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GLOBAL SYMPOSIUM ON SOIL BIODIVERSITY | 19-22 April 2021

Contents lists available at ScienceDirect

Global Food Security

journal homepage: www.elsevier.com/locate/gfs

Role and management of soil biodiversity for food security and nutrition; where do we stand?

V. El Mujtar[a,*], N. Muñoz[b], B. Prack Mc Cormick[c,d], M. Pulleman[e,f], P. Tittonell[a,d]

Goals

- To provide an overview of the relations between soil biodiversity, agricultural management and food production
- To provide scientific evidences of the potential of soil biodiversity management to improves food security and nutrition

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Role and management of soil biodiversity for food security and nutrition; where do we stand?

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SOIL BIODIVERSITY

FOOD SECURITY PILLARS

- AVAILABILITY
- ACCESS
- NUTRITION & SAFETY
- STABILITY

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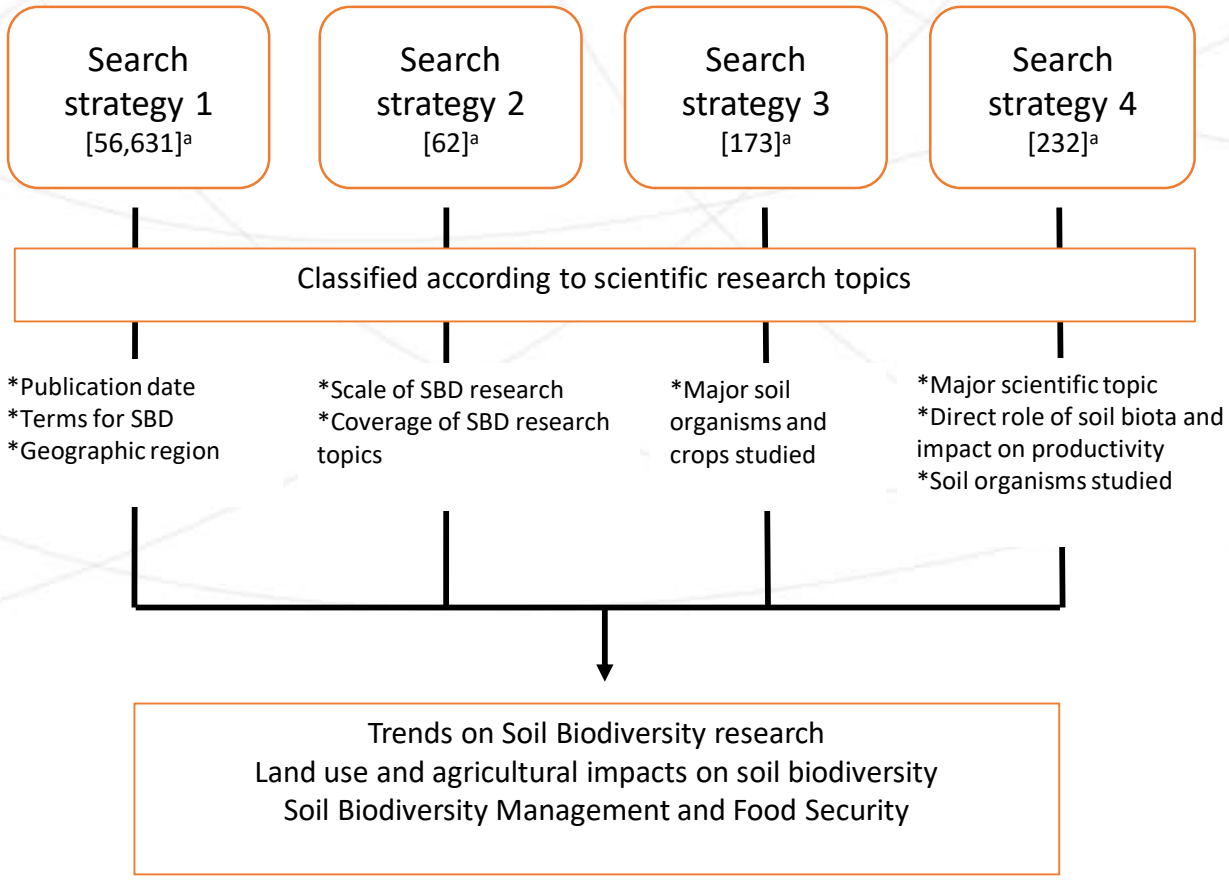
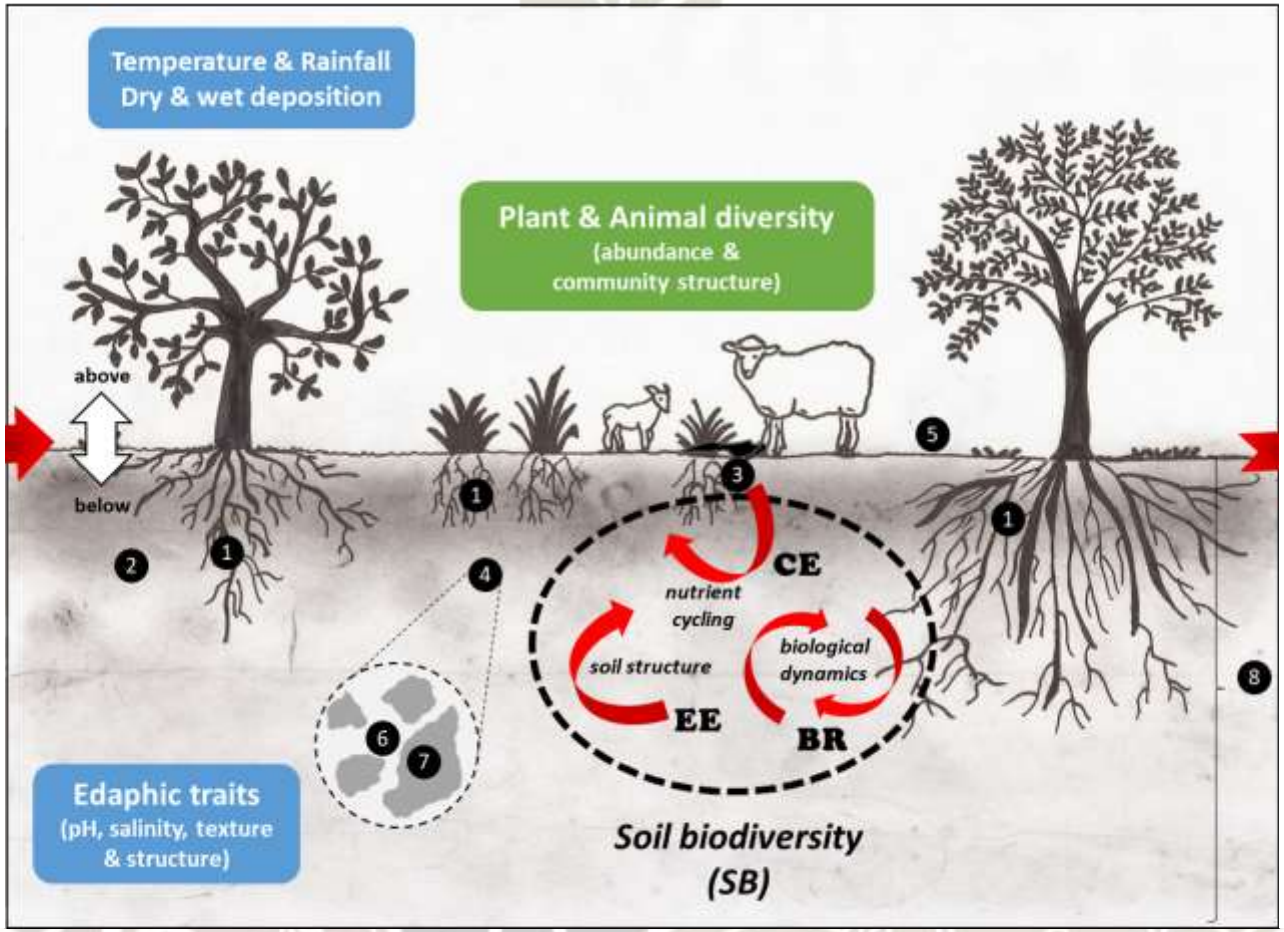
Systematic literature search

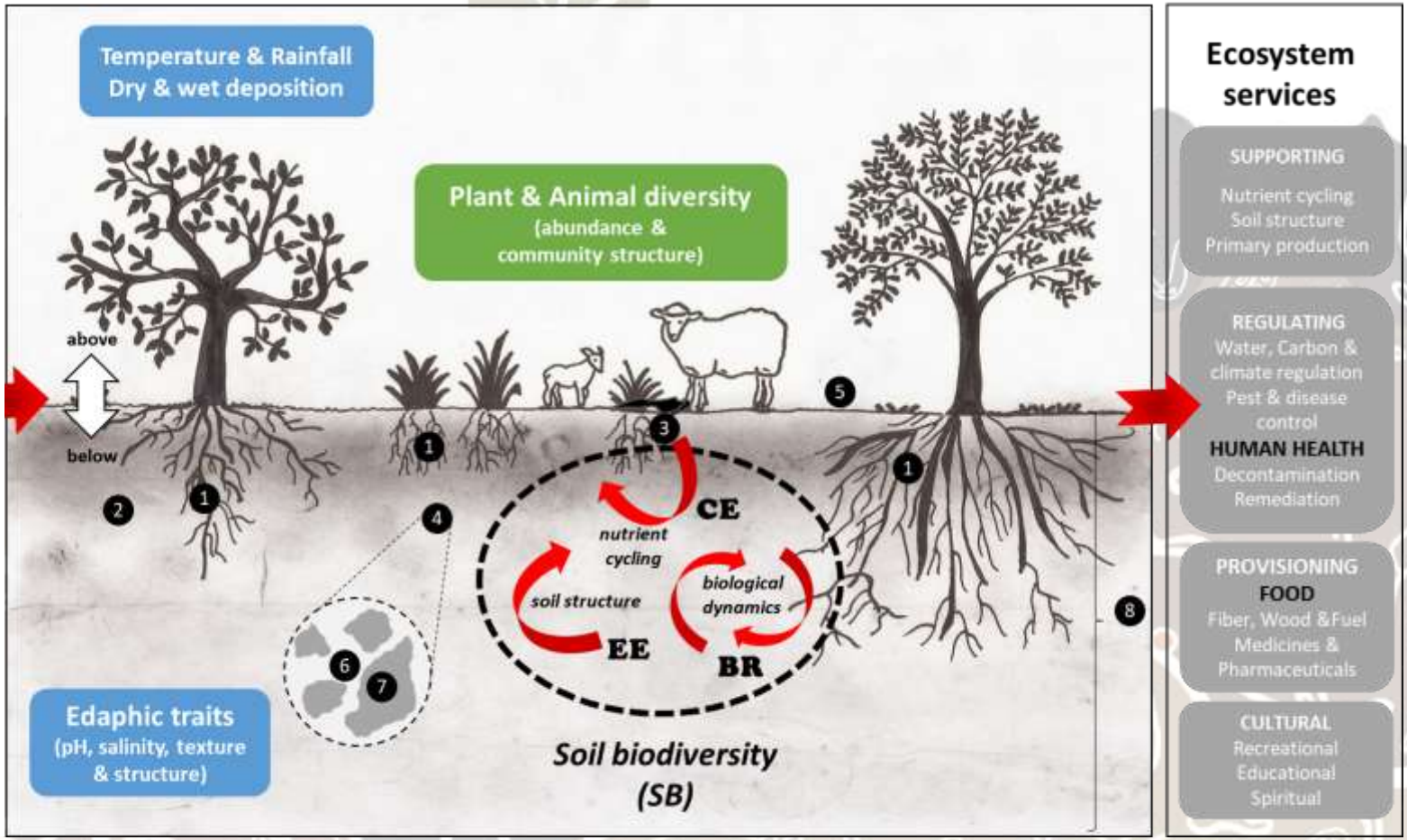


WEB OF SCIENCE™ Scopus®

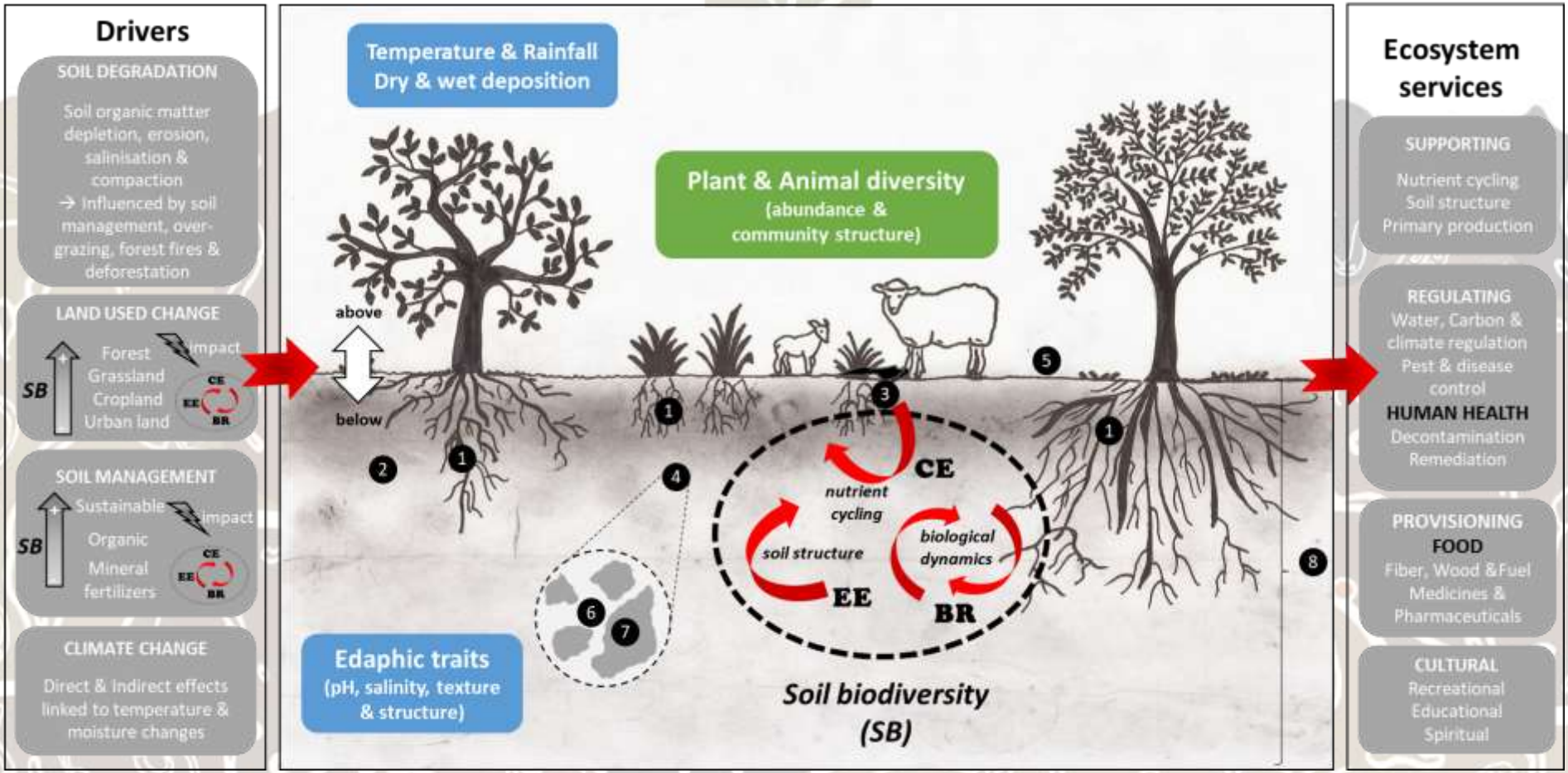
Soil biodiversity



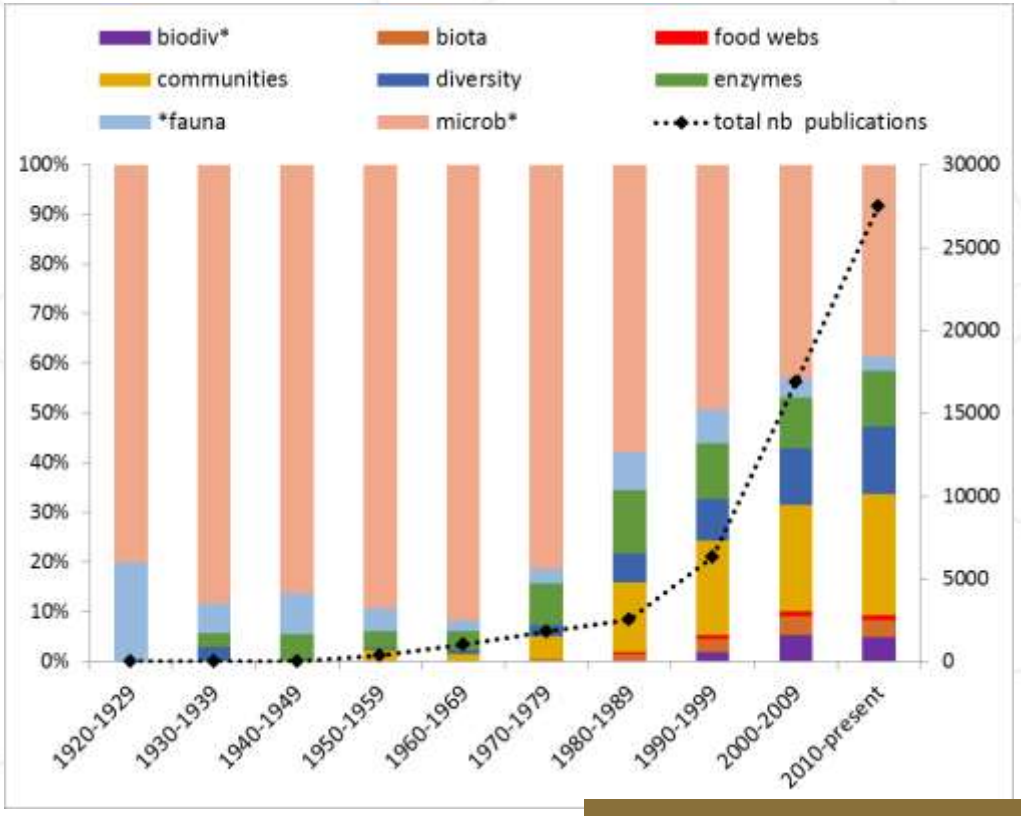
Soil biodiversity



Soil biodiversity



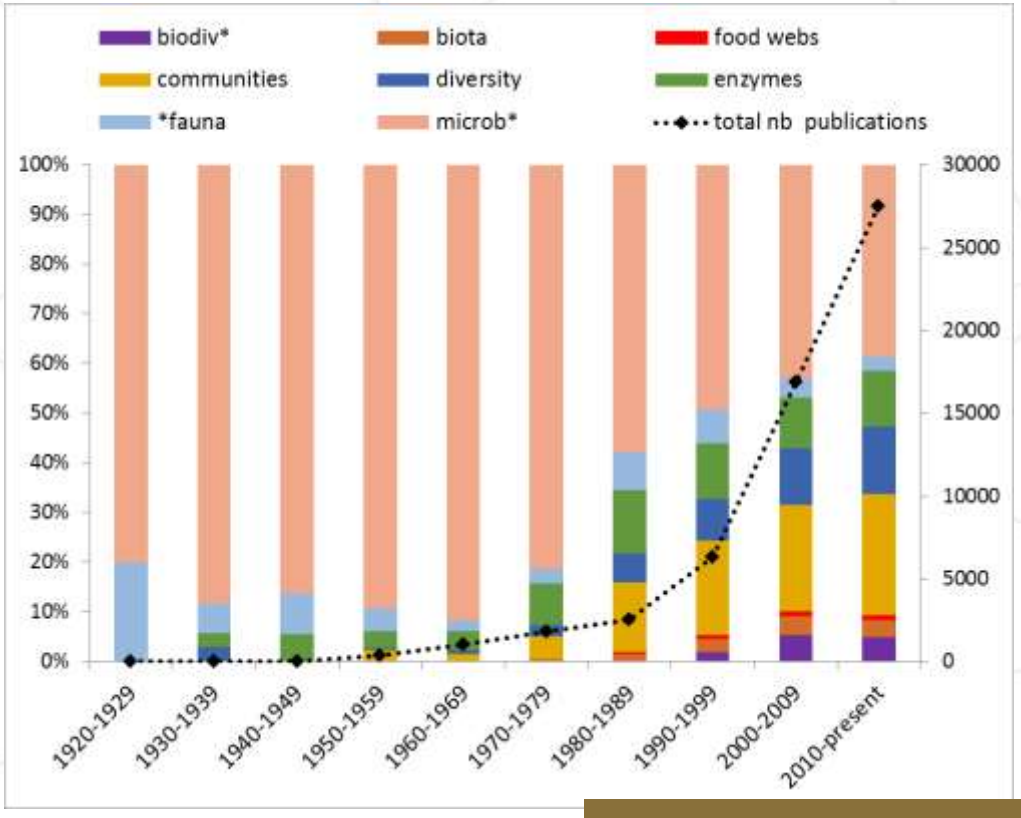
Trends on soil biodiversity research



Soil biodiversity (SB) research over time

Growing understanding and apreciation of soil biodiversity and its complexity

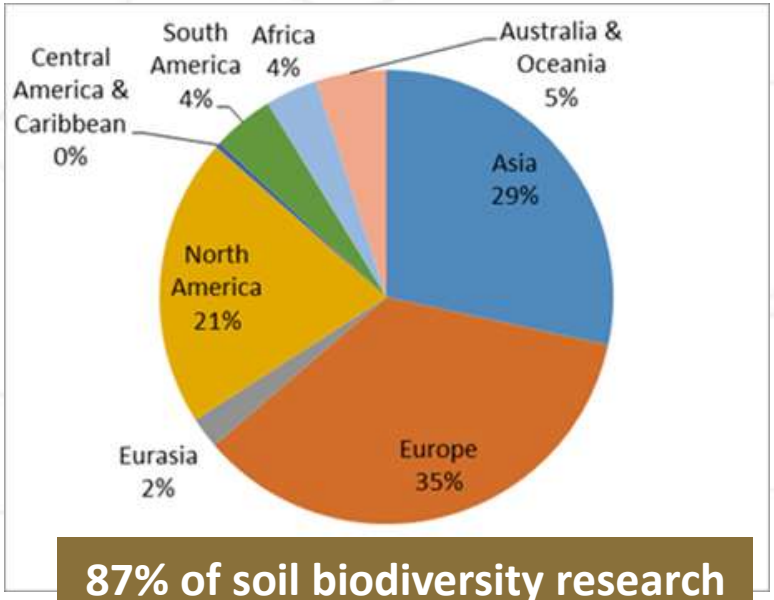
Trends on soil biodiversity research



Soil biodiversity (SB) research over time

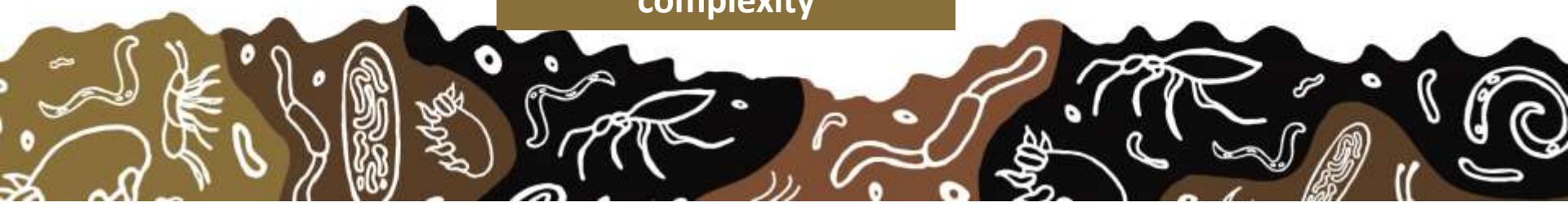
Growing understanding and apreciation of soil biodiversity and its complexity

Geographic distribution of SB research

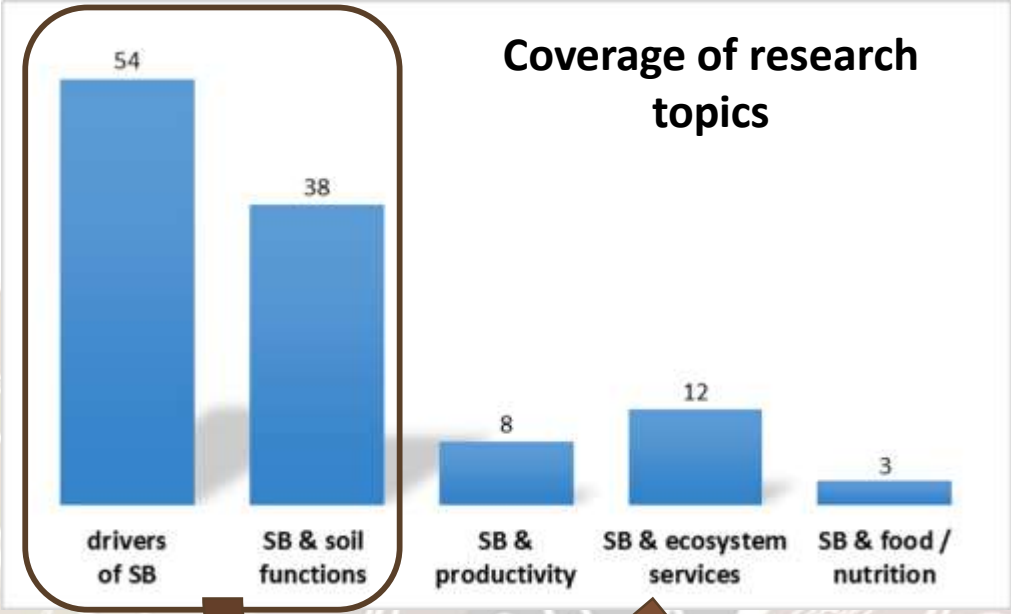


87% of soil biodiversity research is from Northern hemisphere

→ Research gap for Southern hemisphere

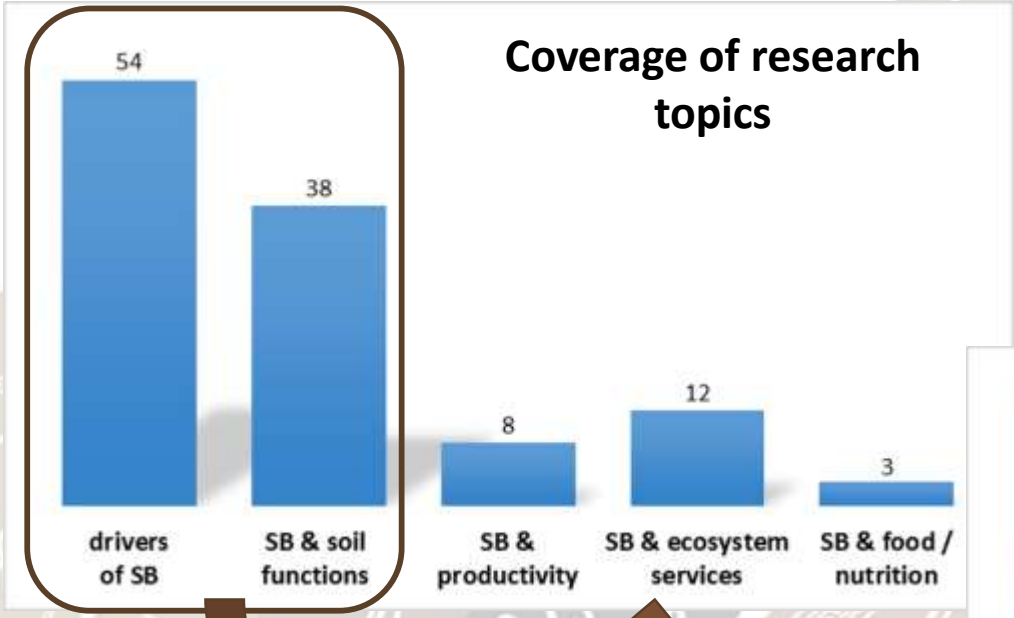


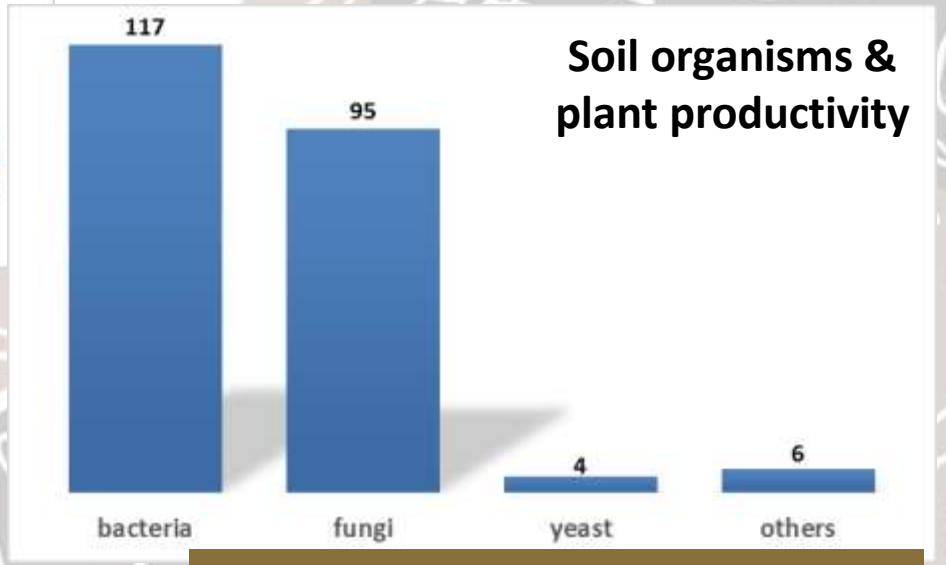
Trends on soil biodiversity research



Potential of soil biodiversity management to improves soil productivity, ecosystem services and food security and nutrition

Trends on soil biodiversity research





Potential of soil biodiversity management to improves soil productivity, ecosystem services and food security and nutrition

Chemical engineers (CE)
Soil processes related to CE
- **C & nutrient cycling**
- **Soil organic matter dynamics**
- **Plant-soil biota interactions**

Trends on soil biodiversity research

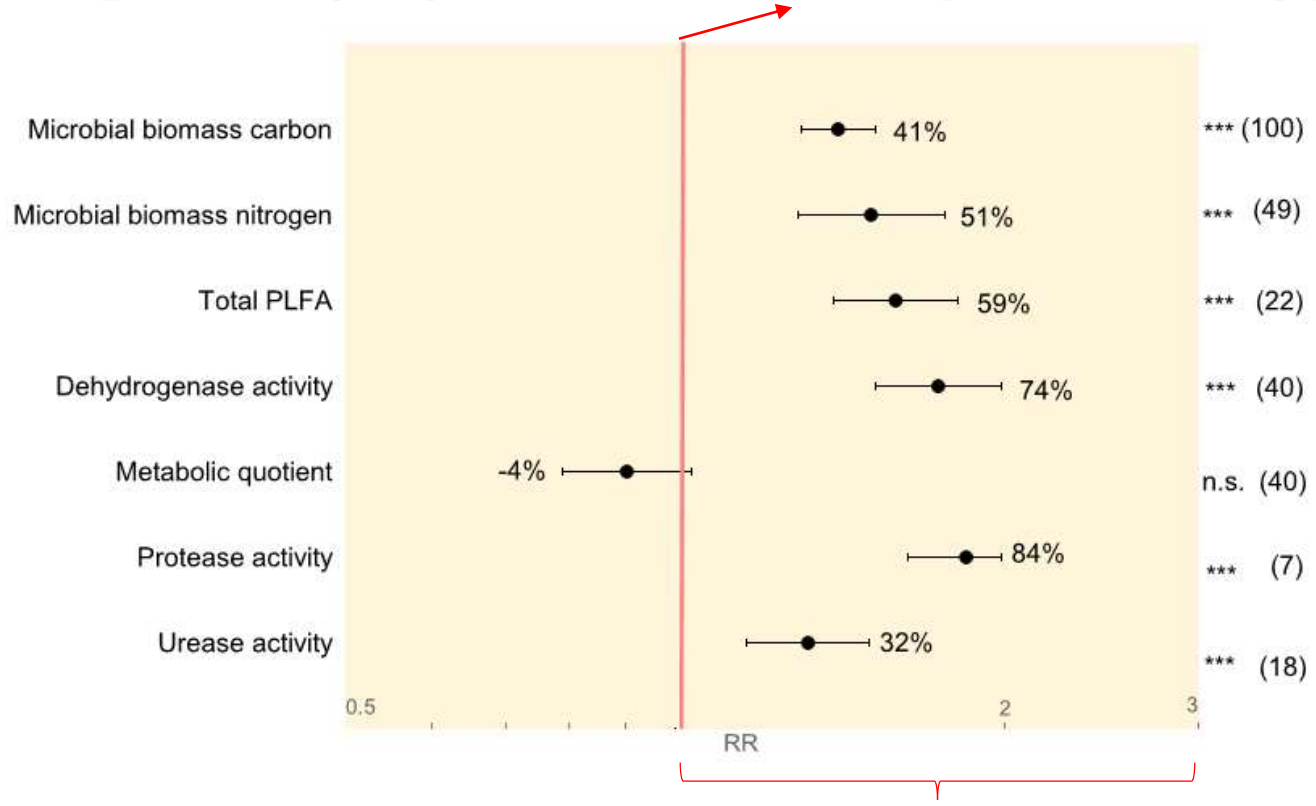
Functional group	Forest → Grassland	Grassland → Cropland	Cropland → Urban land
Chemical engineers	↘ ↘fungi, ↗ bacteria	↘ (but some local ↗)	↘
Biological regulators	= / ↗ ↗ nematodes ↘ microarthropods	↘ Plant-feeding -> bacteria-feeding nematodes	↘
Ecosystem engineers	↗ anecic -> endogeic earthworms	↘ / 0 ↘ anecic earthworms	↘

Ecosystem service	Forest → Grassland	Grassland → Cropland	Cropland → Urban land	Affected soil functions
Soil fertility and nutrient cycling	=/↘	↘	↘	Reduced decomposition of soil organic matter Reduced biological control
Regulation of carbon flux and climate control	↘	↘	↘	Reduced decomposition and mixing of soil organic matter
Regulation of the water cycle	-	↘	↘	Reduced burrowing activity
Decontamination and bioremediation	-	↘	↘	Impaired self-regulation of ecosystems
Pest control	-	↘	↘	Reduced biological control

Diversity & diversity-mediated soil processes are **negatively** affected by land use change and intensive agriculture

Turbé et al. 2010. Soil biodiversity: functions, threats and tolos for policy makers

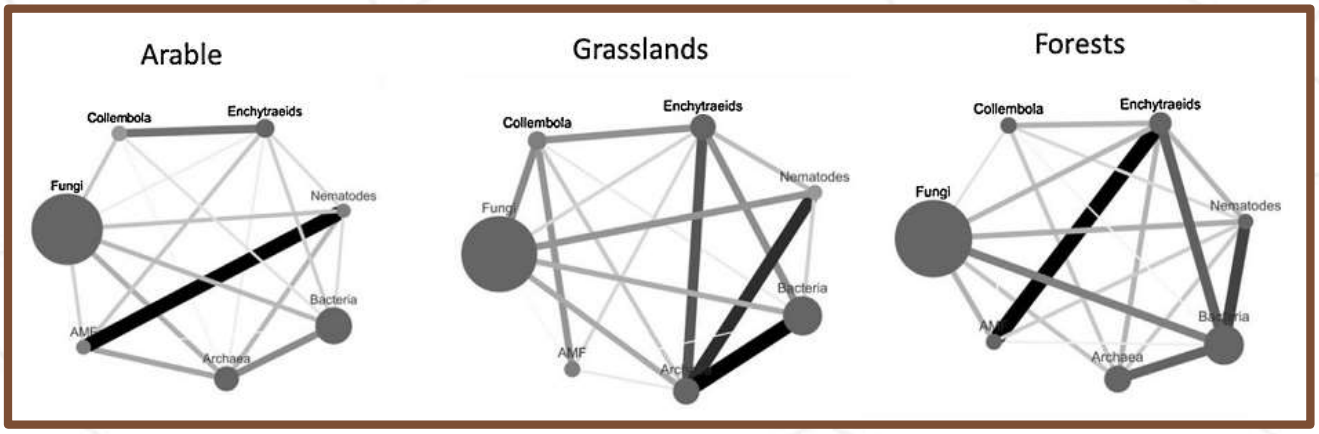
Trends on soil biodiversity research



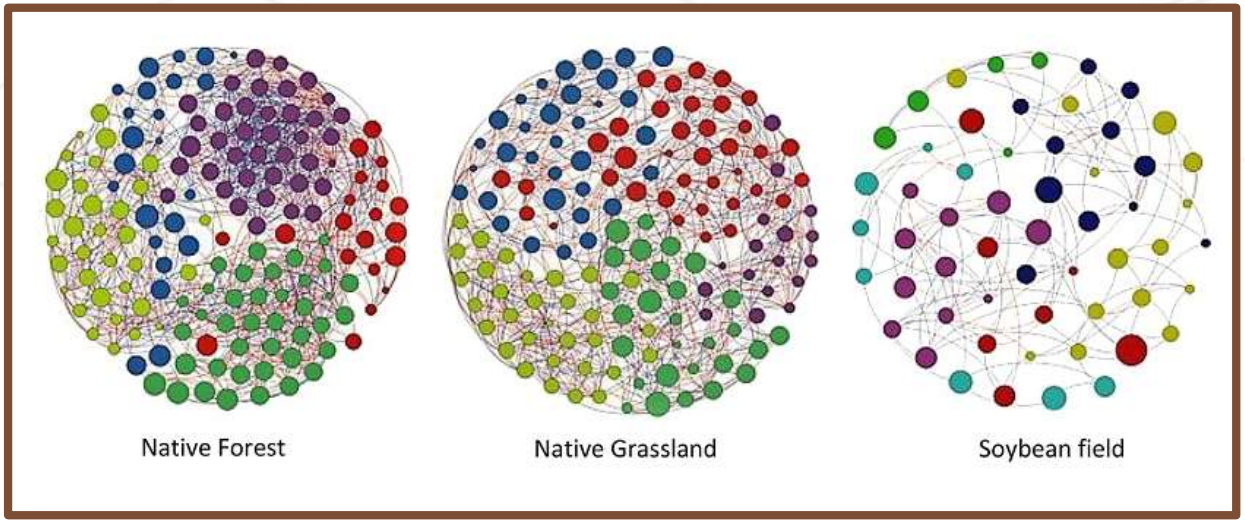
Diversity & diversity-mediated soil processes are **positively** affected by organic or agro-ecological farming

Lori et al. 2017. PLOS ONE, 12(7): e0180442

Trends on soil biodiversity research



Network interactions could be **more important** than richness and abundance

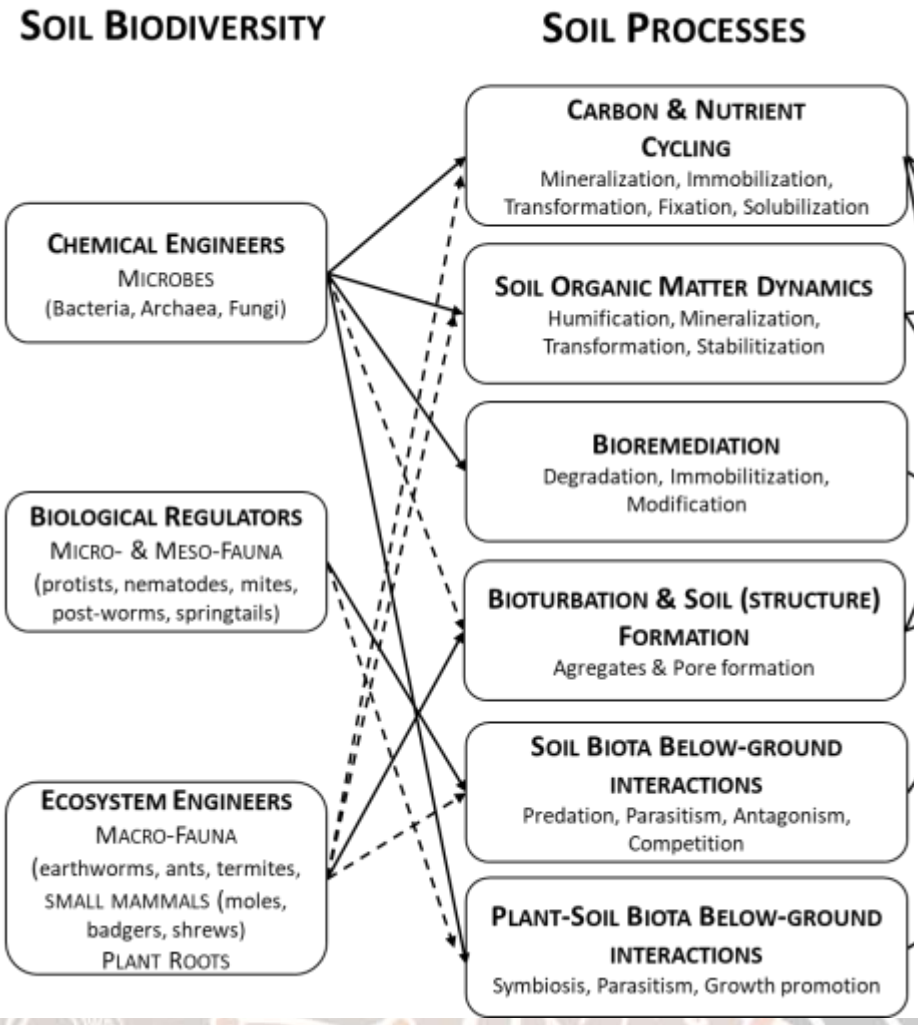


Creamer et al. 2016. Applied Soil Ecology 97, 112–124.

Lupatini et al. 2014. Front. Environ. Scif, envs.2014.00010

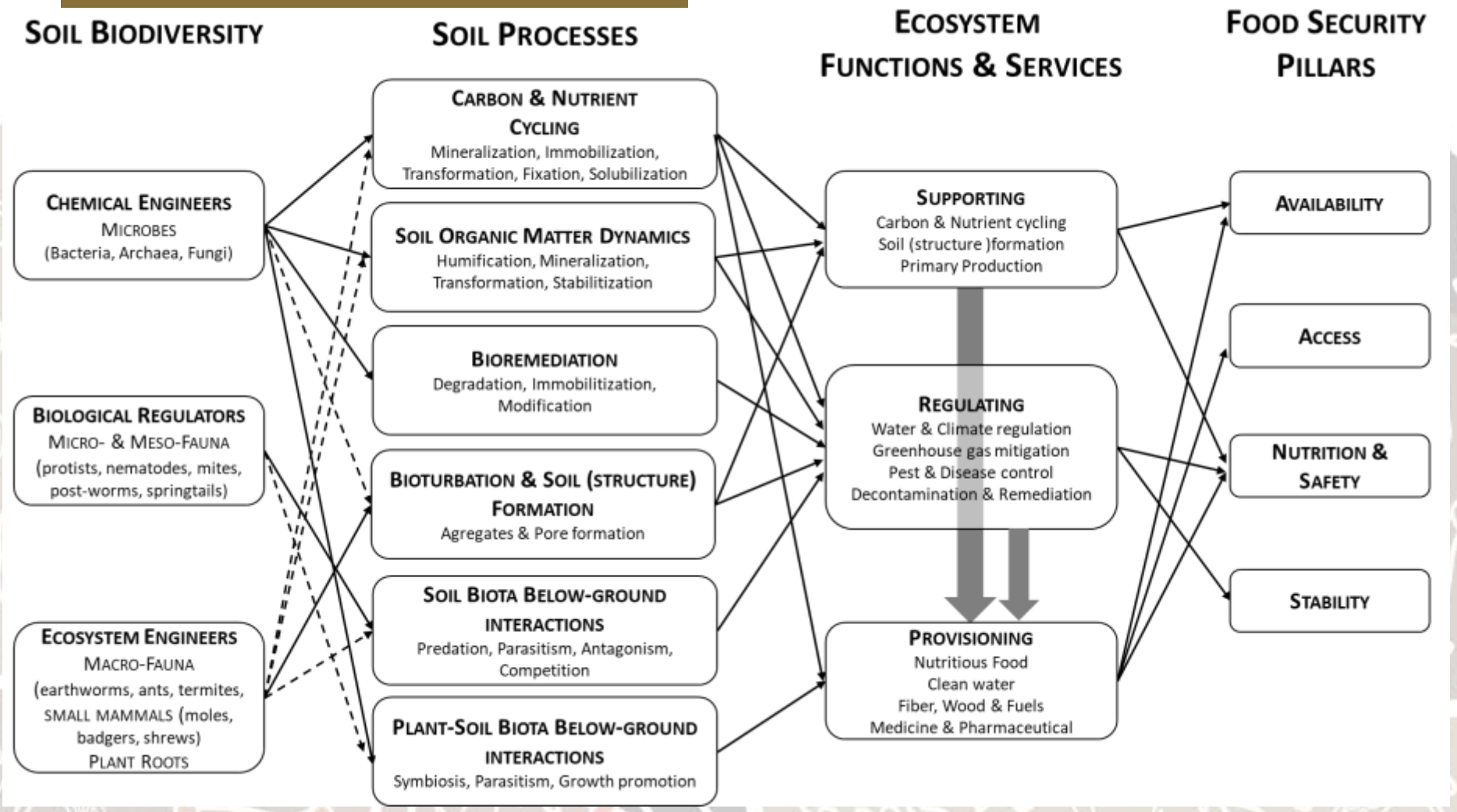
Soil biodiversity and food security

Direct and indirect effects



Soil biodiversity and food security

Direct and indirect effects

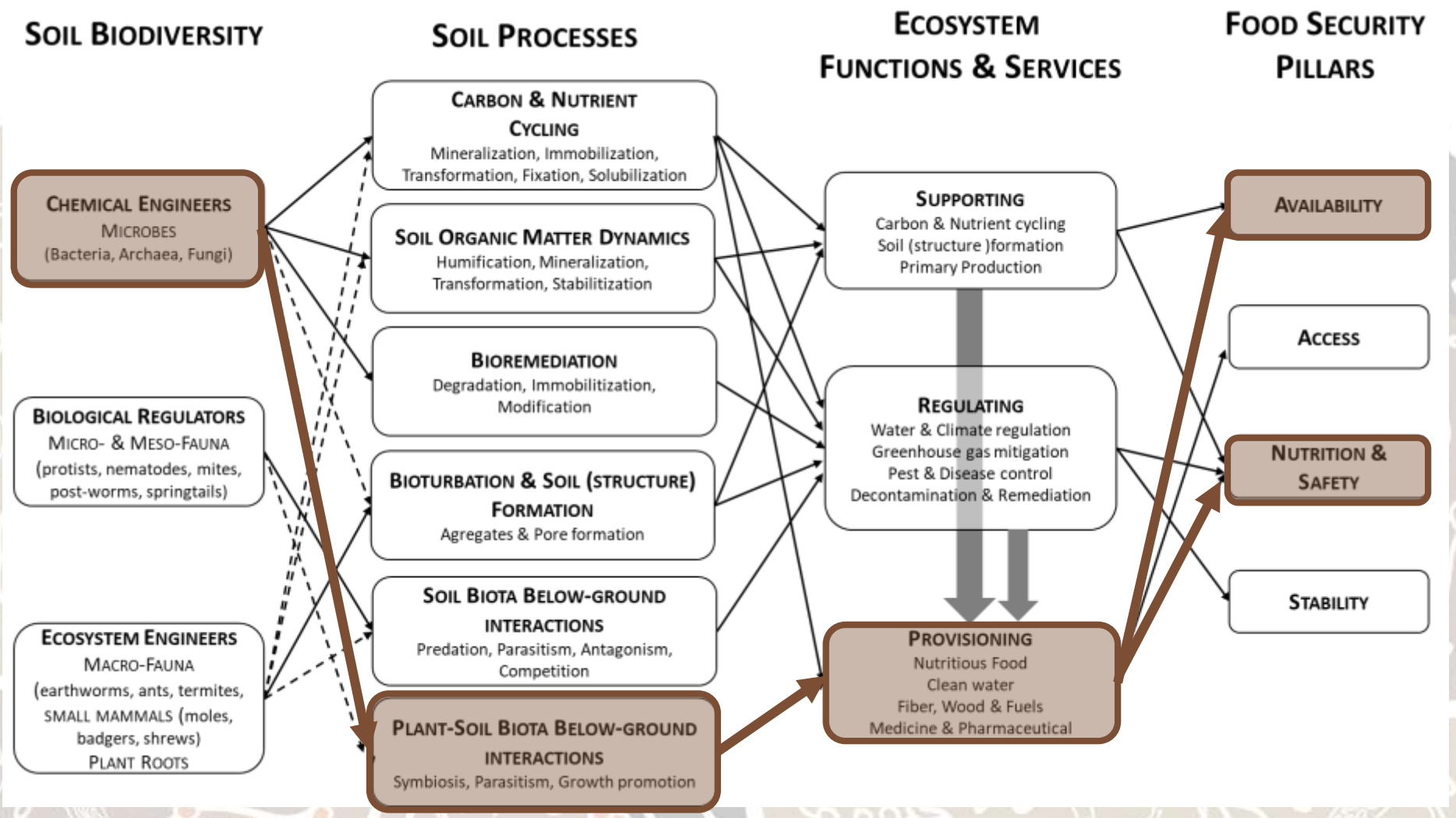


Emerging approaches for soil biodiversity management

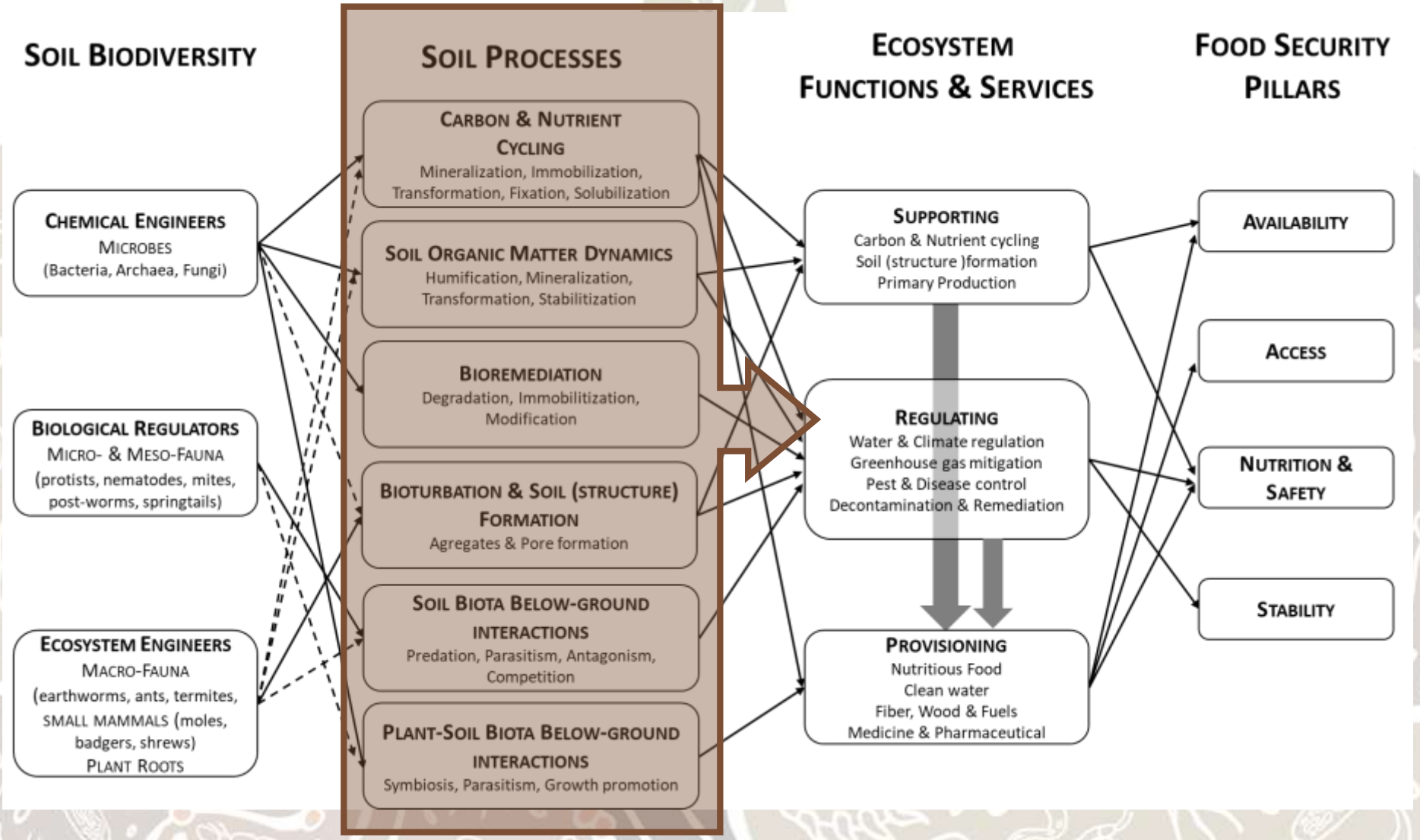
Reductionist Approach

Holistic Approach

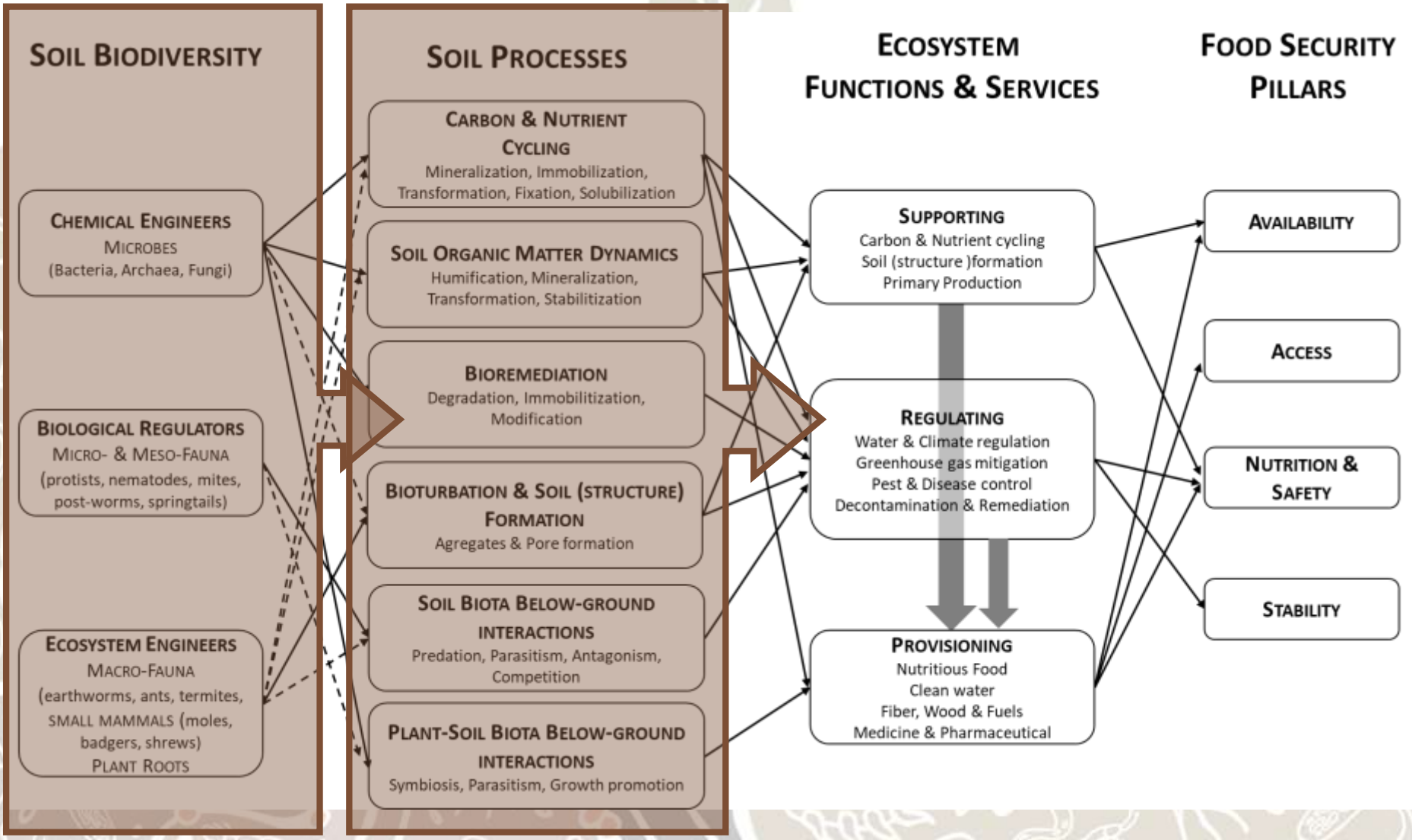
Soil biodiversity management by Reductionist Approach



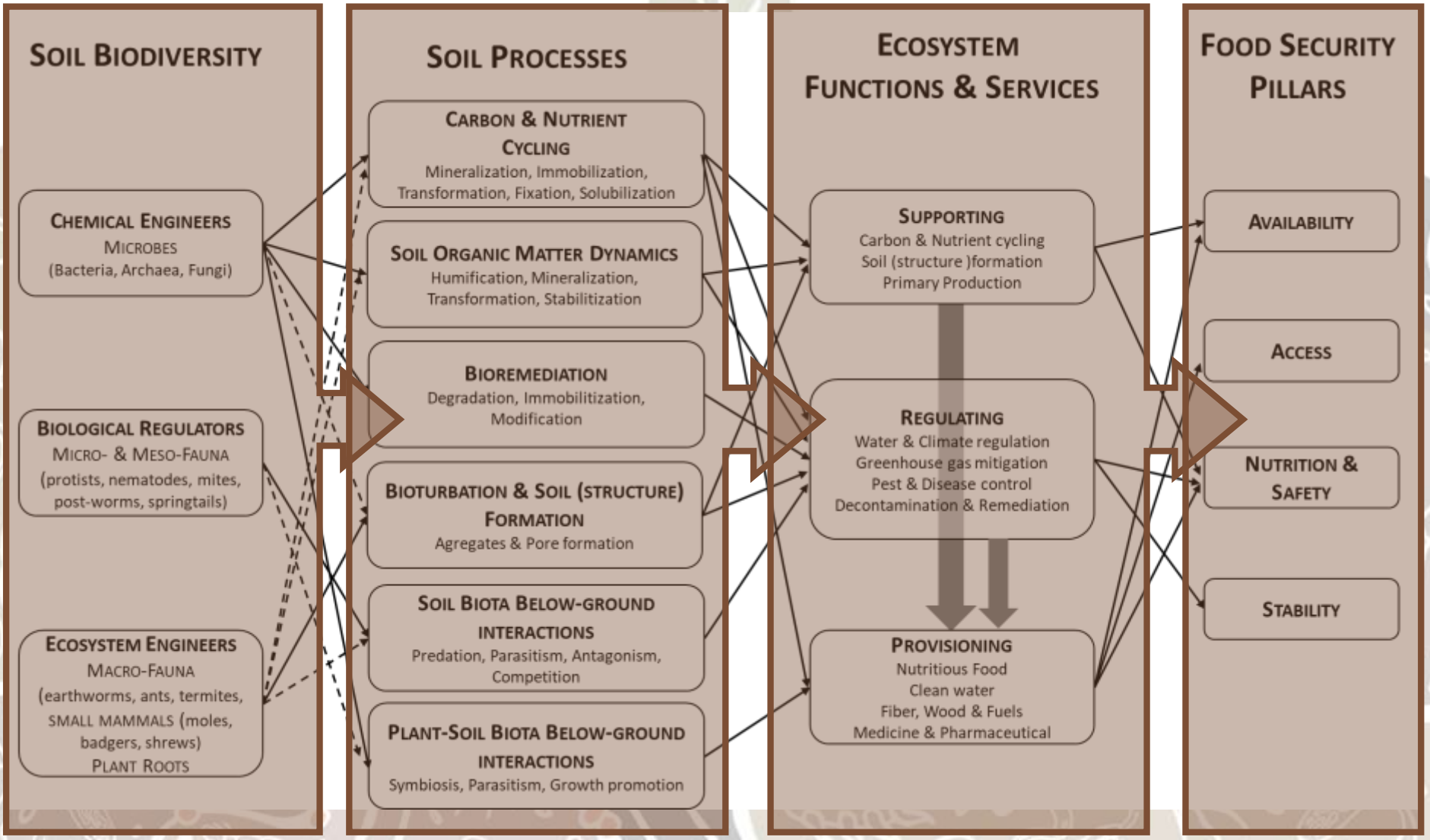
Soil biodiversity management by Holistic Approach



Soil biodiversity management by Holistic Approach



Soil biodiversity management by Holistic Approach



Emerging approaches for soil biodiversity management

Reductionist Approach

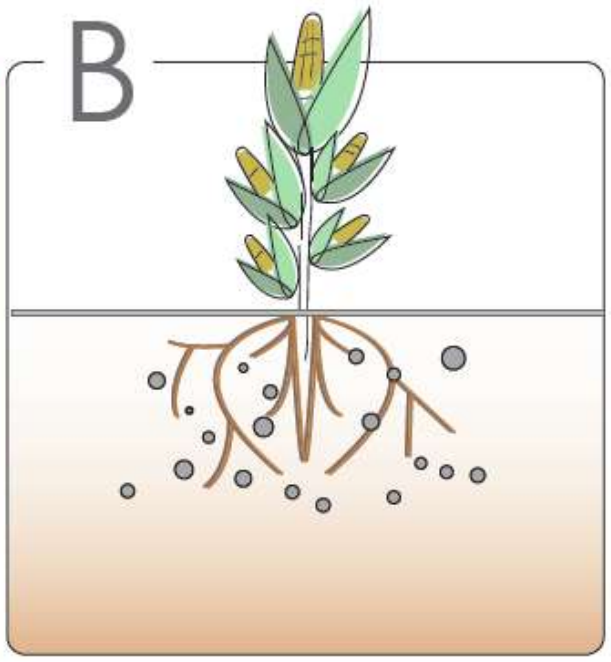
soil-plant interactions
tapping organisms/genes
through biotechnology

Holistic Approach

managing soil ecosystems &
their diversity
→ multifunctionality,
resilience & adaptive capacity

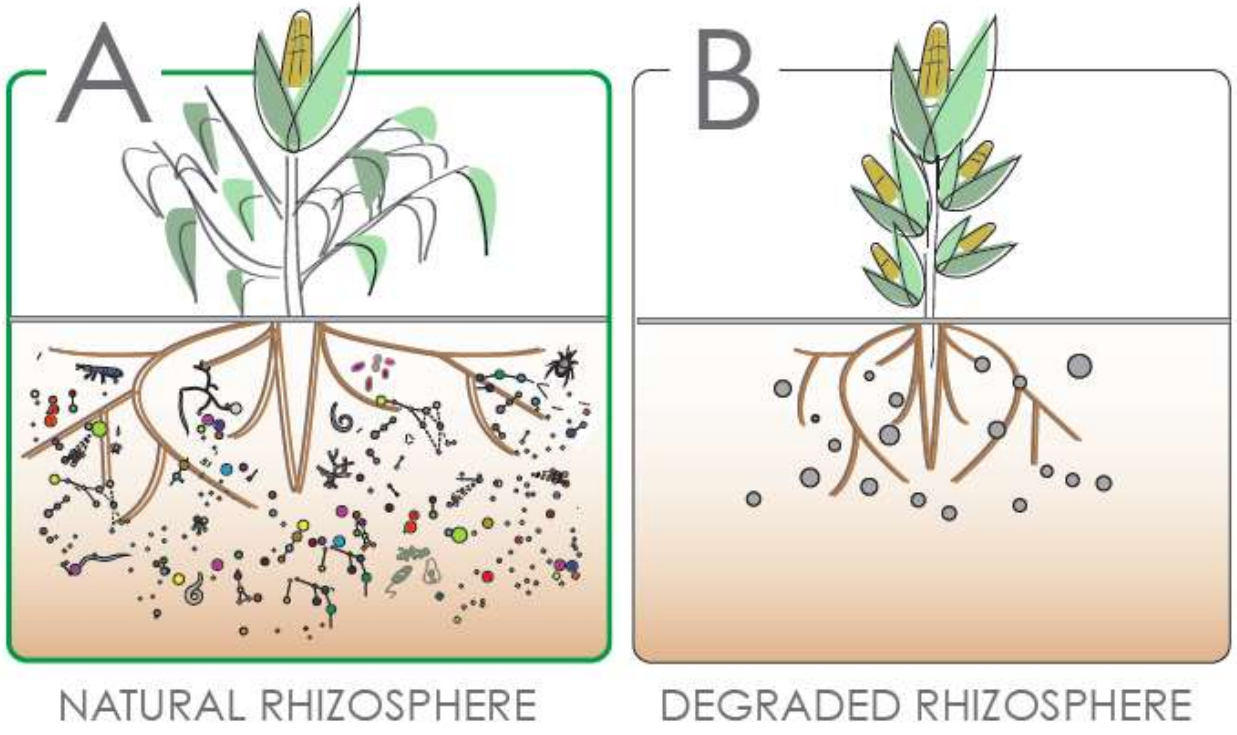
complementarity & self-
regulation of soil interactions

Reductionist approach



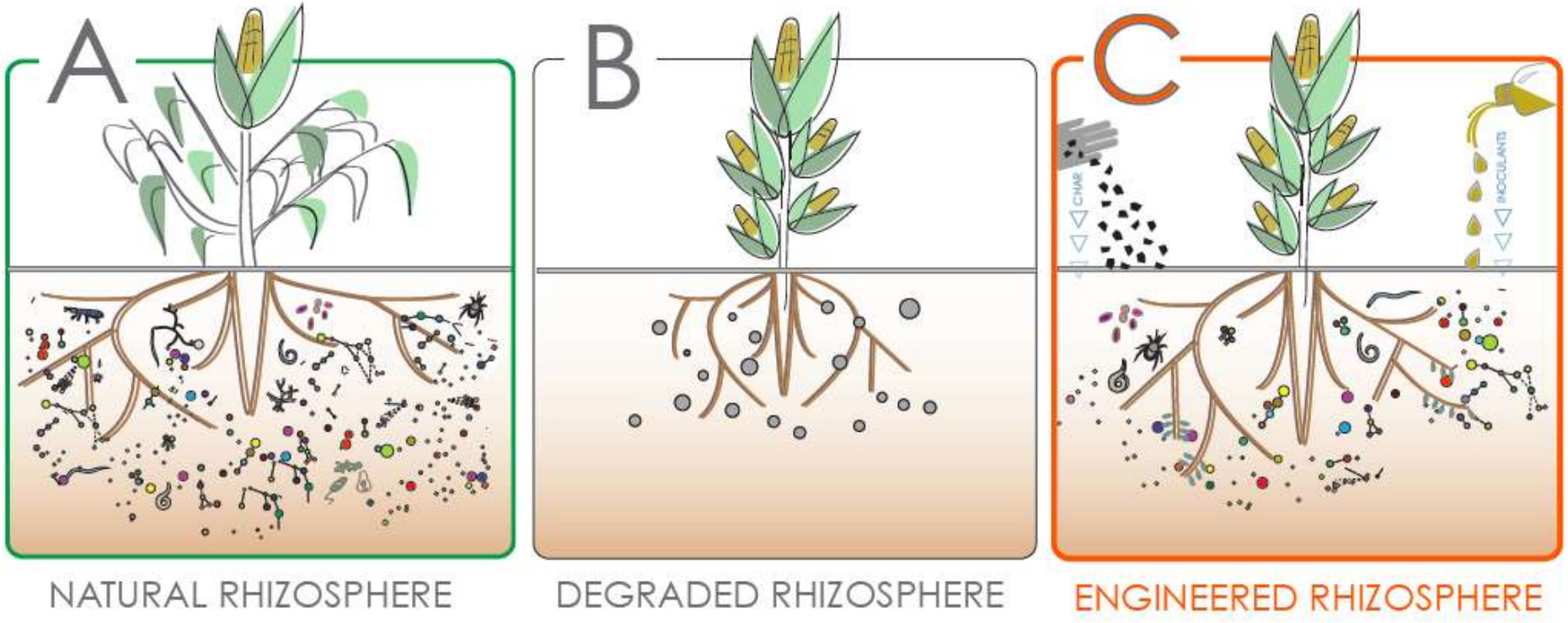
Wallenstein. 2017. Rhizosphere, 3(2): 230-232

Reductionist approach



Wallenstein. 2017. Rhizosphere, 3(2): 230-232

Reductionist approach

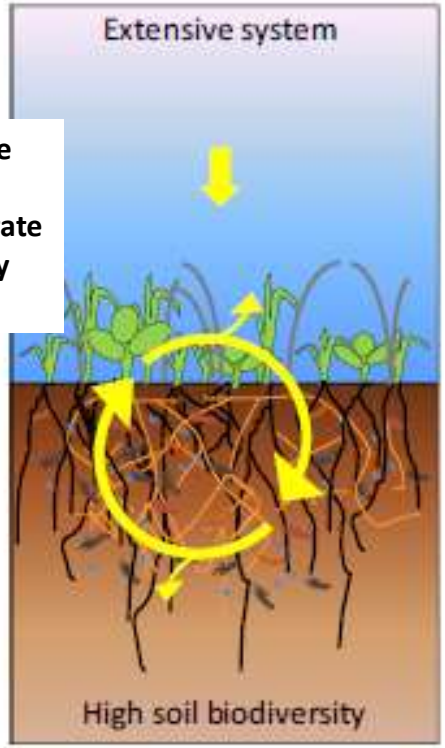


Wallenstein. 2017. Rhizosphere, 3(2): 230-232

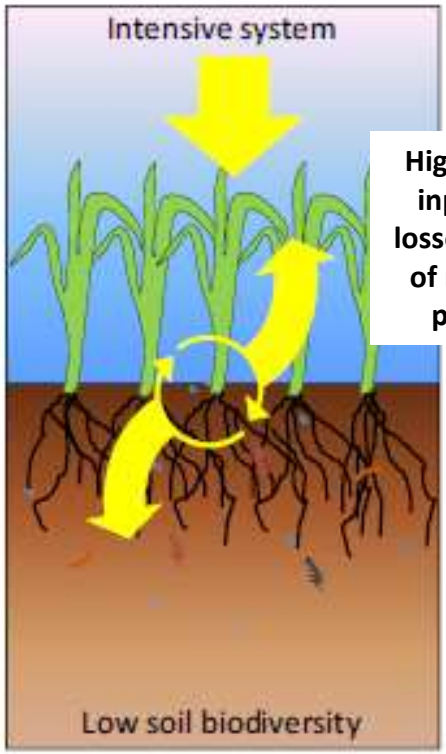
Holistic approach

Low productivity

Low resource inputs and outputs, high rate of regulatory processes



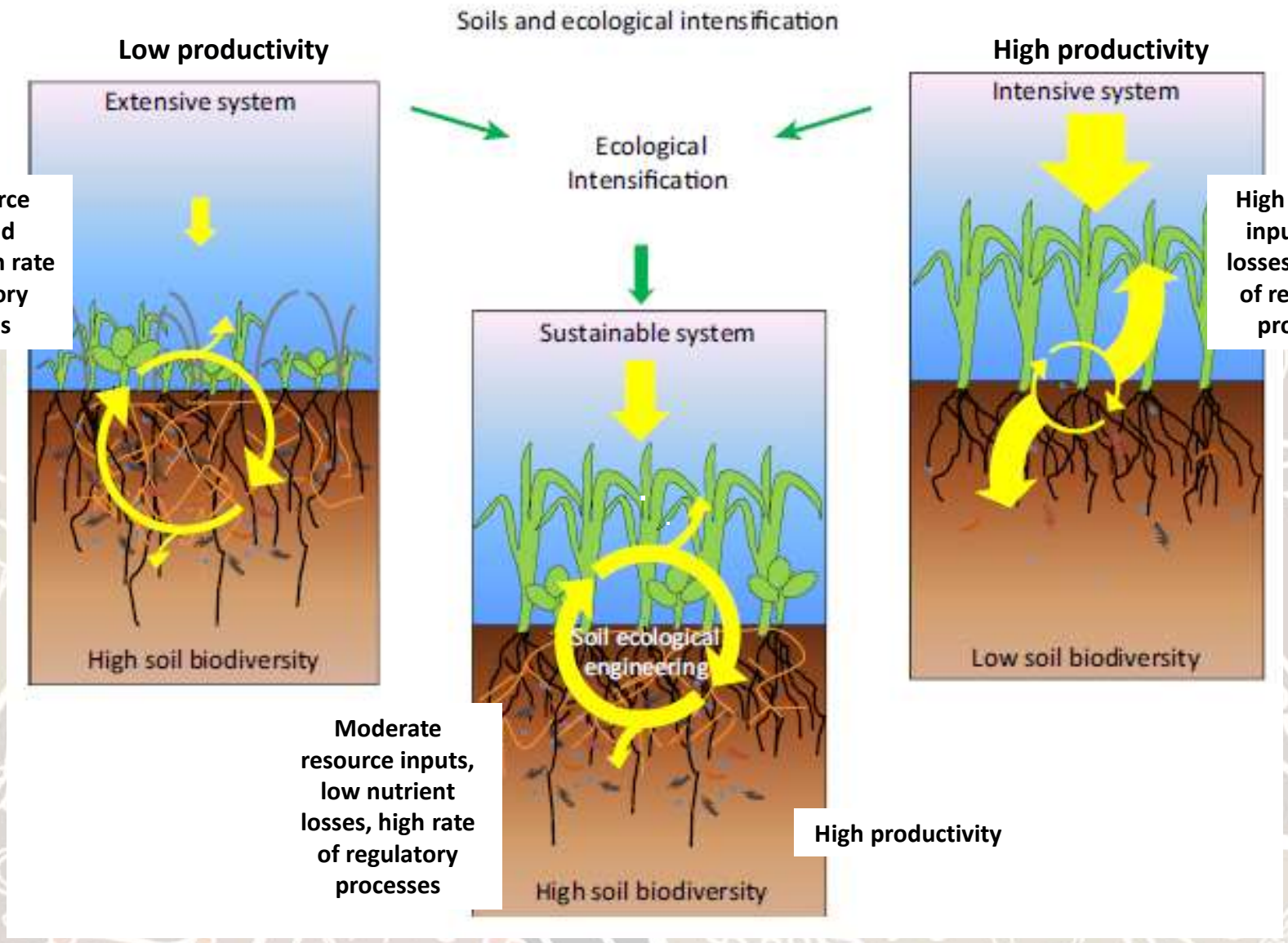
High productivity



High resource inputs, high losses, low rate of regulatory processes

Bender et al. 2016. Trends in Ecology & Evolution, 31 (6): 440-452

Holistic approach



Bender et al. 2016. Trends in Ecology & Evolution, 31 (6): 440-452

This knowledge provides direction on how to improve agroecosystems to support food security and other ecosystem services

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Thank you for your attention!

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