45th annual ECOFARM CONFERENCE

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Asilomar Conference Grounds
Pacific Grove, CA

Reducing Pest Incidence through Synergies Between Plant Diversity and Soil Ecology

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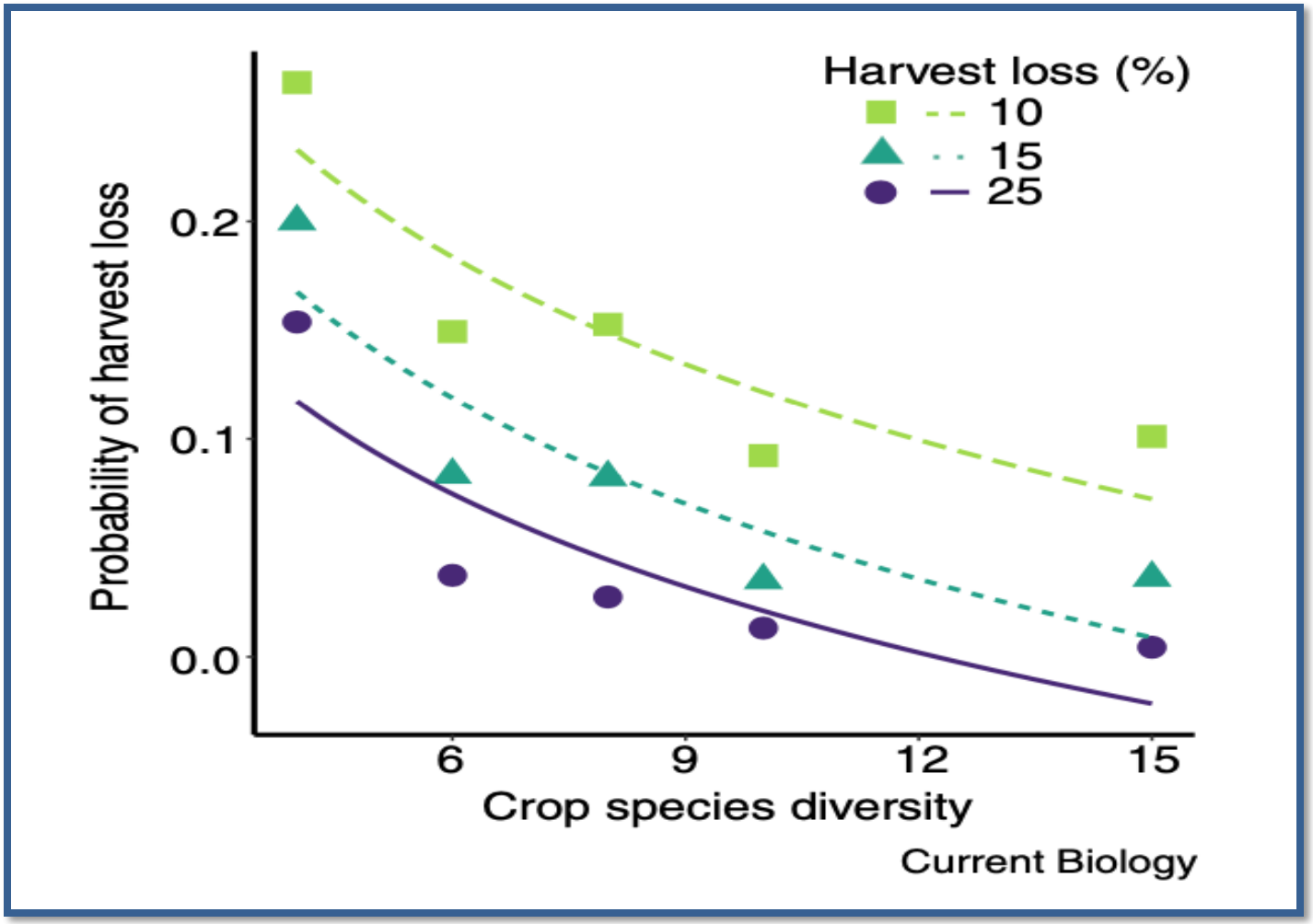
Centro Latino Americano de Investigaciones Agroecologicas

AGROLANDSCAPE SIMPLIFICATION

Strawberry production in Central Coast, California.

Crop species diversity and probabilities of crop harvest losses



Monocultures create dense aggregations of food resources, void of soil biology and habitat for natural enemies, encouraging proliferation of insect pests

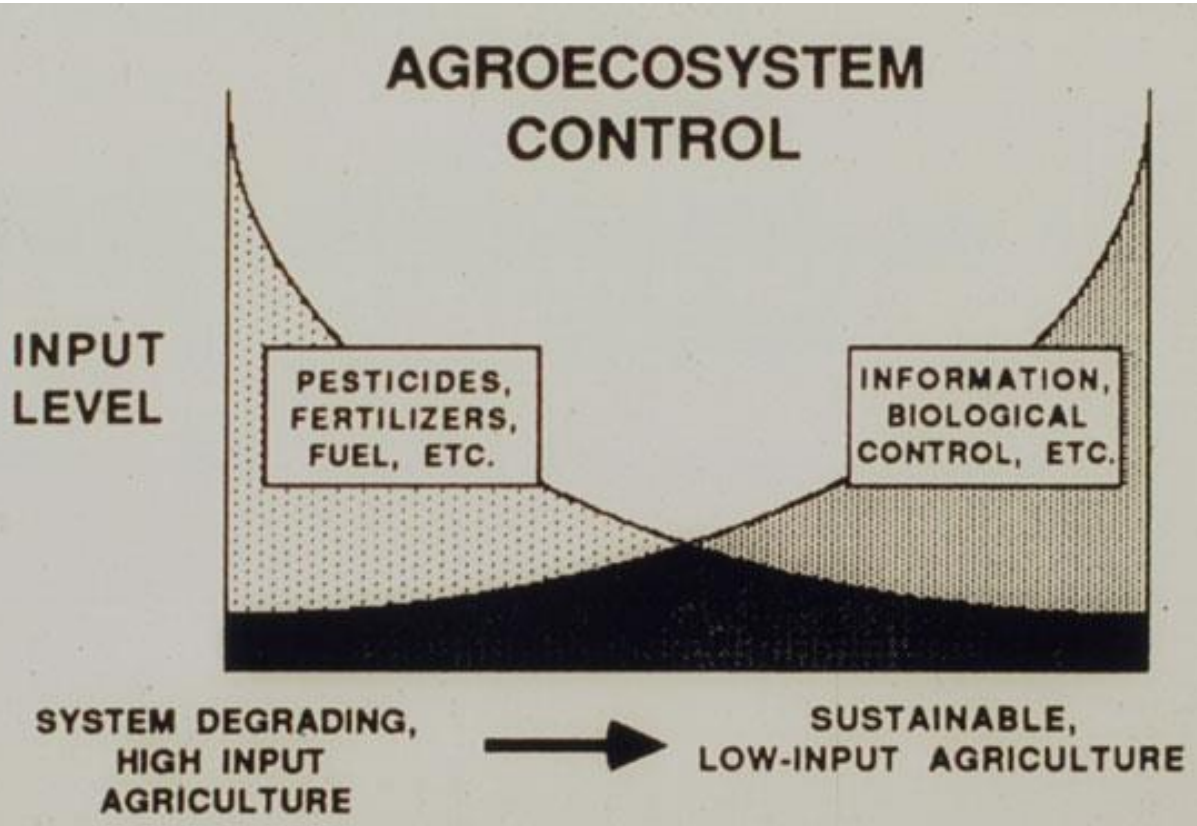


Figure 1. Sustainable agricultural systems are conceptualized here as being low in material input (pesticides, inorganic fertilizers, etc.) and high in information input (applied ecological knowledge of the system). High chemical input practices conceal and depreciate the importance of ecological processes occurring in agricultural systems. However, as pesticides, fertilizers, etc. are reduced, greater knowledge of the interactions occurring in agroecosystems is required for success. Furthermore, this knowledge must be applied in a practical manner to maintain agroecosystem productivity.

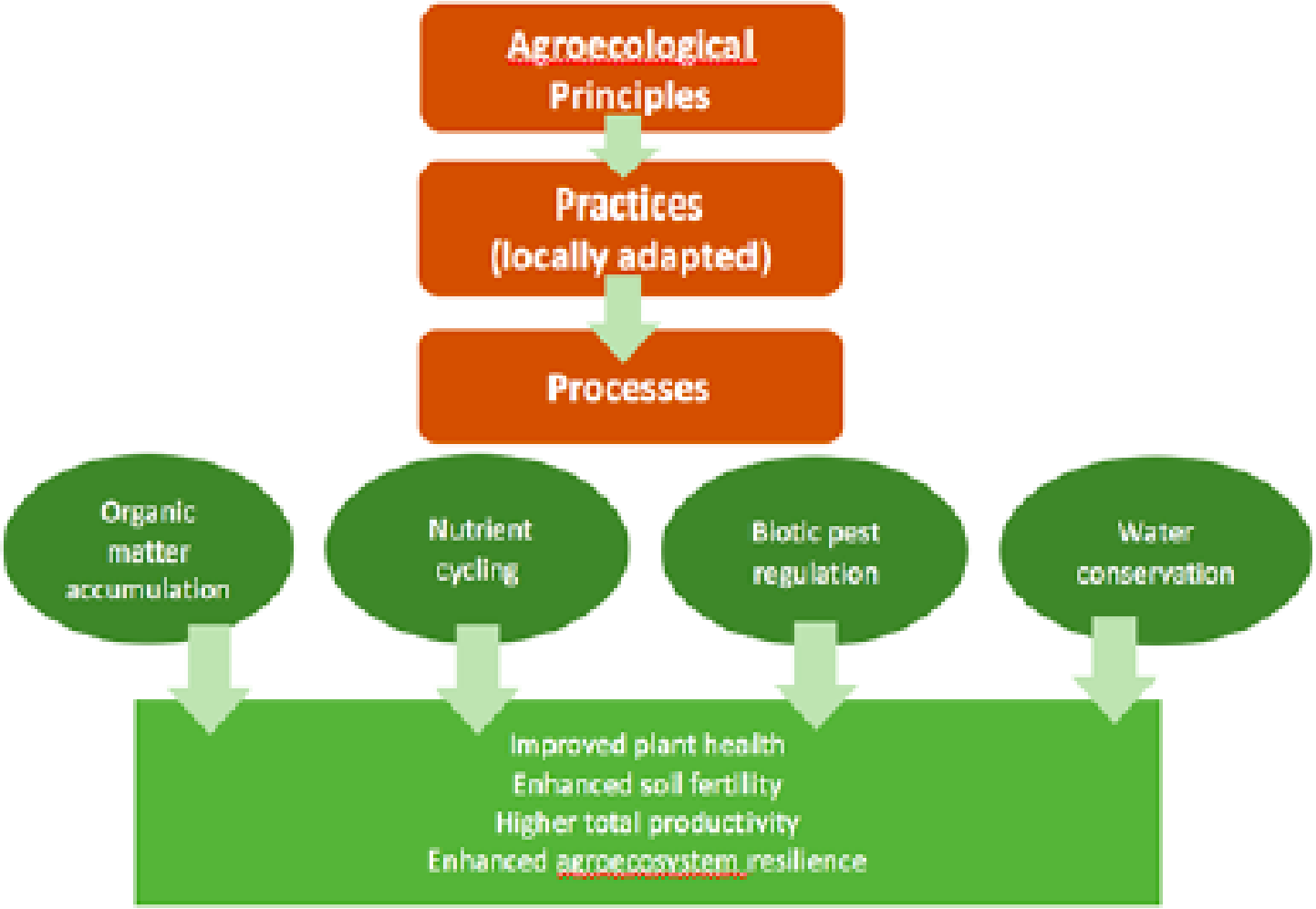
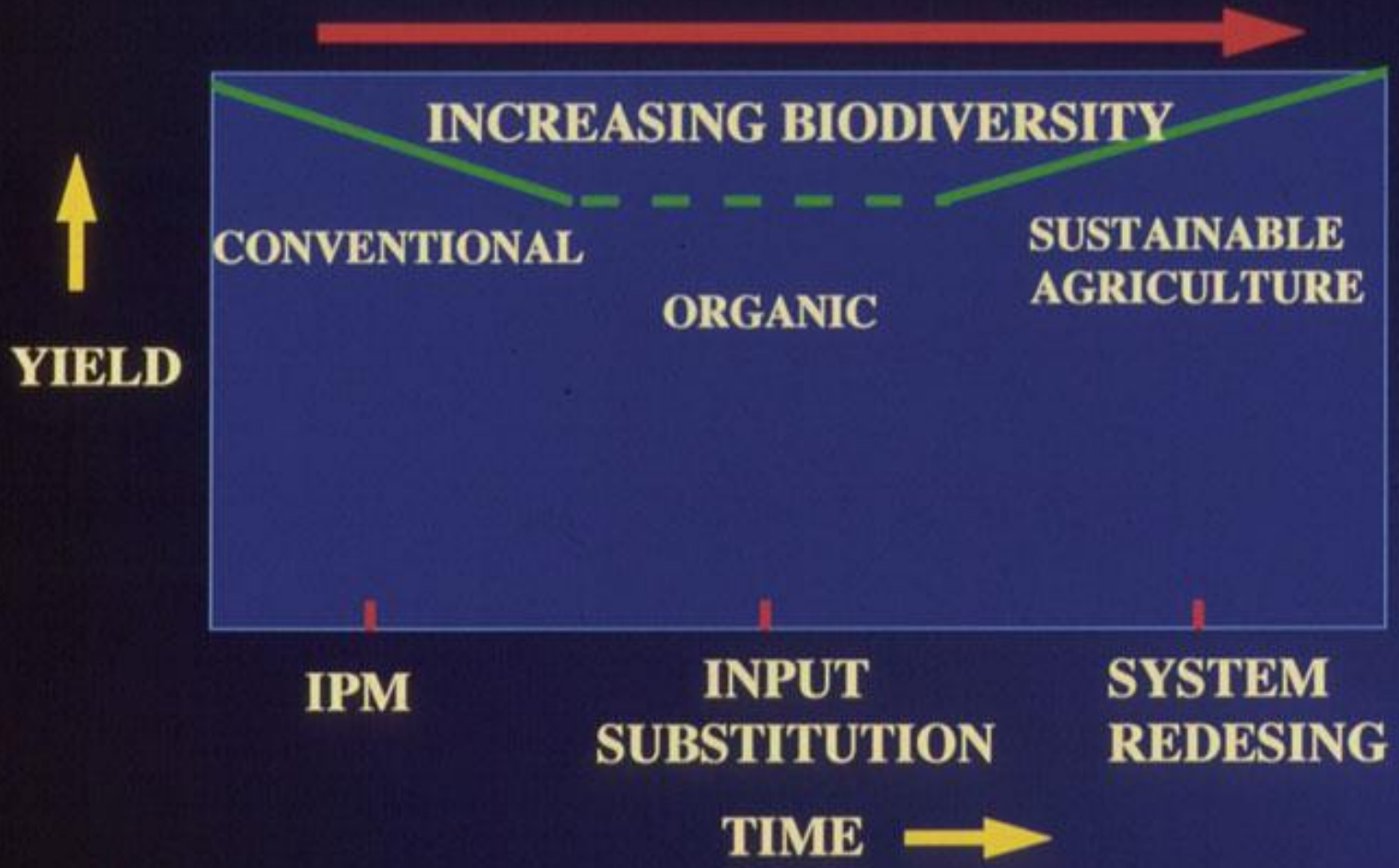


Figure 2: Agroecological principles for the conversion of farming systems.

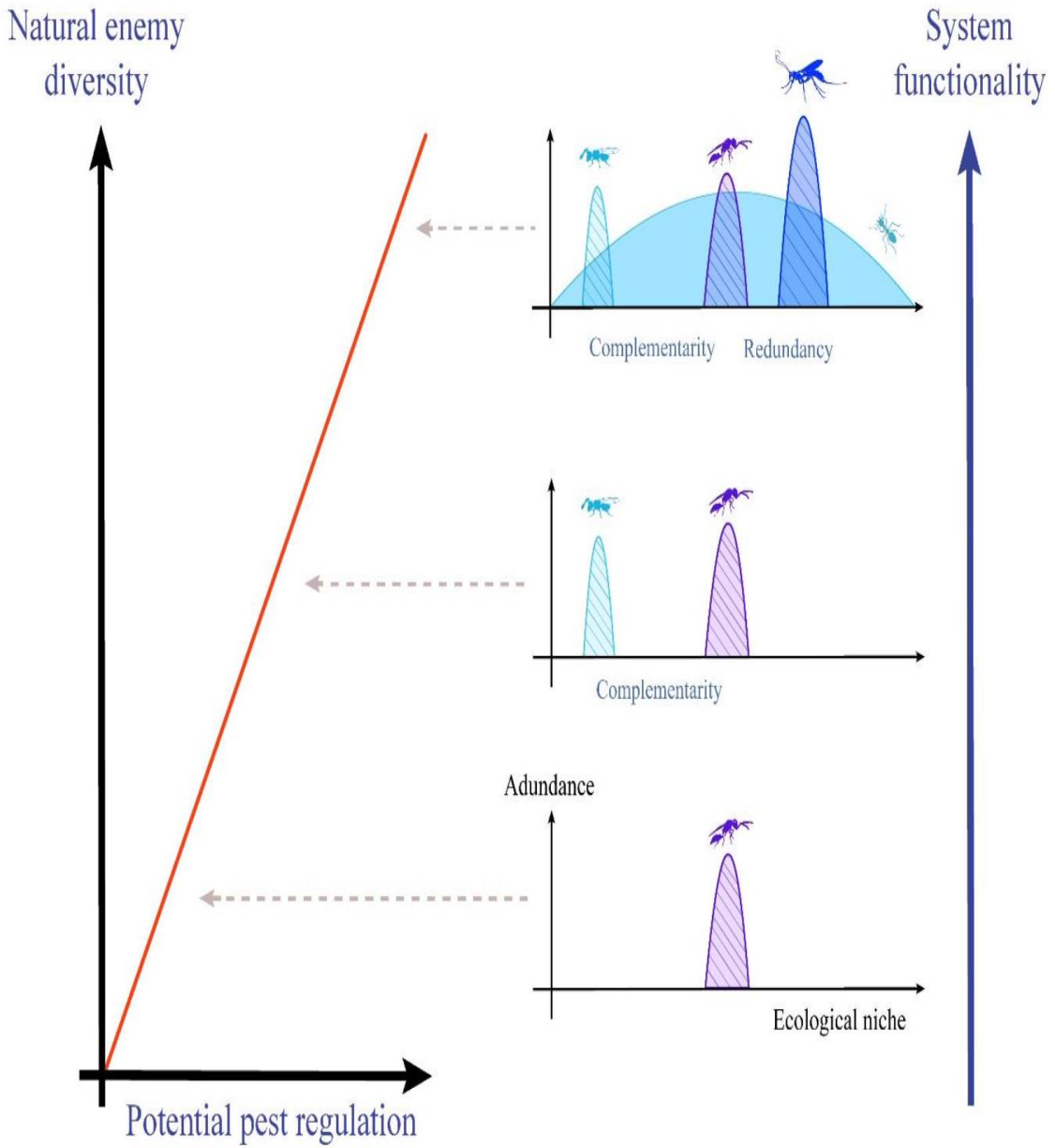
Agroecology

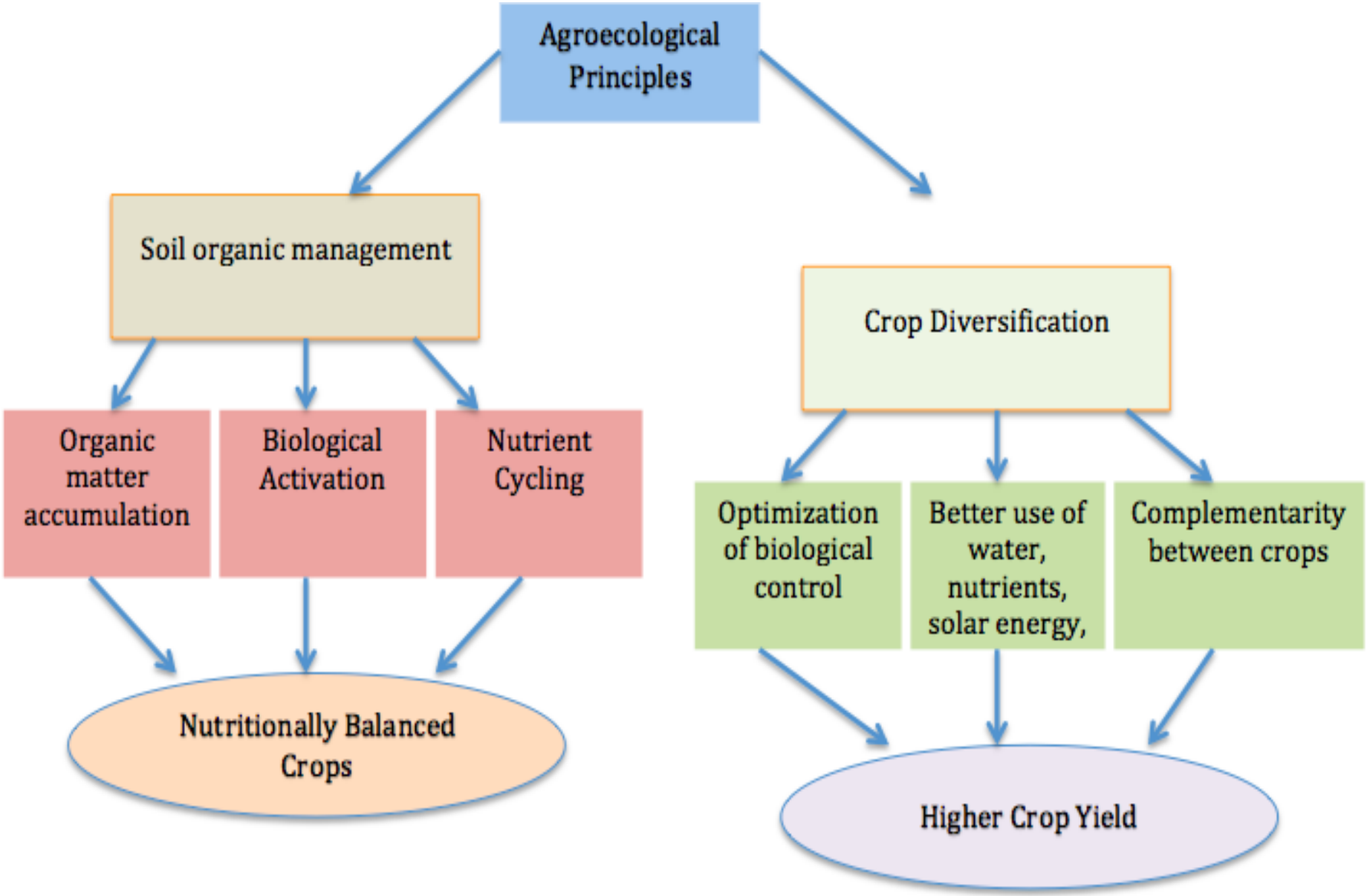
- Enhance plant diversity and abundance of beneficial biota (soil microorganisms, auxiliary plants, natural enemies, etc)
- Amplification of ecological interactions and processes to achieve optimal soil fertility, plant health and productivity
- Replace inputs for processes

Stages in the Agroecological Conversion



From conventional and organic monocultures to polycultures, functional diversity increases so does resilience towards pests

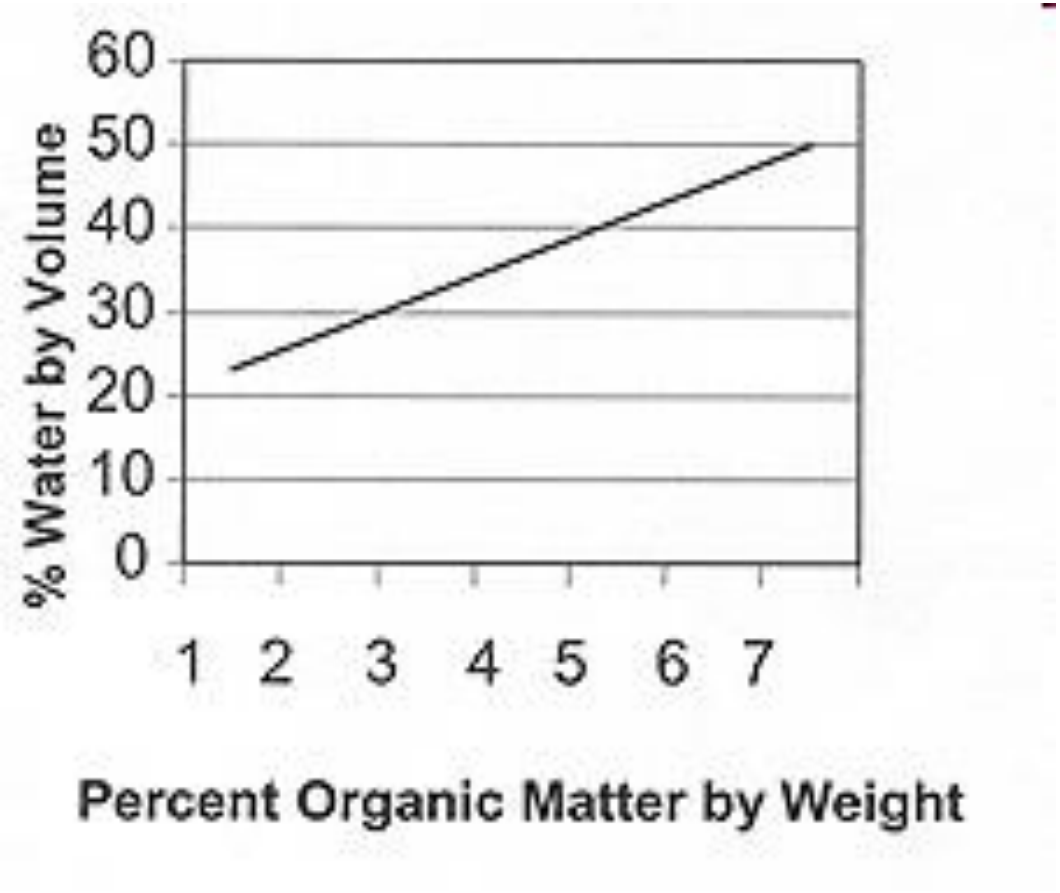


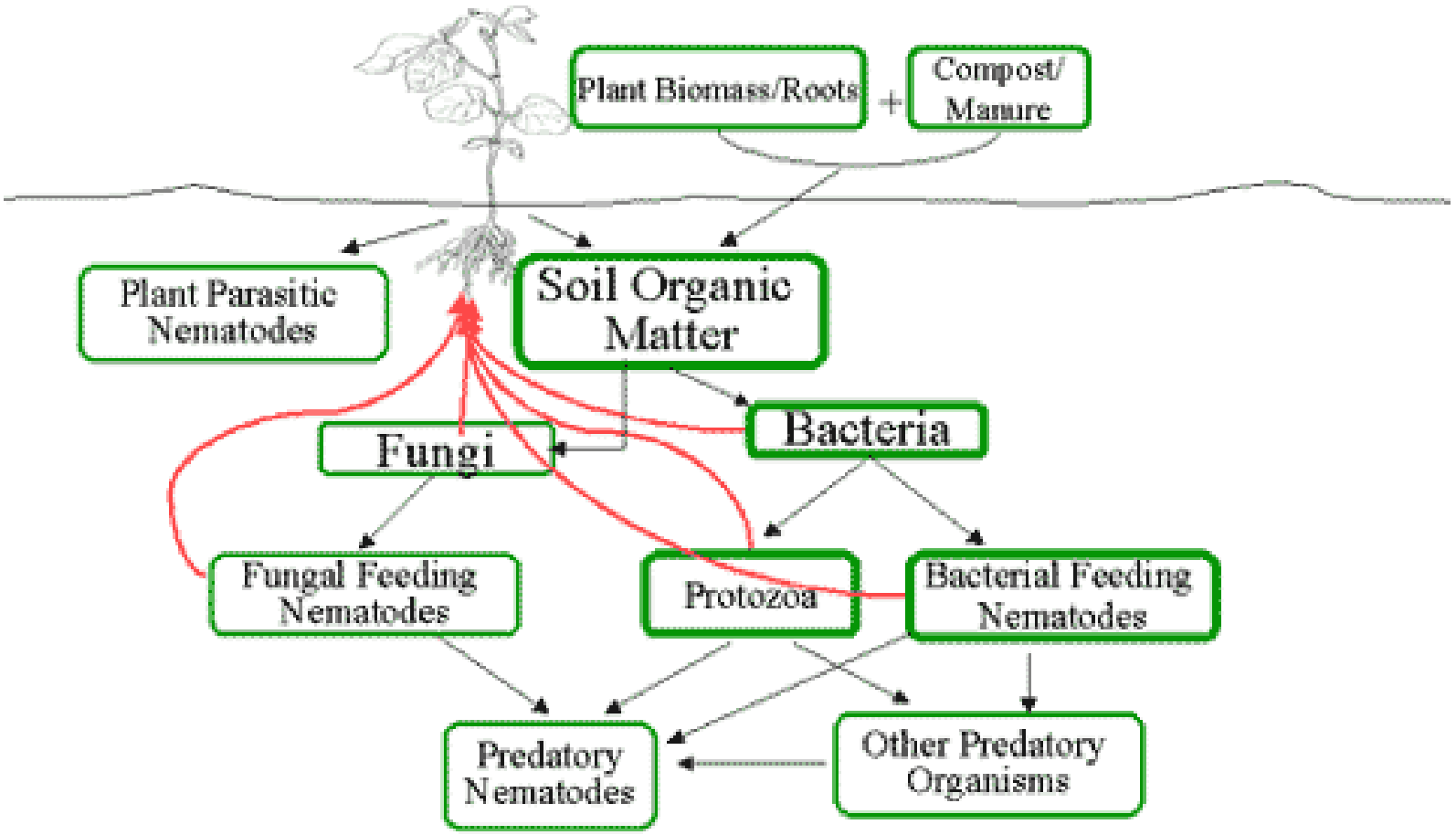

Agroecological Principles
Soil organic management
Crop Diversification
Organic matter accumulation
Biological Activation
Nutrient Cycling
Optimization of biological control
Better use of water, nutrients, solar energy,
Complementarity between crops
Nutritionally Balanced Crops
Higher Crop Yield

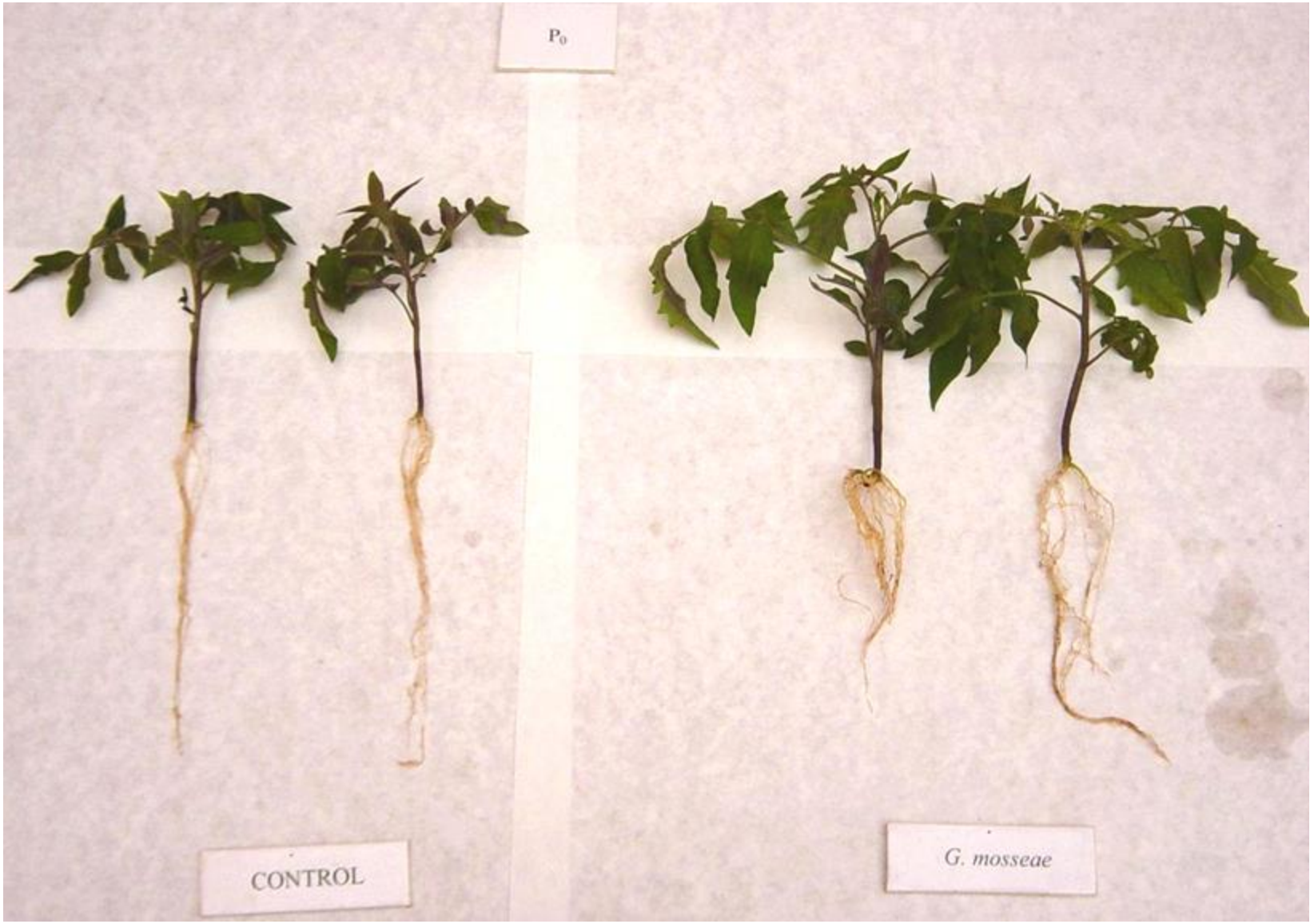
Addition of organic matter essential for biology, structure, fertility, water storage and infiltration

SOM content and moisture

For each 1% increase in organic matter in the soil, 16-17 liters of wáter are stored in the soil




Plant Biomass/Roots
+
Compost/
Manure
Plant Parasitic
Nematodes
Soil Organic
Matter
Fungi
Bacteria
Fungal Feeding
Nematodes
Protozoa
Bacterial Feeding
Nematodes
Predatory
Nematodes
Other Predatory
Organisms

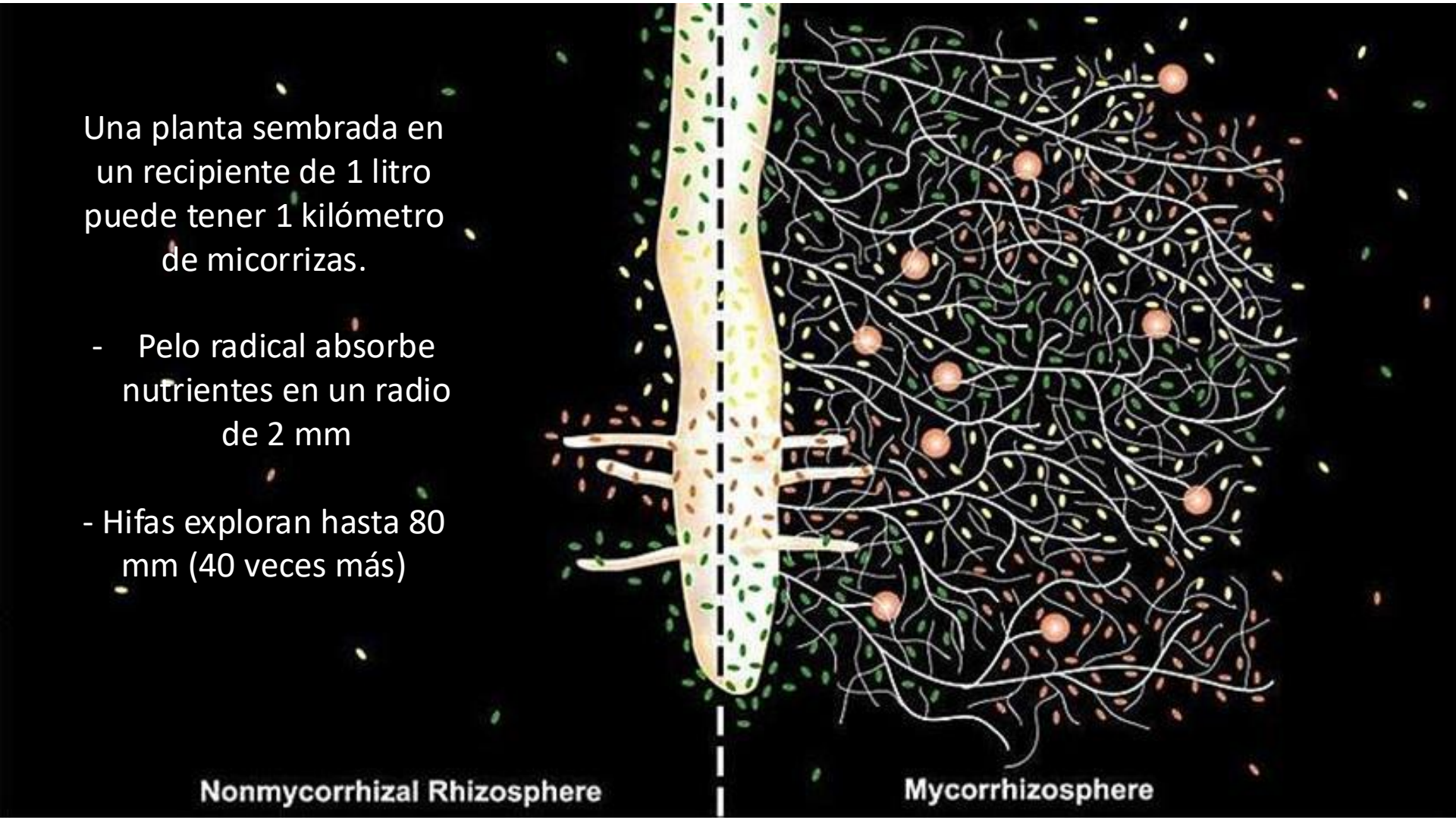

P_0
CONTROL
G. mosseae

¿Qué diferencia hay entre no tener y tener micorrizas?

Una planta sembrada en un recipiente de 1 litro puede tener 1 kilómetro de micorrizas.

- Pelo radical absorbe nutrientes en un radio de 2 mm

- Hifas exploran hasta 80 mm (40 veces más)



Estas redes de filamentos extraen nutrientes de espacios a los cuales las raíces no tienen acceso.

http://creating-a-new-earth.blogspot.com.co/p/endo-mycorrhizae-vam-what-is-it.html

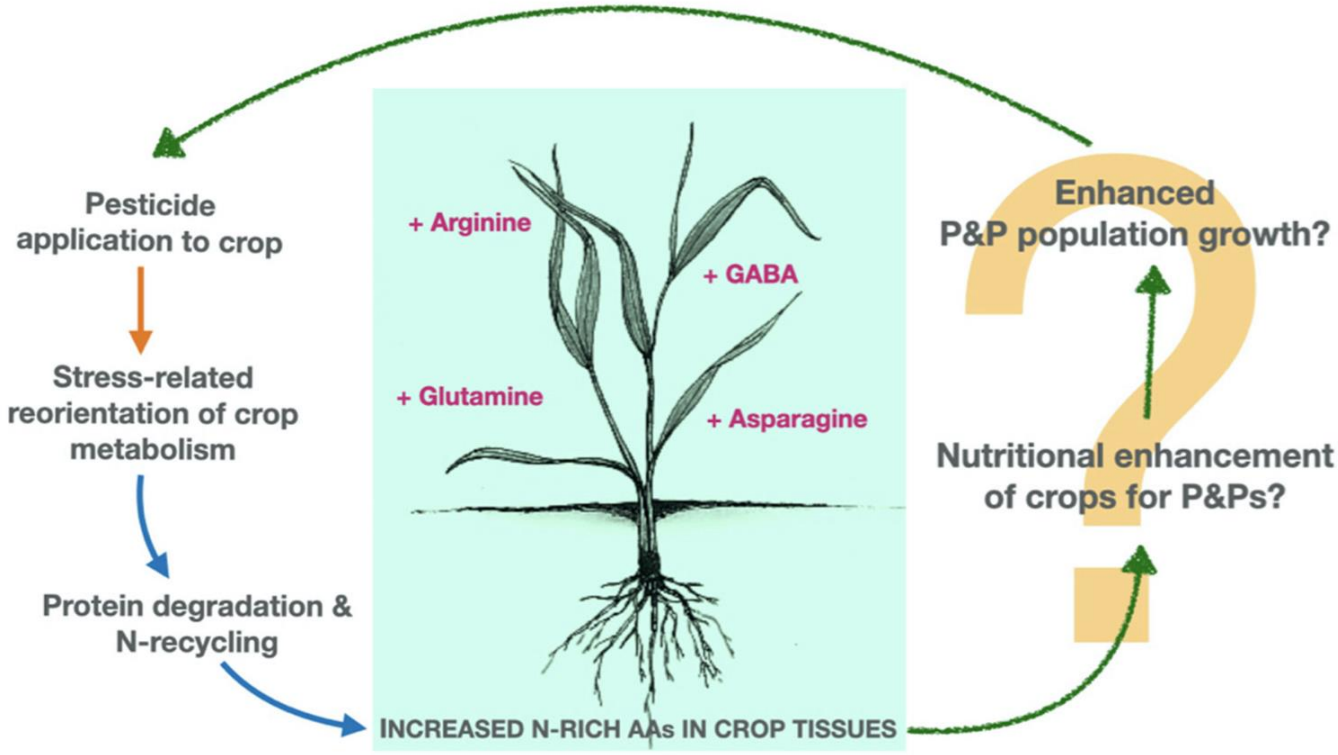


FIGURE 2 | Un-intended impacts of pesticide applications on crops' biochemical susceptibility to subsequent pest and pathogen (P&P) damage. Exposure of crops to agronomically relevant concentrations of various pesticides can trigger a low-level "stress response" in the crop, resulting in subtle but significant metabolic disruption and accumulation of nutritionally valuable amino acids (AAs) within crop tissues. We hypothesise that pesticide-induced alterations to crop biochemistry may result in a favourable nutritional environment for P&P organisms (e.g., those not suppressed by the initial pesticide-application) to feed, develop, and proliferate. Subsequent P&P pressure may then trigger further applications of pesticide (orange arrow, agrochemical inputs; blue arrows, biochemical impacts; green "sketched" arrows, hypothesised ecological impacts).

Trophobiosis (Chabousseau) chemical fertilization influence the relative resistance of agricultural crops to insect pests. Increased soluble N and free aminoacid levels in plant tissue decrease pest resistance

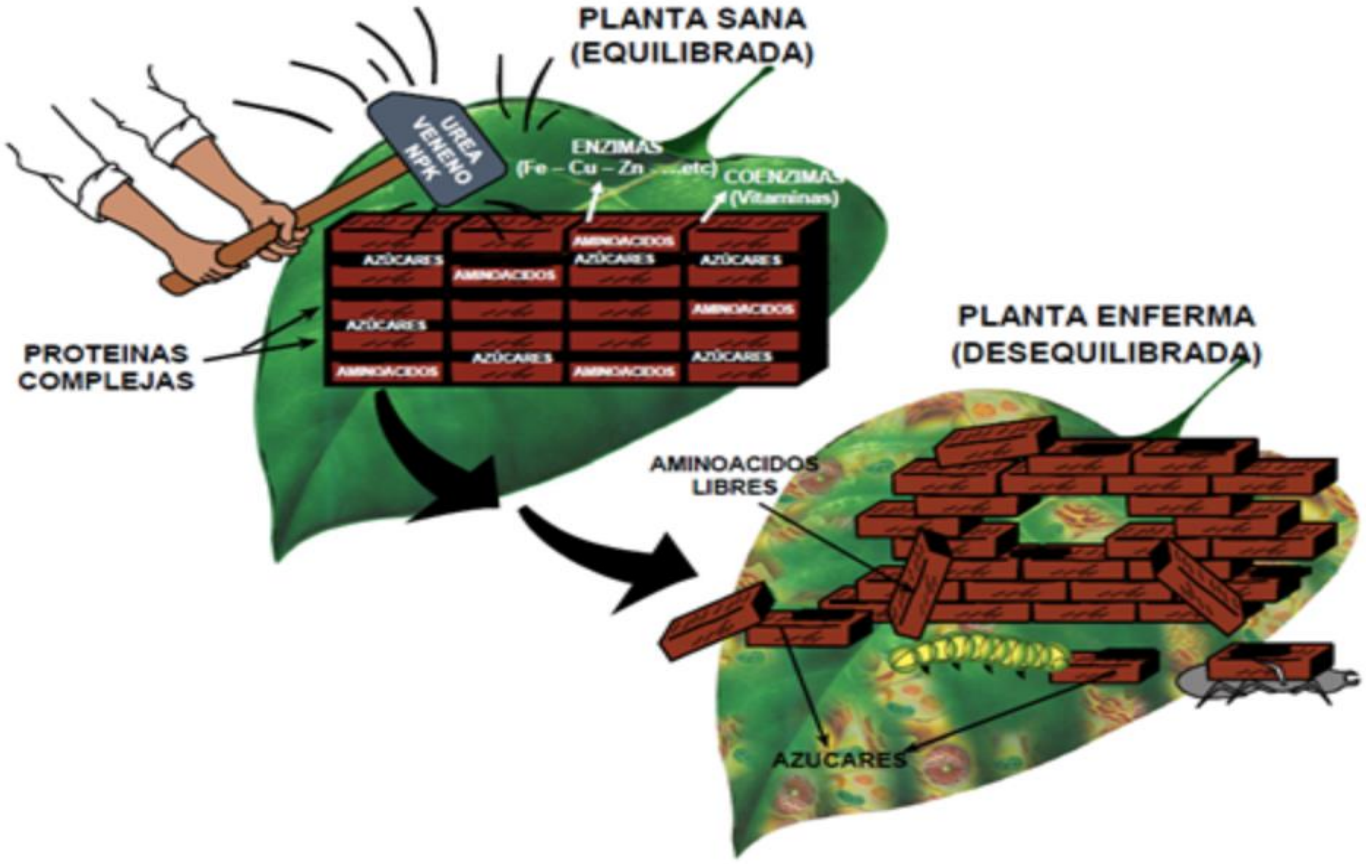
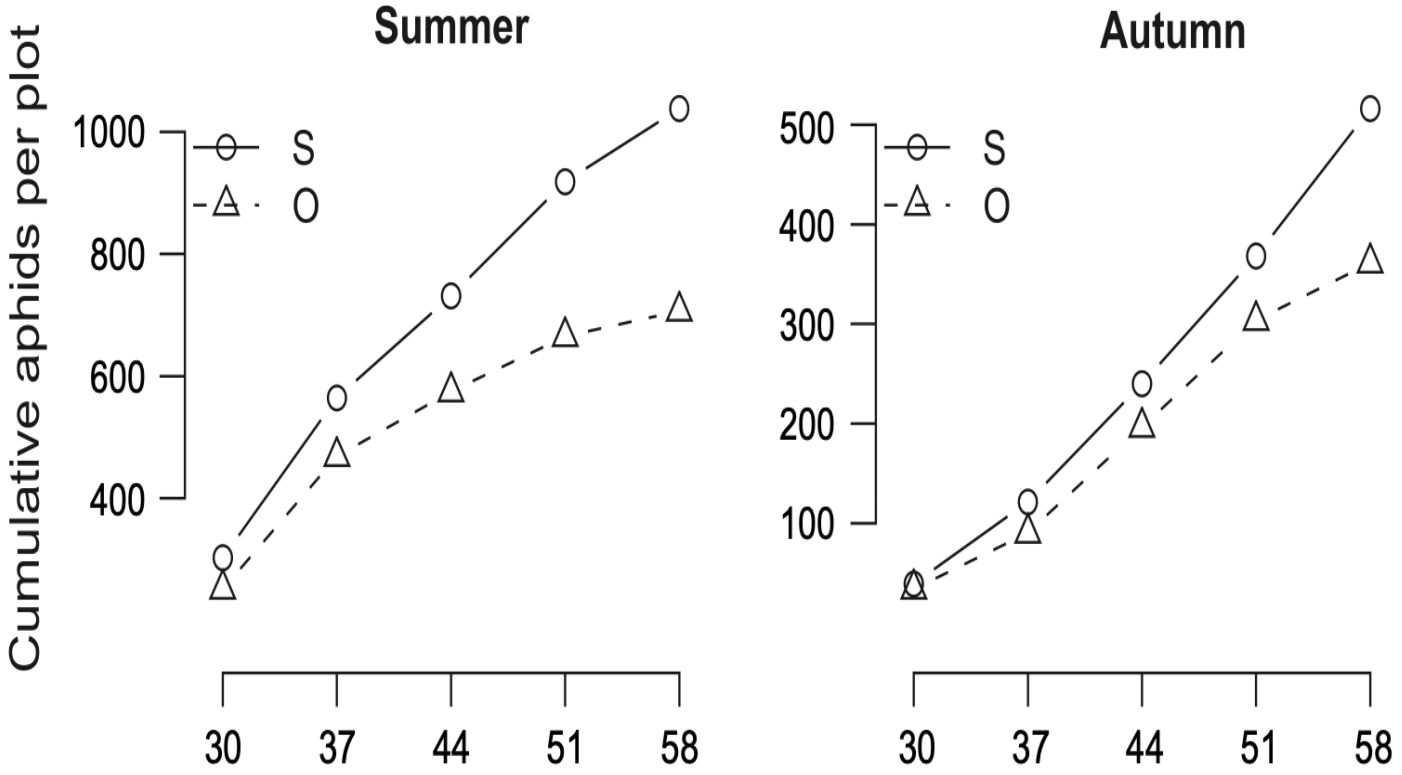
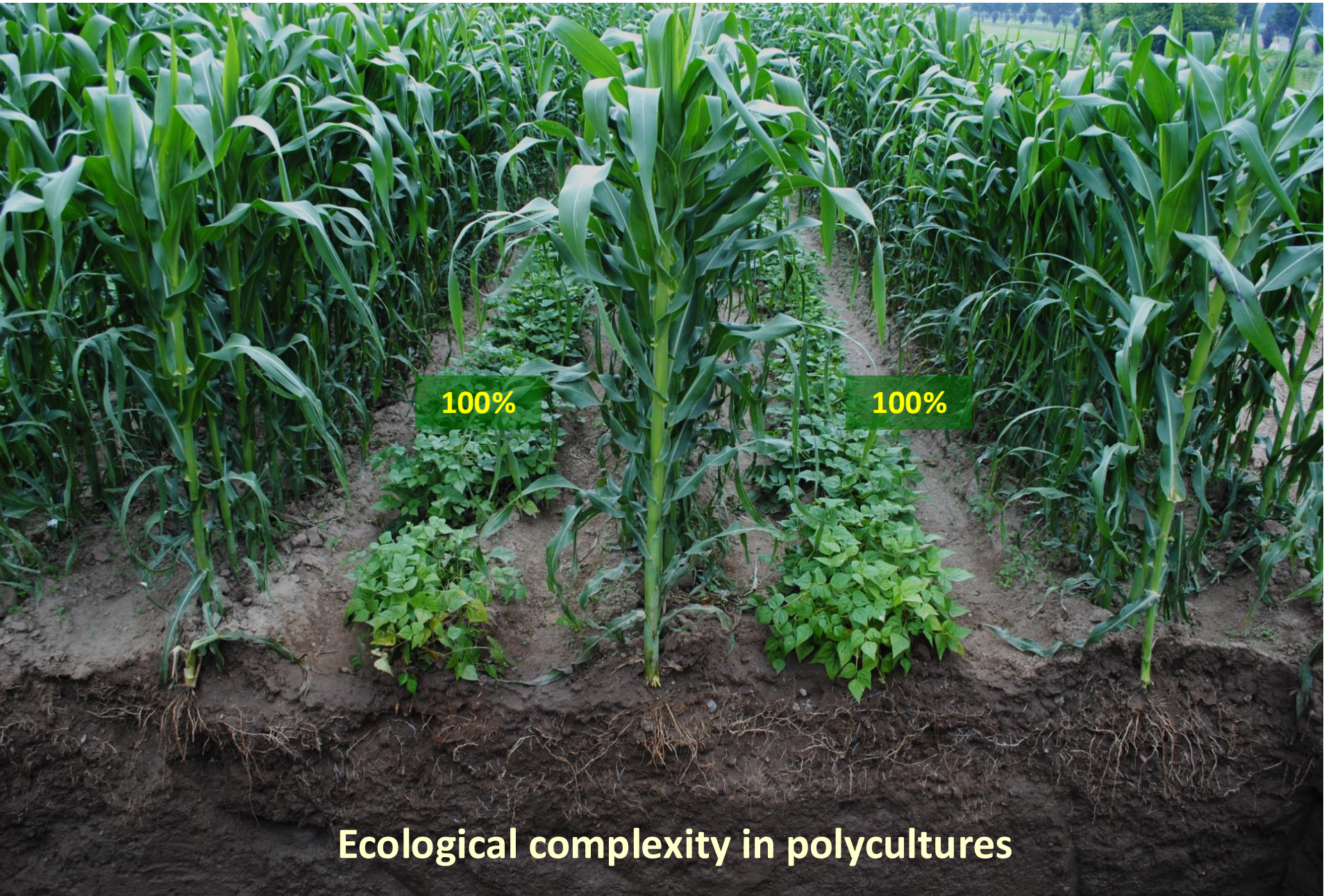


Imagen de Fundación Juquira Candirú

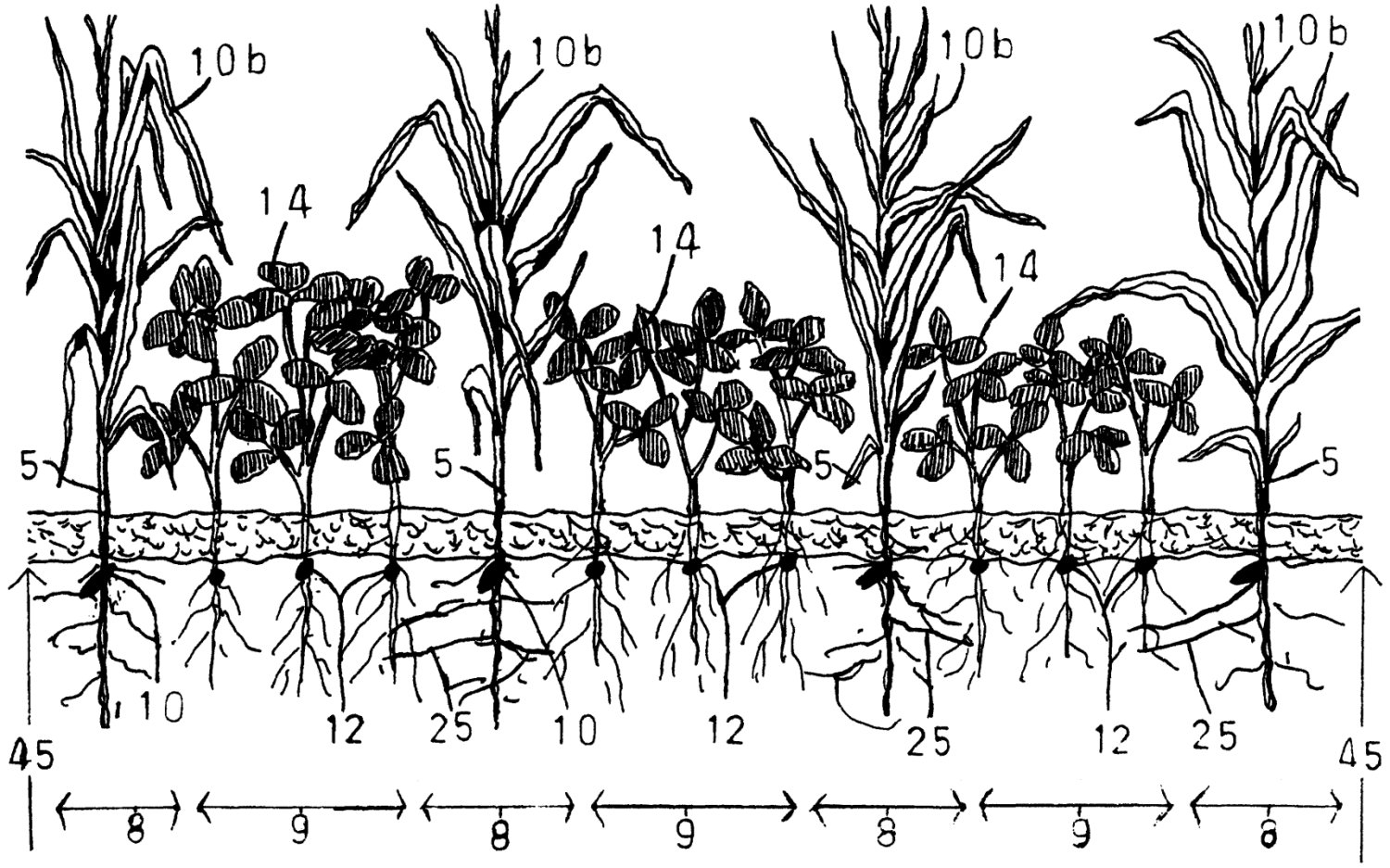
Broccoli had lower aphid densities and higher parasitization rates when fertilized with compost. Compost releases mineral nitrogen in the soil at a slower rate than synthetic fertilizer leading to lower foliar nitrogen content = reduced pest incidence

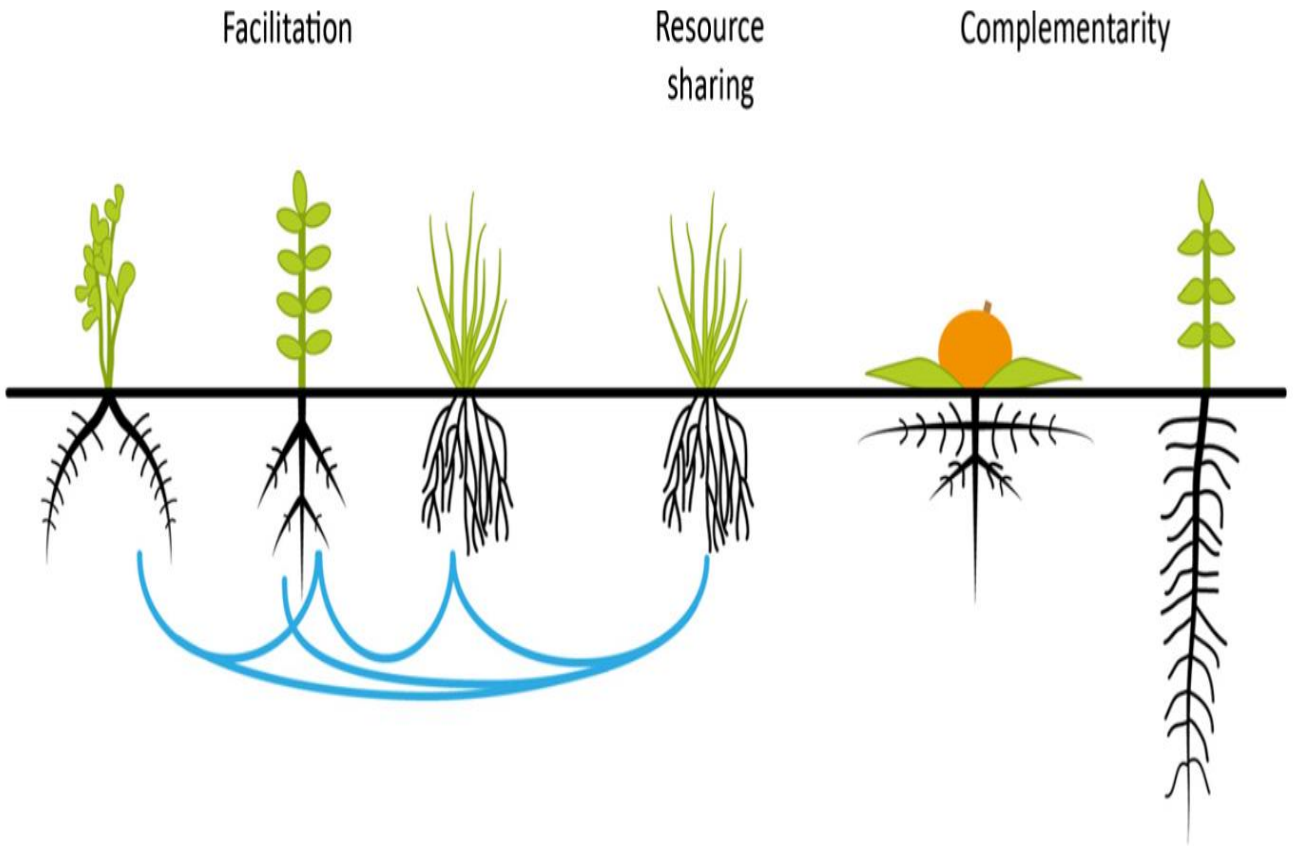




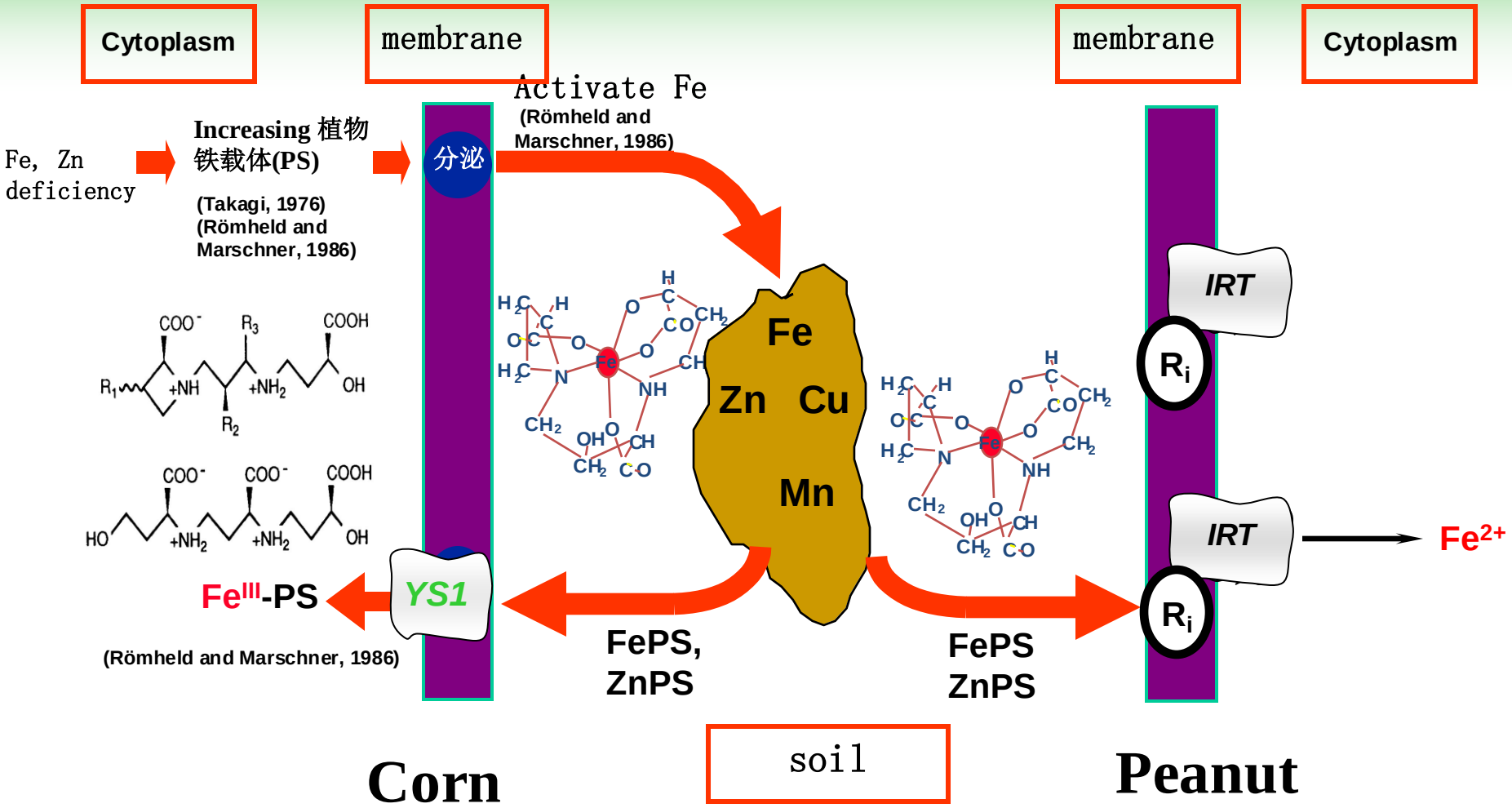
Ecological complexity in polycultures

Below and above ground interactions in polycultures




Facilitation
Resource sharing
Complementarity

来源：李隆



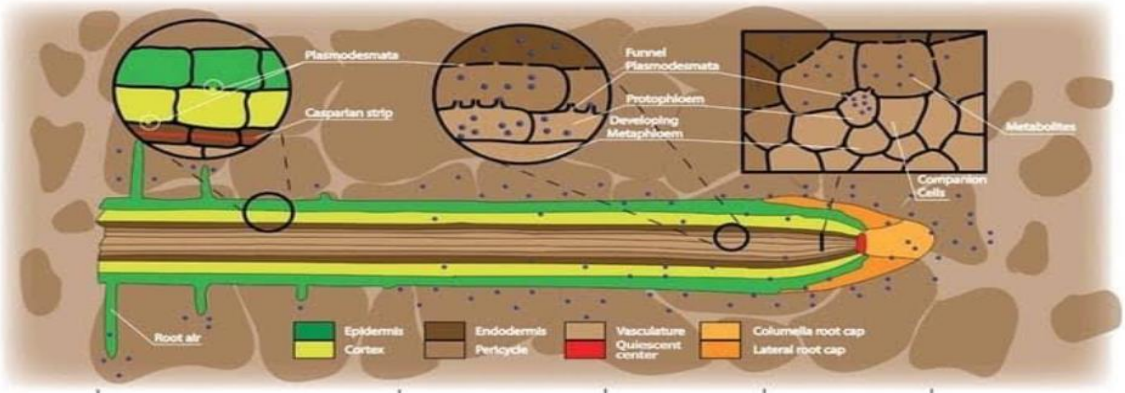
Root exudates are important in the interaction.

来源：李隆

（Plant and Soil, 2000； J. Plant Nutr.2003;Plant Nutr. Soil Sci. 2004）

| Root exudates & their function

Michal Slota | Follow me on



ROOT STRUCTURE AND AREAS OF ROOT EXUDATION

[credits: *Canarini et al. 2019*]

▪ OVERVIEW OF FUNCTIONS:

Nutrient uptake

Soil pH amendment

▪ TYPES OF COMPOUNDS:

« Organic acids

Amino acids and amides »

« Enzymes

Growth factors »

« Phenolic acids

Sugars »

Regulation of positive interactions

PGPR recruitment

Fungi symbiosis

Nematode symbiosis

Growth facilitators

Regulation of negative interactions

Antibacterial activity

Antifungal activity

Insecticidal, nematicidal activity

Allelopathy

Content Farmers

Root exudates and defenses against insect pests

- Root exudates (aminoacids, organic acids, etc) play a key role in recruiting plant beneficial microbes.
- These microbes colonize roots inducing biosynthesis of plant defense compounds against phytophagous insects via changes in levels of salicylic acid
- Reduction of incidence of leafhoppers, aphids and whiteflies in various vegetable crops

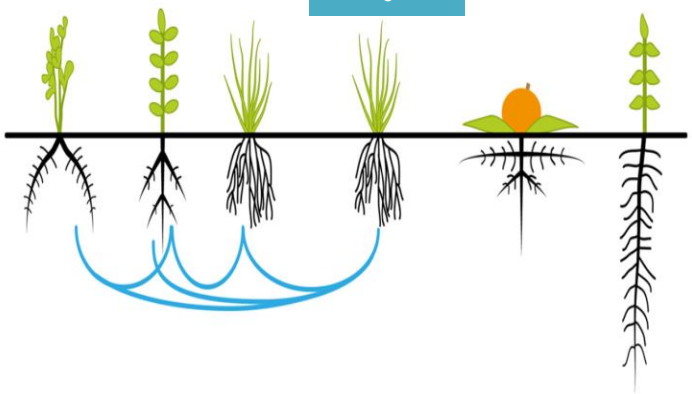
1

La milpa

Facilitación

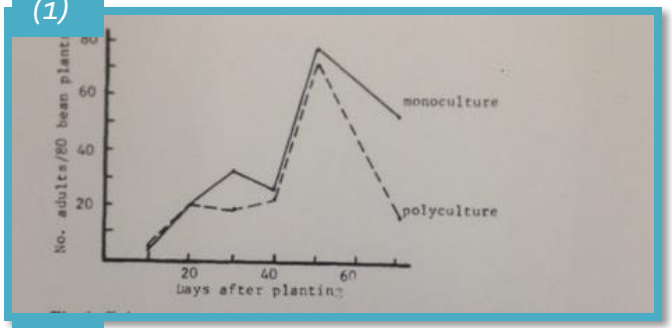
Recursos compartidos

Complementariedad

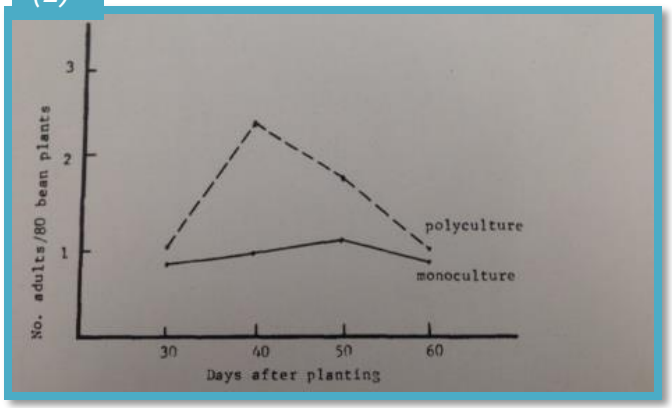


Leafhopper densities in intercropped beans due to higher abundance of predators

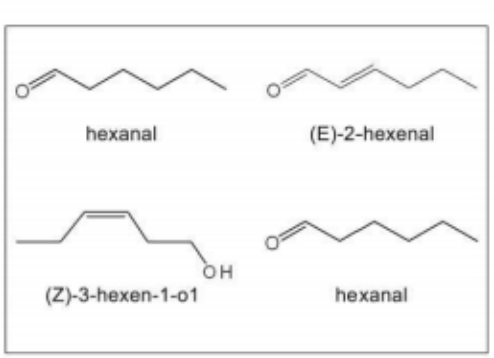
(1)

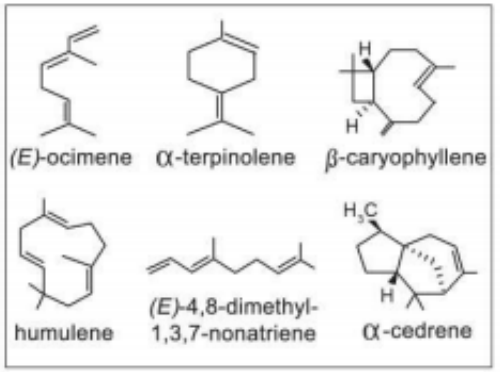


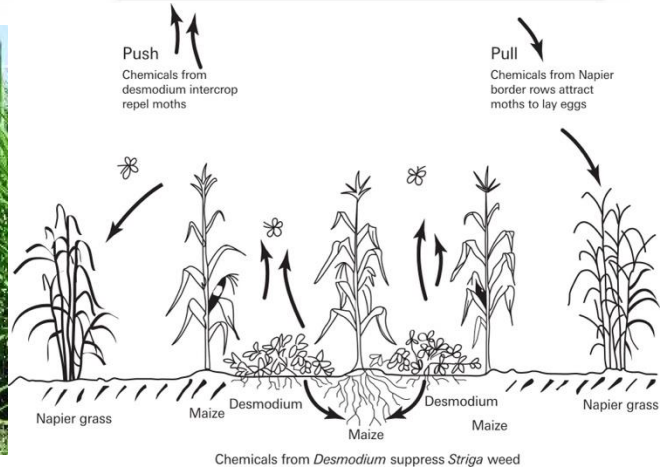
(2)



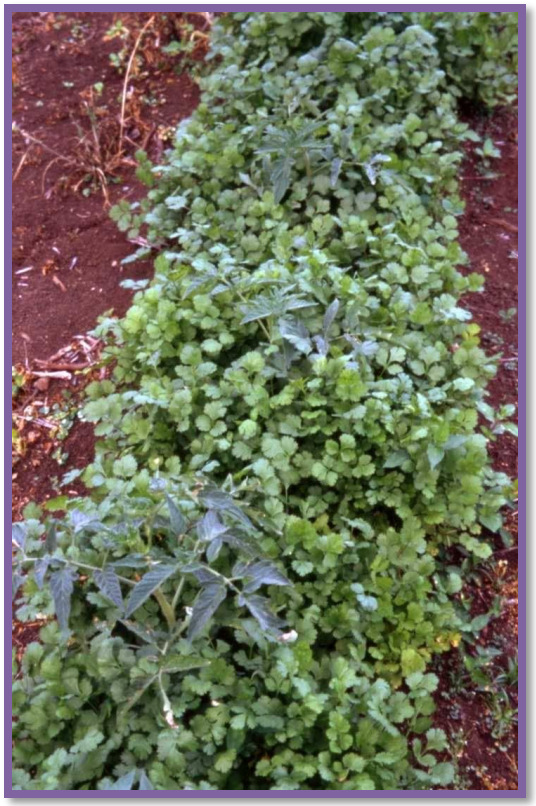
Push-pull system for stem-borer control in African maize



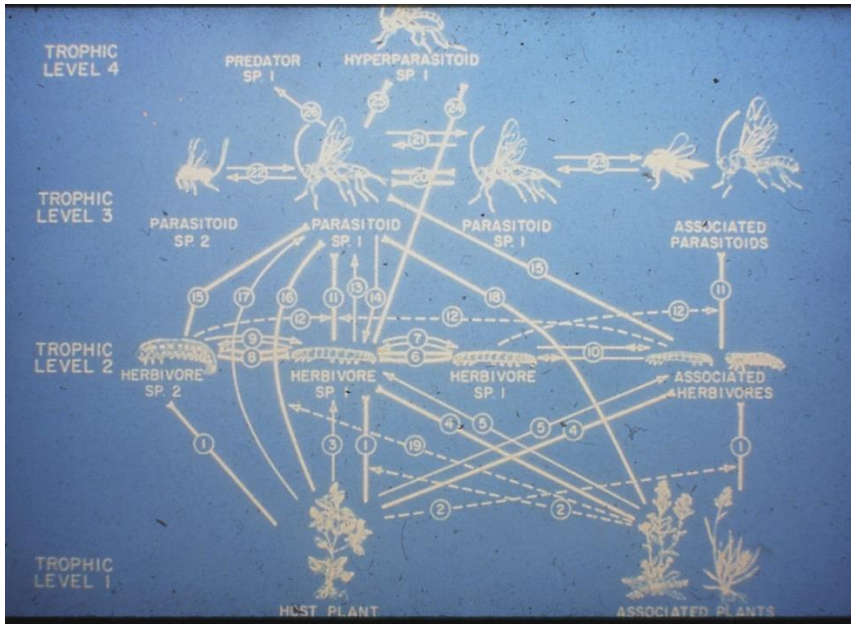


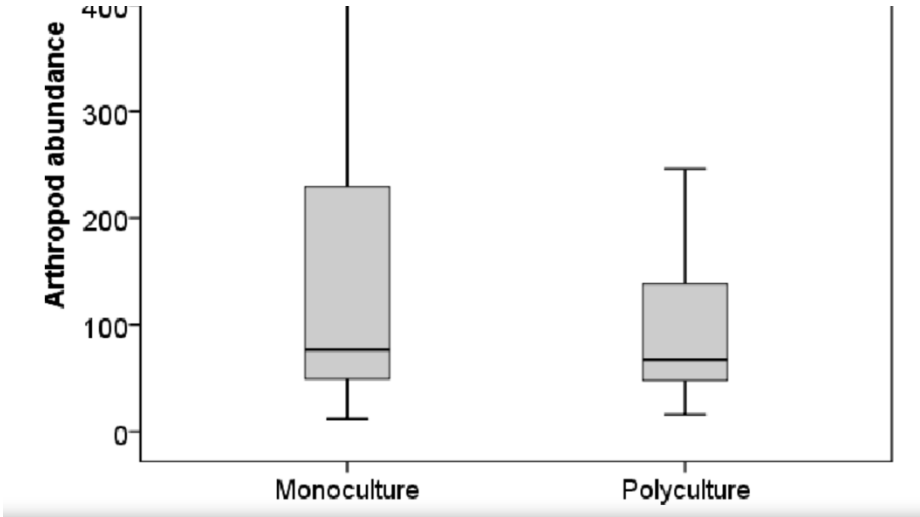


Masking odors of cilantro make tomatoes less apparent to whiteflies

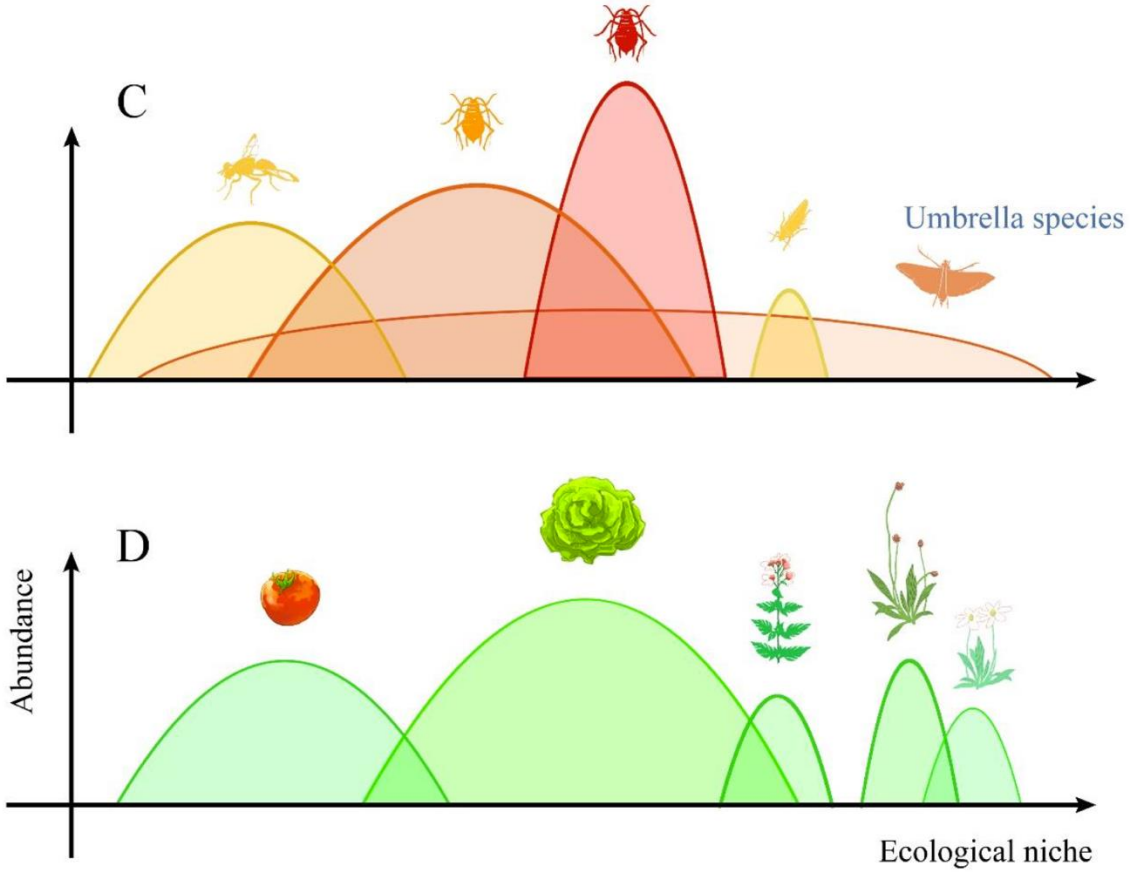


Abundance of herbivore pests in mono vs polycultures





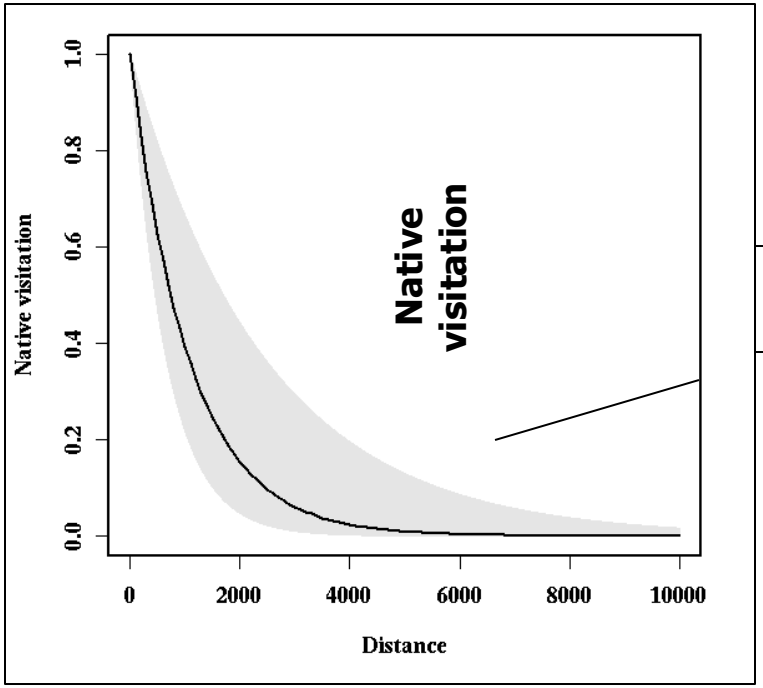
Vegetational diversity generates positive trophic cascades leading to increased pest control



Depredadores: Escala paisajística

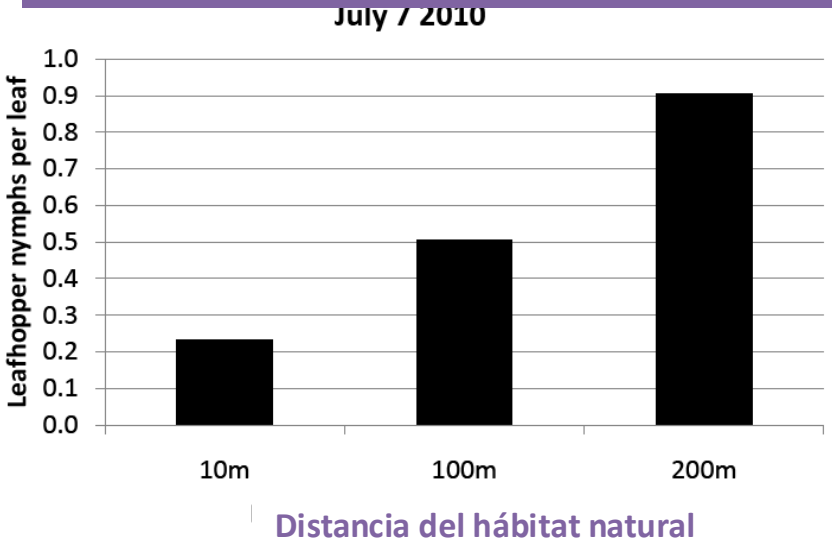
Generalización de más de 23 estudios

Resultados para la riqueza de especies de depredadores



90% credible interval

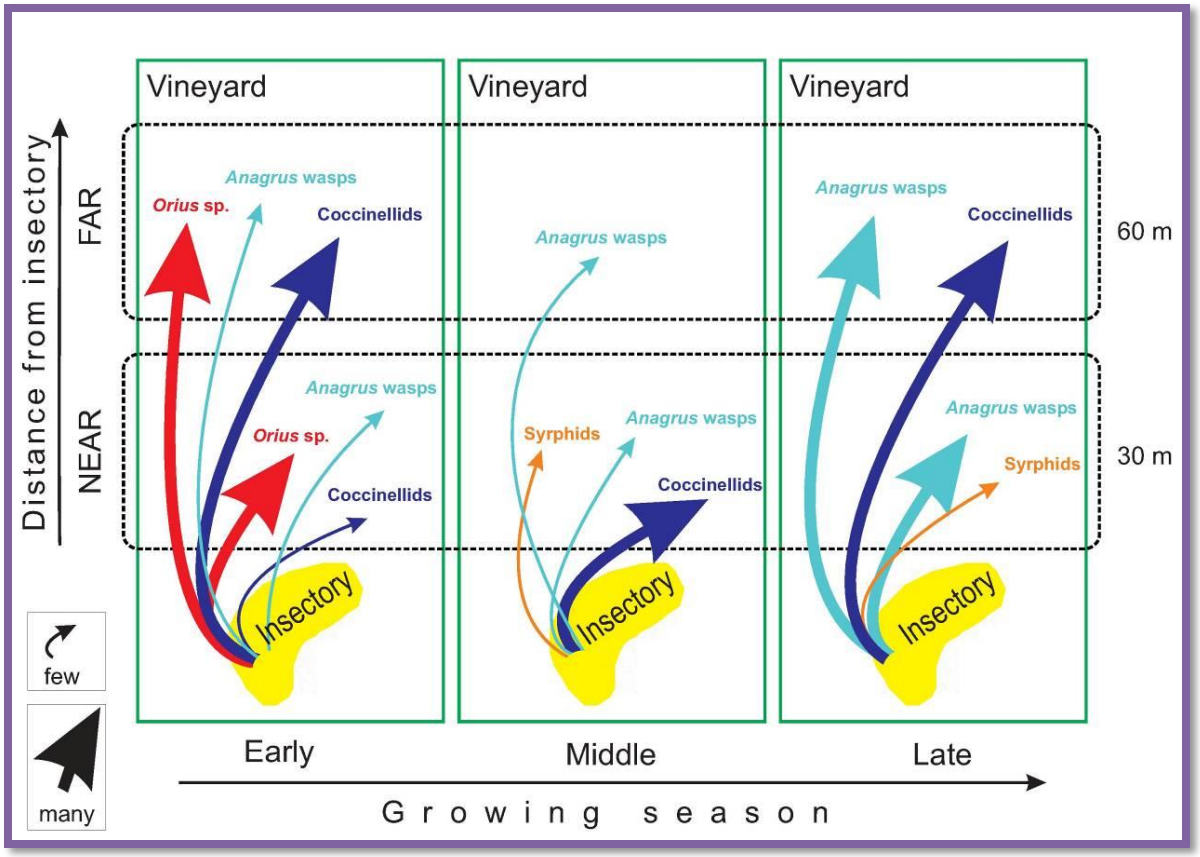
Densidad de ninfas de cicadélidos incrementa con la distancia Densidad de ninfas de cicadélidos incrementa con la distancia desde el bosque ripario Julio 2010



Ricketts et al. Ecology Letters 2008 11:499-515

Biological corridor for circulation of natural enemies from forest edge into field

Dispersión del parasitoide *Anagrus* y de los predatores generalistas desde las islas de vegetación (insectario) al viñedo



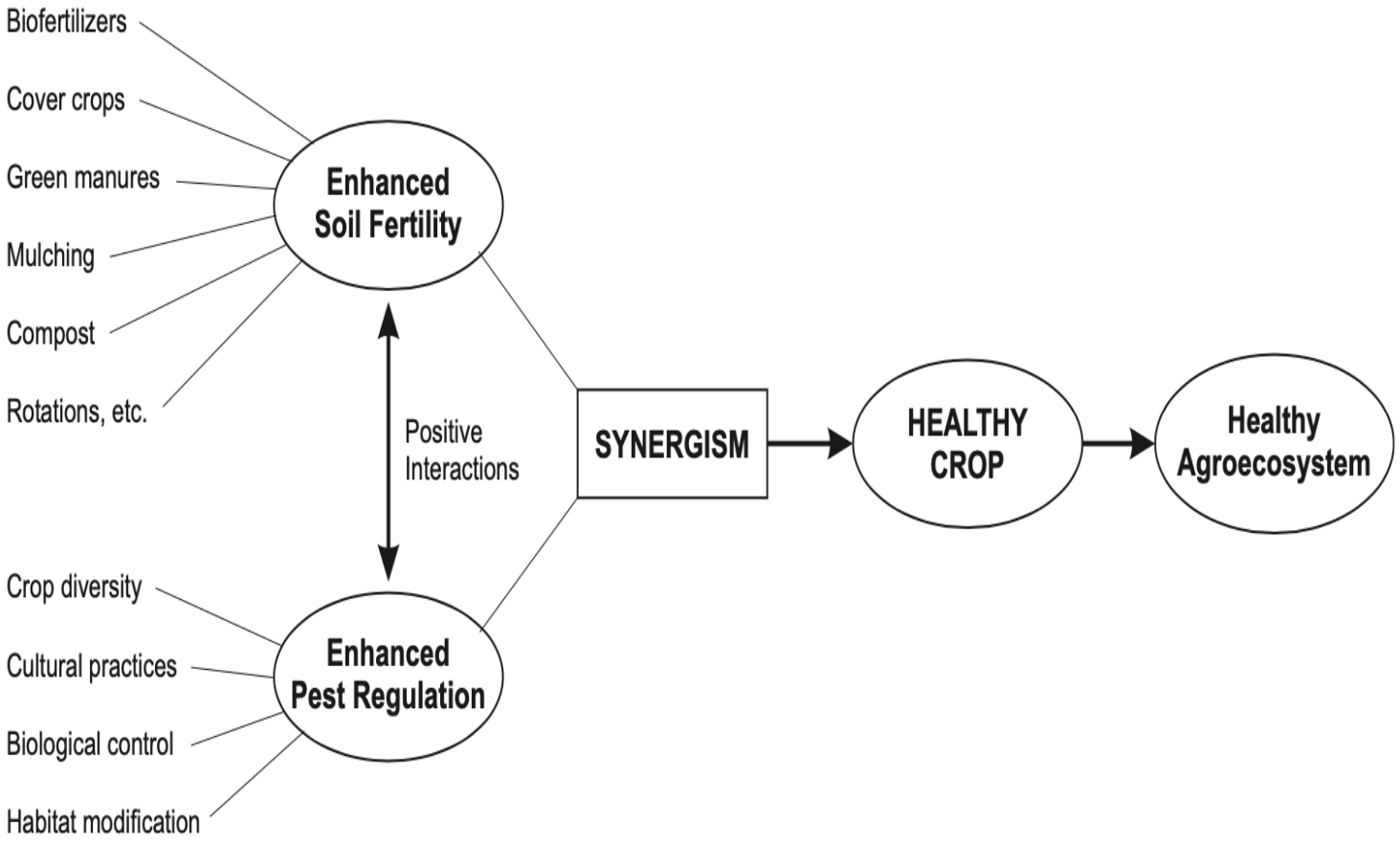


Figure 5.1 The potential synergism between soil fertility management and IPM.

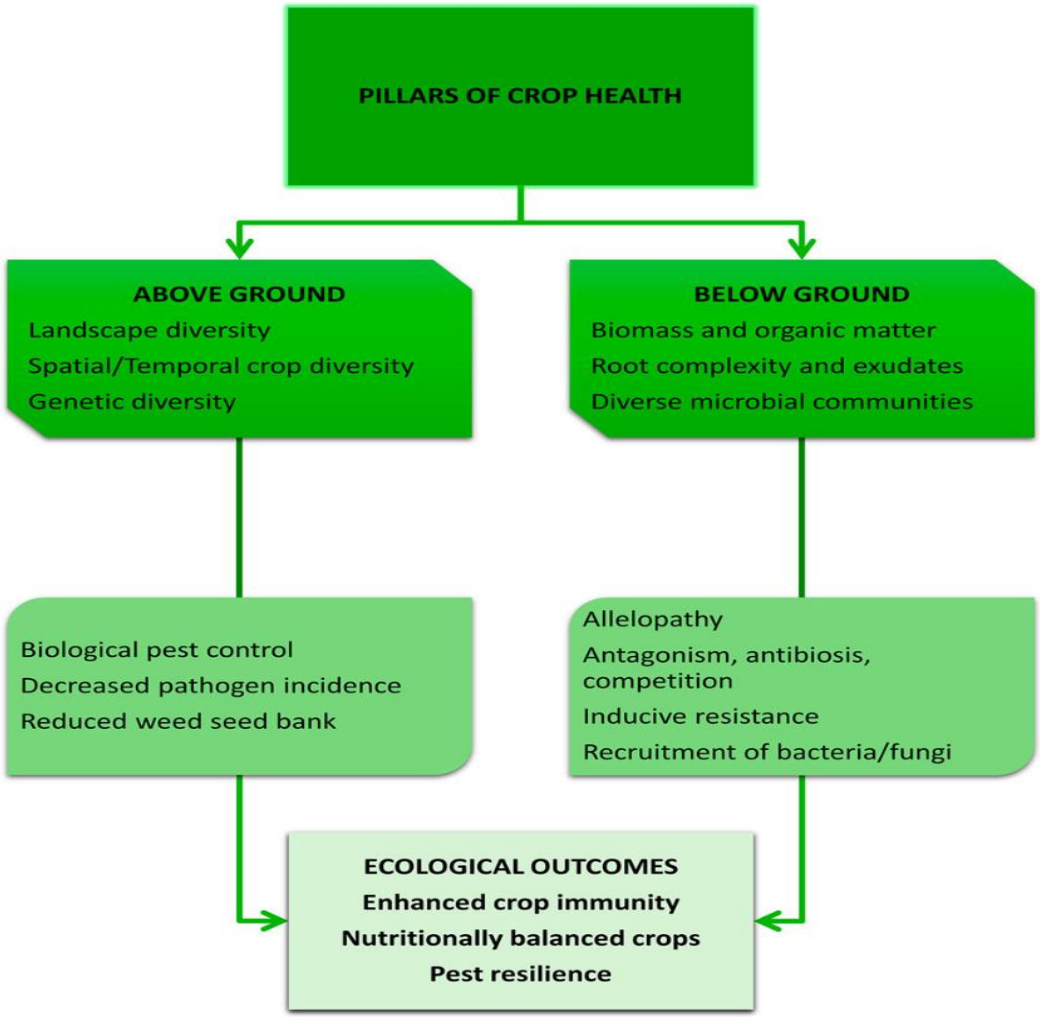


Fig. 1 | The pillars of plant health in agroecosystems. Exploiting the synergies between plant diversity and microbial community ecological activity.