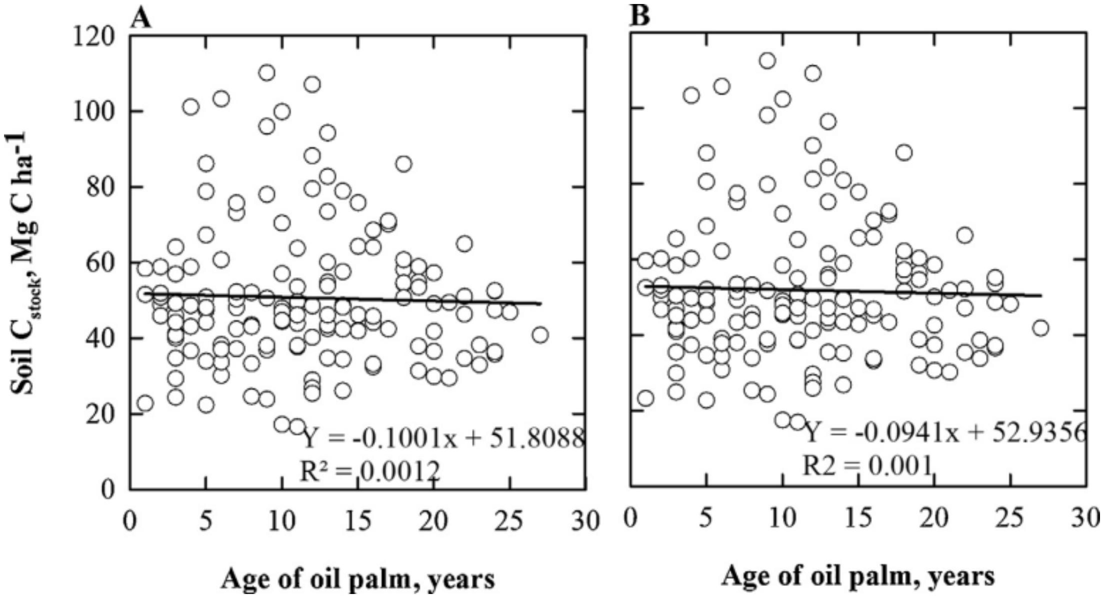





Rahman, Bruun, Giller, Magid, van de Ven, de Neergaard (2019) Global Change Biology: Bioenergy 214, 107-119

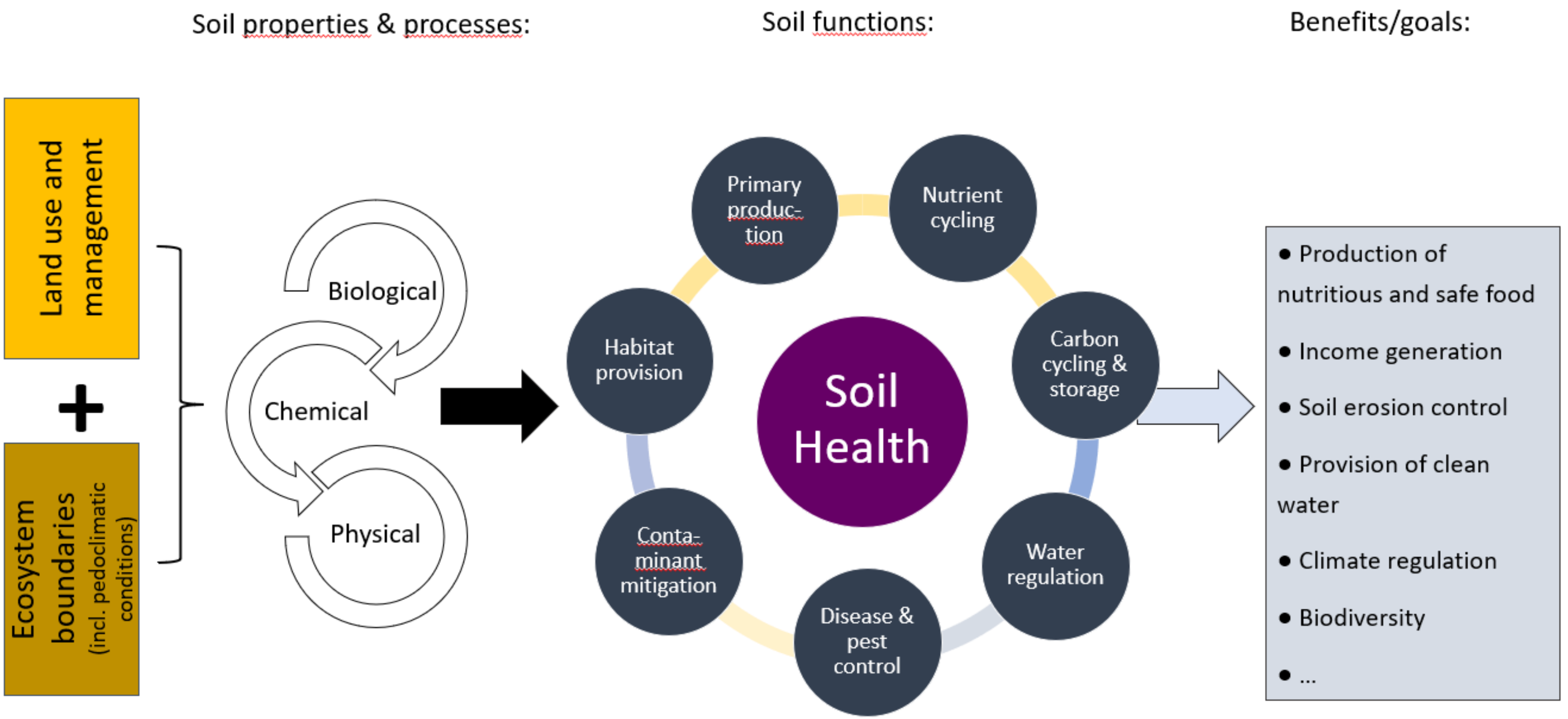
# Soil stocks

- Primary forest ~ 60 t C $ha^{-1}$
- Stable under oil palm and cocoa at ~ 50 t C $ha^{-1}$




Khasanah et al. (2015). Carbon neutral? No change in mineral soil carbon stock under oil palm plantations derived from forest or non-forest in Indonesia. *Agriculture, Ecosystems and Environment* **211**, 195 - 206.

# Soil Health



Soil properties & processes:
Soil functions:
Benefits/goals:
Land use and management
+
Ecosystem boundaries (incl. pedoclimatic conditions)
Biological
Chemical
Physical
Primary produc-tion
Nutrient cycling
Habitat provision
Soil Health
Carbon cycling & storage
Conta-minant mitigation
Water regulation
Disease & pest control
Production of nutritious and safe food
Income generation
Soil erosion control
Provision of clean water
Climate regulation
Biodiversity
...

# Selection of criteria – linked to functions

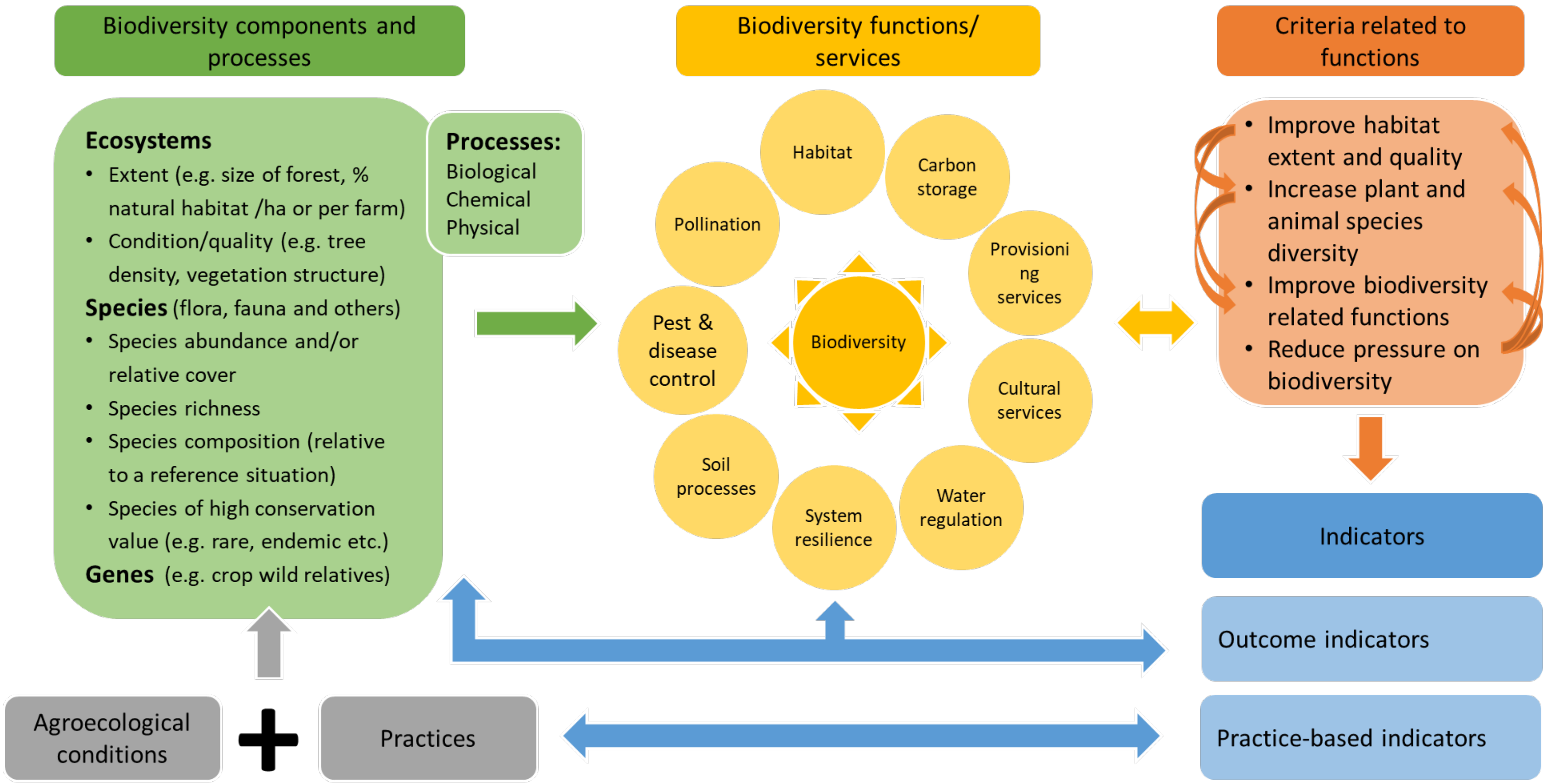
- Soil erosion
- Soil acidification
- Nutrient cycling
- Carbon cycling and SOC storage
- Water retention (infiltration/storage capacity)
- Biocontrol of soil-borne pests/diseases
- Enhance soil biodiversity (habitat provision)

**Table 1.** Strength of evidence# for the links between supporting practices and each of the objectives/criteria for soil health. For further detail and references see Annex 1.

| **Criteria:** <br> **Practices:** | **Control soil erosion** | **Prevent soil acidification** | **Improve nutrient cycling** | **Increase C cycling & SOC** | **Improve water retention** | **Enhance soil biodiversity (habitat** | **Biocontrol of pests & diseases** | **Reduce cadmium** |
|---|---|---|---|---|---|---|---|---|
| **Nature-based erosion measures** | WE | | WE | | WE | EI | | |
| **Agroforestry** | WE | | EI | UR | WE | EI | IC | |
| **Soil cover** | WE | | WE | EI | WE | EI | EI | |
| **Optimized fertilization** | | WE | WE | | | EI | EI | IC |
| **Organic amendments** | | WE | EI | EI | EI | EI | IC | IC |
| **Biostimulants** | | | UR/IC | | | | IC | IC |
| **Limit pesticide use** | | | | | | EI | EI | |
| **Inorganic amendments** | | WE | | | EI | | | IC |

#WE = Well established (ample supporting evidence); EI = Established but incomplete (few available studies, but what's there is in agreement); IC = Inconclusive (few studies and little agreement); UR = Unresolved (ample studies but contradictory results).

# Biodiversity



# Common indicators: Outcome and Practice

| Criteria | Indicator | Methods |
|---|---|---|
| On farm forest | Area still covered in forest/native vegetation | • Remote sensing (crowns)<br>• Farmer reporting (e.g. app) |
| Habitat and connectivity (O) | • Vegetation structure (strata)<br>• Crown cover non cocoa/coffee<br>• Understory<br>• Litter cover and composition | • Remote sensing (limitations) |
| Species diversity (O) – Flora and/or Fauna | • Richness<br>• Abundance<br>• Similarity to reference habitat | • Field surveys<br>• Farmer data<br>• (acoustics, eDNA) |
| "Shade" trees (P) | • Number of (native) shade trees/ha<br>• Shade cover (%)<br>• Average species diversity | • Farmer reporting<br>• Farm surveys |
| Other biodiversity supporting practices | • Cover cropping<br>• Selective weeding<br>• Residue management | • Plot surveys<br>• Farmer data |
| Reduce pressure on biodiversity (P) | • Agrochemical management | • Farmer data |
| *Biodiversity related functions:* Carbon (O) | • Biomass non-cocoa/coffee<br>• soil carbon | • On farm tree measurements<br>• Remote sensing (challenges) |

# Regenerative practices in smallholder oil palm fields

**RSPO BMP recommendations for soil fertility:**

- *Practices are undertaken to maintain soil fertility, or where possible improve the soil fertility, up to a level that provides optimal and sustainable results*

Challenges for smallholders:

- Fertilizers expensive and availability limited, especially K-rich fertilizers. Smallholder fields often nutrient deficient Empty fruit bunches not always available and logistical challenges
- Manure not available as most smallholders have little to no livestock

**RSPO standard on pesticides (criteria 4.8):**

- *Application of an Integrated Pest Management (IPM) approach, in order to minimize any pesticide used*
- *No use of pesticides that are categorised as World Health Organisation Class 1A or 1B, or that are listed by the Stockholm or Rotterdam Conventions, or of Paraquat except in specific situations*
- *Ensure safe use, storage and disposal*

Challenges for smallholders:

- Manual weeding is time-consuming and costly
- Harvest workers request weed-free harvest paths for easy harvesting and safety (snakes)
- Lack of local waste disposal infrastructure. Pesticide / herbicide bottles are eventually burned.
- Lack of knowledge on health risks of pesticides: smallholders tend not to use protective clothing

**RSPO does not yet have guidelines on intercropping or livestock integration as means to implement regenerative practices in oil palm**

# Regenerative agriculture is here to stay

How can we build on the huge positive momentum?

- Regenerative Agriculture moves the goalposts from ‘do no harm’ to ‘do better’
- A clear definition is lacking - which may be more help than hindrance?
- A common set of **principles** for Regenerative Agriculture can be identified
- The huge diversity of farms, farming systems and take-off points across the world means that a tailored approach is needed for implementation of **practices**
- Measuring and monitoring progress will remain a challenge

# With thanks to

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Lotte Woittiez

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# Exploring evidence and values in global food systems debates

A collaboration between

- Why do people hold the views they do about food?
- TABLE is a new food dialogue platform that aims to **set out the evidence, assumptions, and values** underpinning views on food systems controversies

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