

Ecosystem services of Perennial Forages

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THE UNIVERSITY
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2022

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CA | USA



Why do we need to talk about
ecosystem services?

Food is not the only thing we produce...



Ecosystem services



Food

Biodiversity

Climate change
mitigation

Soil
protection

Carbon
sequestration

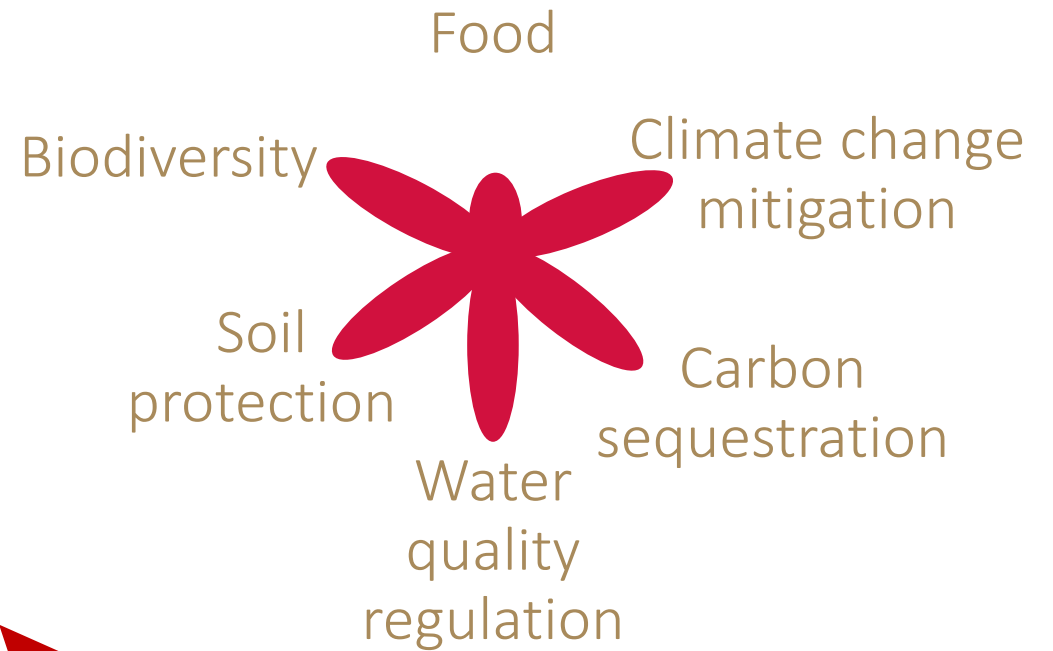
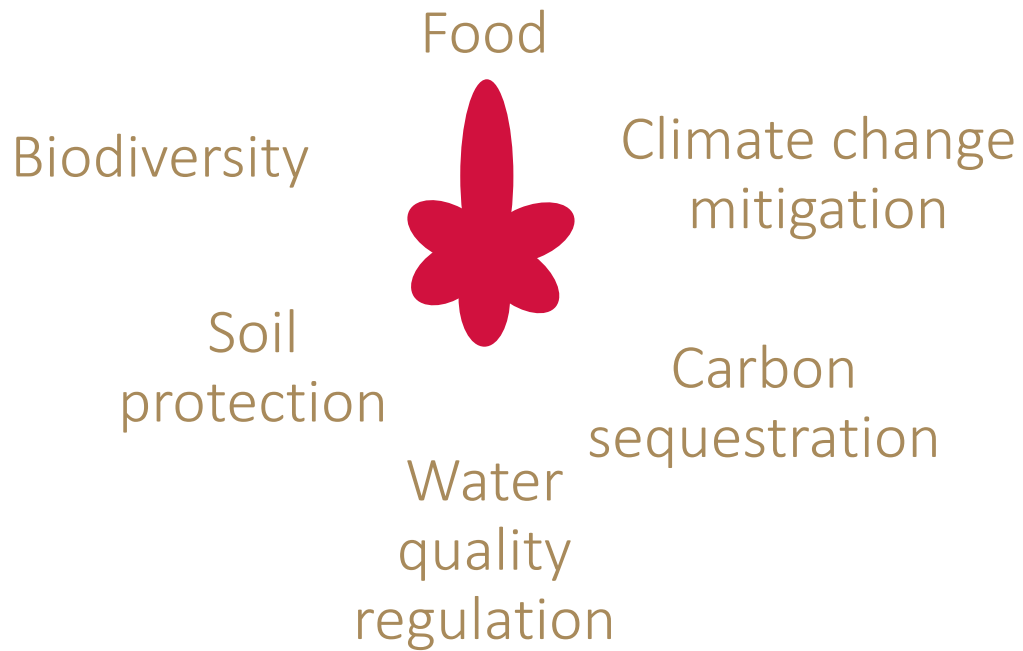
Water
quality
regulation

Ecosystem services



Agroecosystem

Natural ecosystem



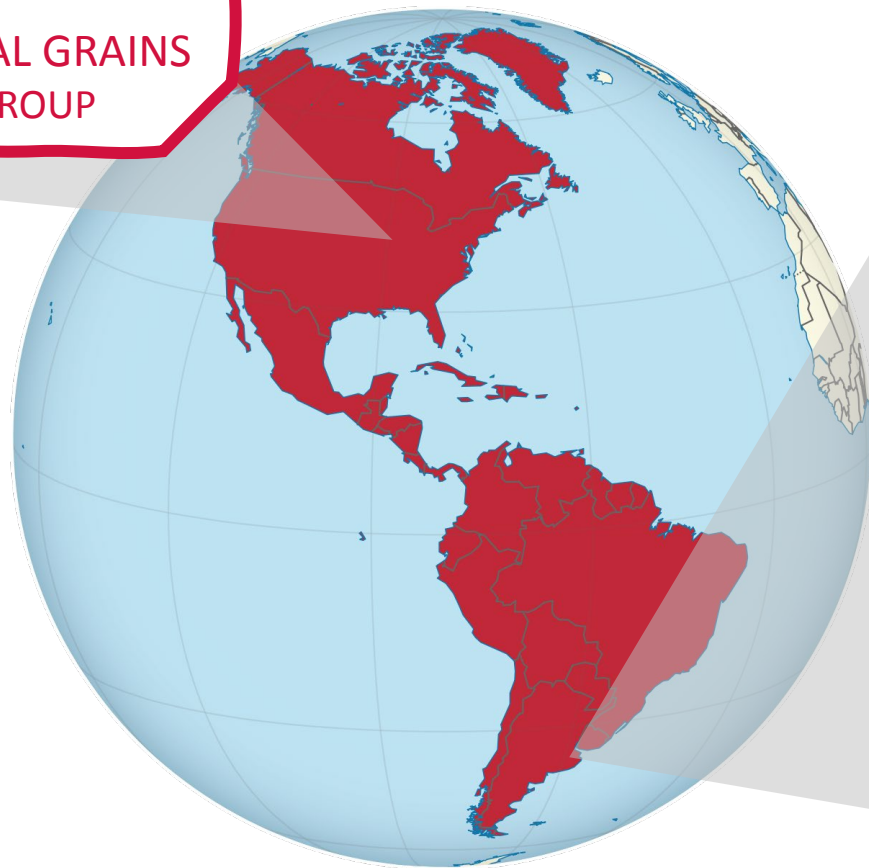
ECOLOGICAL INTENSIFICATION

Adapted from Foley et al., 2005



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FORAGES AND PERENNIAL GRAINS
PICASSO RESEARCH GROUP



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Ecological Intensification

- Biodiversity and perenniality
- Crop-livestock integration
- Soil organic matter formation
- Biological N fixation



Review

Ecological Intensification of Food Production by Integrating Forages

José G. Franco ^{1,*}, Marisol T. Berti ², John H. Grabber ³, John R. Hendrickson ³, Christine C. Nieman ⁴, Priscila Pinto ⁵, David Van Tassel ⁶ and Valentin D. Picasso ⁵

Front. Agr. Sci. Eng.

<https://doi.org/10.15302/J-FASE-2020380>

REVIEW

LAND-USE INTENSIFICATION TRENDS IN THE RIO DE LA PLATA REGION OF SOUTH AMERICA: TOWARD SPECIALIZATION OR RECOUPLING CROP AND LIVESTOCK PRODUCTION

Paulo César DE FACCIO CARVALHO ¹✉, Jean Víctor SAVIAN², Tomas DELLA CHIESA², William DE SOUZA FILHO¹, José Alfredo TERRA², Priscila PINTO³, Amanda POSSELT MARTINS¹, Sebastian VILLARINO⁴, Júlio Kuhn DA TRINDADE⁵, Pedro Arthur DE ALBUQUERQUE NUNES¹, Gervasio PIÑEIRO^{3,6}

SCIENCE ADVANCES | RESEARCH ARTICLE

PLANT SCIENCES

Plant rhizodeposition: A key factor for soil organic matter formation in stable fractions

Sebastián H. Villarino ^{1,2,*}, Priscila Pinto³, Robert B. Jackson⁴, Gervasio Piñeiro^{3,5}


Plant Soil

<https://doi.org/10.1007/s11104-021-04916-x>

REGULAR ARTICLE



Variable root:shoot ratios and plant nitrogen concentrations discourage using just aboveground biomass to select legume service crops

Priscila Pinto  · Gerardo Rubio · Félix Gutiérrez · Jorge Sawchik · Santiago Arana · Gervasio Piñeiro



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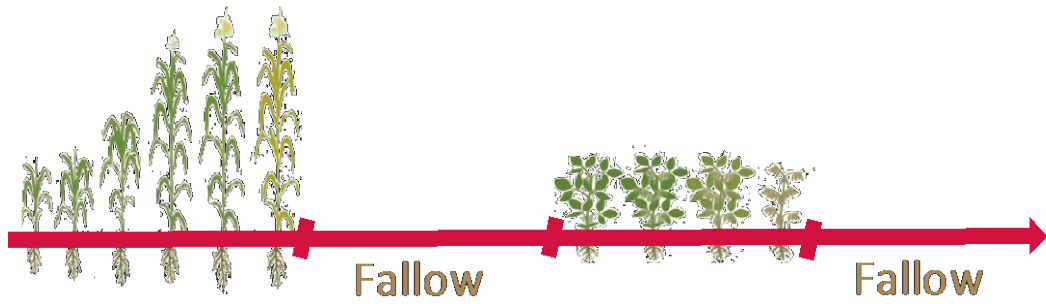
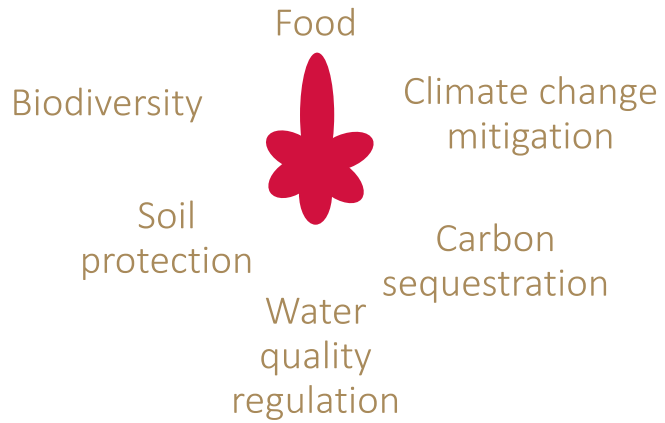
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Ecological Intensification

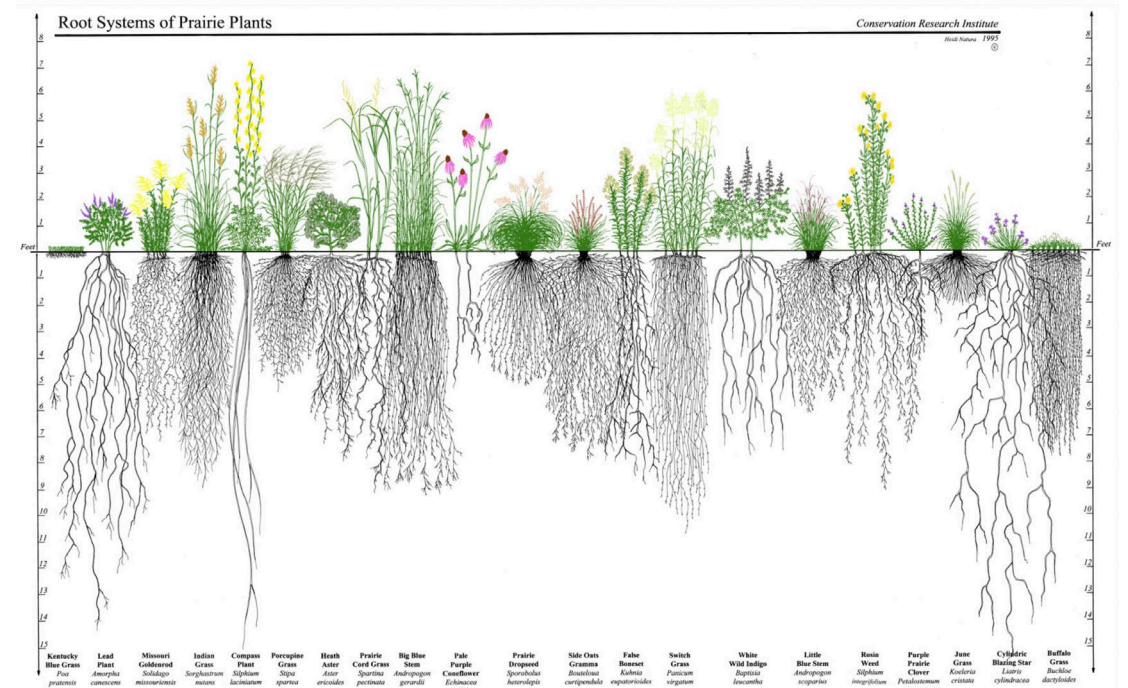
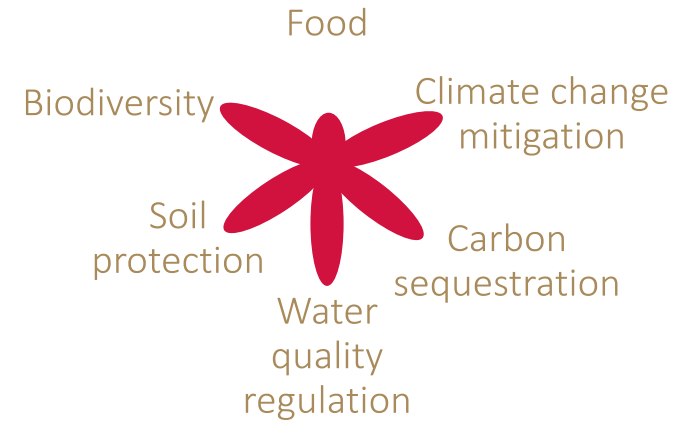
- Biodiversity and perenniality

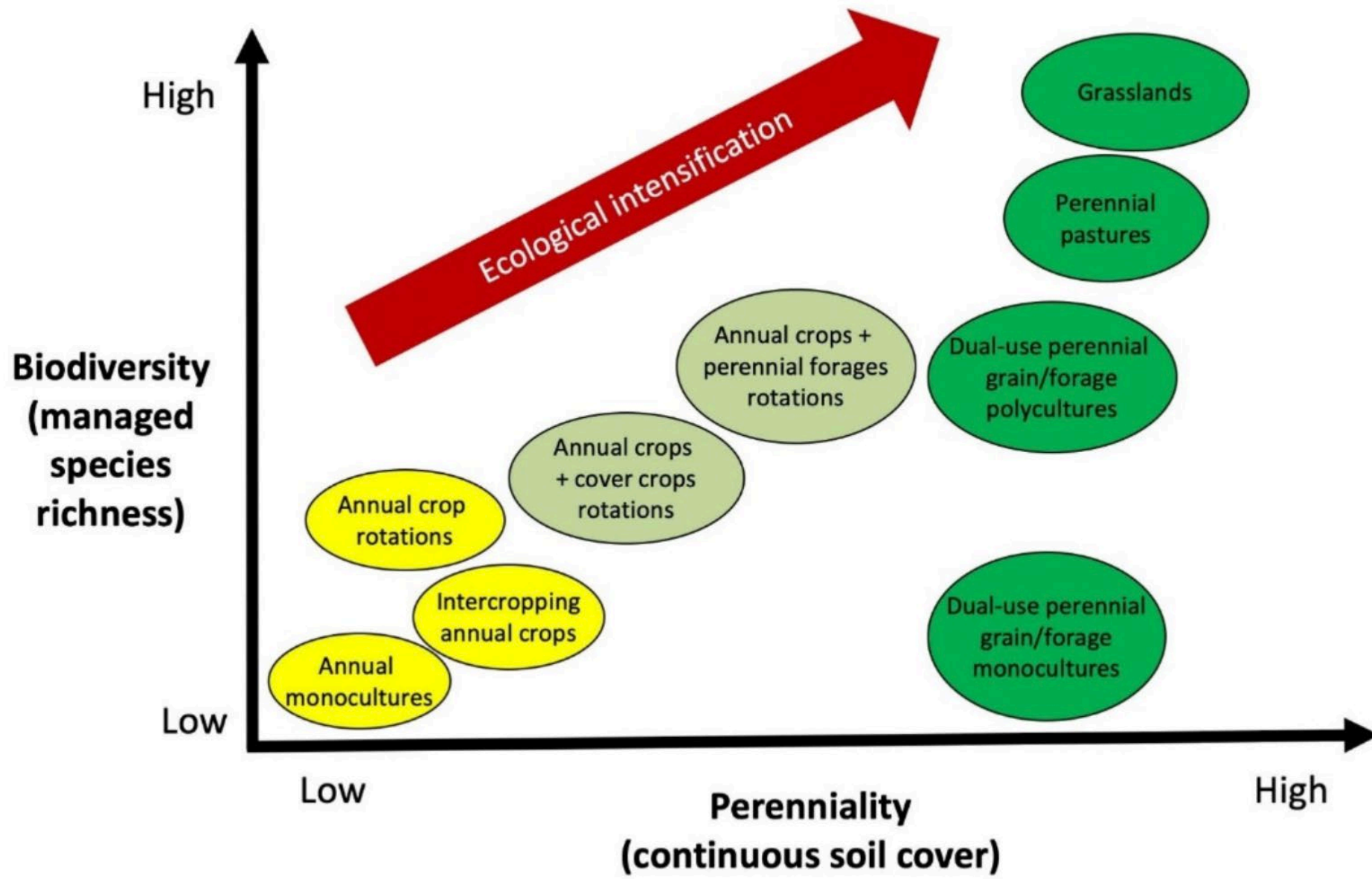


Agroecosystem



Natural ecosystem







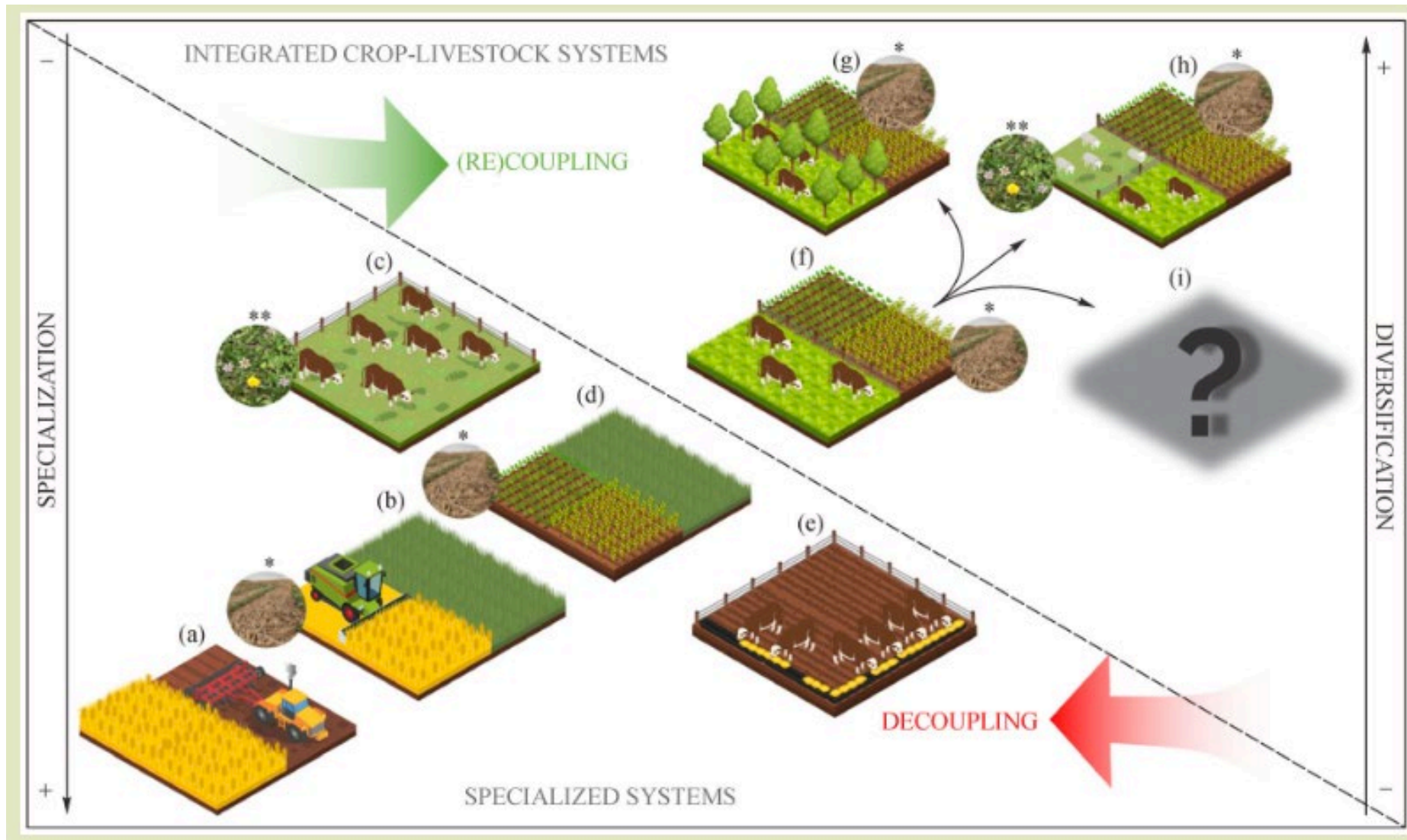
Ecological Intensification

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- Crop-livestock integration



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Ecological Intensification

- Biodiversity and perenniality
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- Soil organic matter formation



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Particulate organic matter (POM)

Soil organic matter

Mineral-associated organic matter (MAOM)

Carbon sequestration

Soil aggregation

Nutrient reservoir

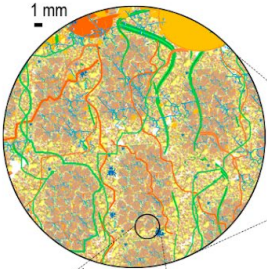


Piazza - Pinto, et al (*in review*)
Frontiers in Ecology and the Environment

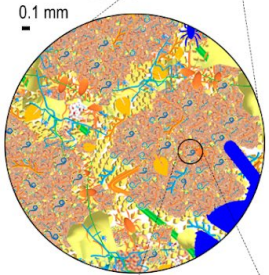


(a)

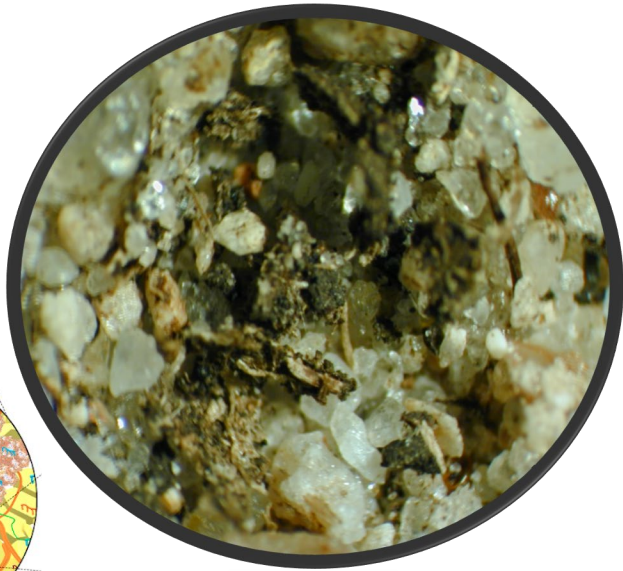
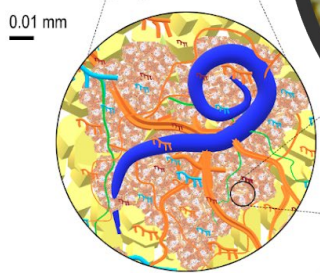
II. Macroaggregates



III. Mesoaggregates



IV. Microaggregates



Particulate organic matter (POM)

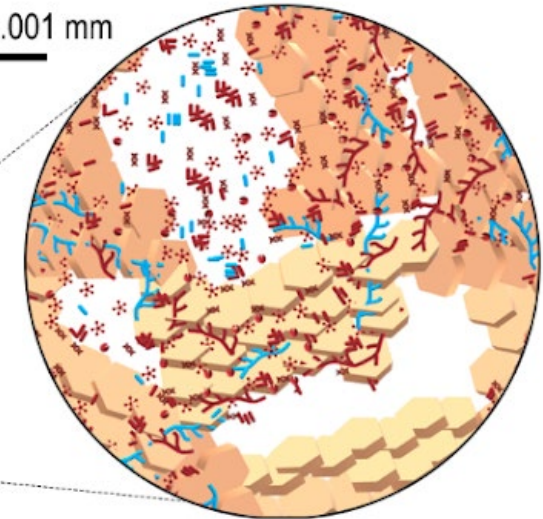
Mineral-associated organic matter (MAOM)



Soil biota products,
root exudates..

V. Small minerals and colloids

0.001 mm

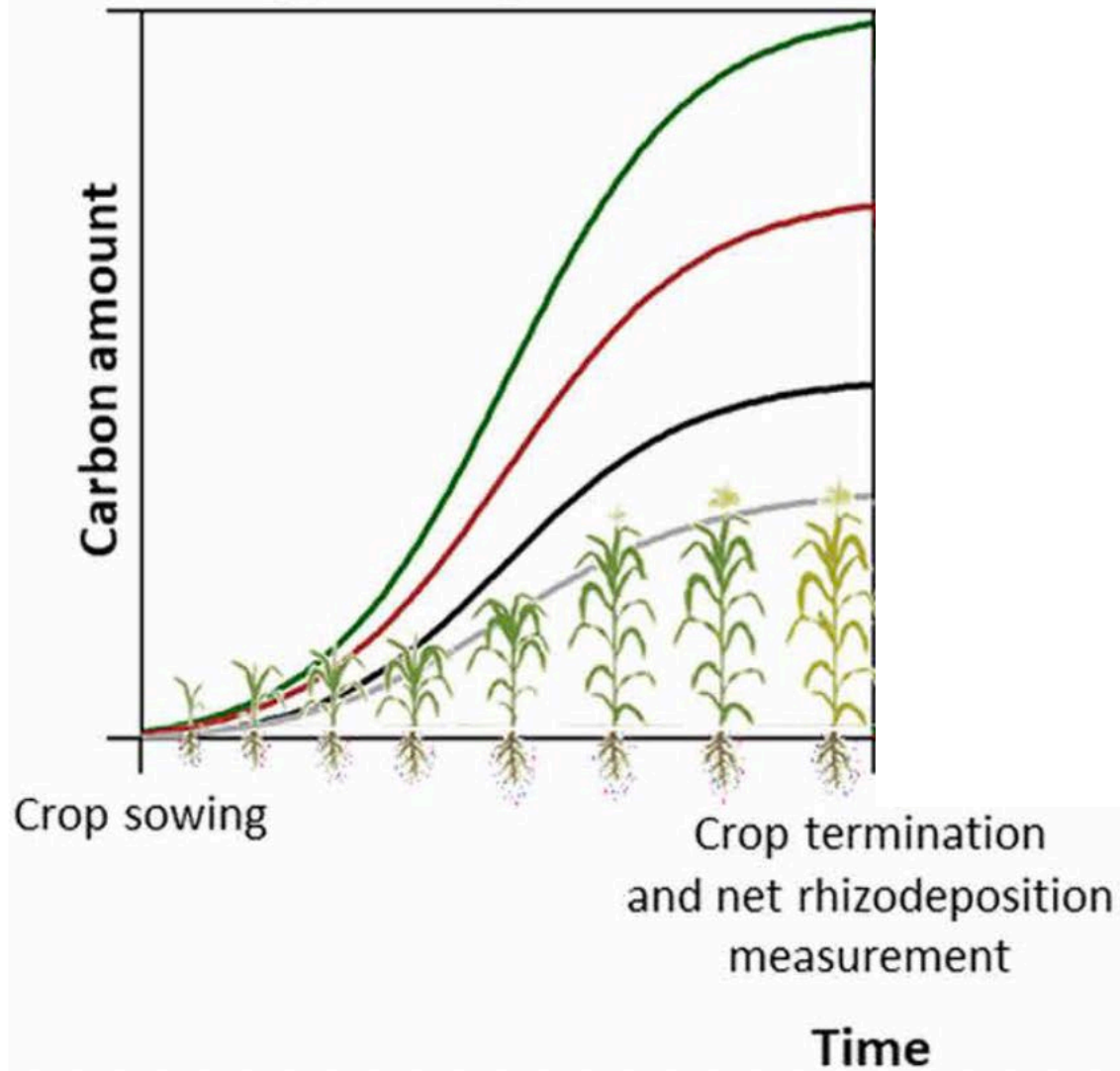


Piazza - Pinto, et al (*in review*)
Frontiers in Ecology and the Environment

Isotope experiments review



B Living plant experiments

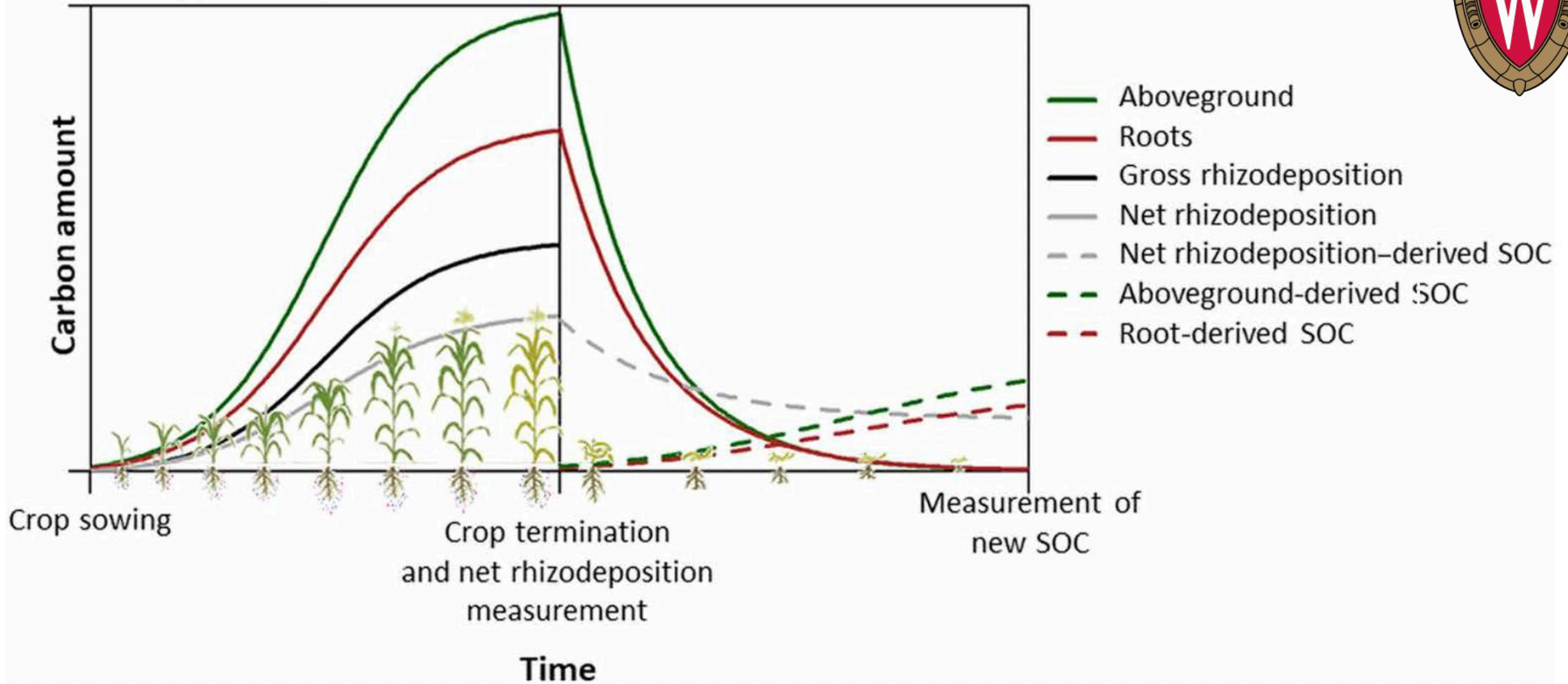


- Aboveground
- Roots
- Gross rhizodeposition
- Net rhizodeposition

Isotope experiments review



B Living plant experiments





Aboveground inputs



5%

Particulate organic matter (POM)



Roots

14%

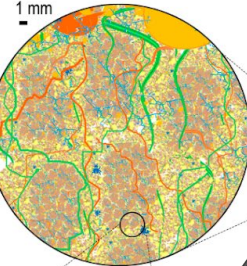
2%

Rhizodeposition

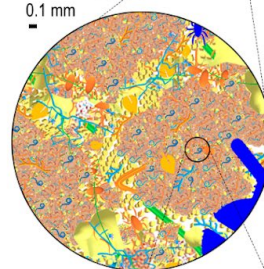
Belowground inputs

(a)

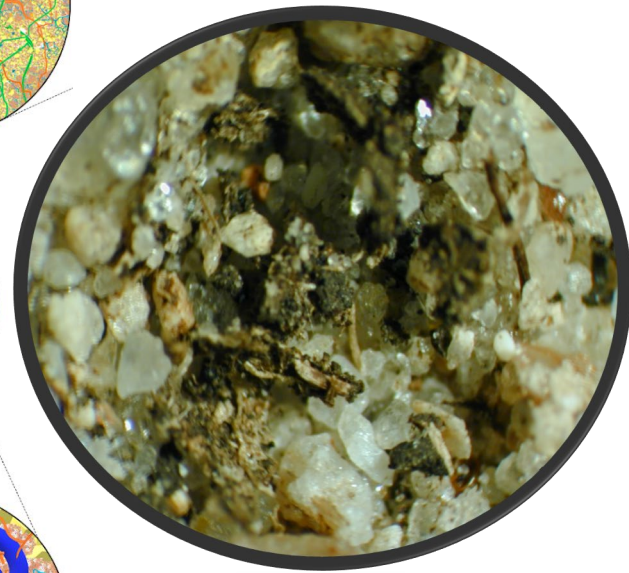
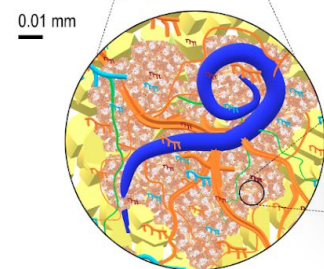
II. Macroaggregates



III. Mesoaggregates



IV. Microaggregates





Aboveground inputs



7%



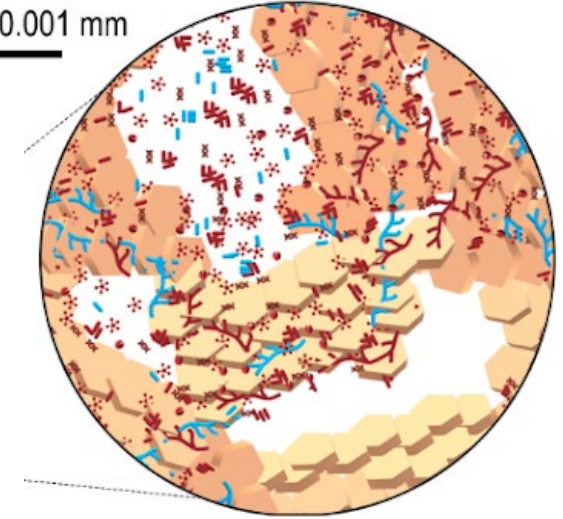
Mineral-associated organic matter (MAOM)



Soil biota products, root exudates..

V. Small minerals and colloids

0.001 mm

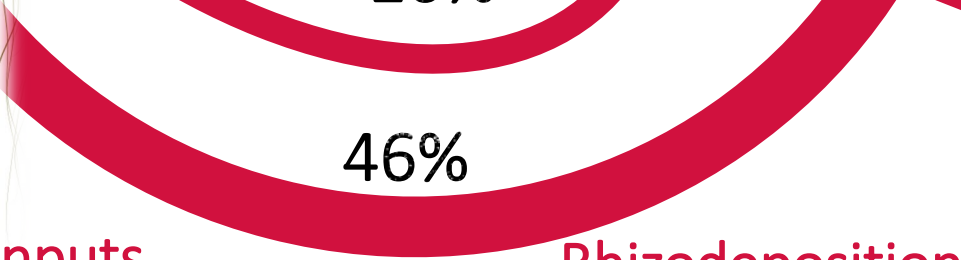


Roots

20%

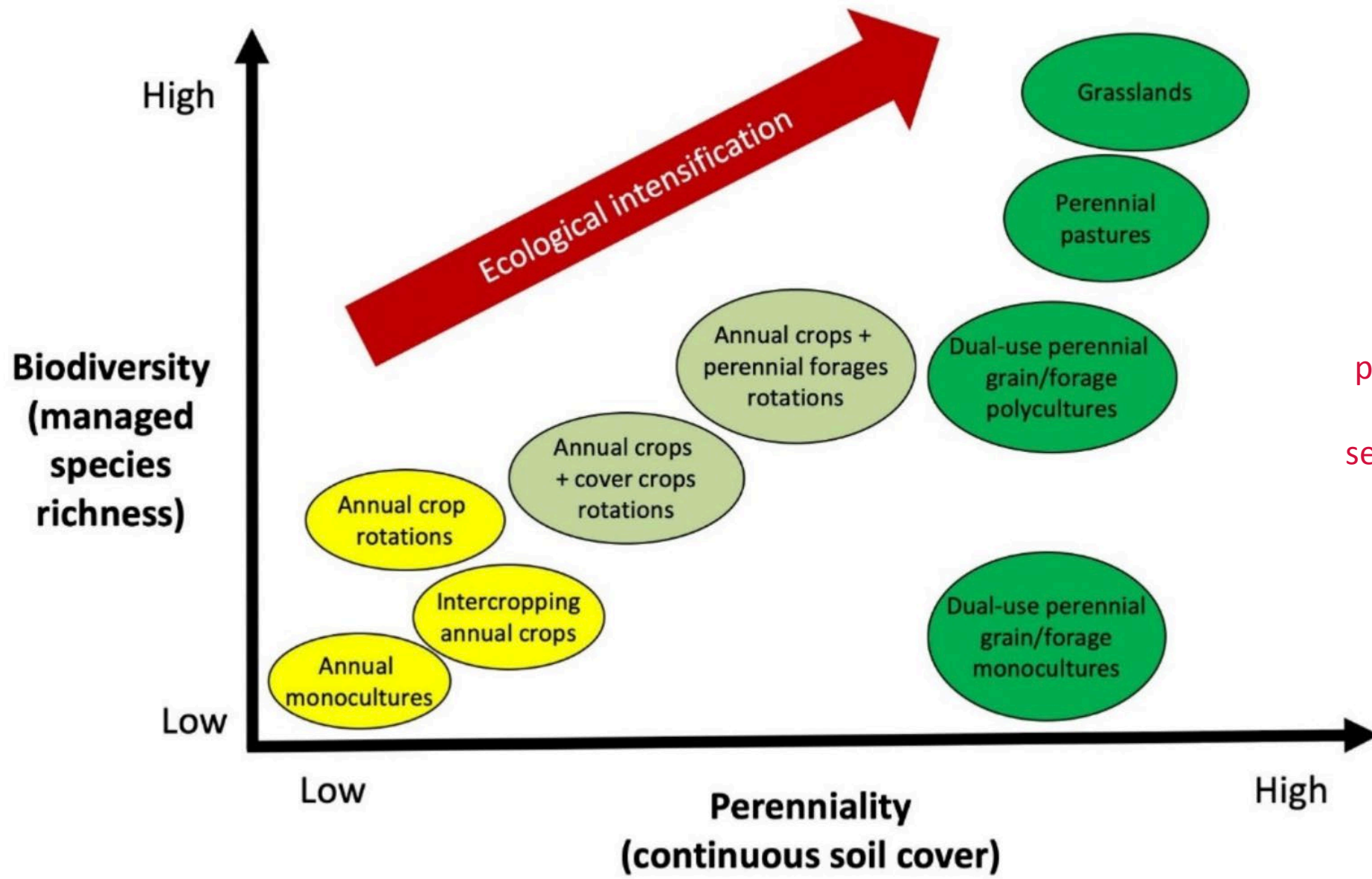


46%



Rhizodeposition

Belowground inputs



High belowground production can help to increase carbon sequestration in the soil organic matter



Ecological Intensification

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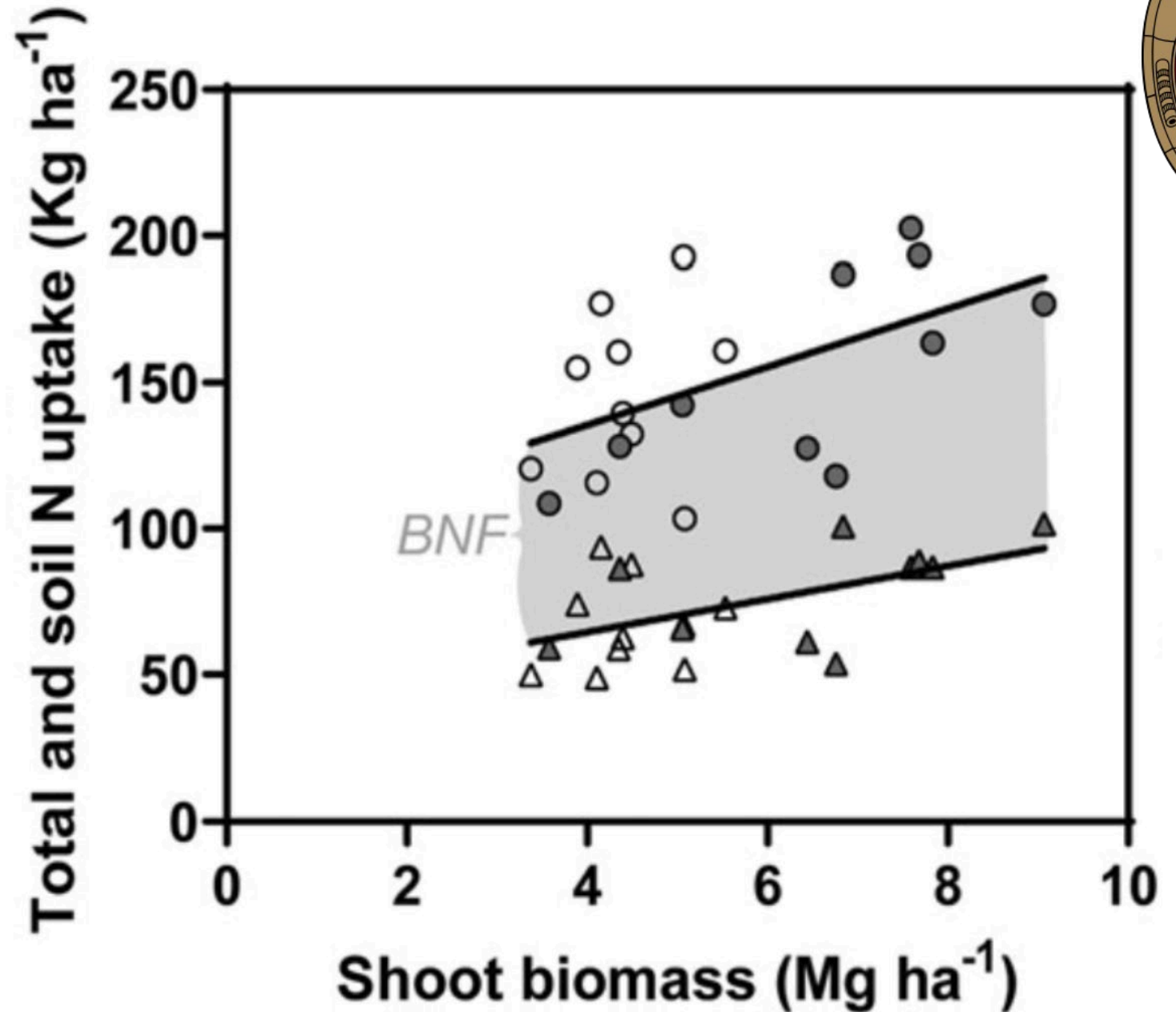




Exp:

- 10 legumes x 2 years
- La Estanzuela (Uruguay)
- ^{15}N natural abundance

$\sim 100 \text{ kg ha}^{-1} \text{ year}^{-1}$



Ecological Intensification

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Avenue of the stars, Los Angeles





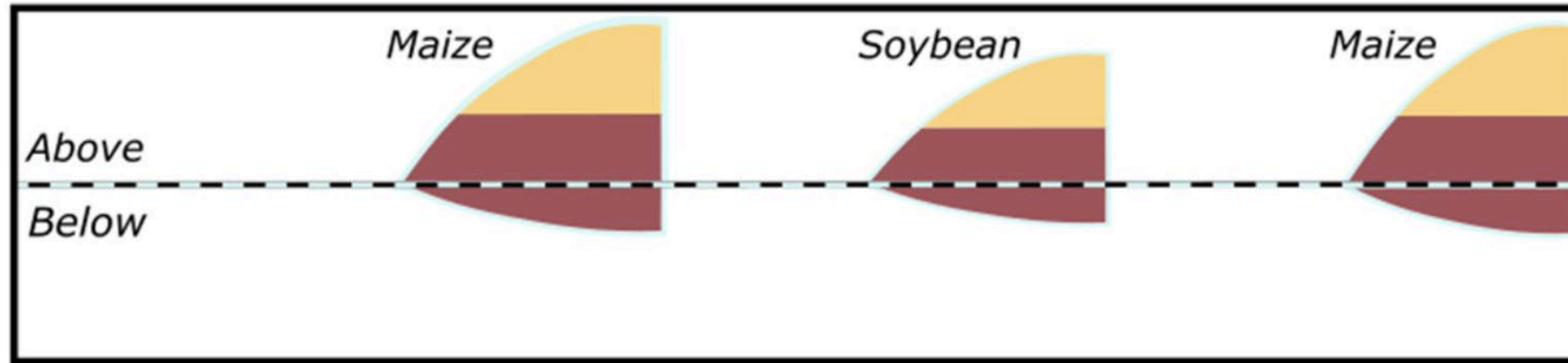
Year 1

Year 2

Year 3

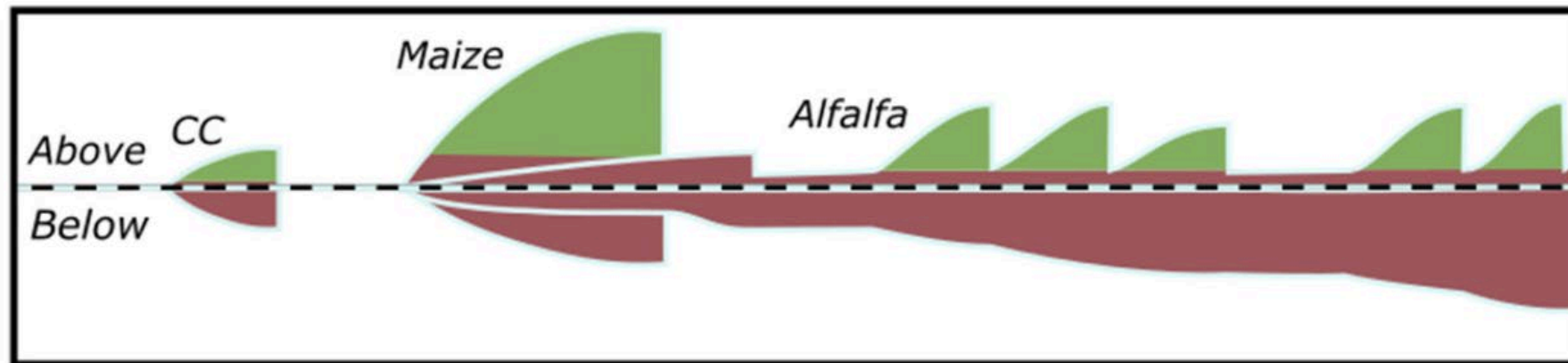
Fa Wi Sp Su Fa Wi Sp Su Fa Wi Sp Su

2.1 Annual crops



- Grain harvest
- Forage harvest
- Crop residue + belowground input to soil

2.4 Annual crops + perennial forages





Alfalfa

Reduce soil and nutrient losses

Wu, et al. 2011,
Osterholz, et al. 2019

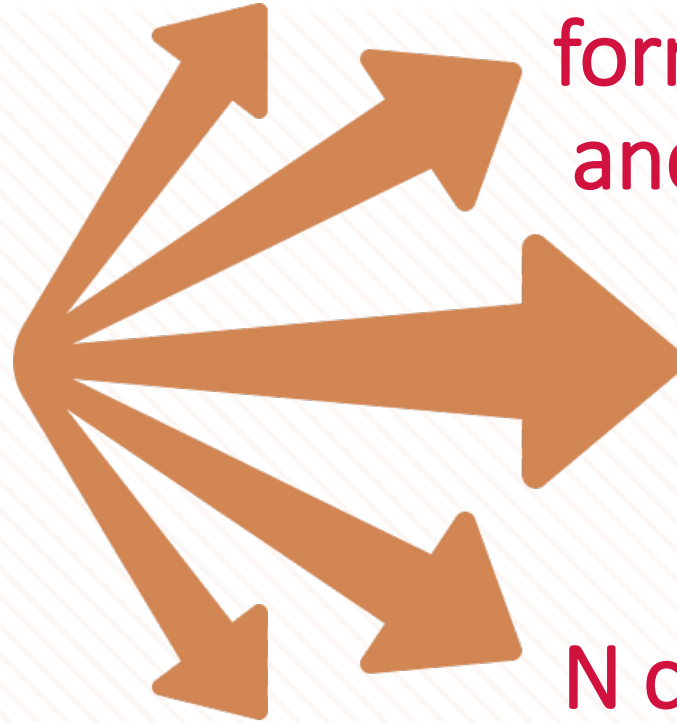
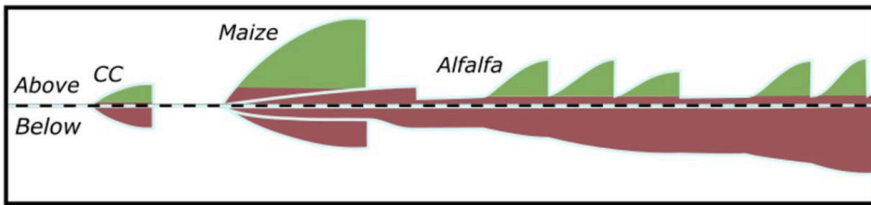
Soil organic matter formation by roots and rhizodeposits

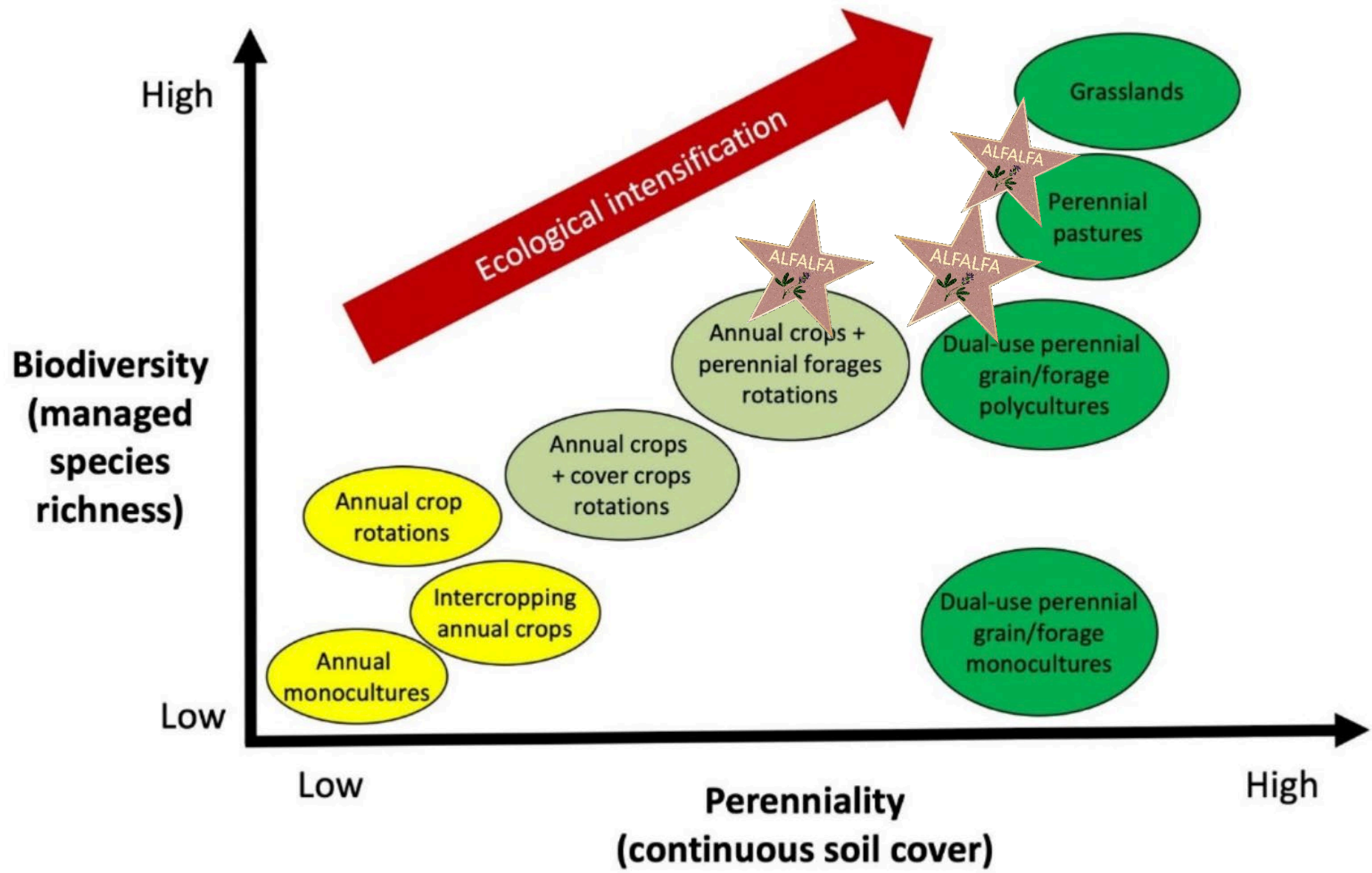
Food

N credits by BNF

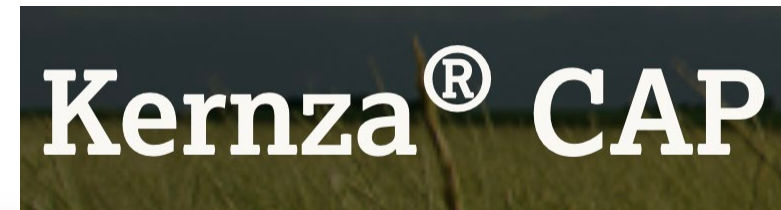
Food source and habitat for pollinators and beneficial insects

Fernandez, et al. 2019

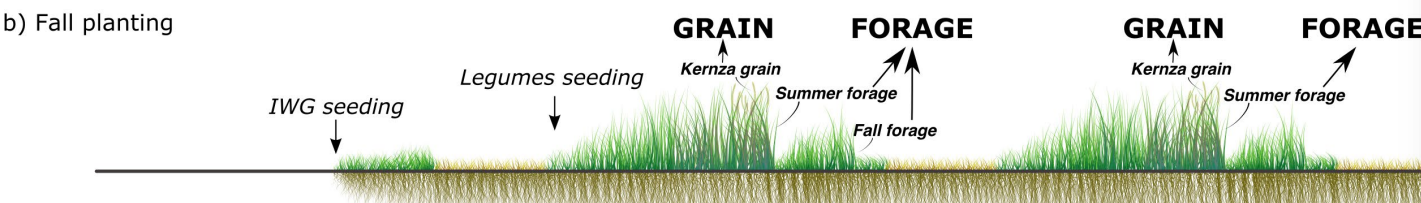
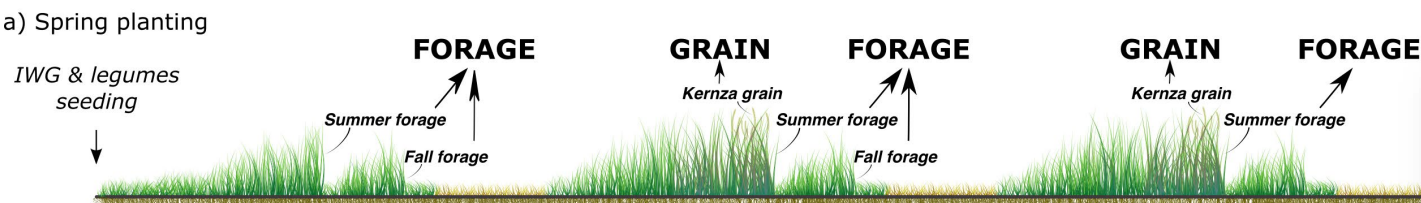




Intercropping alfalfa and perennial crops



Year	Establishment				First grain production				Second grain production			
season	spring	summer	fall	winter	spring	summer	fall	winter	spring	summer	fall	winter



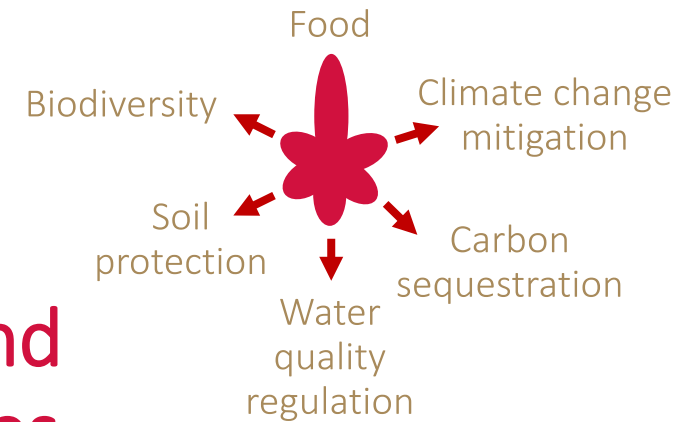
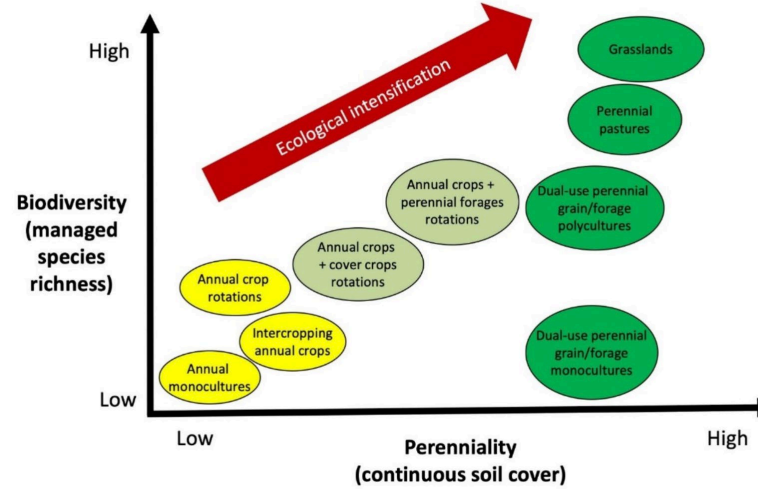
Pinto, et al. (*in review*)

Concluding remarks



Alfalfa

The increased use of alfalfa in integrated crop-livestock systems is very promising to make the agroecosystems more perennial and provide multiple ecosystem services





Thanks!

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