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<https://giaasp.org/>

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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. Titttonell^{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

Systematic literature search



WEB OF SCIENCE™
Scopus®

Search
strategy 1
[56,631]^a

Search
strategy 2
[62]^a

Search
strategy 3
[173]^a

Search
strategy 4
[232]^a

Classified according to scientific research topics

- *Publication date
- *Terms for SBD
- *Geographic region

- *Scale of SBD research
- *Coverage of SBD research topics

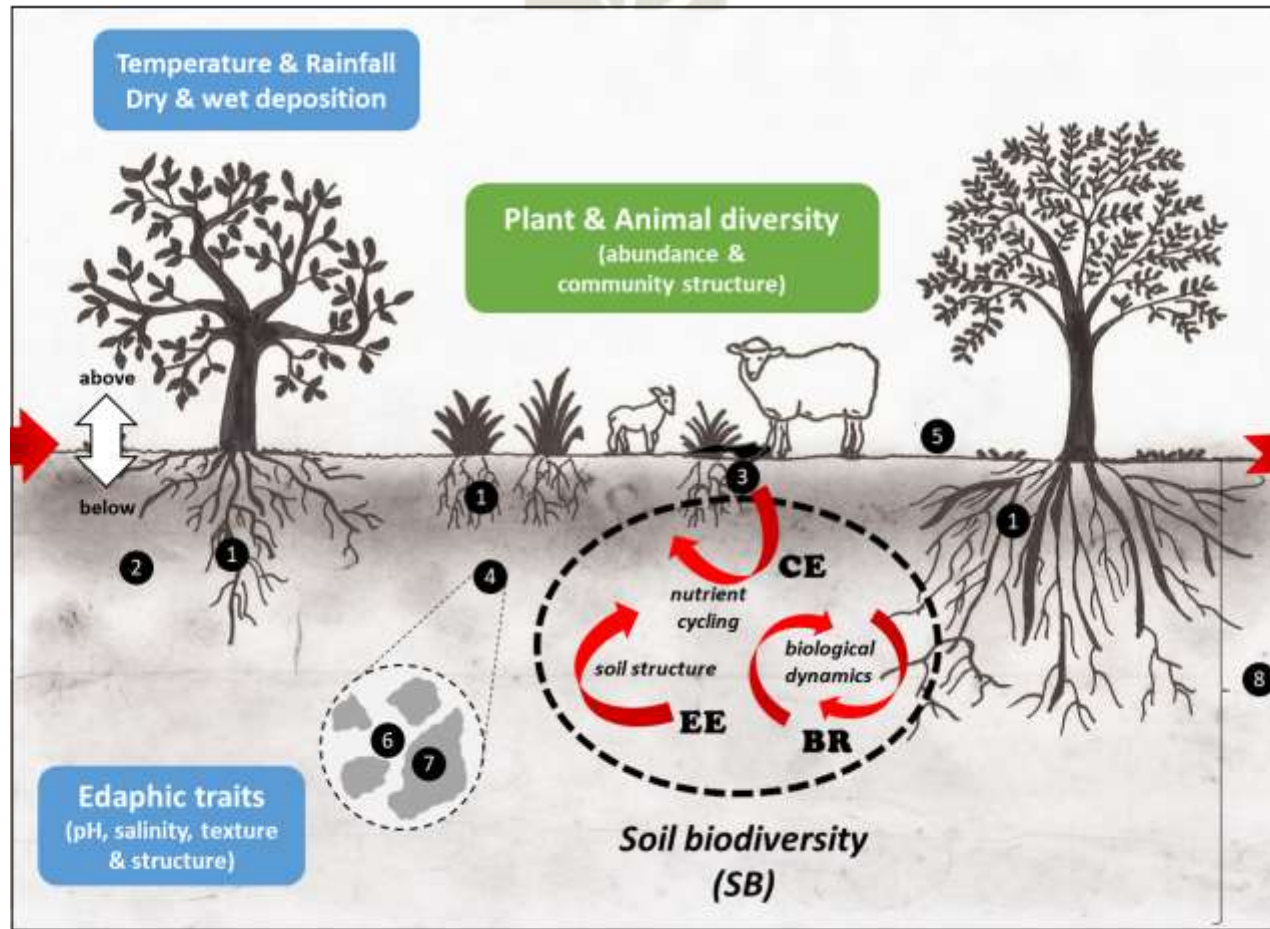
- *Major soil organisms and crops studied

- *Major scientific topic
- *Direct role of soil biota and impact on productivity
- *Soil organisms studied

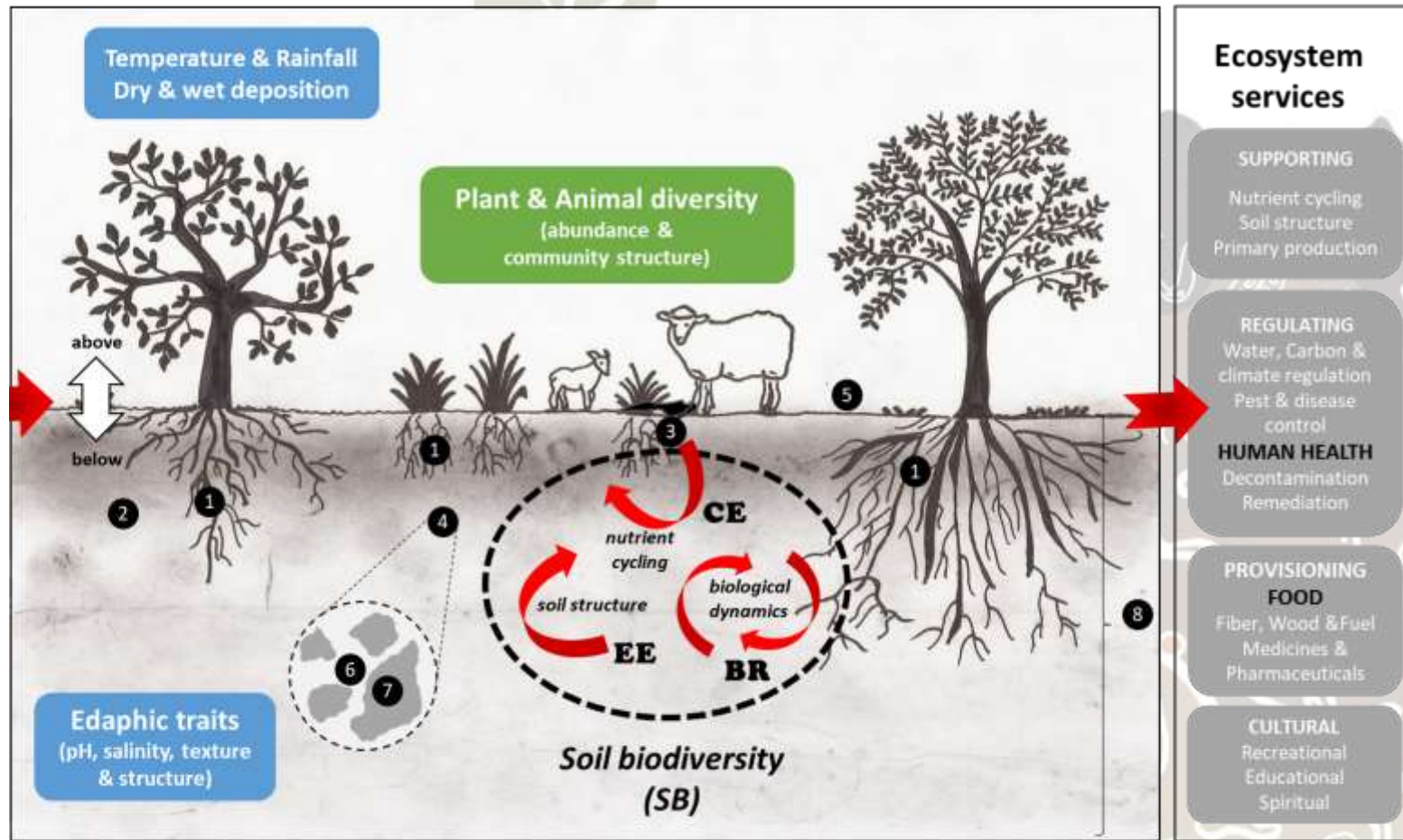
Trends on Soil Biodiversity research
Land use and agricultural impacts on soil biodiversity
Soil Biodiversity Management and Food Security



Soil biodiversity



Soil biodiversity



Soil biodiversity

Drivers

SOIL DEGRADATION

Soil organic matter depletion, erosion, salinisation & compaction
→ Influenced by soil management, over-grazing, forest fires & deforestation

LAND USED CHANGE



SOIL MANAGEMENT

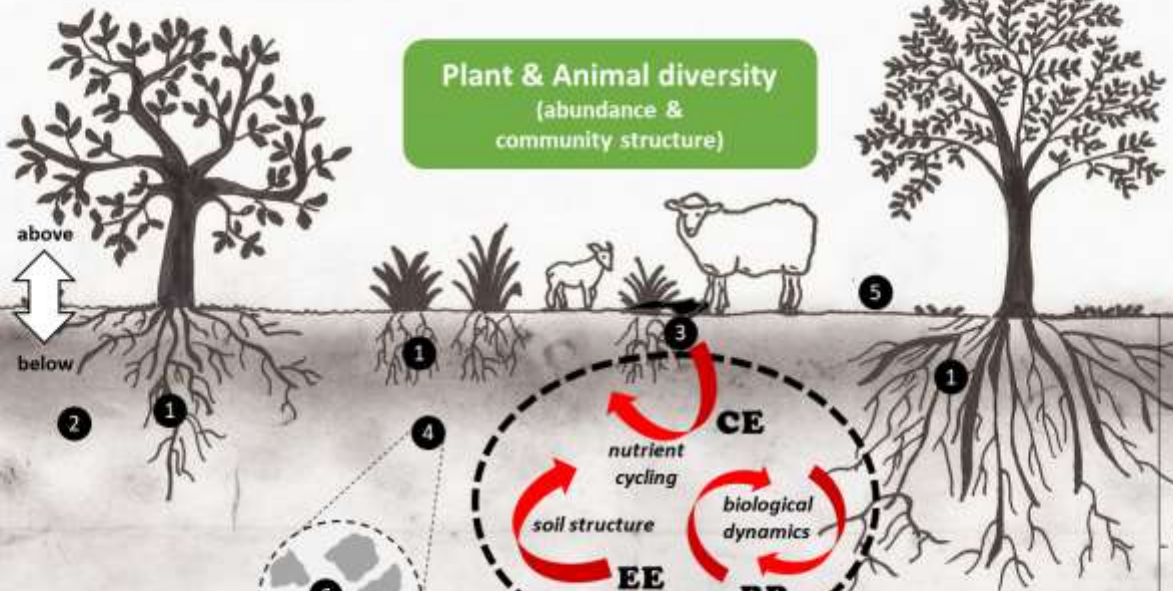


CLIMATE CHANGE

Direct & Indirect effects linked to temperature & moisture changes

Temperature & Rainfall
Dry & wet deposition

Plant & Animal diversity
(abundance & community structure)



Edaphic traits
(pH, salinity, texture & structure)

Ecosystem services

SUPPORTING

Nutrient cycling
Soil structure
Primary production

REGULATING

Water, Carbon & climate regulation
Pest & disease control

HUMAN HEALTH

Decontamination
Remediation

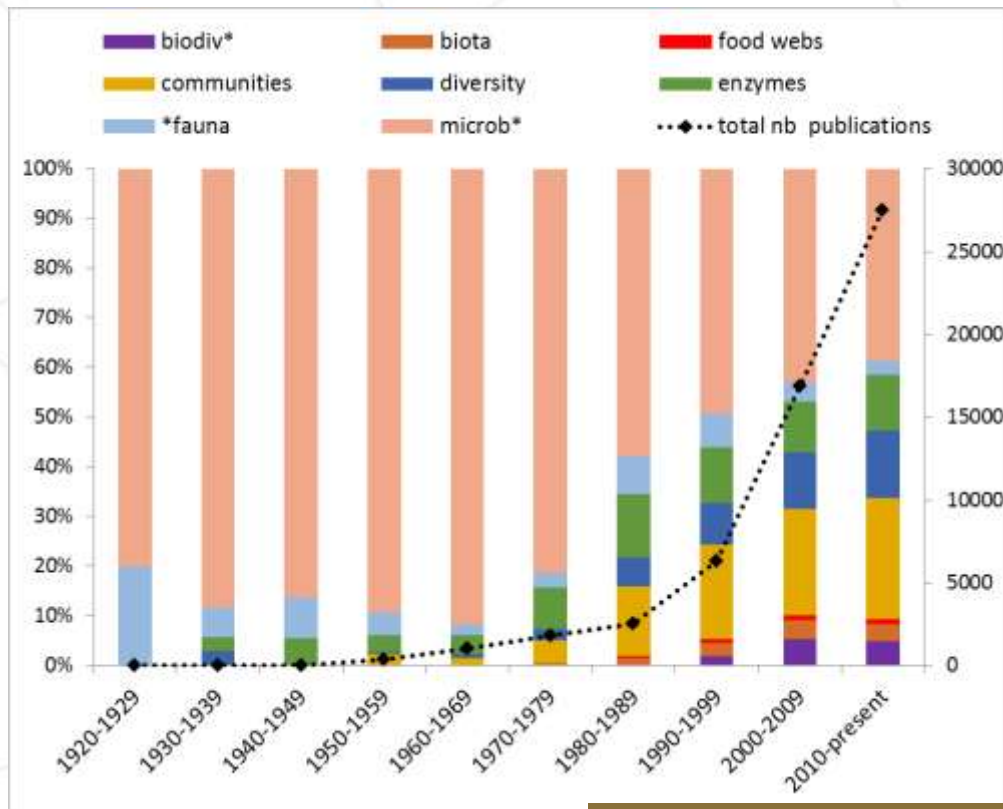
PROVISIONING

FOOD
Fiber, Wood & Fuel
Medicines & Pharmaceuticals

CULTURAL

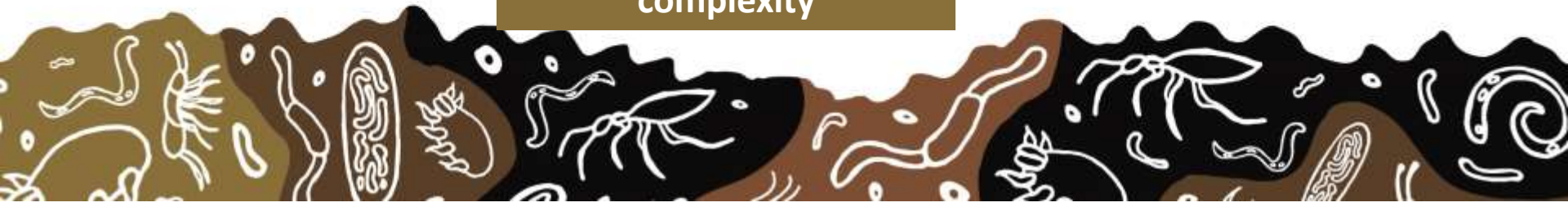
Recreational
Educational
Spiritual

Trends on soil biodiversity research

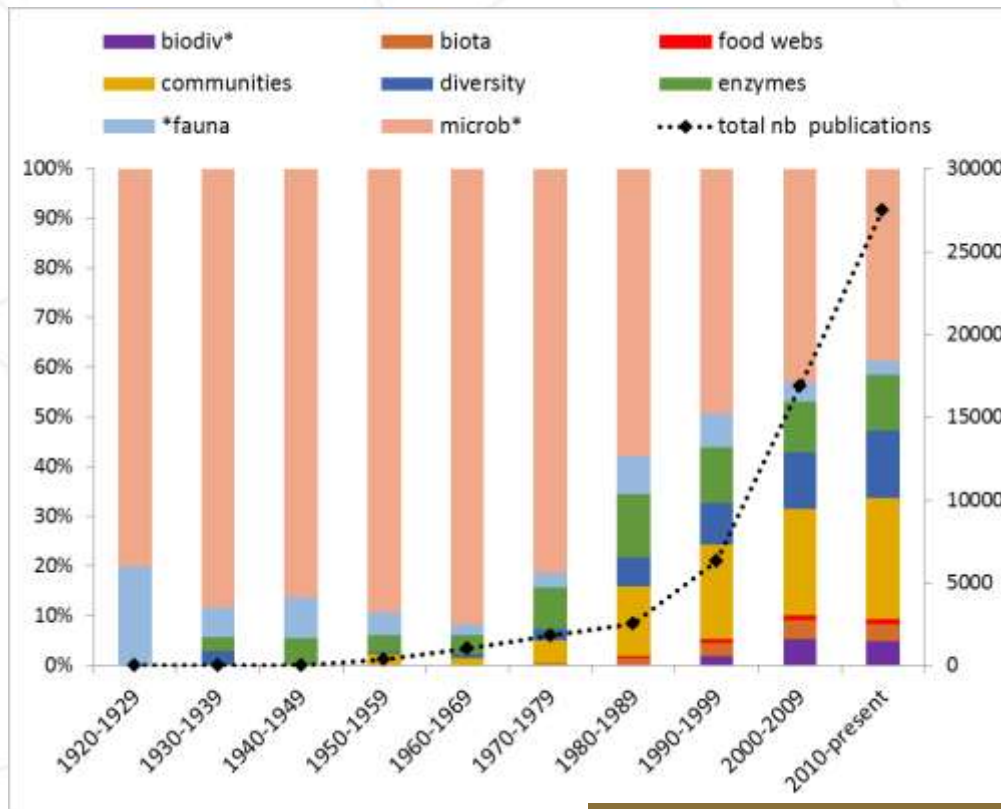


**Soil biodiversity (SB)
research over time**

**Growing understanding
and appreciation of soil
biodiversity and its
complexity**



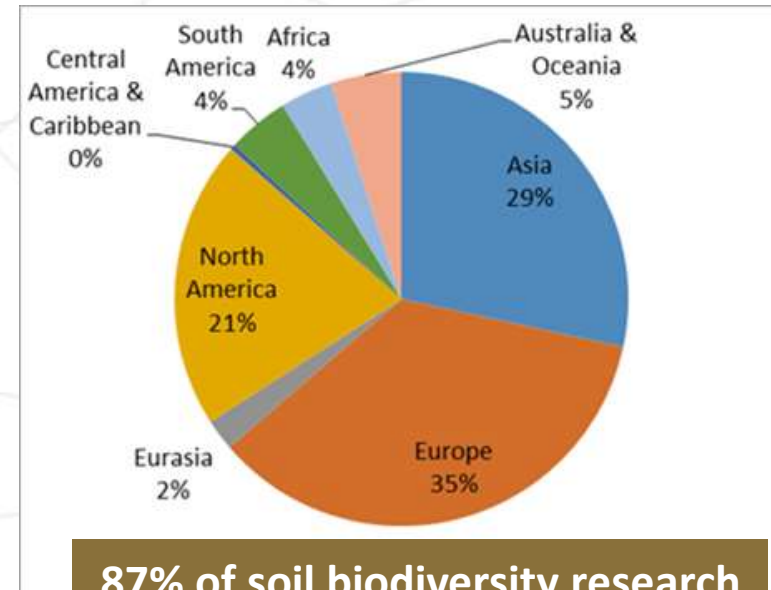
Trends on soil biodiversity research



**Soil biodiversity (SB)
research over time**

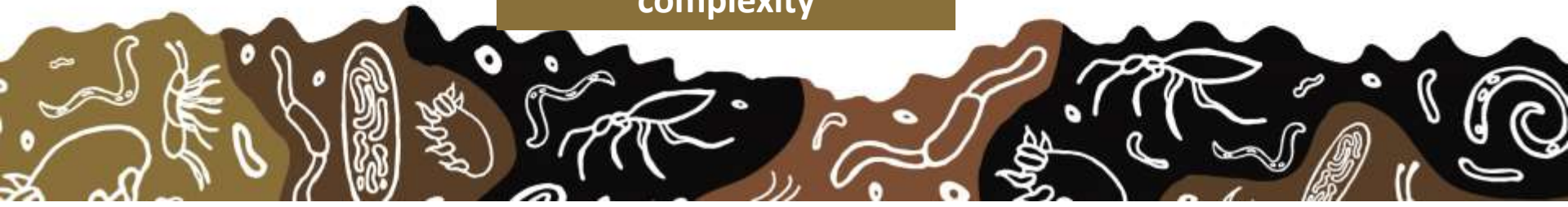
**Growing understanding
and appreciation of soil
biodiversity and its
complexity**

Geographic distribution of SB research

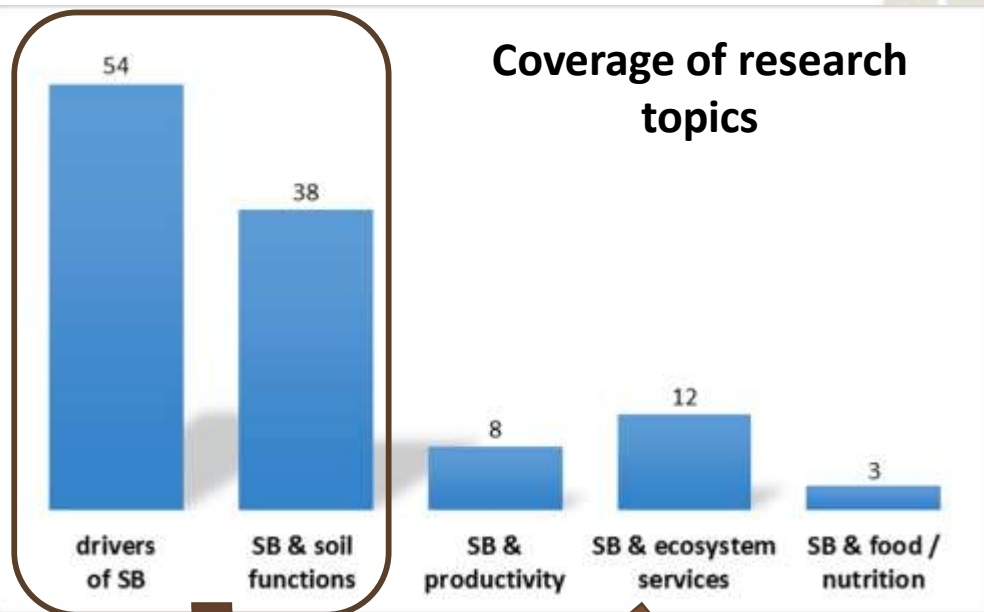


**87% of soil biodiversity research
is from Northern hemisphere**

**→ Research gap for Southern
hemisphere**



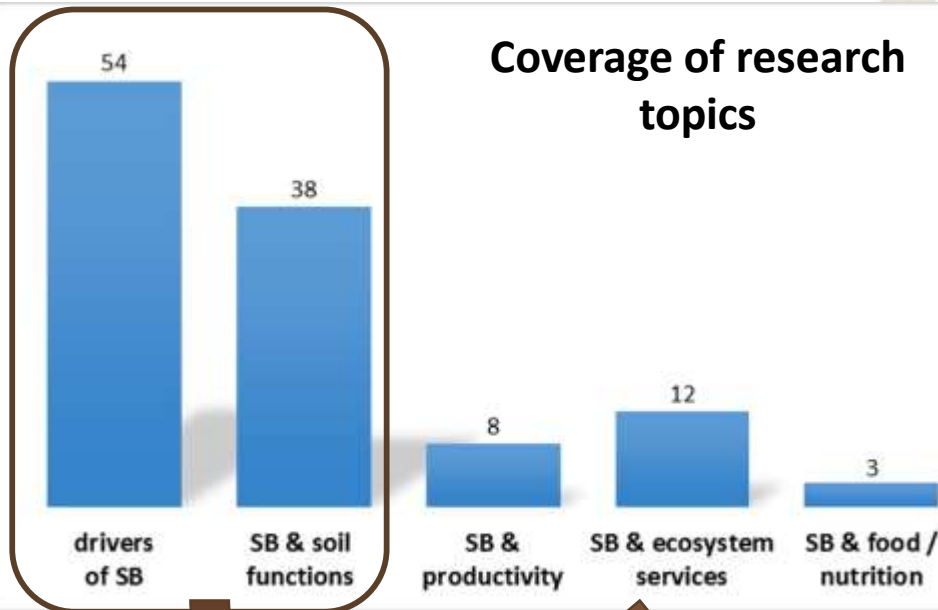
Trends on soil biodiversity research



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

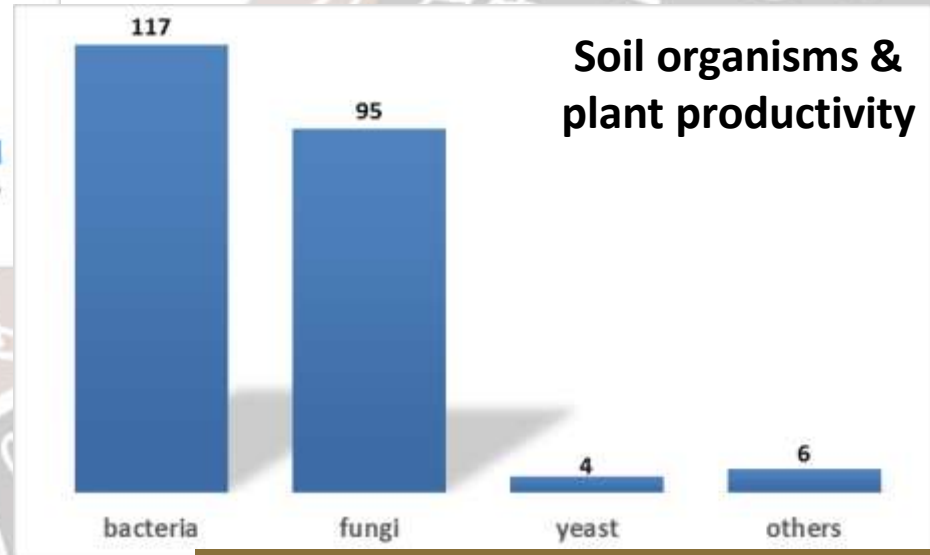
Trends on soil biodiversity research

Coverage of research topics



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

Soil organisms & plant productivity



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

Trends on soil biodiversity research

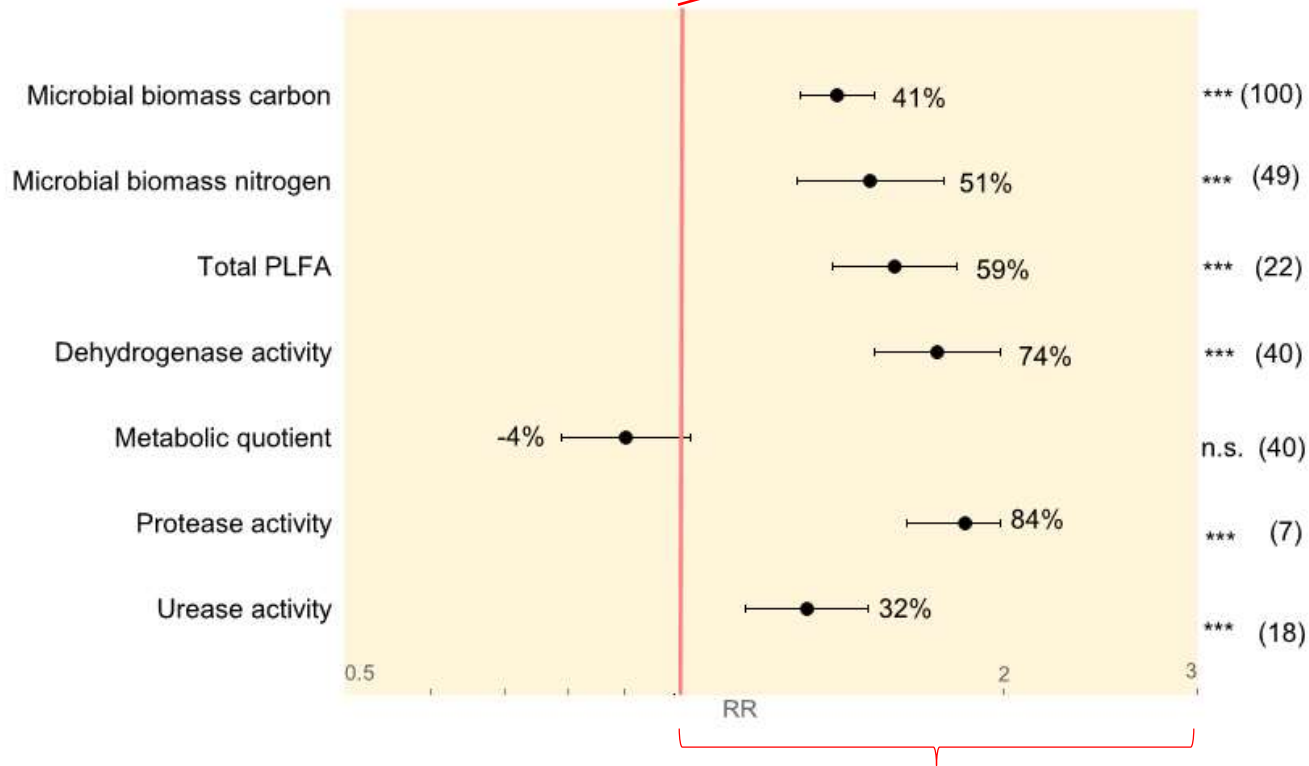
Functional group	Forest → Grassland	Grassland → Cropland	Cropland → Urban land
Chemical engineers	↘ ↘ fungi, ↗ bacteria	↘ (but some local ↗)	↘
Biological regulators	= / ↗ ↗ nematodes ↘ microarthropods	↘ Plant-feeding → bacteria-feeding nematodes	↘
Ecosystem engineers	↗ anecic → endogeic earthworms	↘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

Trends on soil biodiversity research

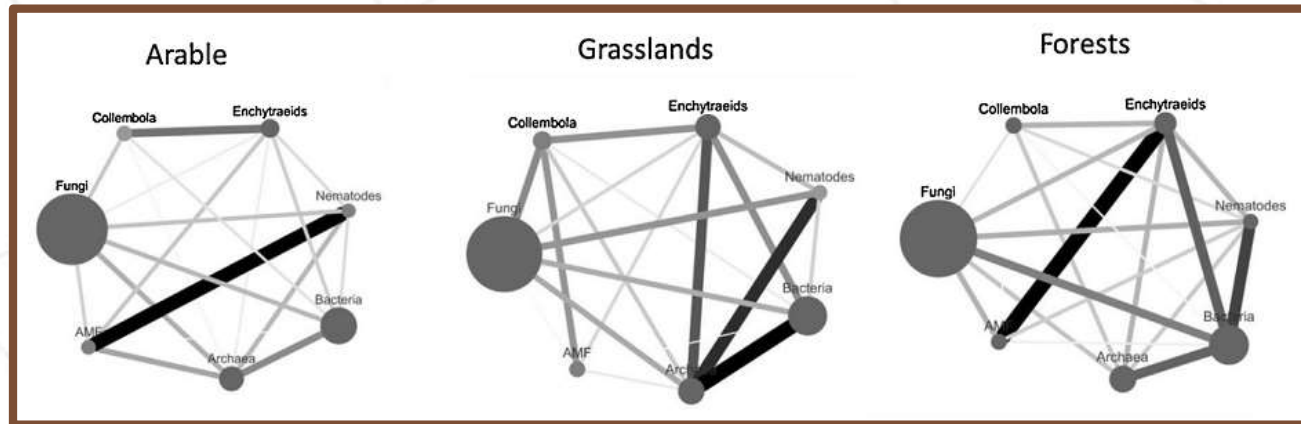
no difference between organic and conventional systems



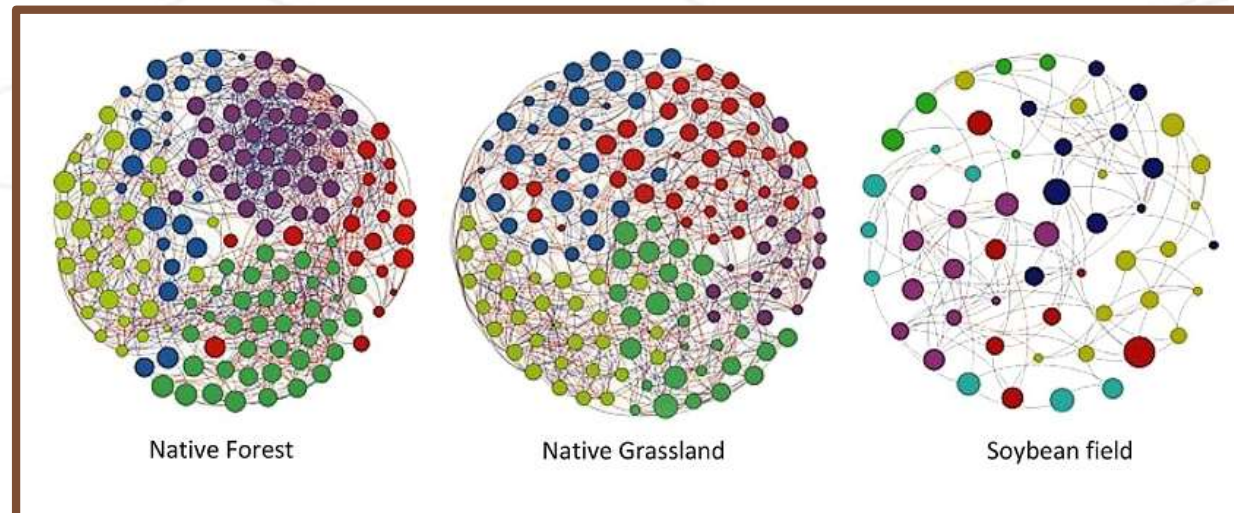
Positive effect of organic systems

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

Trends on soil biodiversity research



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

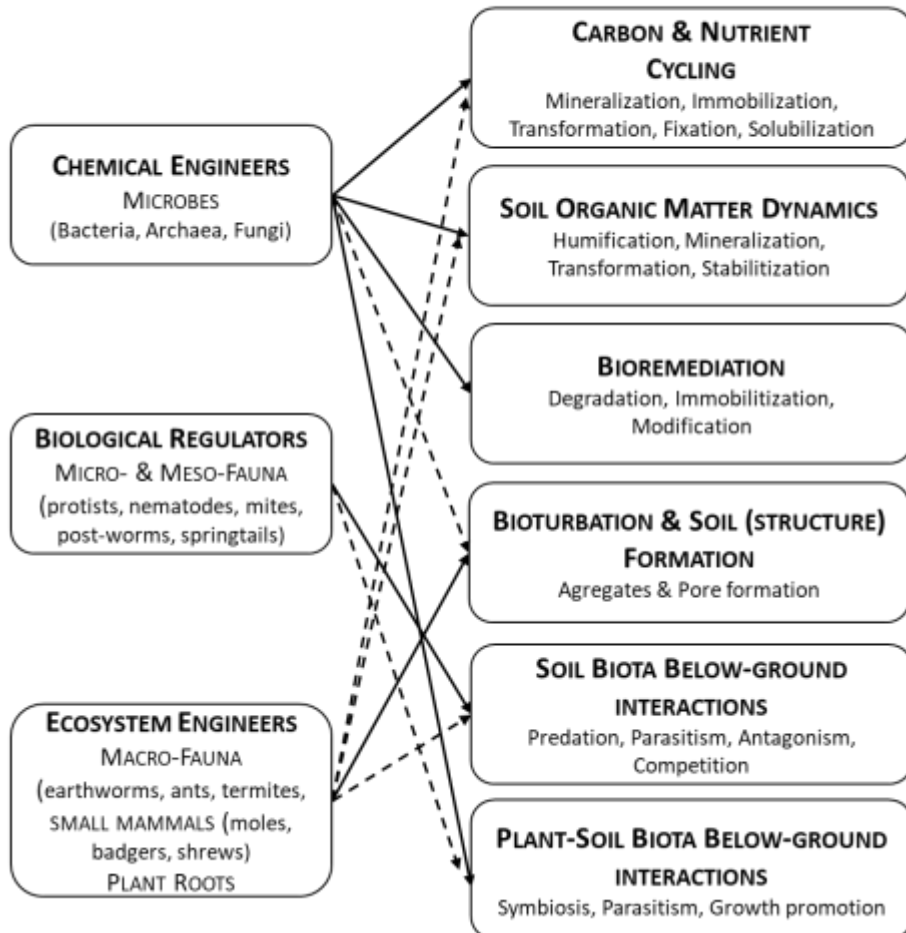


Soil biodiversity and food security

Direct and indirect effects

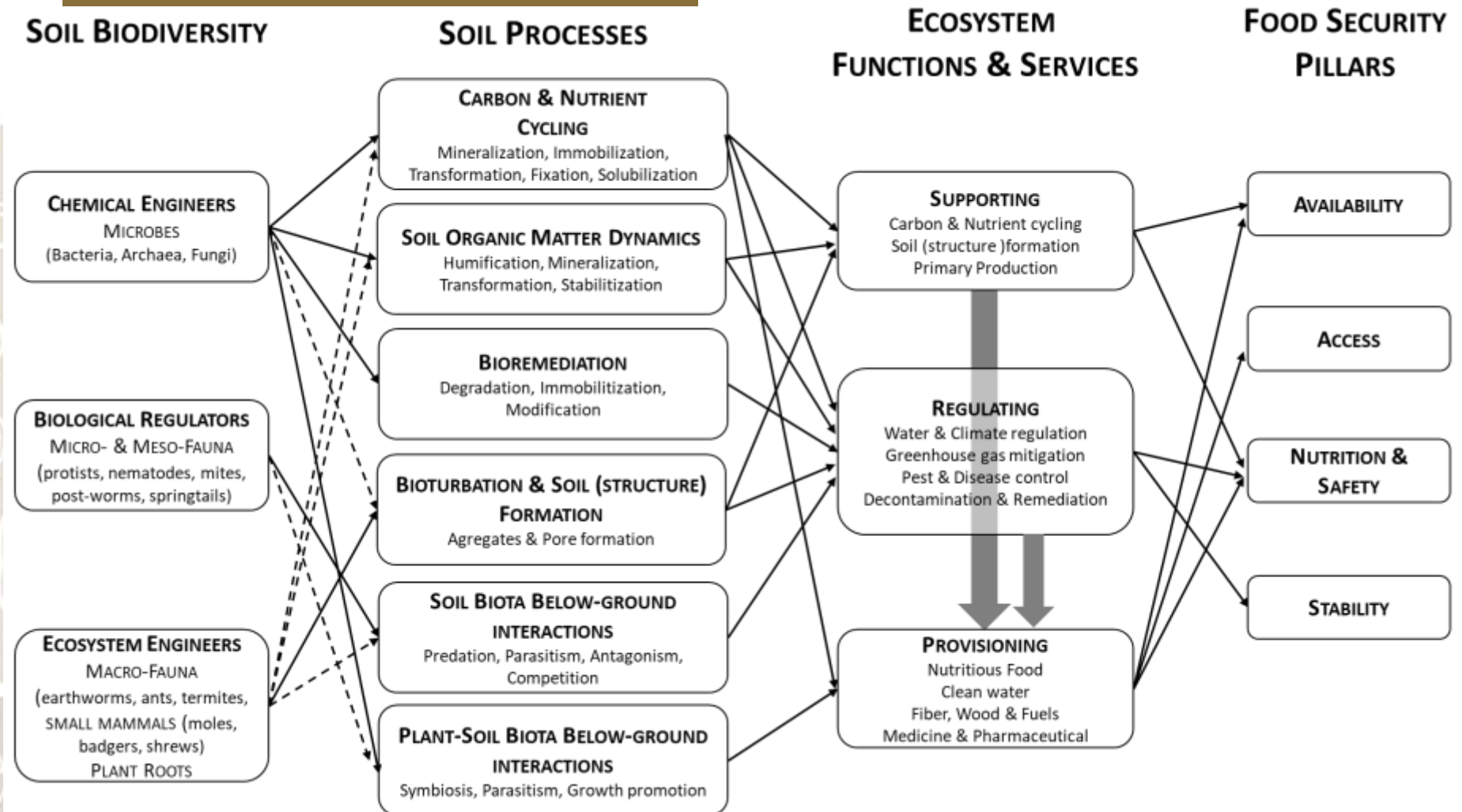
SOIL BIODIVERSITY

SOIL PROCESSES



Soil biodiversity and food security

Direct and indirect effects



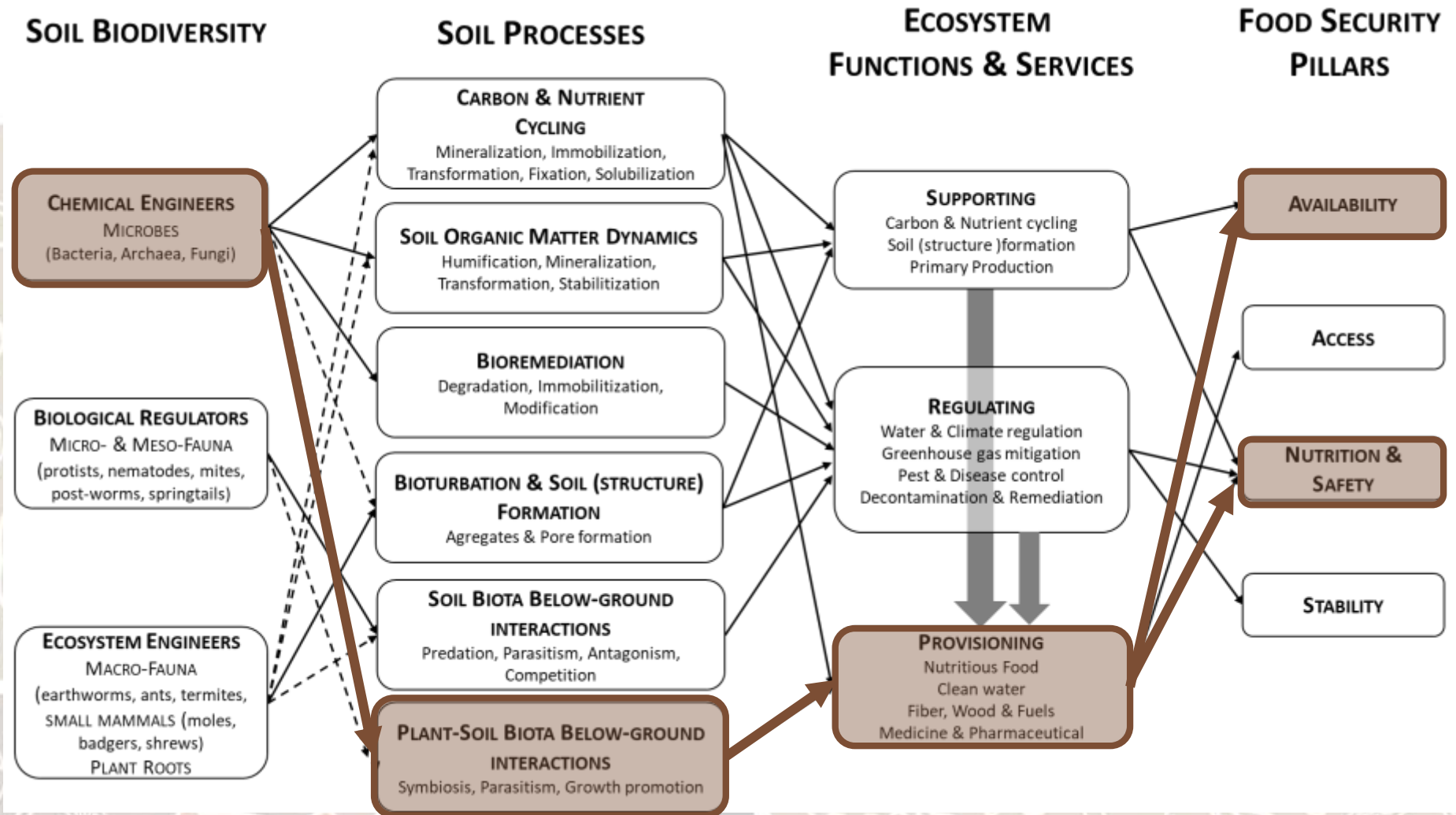
Emerging approaches for soil biodiversity management

The background of the slide features a stylized illustration of soil biodiversity. At the top center is a single green leaf. Below it, a network of white, branching lines represents soil roots or microbial pathways. Interspersed among these lines are various small, colorful icons of soil organisms, including worms, insects, and microscopic life forms, set against a light brown and beige background.

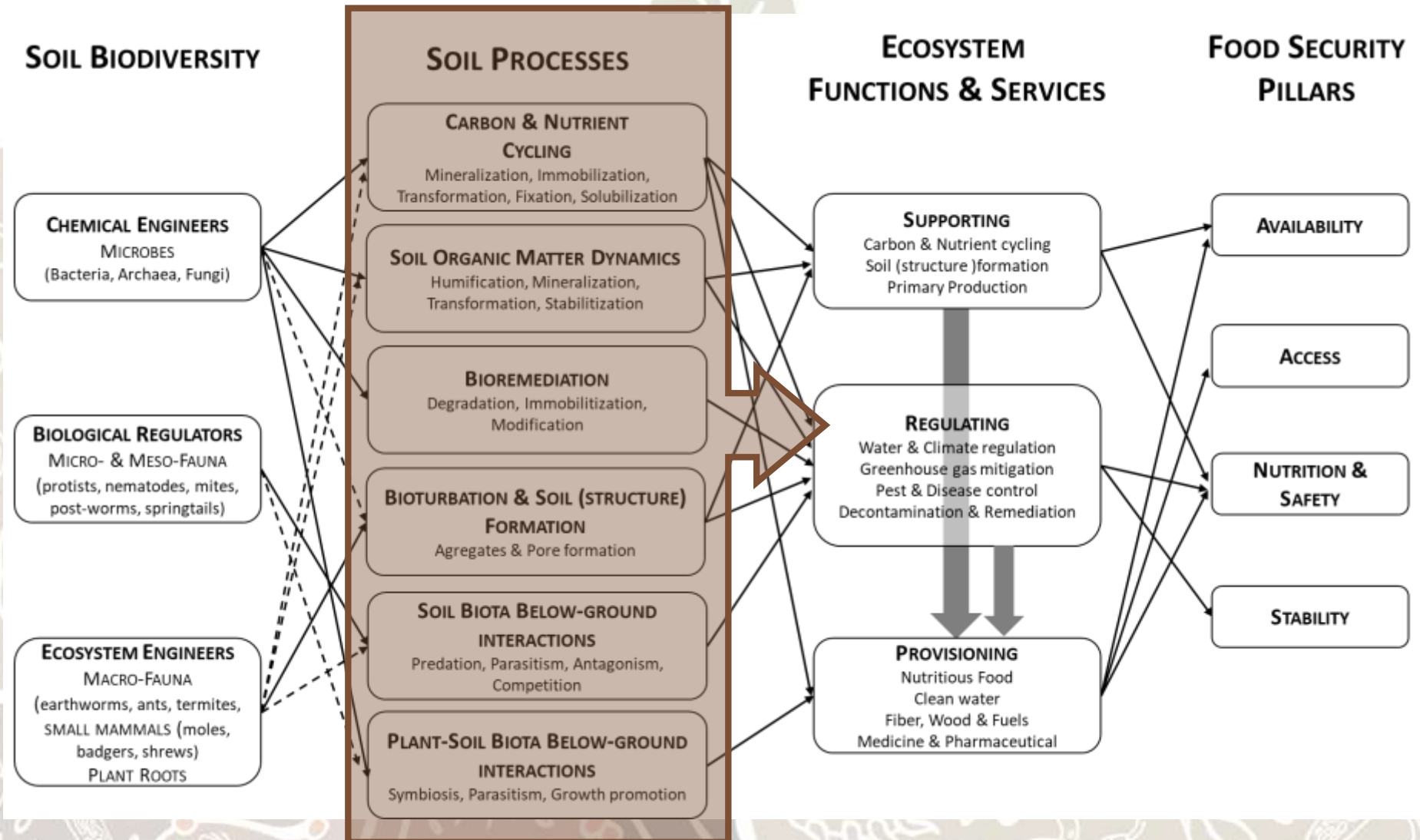
Reductionist Approach

Holistic Approach

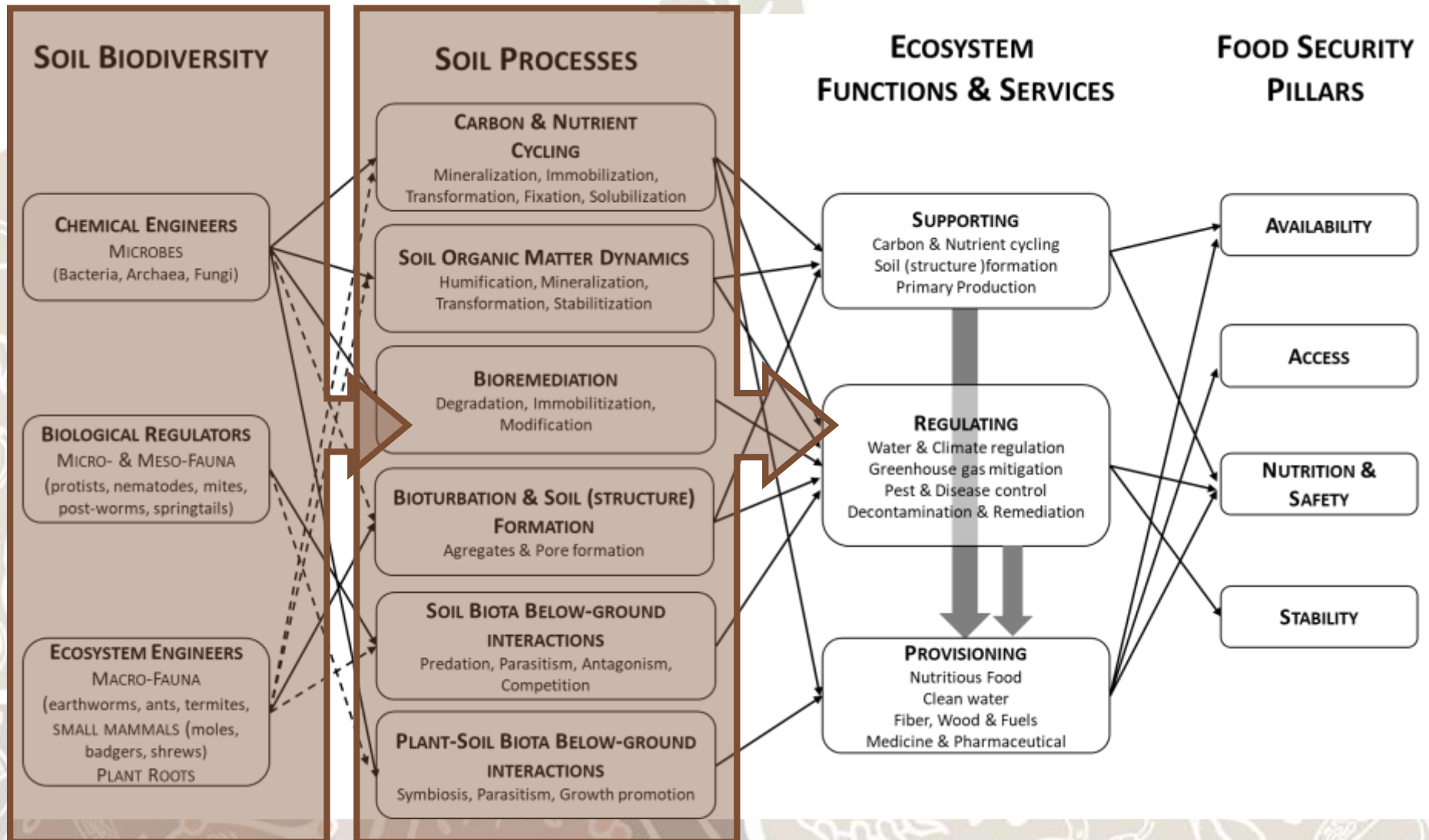
Soil biodiversity management by Reductionist Approach



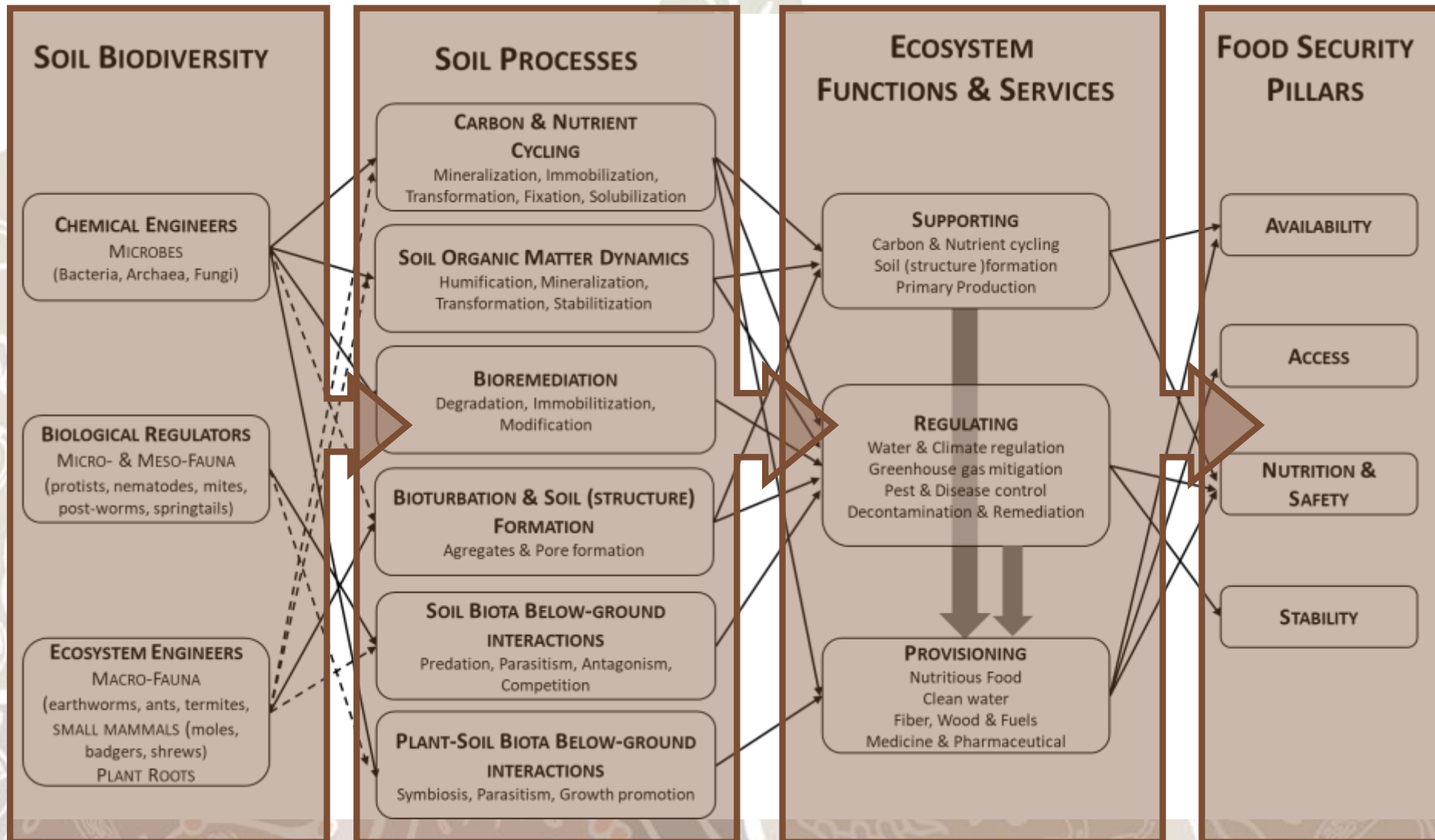
Soil biodiversity management by Holistic Approach



Soil biodiversity management by Holistic Approach



Soil biodiversity management by Holistic Approach



Emerging approaches for soil biodiversity management

The background features a stylized illustration of soil biodiversity. At the top, a large green leaf is visible. Below it, a network of white, branching lines represents soil roots or microbial pathways, interspersed with small orange and red dots. The bottom half of the image is filled with a dense, intricate pattern of white line art depicting various soil organisms, including worms, insects, and microorganisms, set against a light beige background.

Reductionist Approach

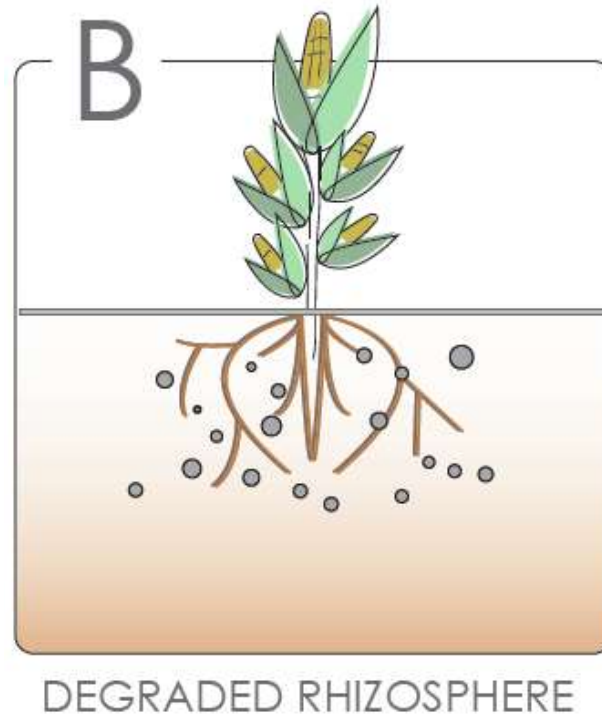
soil-plant interactions
tapping organisms/genes
through biotechnology

Holistic Approach

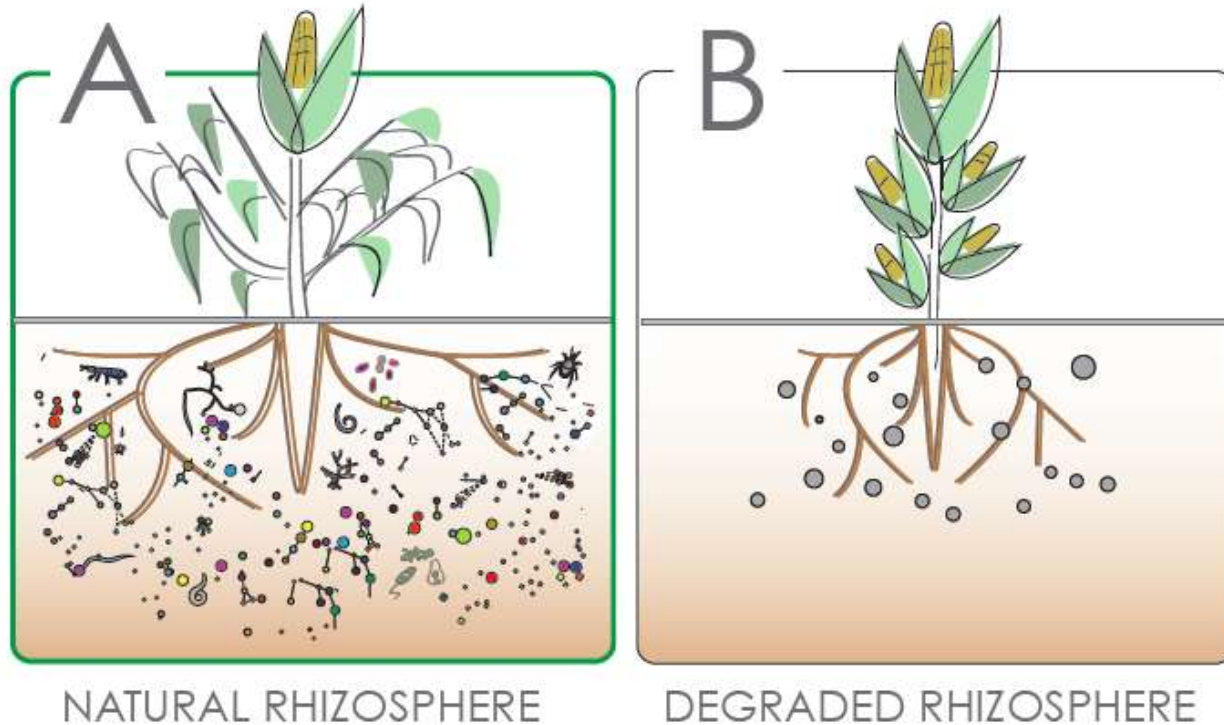
managing soil ecosystems &
their diversity
→ multifunctionality,
resilience & adaptive capacity

complementarity & self-
regulation of soil interactions

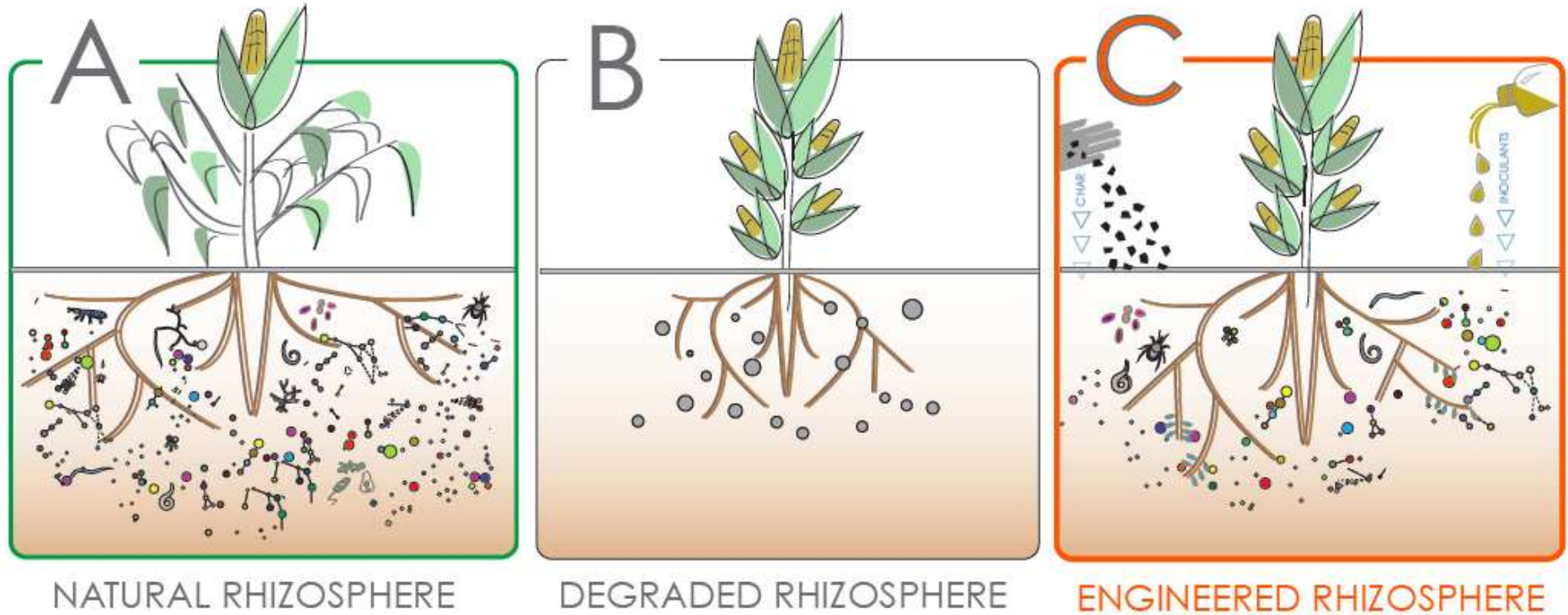
Reductionist approach



Reductionist approach



Reductionist approach

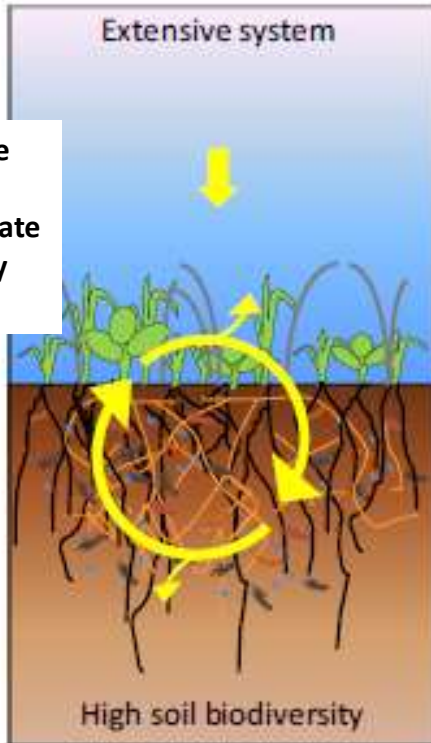


Holistic approach

Low productivity

Extensive system

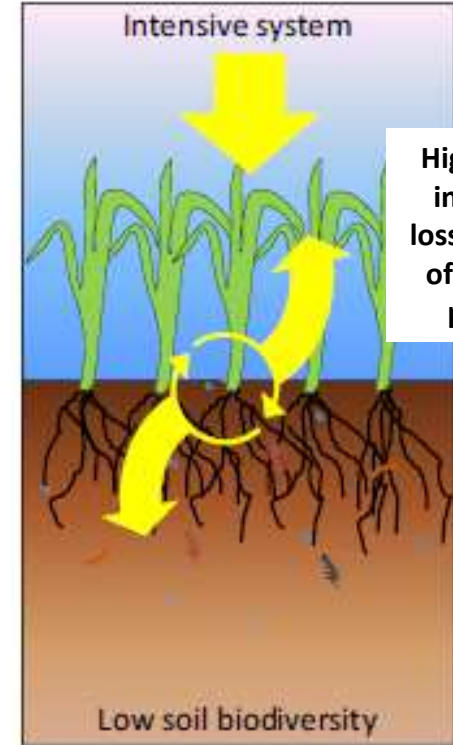
Low resource inputs and outputs, high rate of regulatory processes



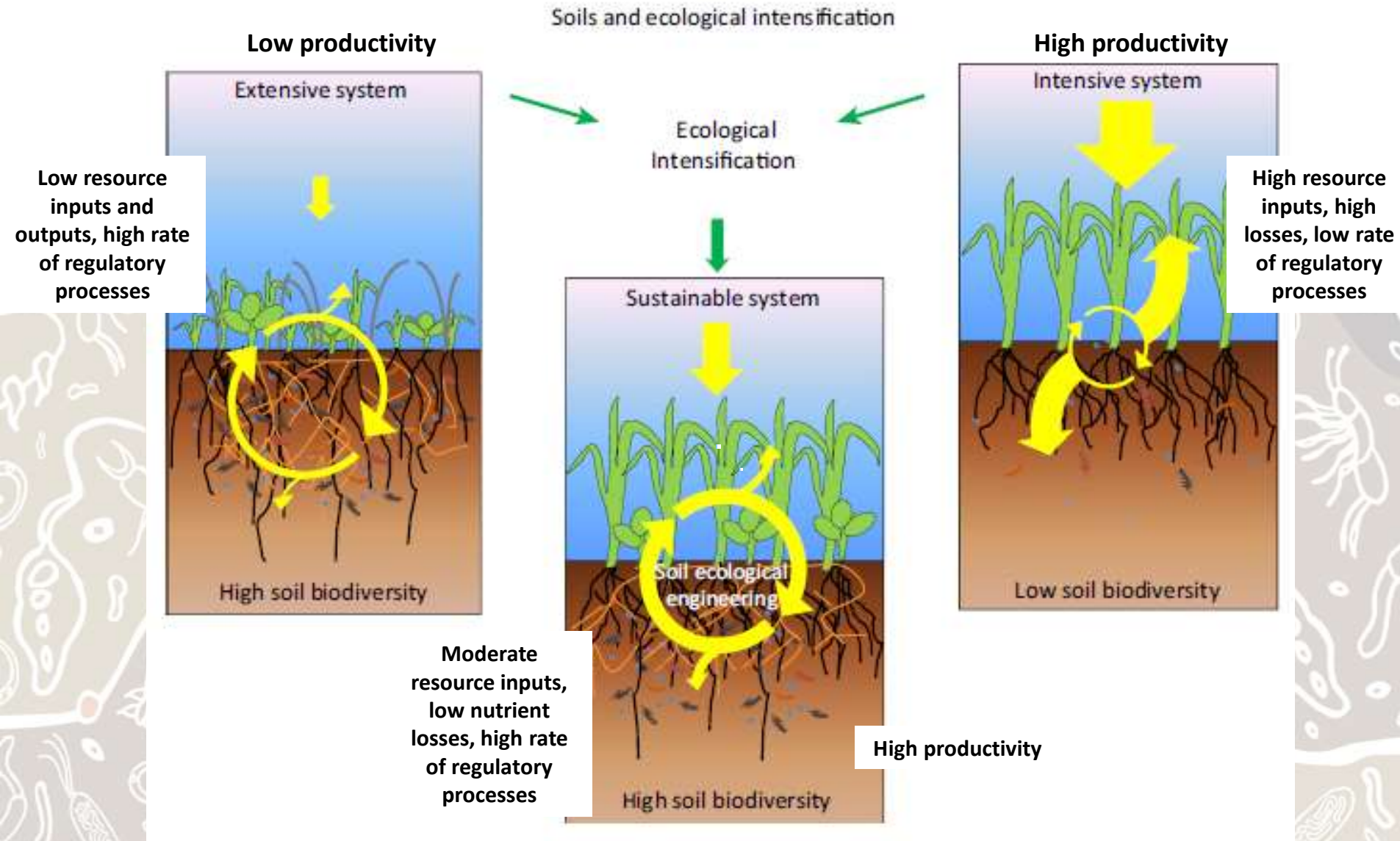
High productivity

Intensive system

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



Holistic approach



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



Thank you for your attention!



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