
Photo by Victoria Maguire-Rajpaul

A importância da ecologia da paisagem e dos padrões históricos no fornecimento de serviços ecossistêmicos para a agricultura

24 Março 2025

ENBT

Dr. Felipe Librán Embid

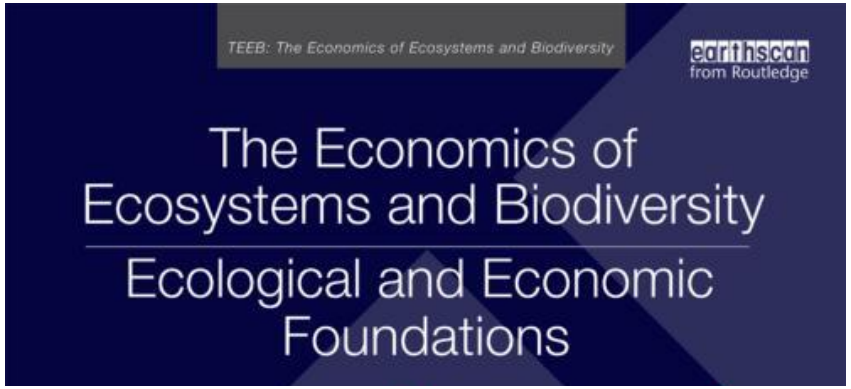
Institut für Tierökologie
und Spezielle Zoologie

JUSTUS-LIEBIG-
UNIVERSITÄT
GIESSEN

Ecosystem services

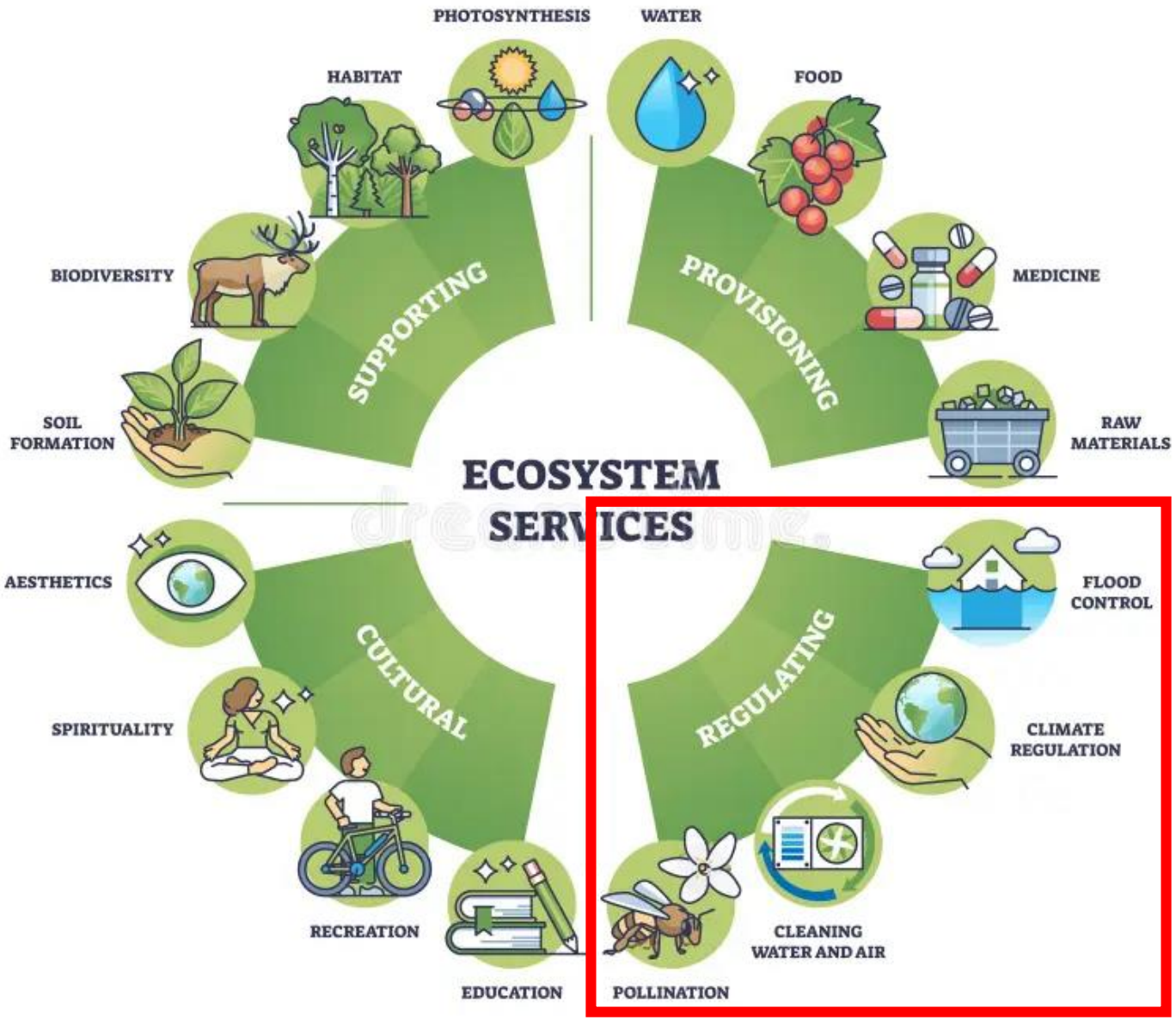
2005

2010

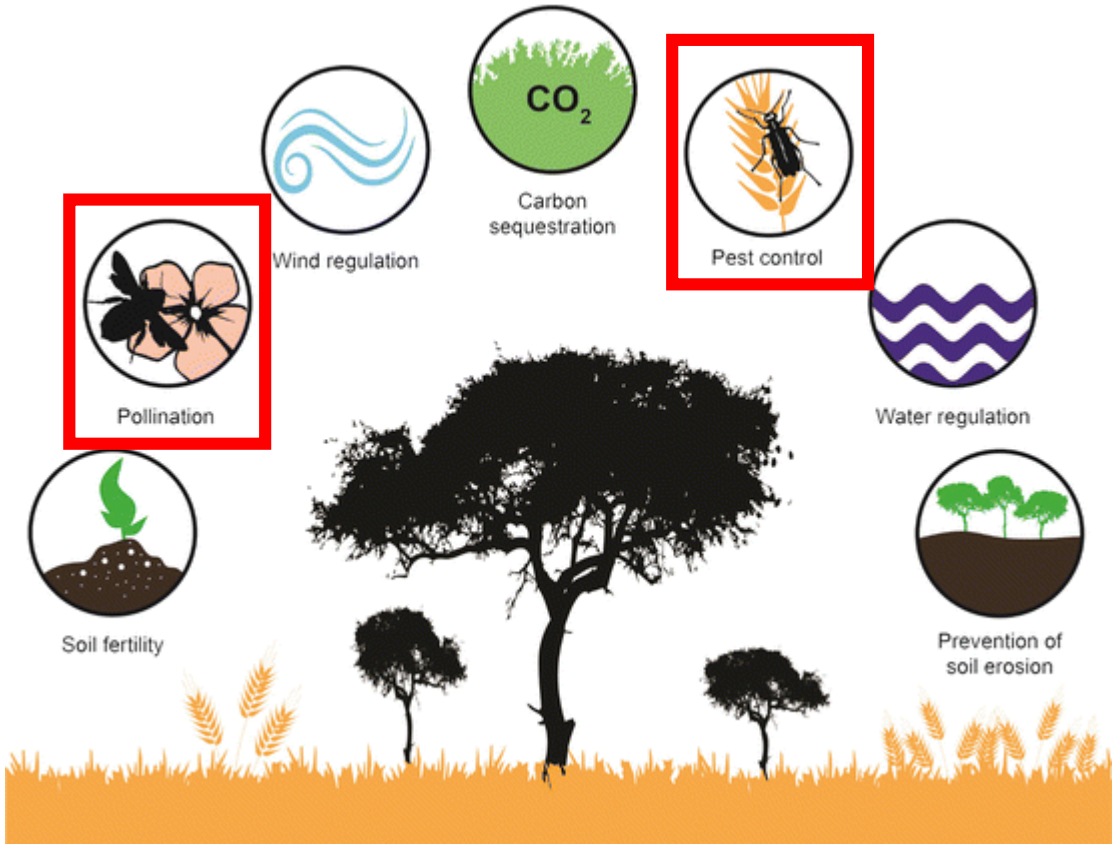


“the direct and indirect contributions of ecosystems to human wellbeing”

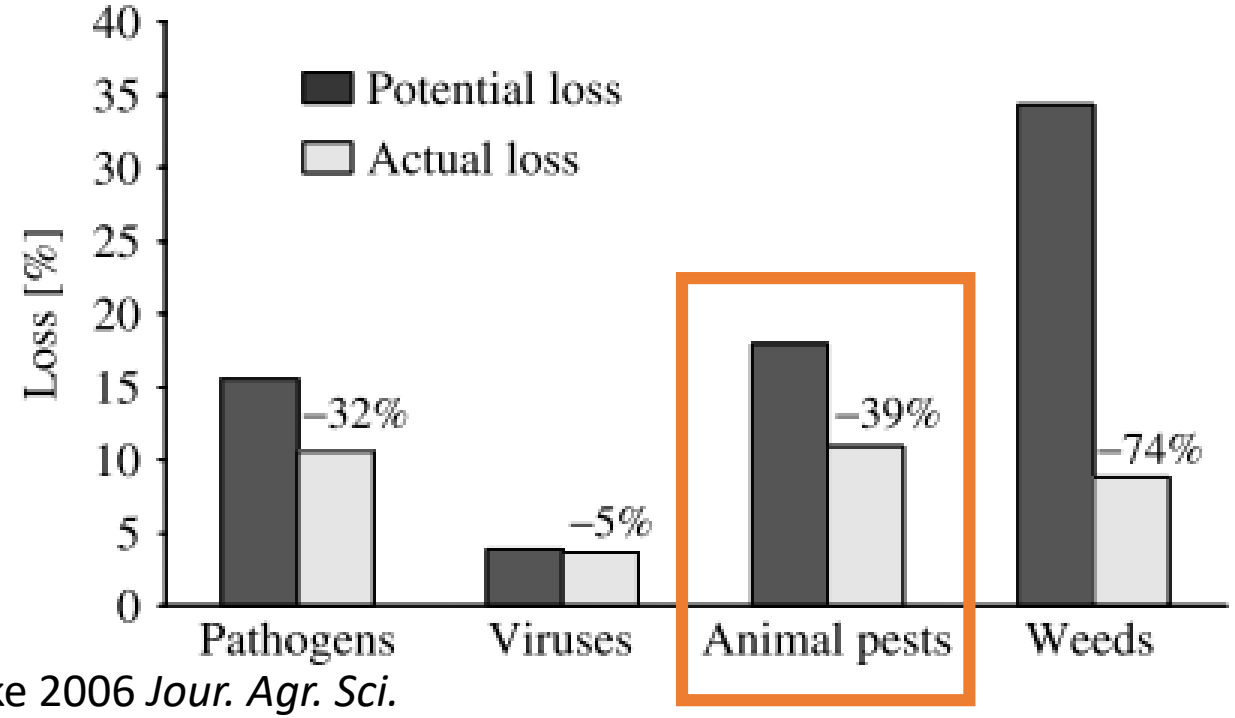
Ecosystem services



Regulating services



Biological pest control



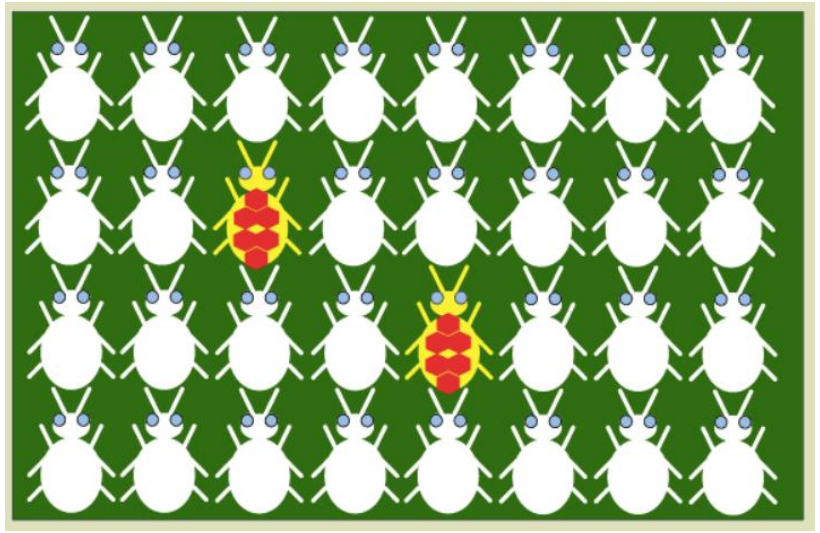
Oerke 2006 *Jour. Agr. Sci.*

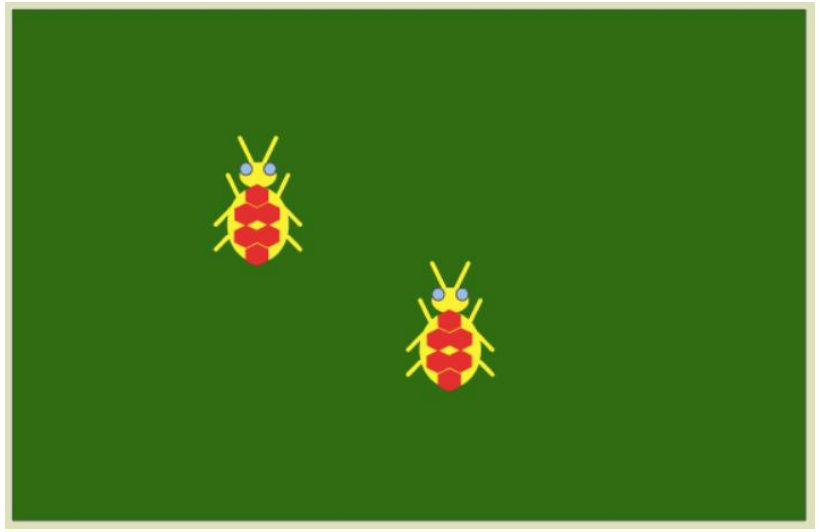
Despite a clear increase in pesticide use, crop losses have not significantly decreased during the last 40 years.

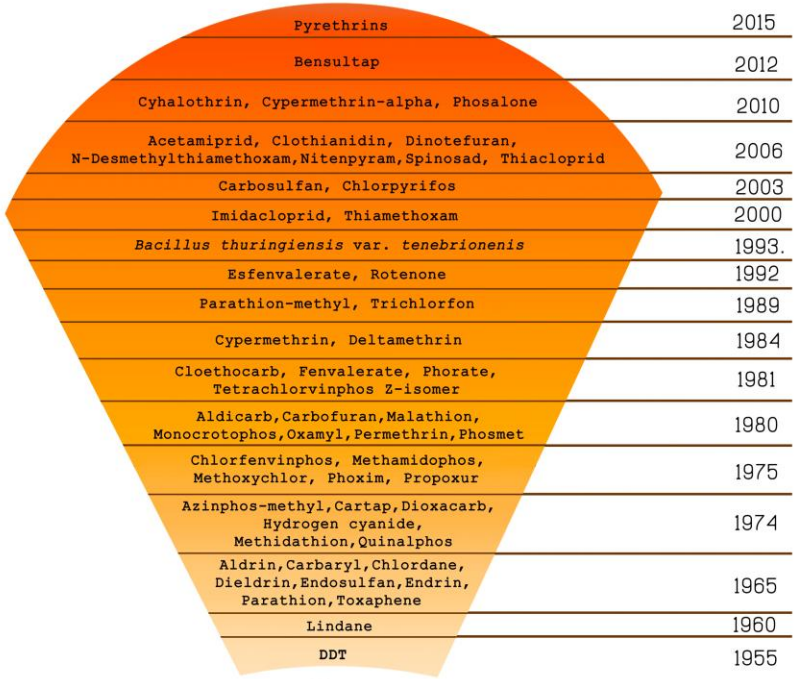
Pesticide abuse causes risks to pollinators, to the environment and to human health.

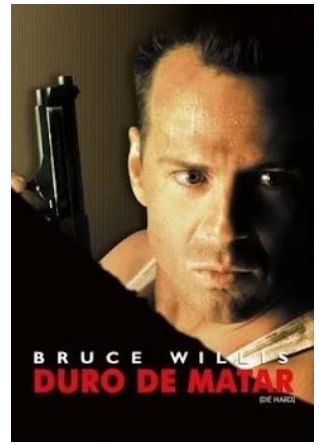
Pesticides are usually unaffordable for subsistence farmers

Colorado Potato Beetle (*Leptinotarsa decemlineata* Say)

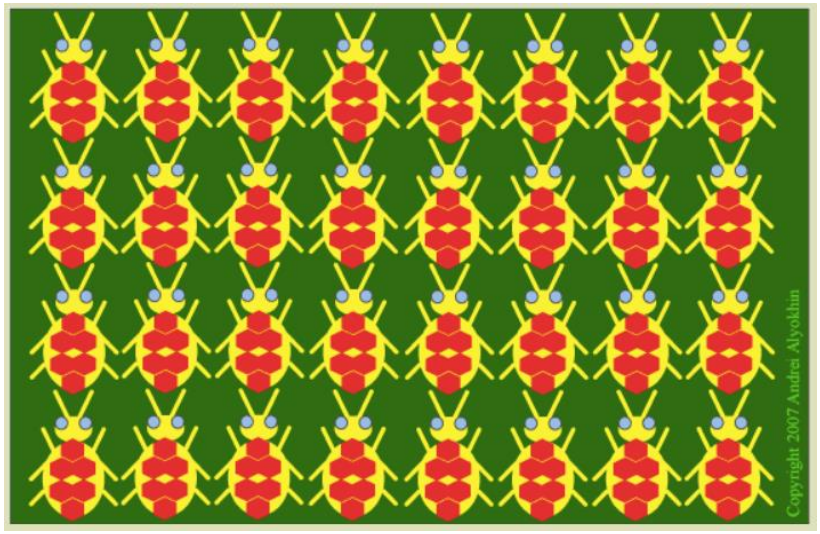








Resistance to 56 different compounds!!!



Biological pest control

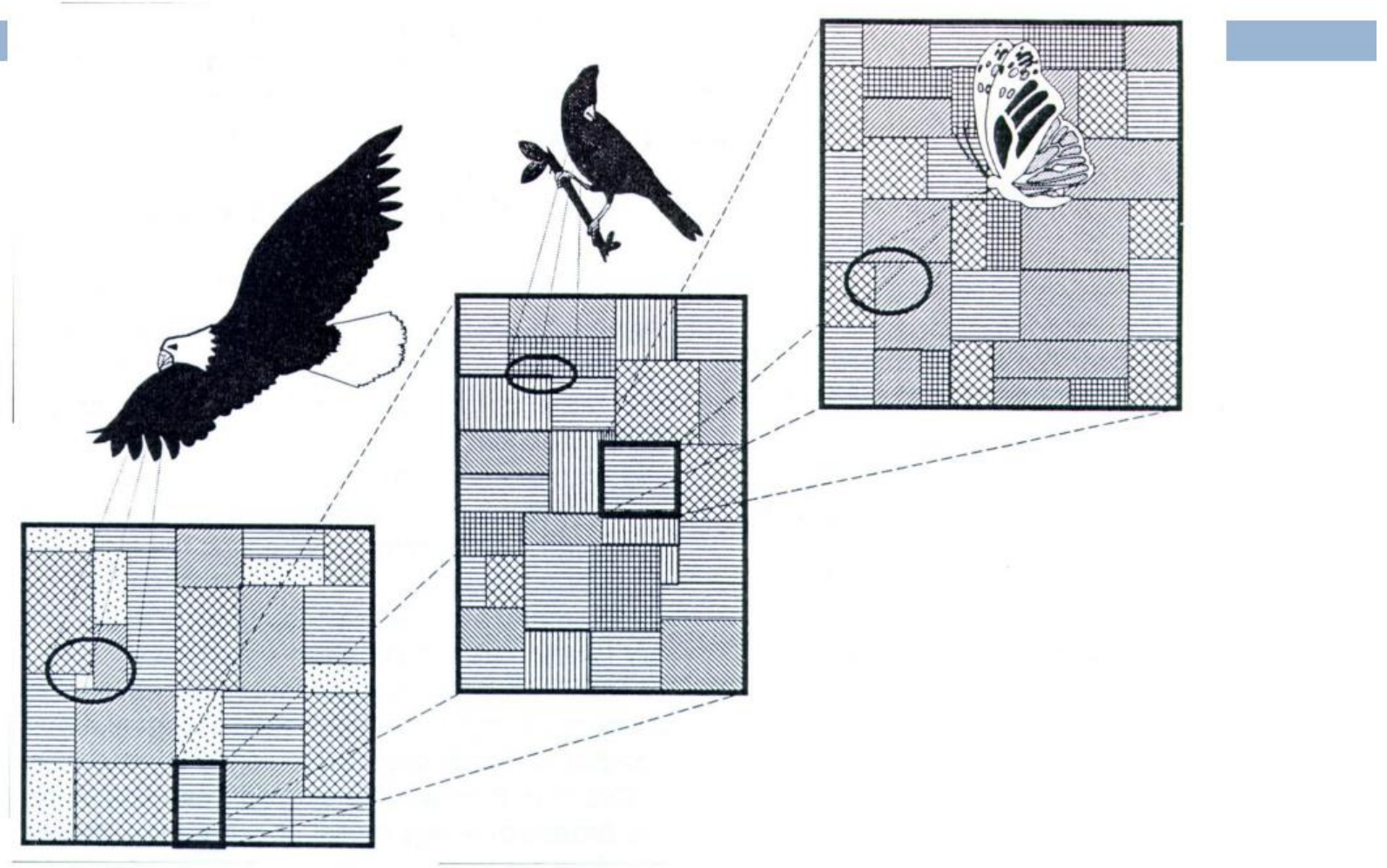
Significance of natural (biological) pest control

- Predation and parasitism of pests by natural enemies is an ecosystem service valued at $13.7 billion in the USA
- Natural enemies provide 50-90% of pest control in crops even when pesticides are sprayed
- They are a promising alternative to pesticides to increase the sustainability of food production

Oerke 2006 JAgSci
Pimentel 2008 EnvDevSust

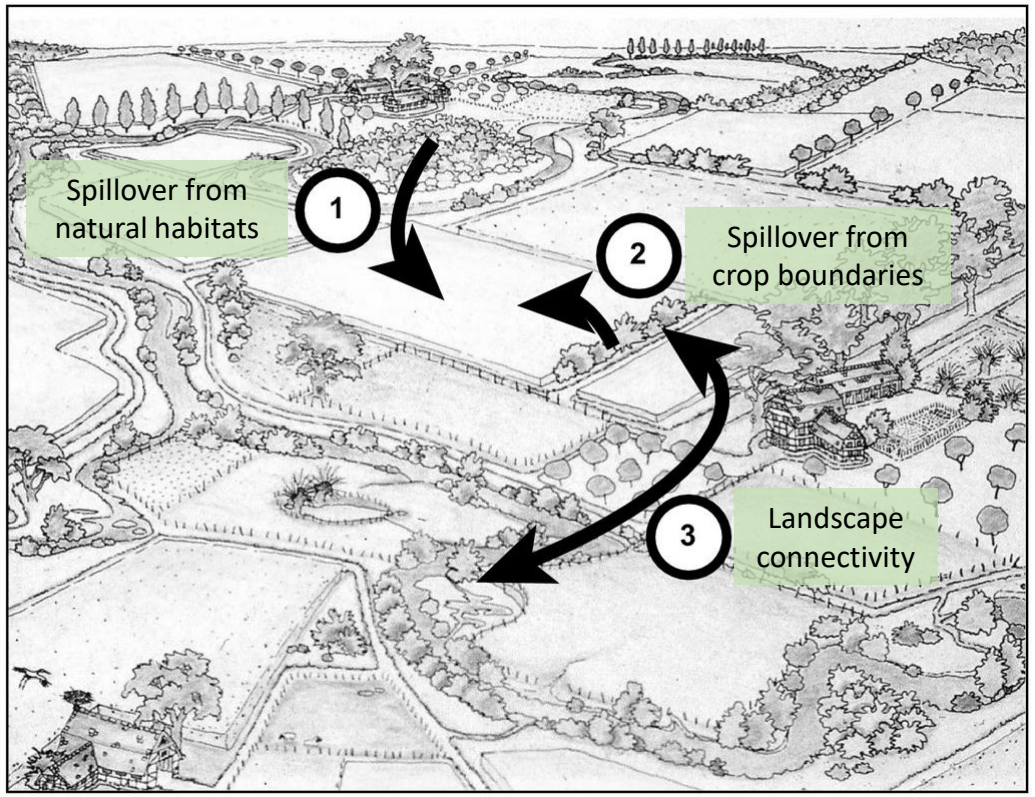
Landscape Ecology

Pollination and biological pest control are delivered by mobile organisms which are affected by the landscape at different spatial scales



Landscape Ecology

How to maximize pollination and biological pest control delivery to agriculture?



Grass et al., 2019 *People Nat*

Biodiversity-friendly agricultural landscapes integrate **local** and **landscape measures** to benefit biodiversity

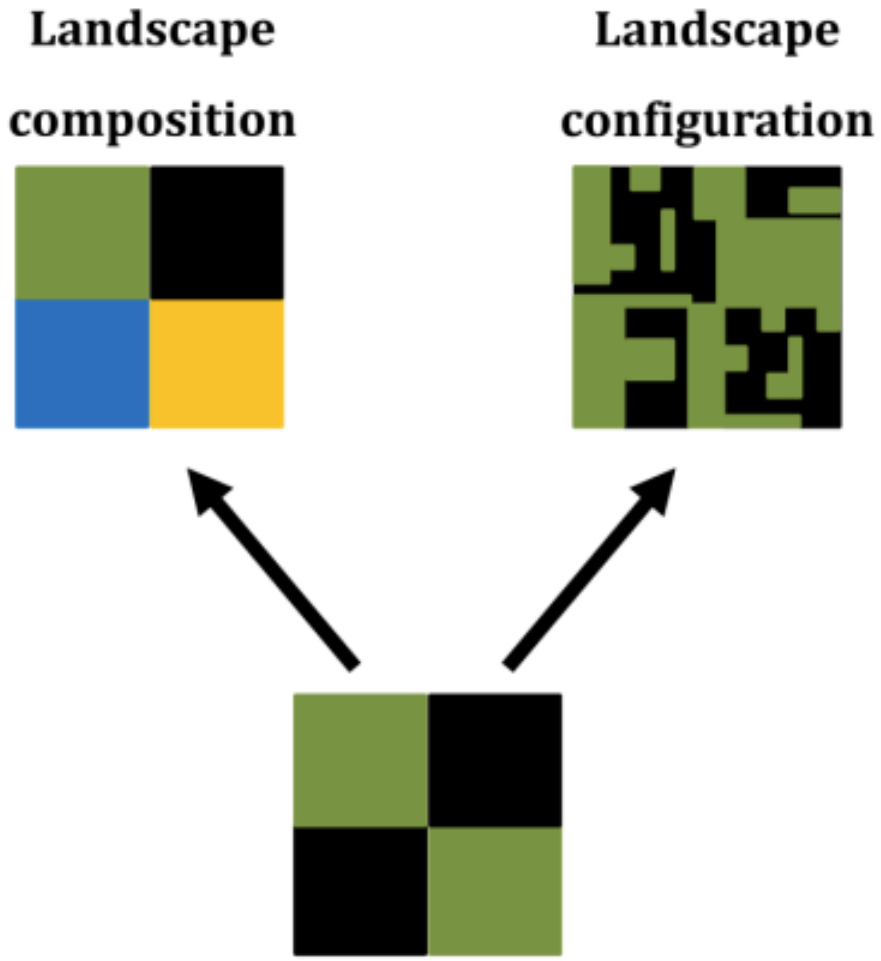
Local

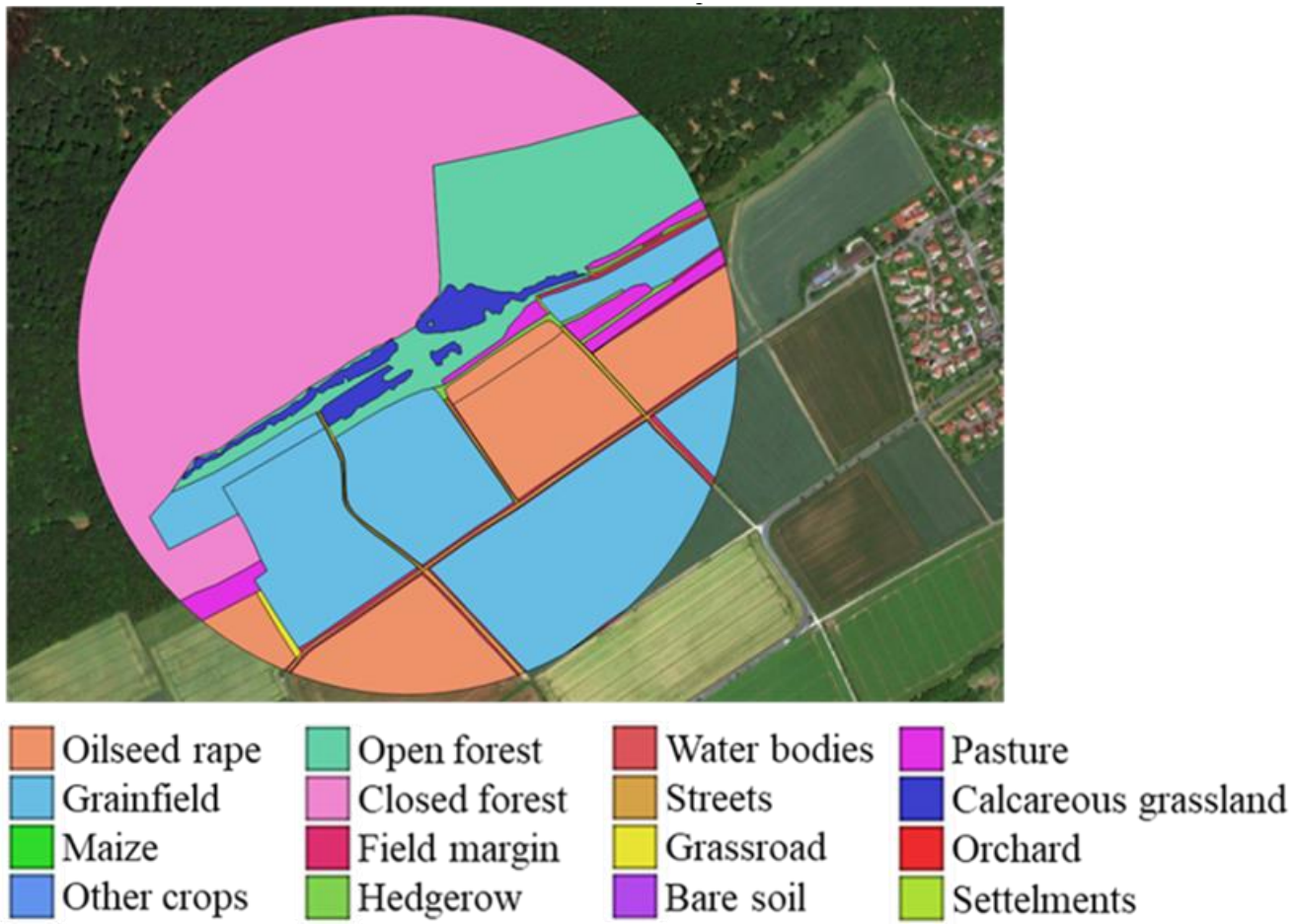
Cropland diversification, flower strips, hedgerows, set asides

Landscape

Natural habitat protection and heterogeneous landscape structure

Landscape-level processes





Landscape-level processes

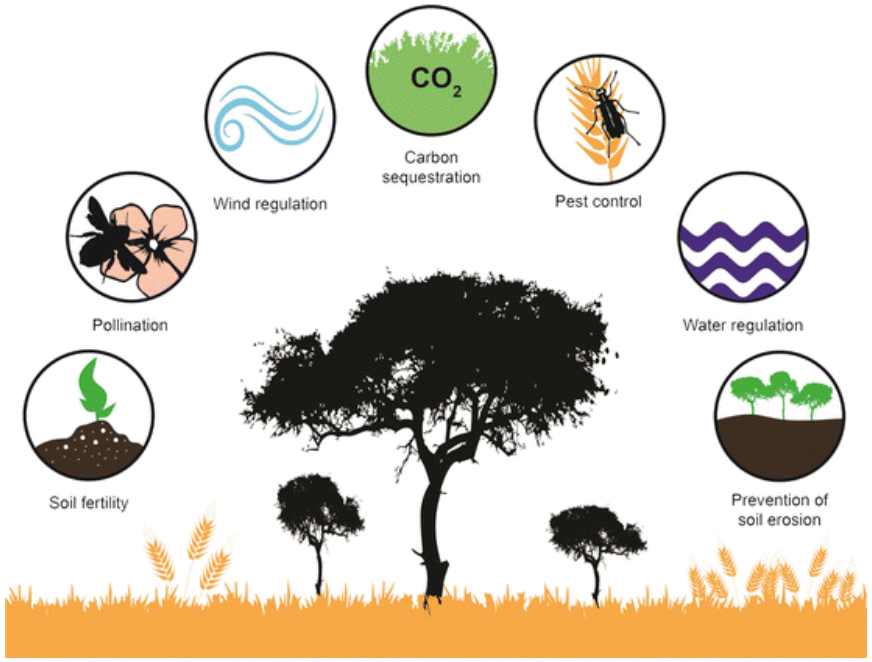
Measures of landscape complexity / heterogeneity

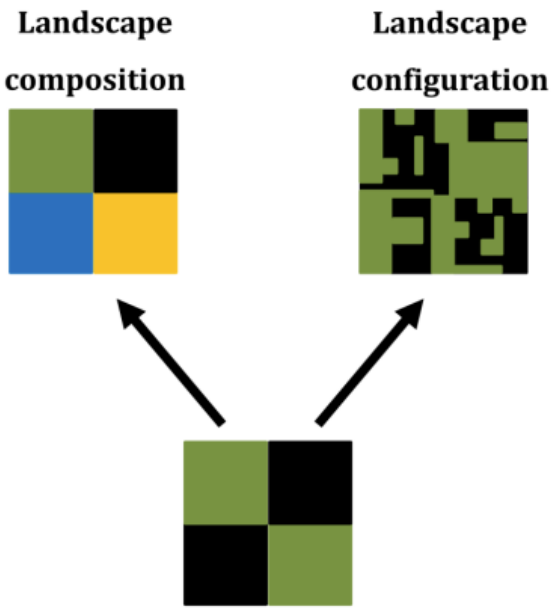
Variable type	Measured value	Significance
Classic measure = Amount of habitat	% seminatural % arable…	Composition
Habitat diversity	Shannon´s index of habitat diversity	
Complexity of patch shapes	Edge length, Perimeter-area ratio…	Configuration
Connectivity	Distance to patch, Hanski´s index…	

Recap

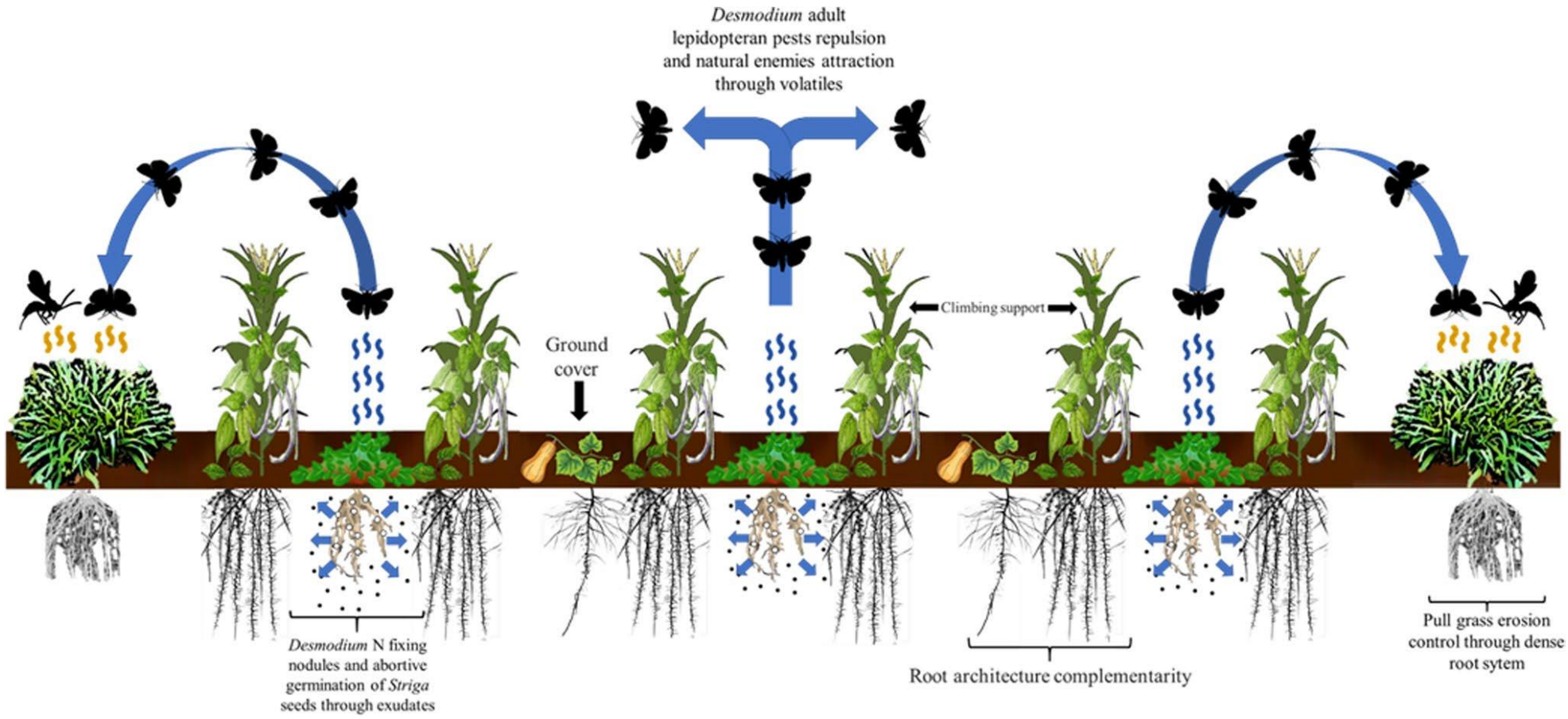
- Pollination and biological pest control are regulating services provided by mobile organisms and fundamental for agriculture

- Landscape ecology is crucial to maximize these services and to conserve the organisms that provide them



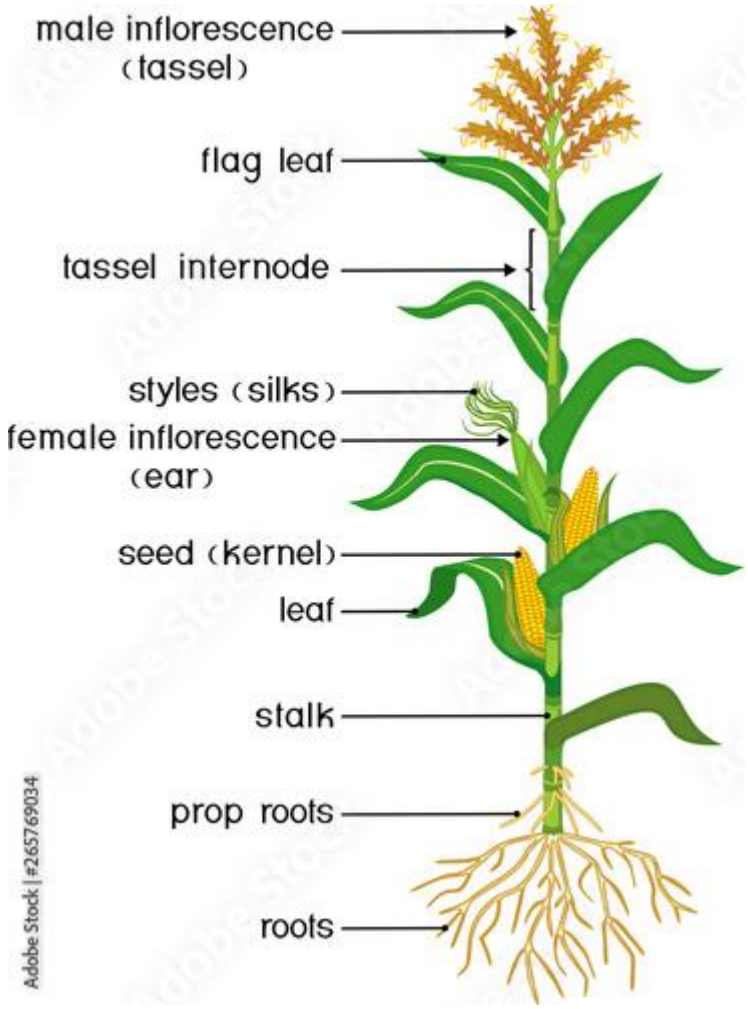


Study system 2 → Maize



Maize

Maize (*Zea mays ssp. mays*) origins trace back nearly 9000 years to the Mesoamerican region

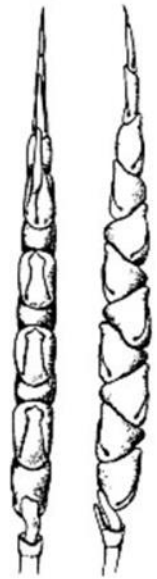


Maize

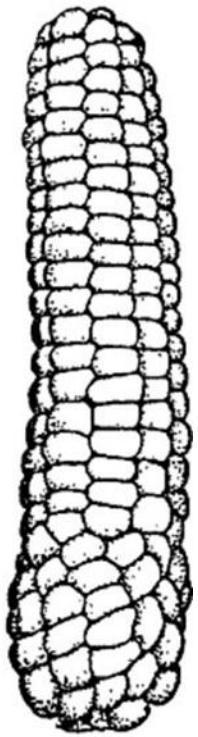
It was domesticated from its wild relative teosinte (*Z. mays ssp. Parviglumis)* by early settlers

Teosinte

Maize



Teosinte



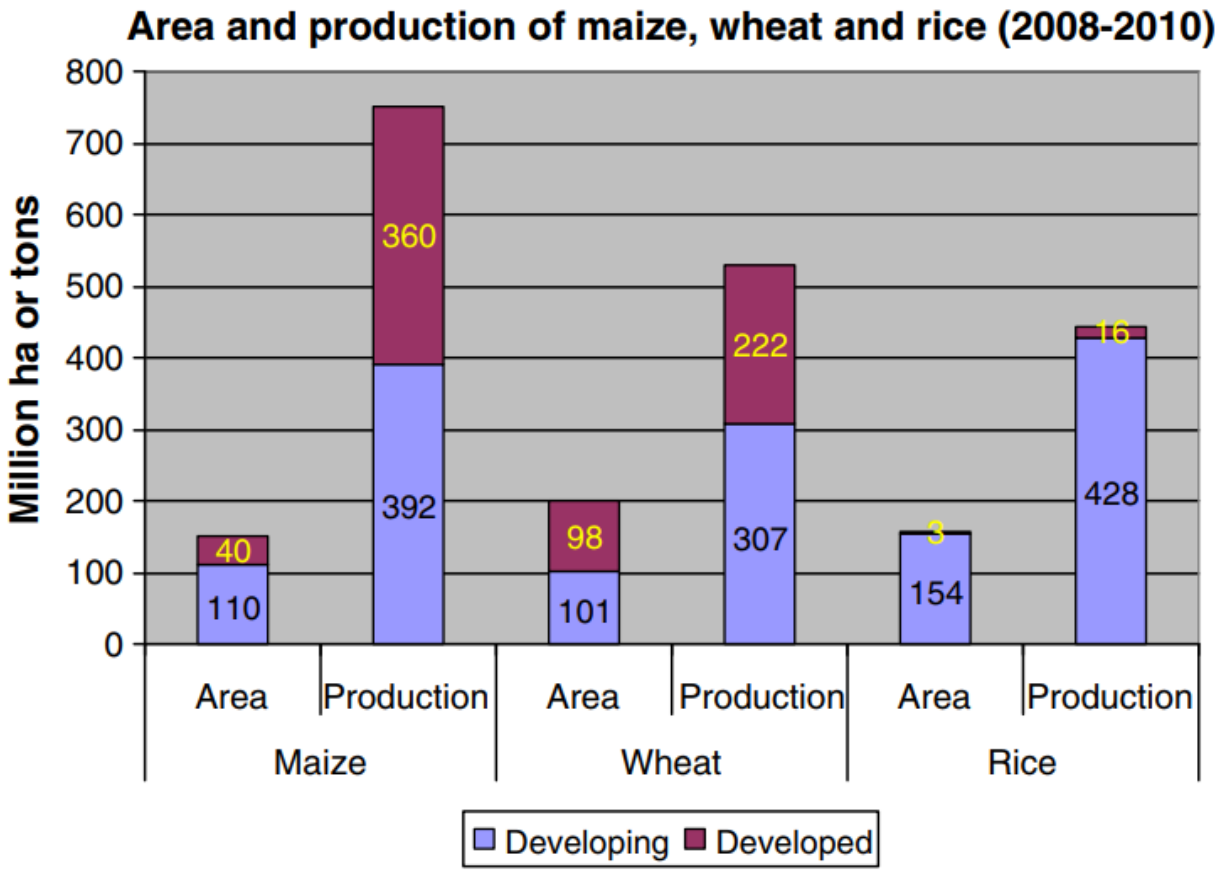
Maize

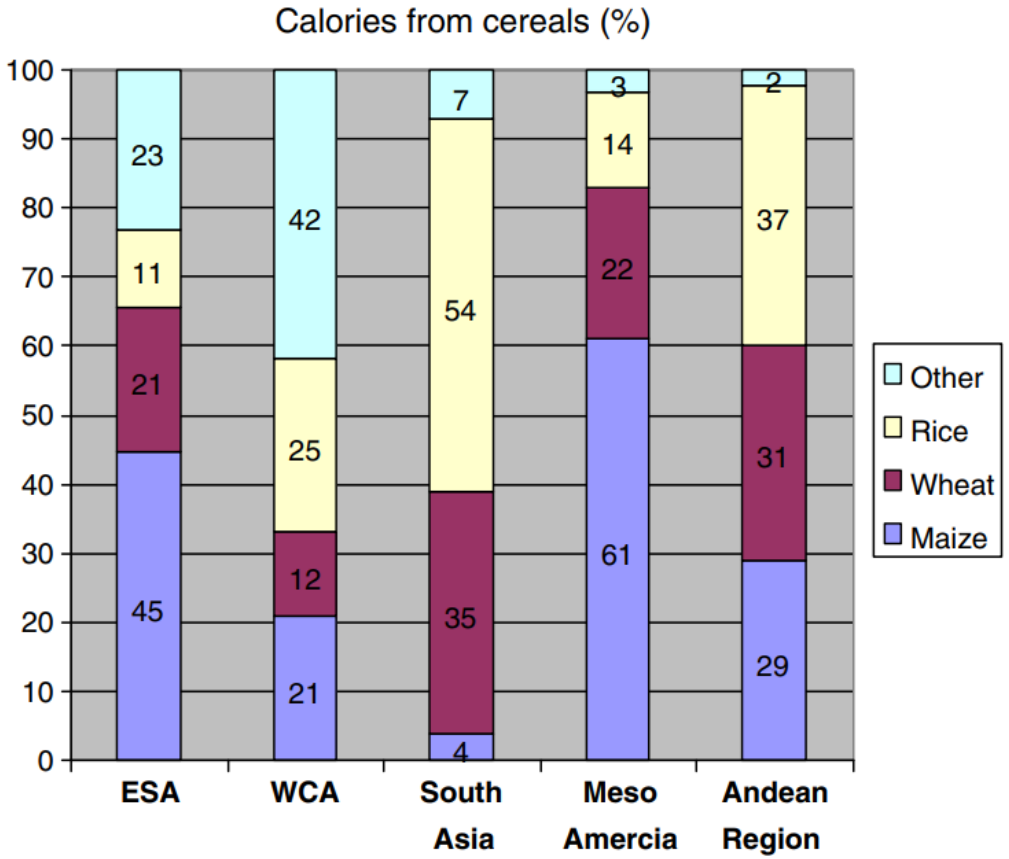
Staller 2011

Yang et al., 2019 *PNAS*

Maize

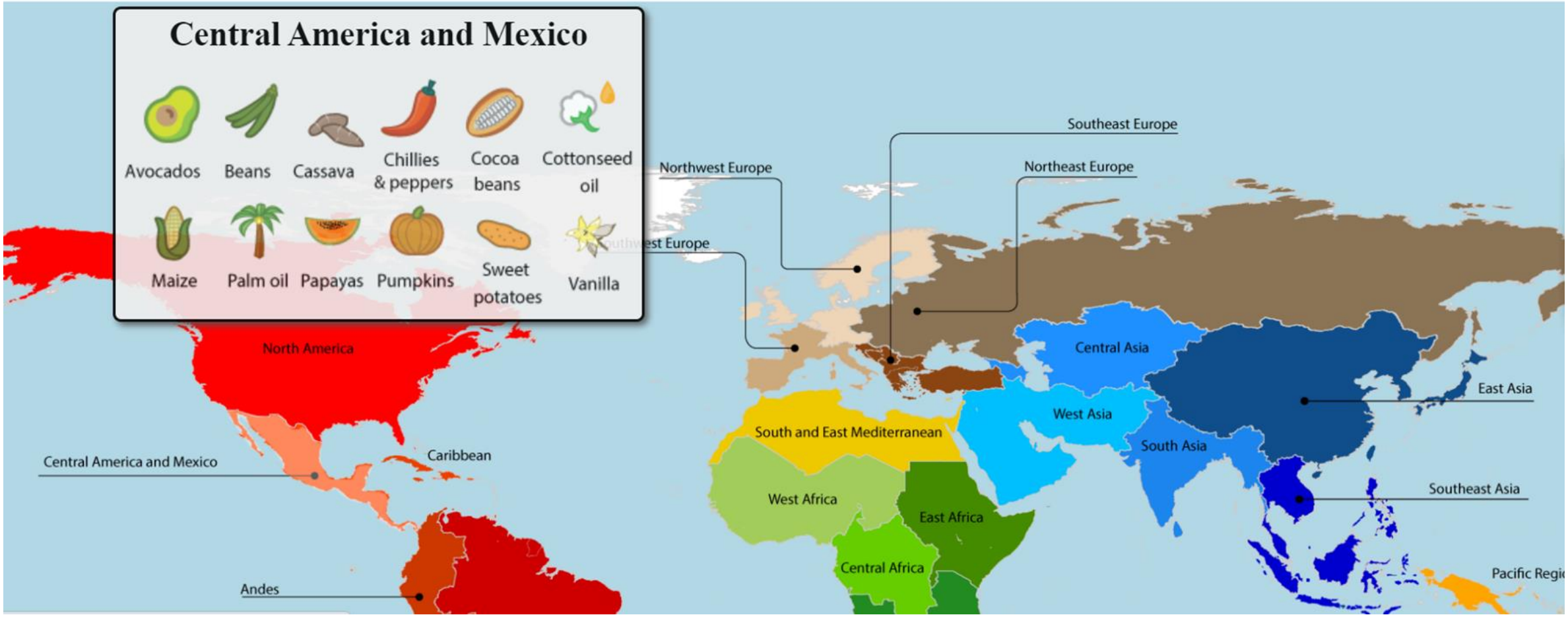
Maize has became a crucial component of subsistence farmers' diets across the Americas and Africa





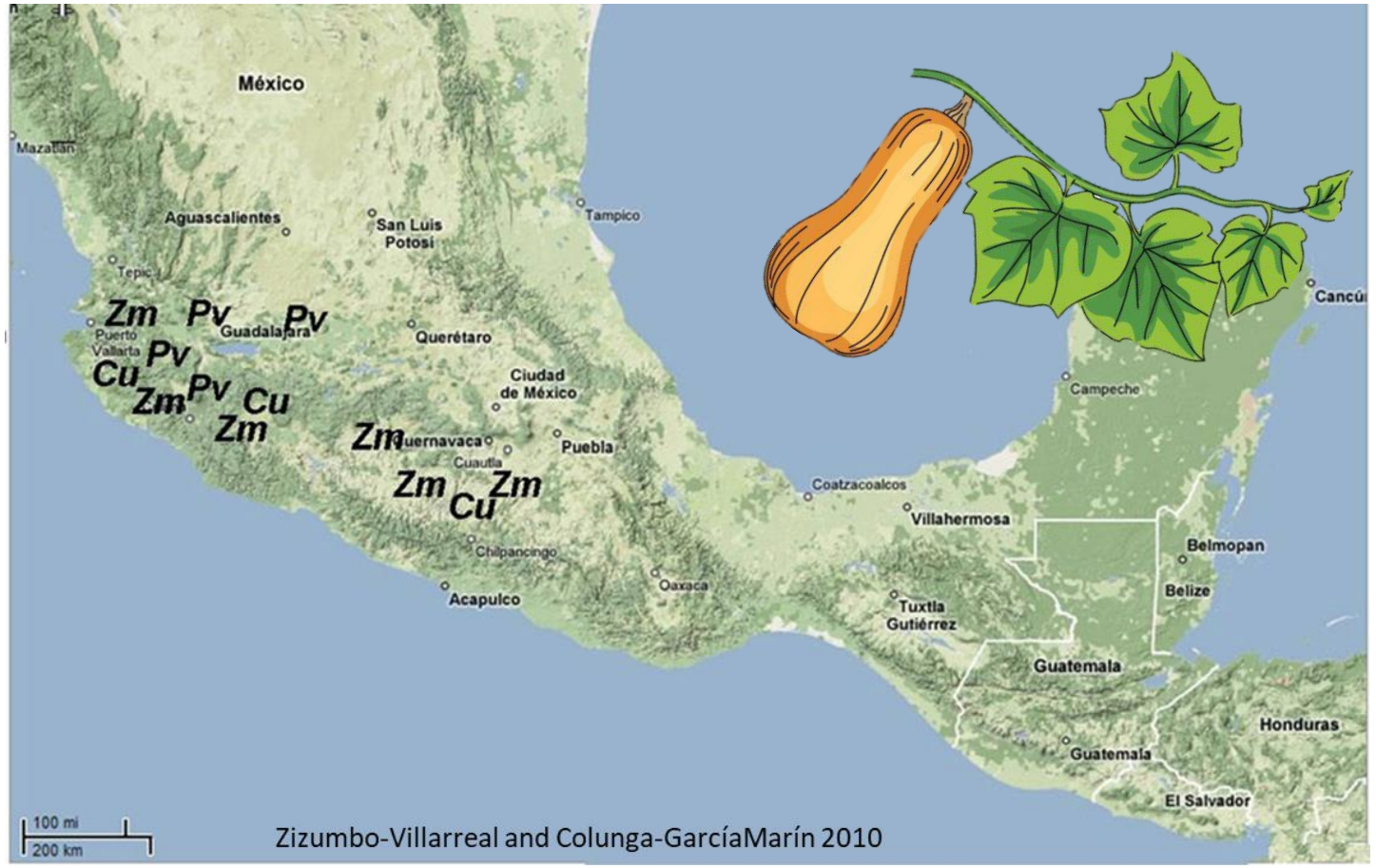
Shiferaw et al., 2011 *Food Sec.*

Associated biodiversity

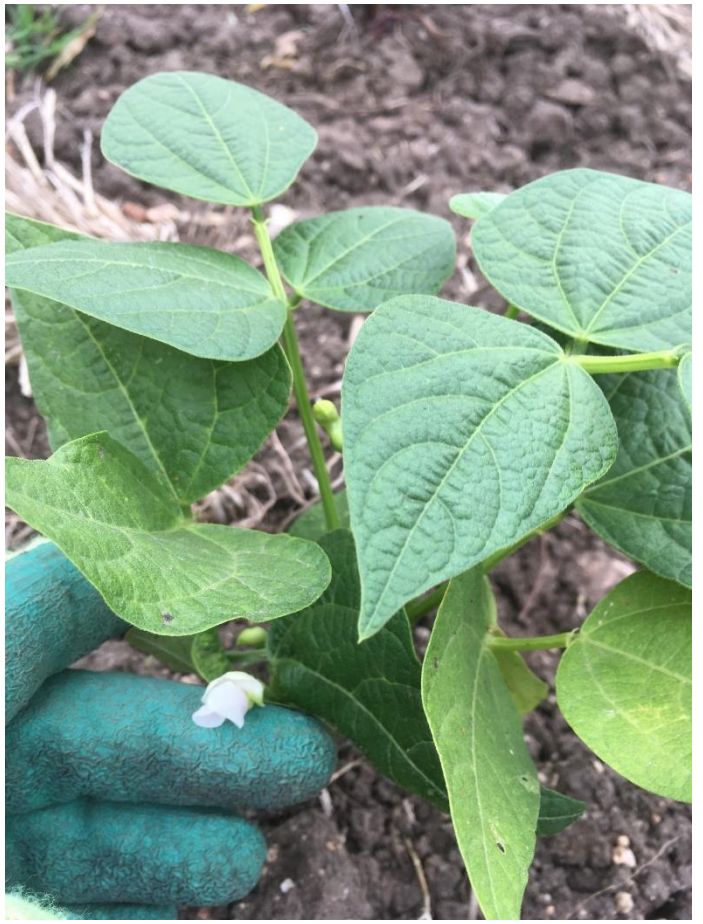


Khoury et al., 2016 *Proc. R. Soc. B*

Associated biodiversity



Zizumbo-Villarreal and Colunga-GarcíaMarín 2010



Associated biodiversity

The principal herbivore groups are stem borers; rootworms; earworms; armyworms; cutworms; aphids, leafhoppers and mites.

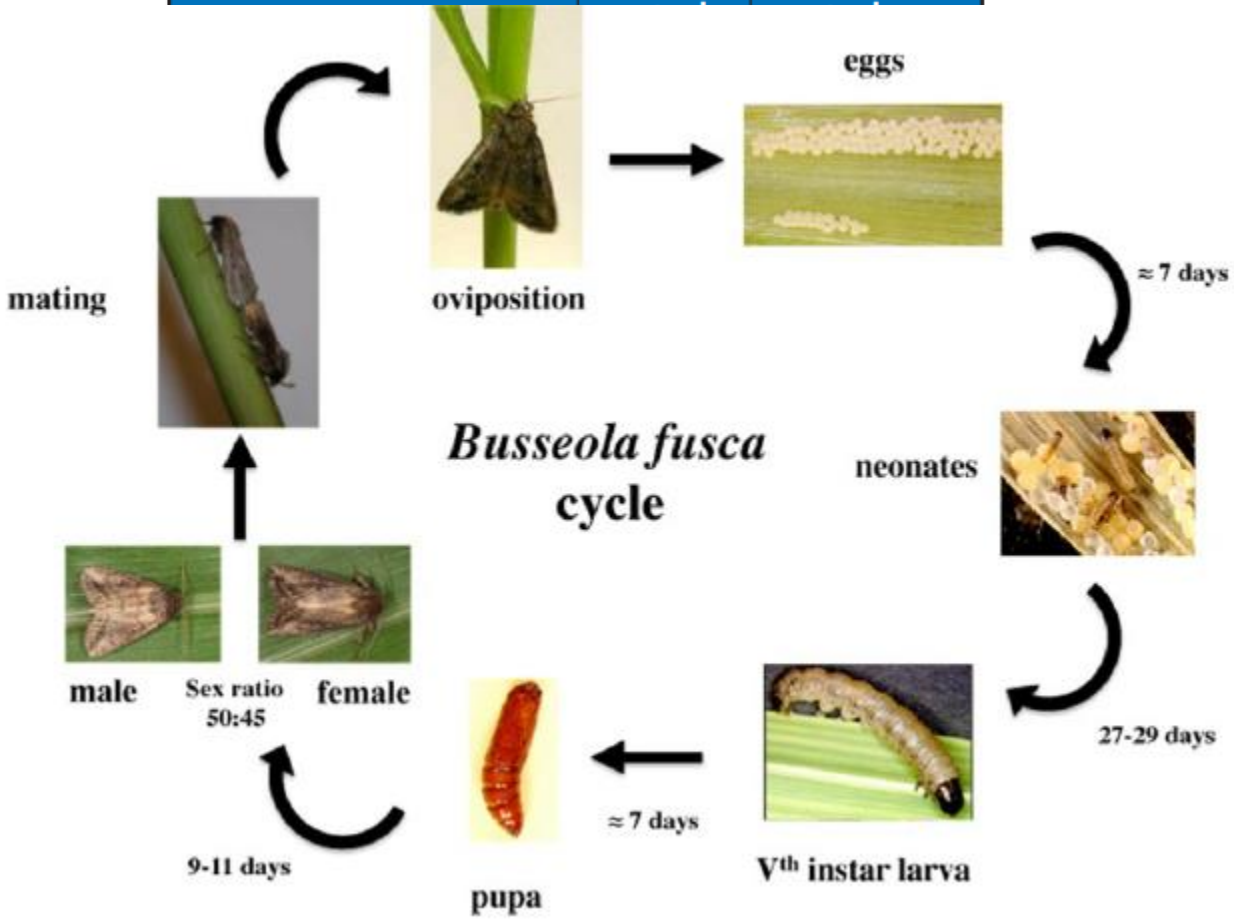
Feeding behavior	Primary taxon	Common name	Scientific name	Location
Foliage (leaf), chewing	Lepidoptera	Fall armyworm	*Spodoptera frugiperda*	Americas
		African armyworm	*Spodoptera exempta*	Asia, Africa
		Common armyworm	*Pseudaletia unipuncta*	Asia, Europe, Africa, America
		Maize webworm	*Marasamia trapezalis*	Africa
	Coleoptera	Grey weevils	*Tanymecus* spp.	Asia, Europe
Foliage, piercing-sucking	Hemiptera	Corn leaf aphid	*Rhopalosiphum maidis*	Asia, Europe, Africa, America
		Corn delphacid	*Peregrinus maidis*	Americas
		Corn leafhopper	*Dalbulus maidis*	Americas
		African leafhopper	*Cicadulina* spp.	Africa
		Chinch bug	*Blissus leucopterus*	N. America
	Acarina	Twospotted spider mite	*Tetranychus urticae*	Asia, Europe, Africa, America
		Banks grass mite	*Oligonychus pratensis*	C., N. America
Stalk, chewing	Lepidoptera	European corn borer	*Ostrinia nubilalis*	Asia, Europe, Africa, N. America
		Asian corn borer	*Ostrinia furnacalis*	Asia
		Lesser cornstalk borer	*Elasmopalpus lignosellus*	Americas

Feeding behavior	Primary taxon	Common name	Scientific name	Location
		Southwestern corn borer	*Diatrea grandsiosella*	N., C. America
		Neotropical corn borer	*Diatrea lineolata*	C., S. America
		Sugarcane borer	*Diatrea saccharalis*	Americas
		Asiatic rice borer	*Chilo suppresalis*	Asia
		Spotted stem borer	*Chilo partellus*	Asia, Africa
		Pink stem borer	*Sesamia cretica*	Africa
		African pink stem borer	*Sesamia calamistis*	Africa
		Mediterranean corn borer	*Sesamia nonagroides*	Europe
		Asiatic pink stem borer	*Sesamia inferens*	Asia
		African maize stalk borer	*Busseola fusca*	Africa
		African sugarcane borer	*Eldana saccharina*	Africa
		Potato stem borer	*Hydraecia micacea*	Asia, Europe, N. America
		Cutworms	Various	Asia, Europe, Africa, Americas
		Termites	*Microtermes* spp.	Africa, Asia
	Diptera	Frit fly	*Oscinella frit*	Europe
		Shoot flies	*Atherigona* spp.	Asia, Africa
	Coleoptera	Epilachna beetle	*Epilachna similis*	Africa
Ear, chewing	Lepidoptera	Corn earworm	*Helicoverpa zea*	Americas
		Corn earworm	*Helicoverpa armigera*	Asia, Africa
		Western bean cutworm	*Loxagrotis albicosta*	N. America
	Diptera	Cornsilk fly	*Euxesta* spp.	Americas
	Coleoptera	Dusky sap beetle	*Carpophilus lugubris*	Americas

Capinera 2007

Associated biodiversity

Sesamia calamistis



	Actual % loss with	Potential % loss without
Europe	9	14

Associated biodiversity

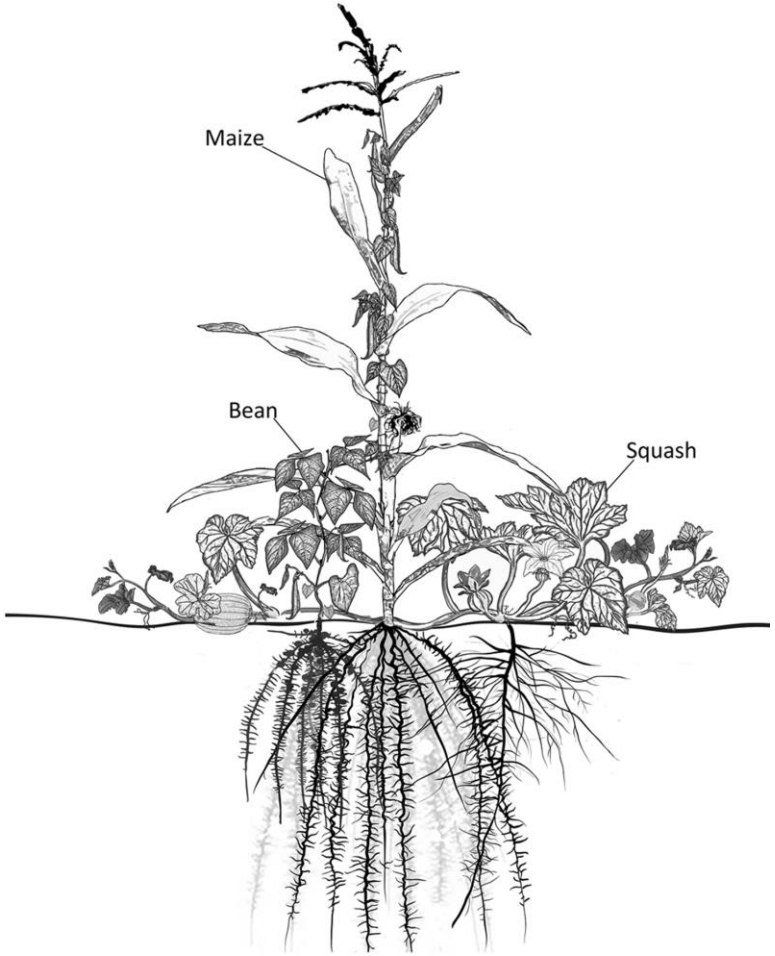
Trichogramma spp.

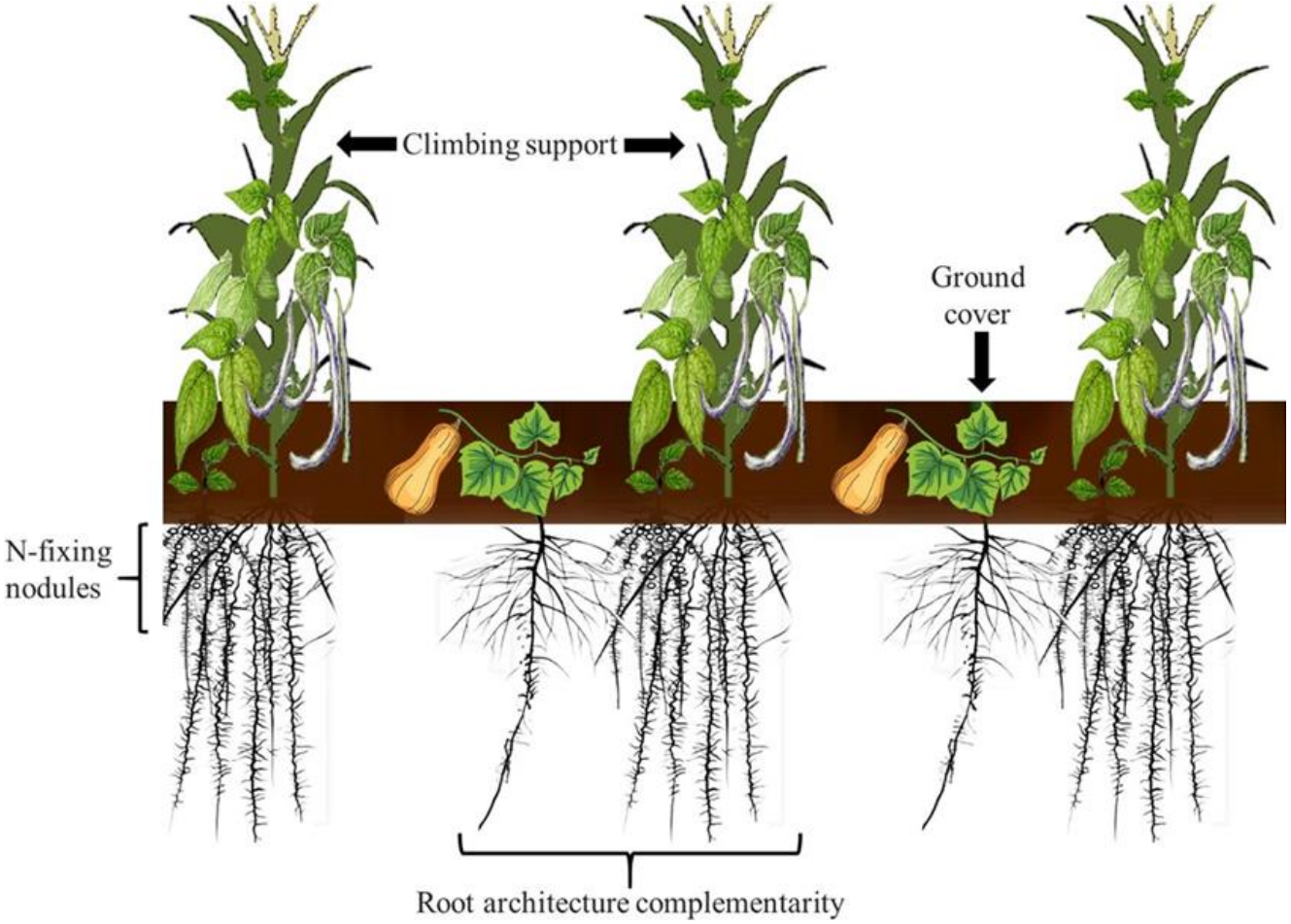
Cotesia icipe

Cotesia sesamiae

Planting systems

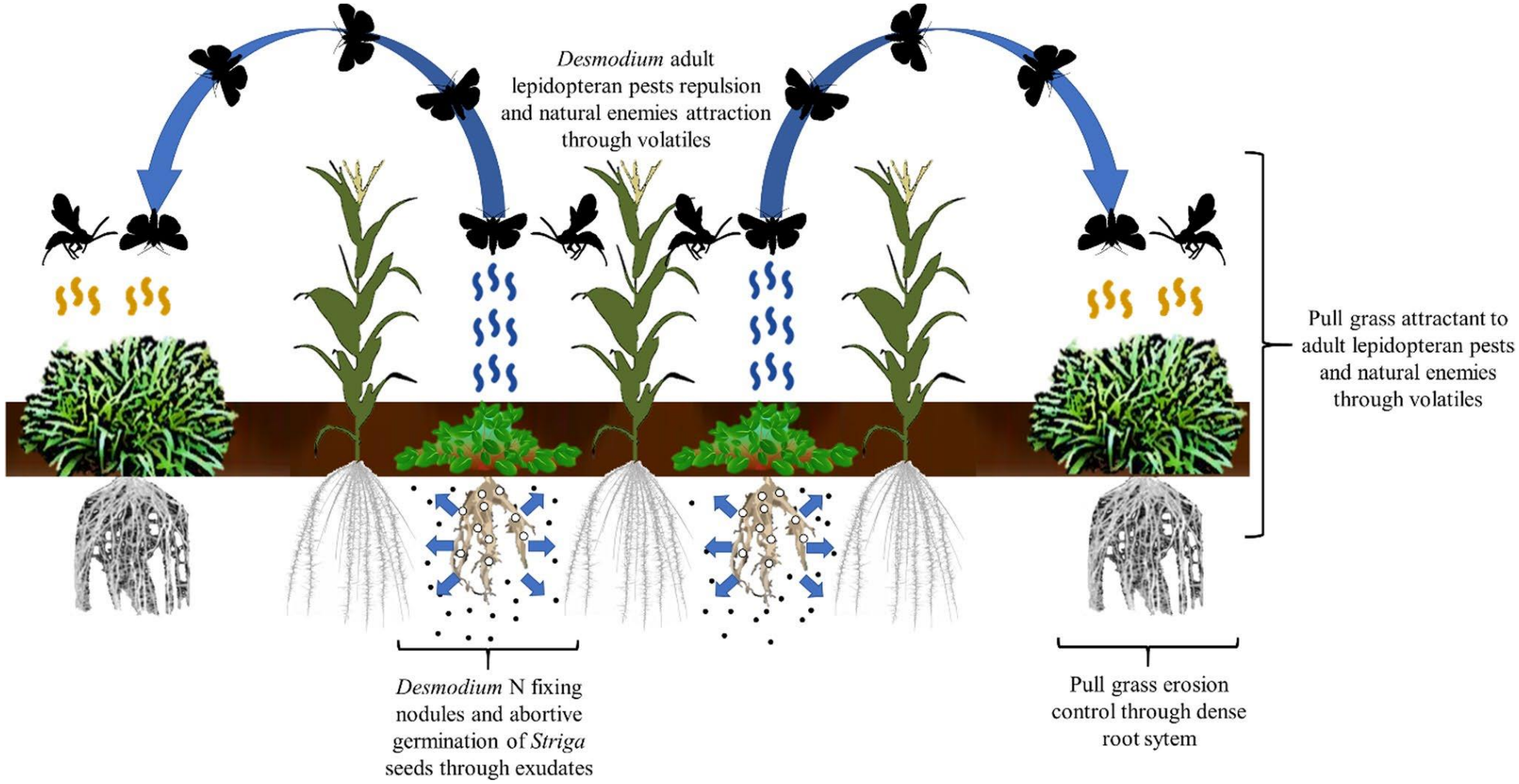
Milpa is a highly successful traditional mixed-cropping system





Planting systems

Push-pull



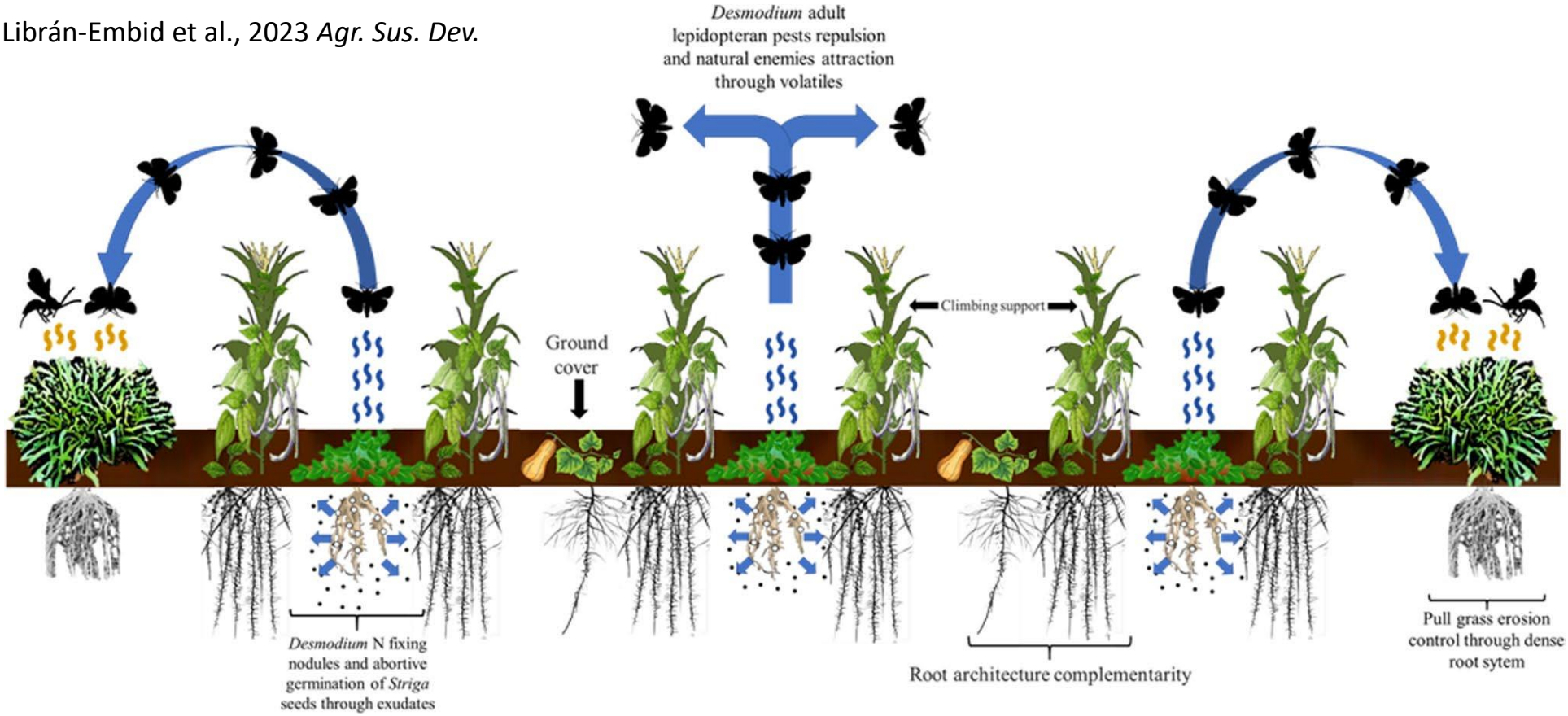
Home › Agronomy for Sustainable Development › Article

Combining *Milpa* and Push–Pull Technology for sustainable food production in smallholder agriculture. A review

Review Article | Open access | Published: 13 July 2023

Volume 43, article number 45, (2023) Cite this article

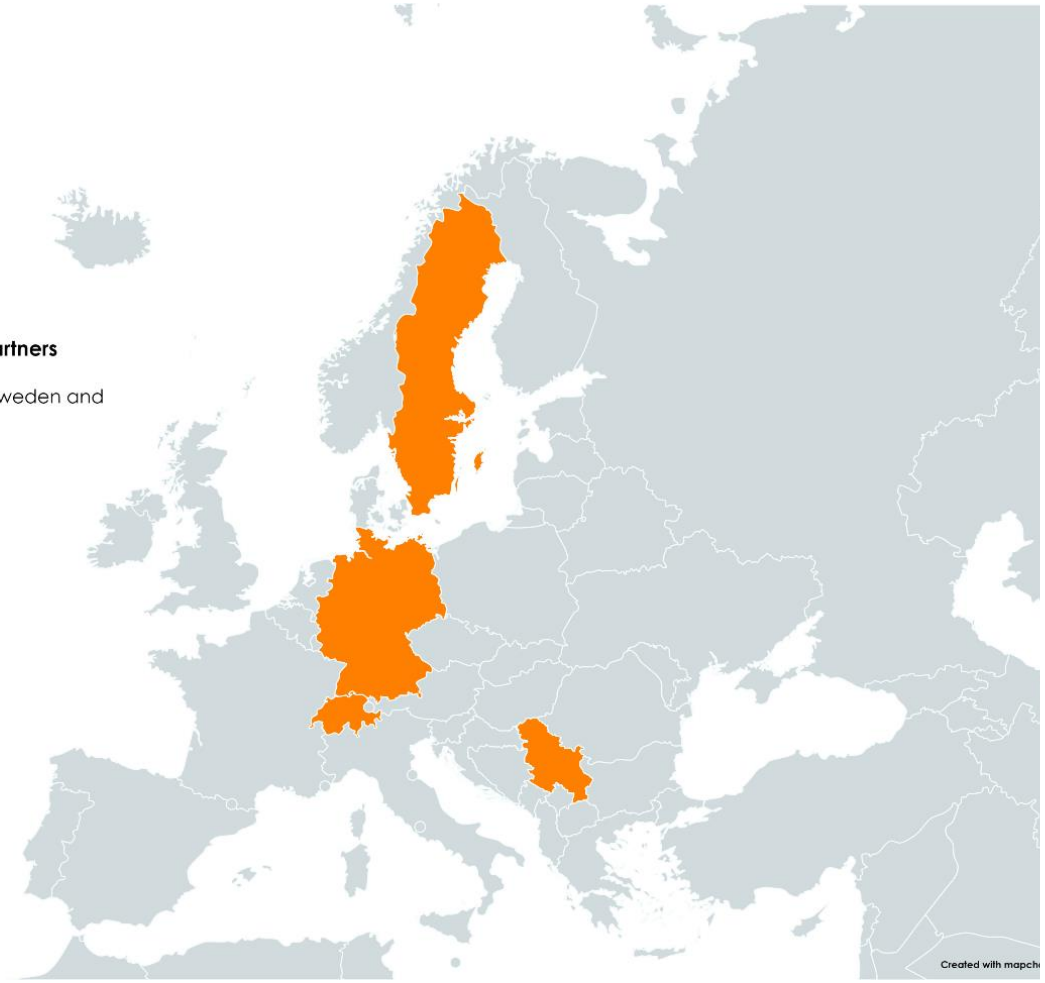
Librán-Embid et al., 2023 *Agr. Sus. Dev.*



The UPSCALE project

UPSCALE European partners

Germany, Serbia, Sweden and Switzerland



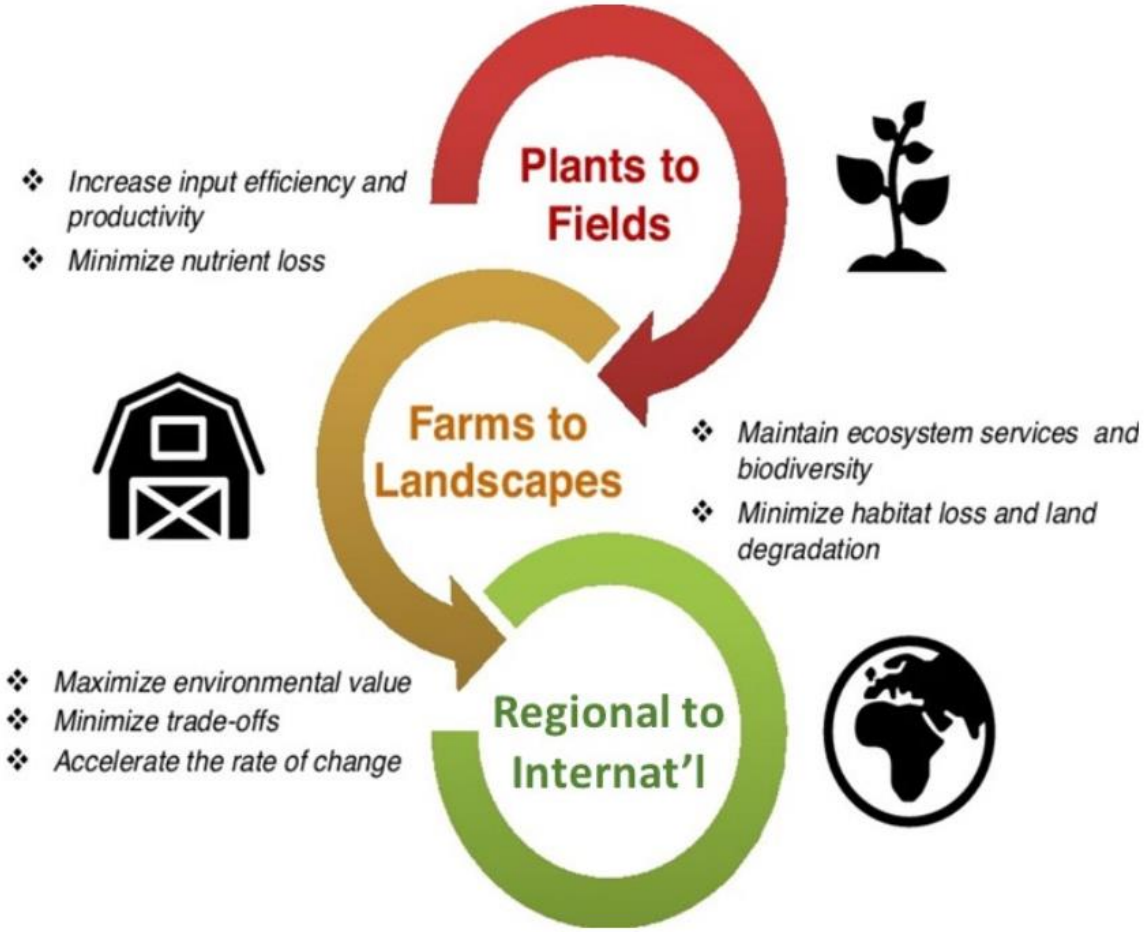
UPSCALE African partners

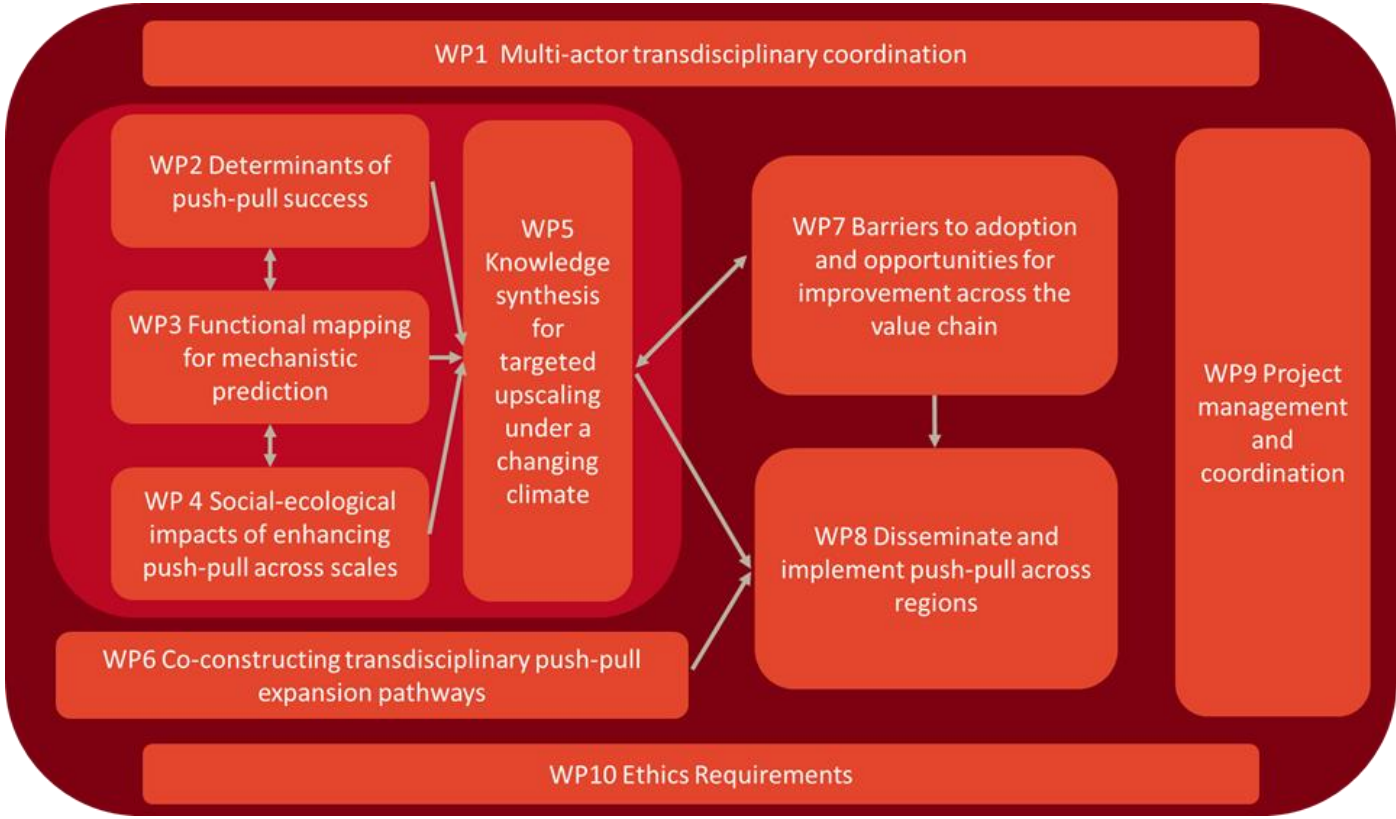
Ethiopia, Kenya, Rwanda, South Africa, Tanzania and Uganda

Created with mapchart.net

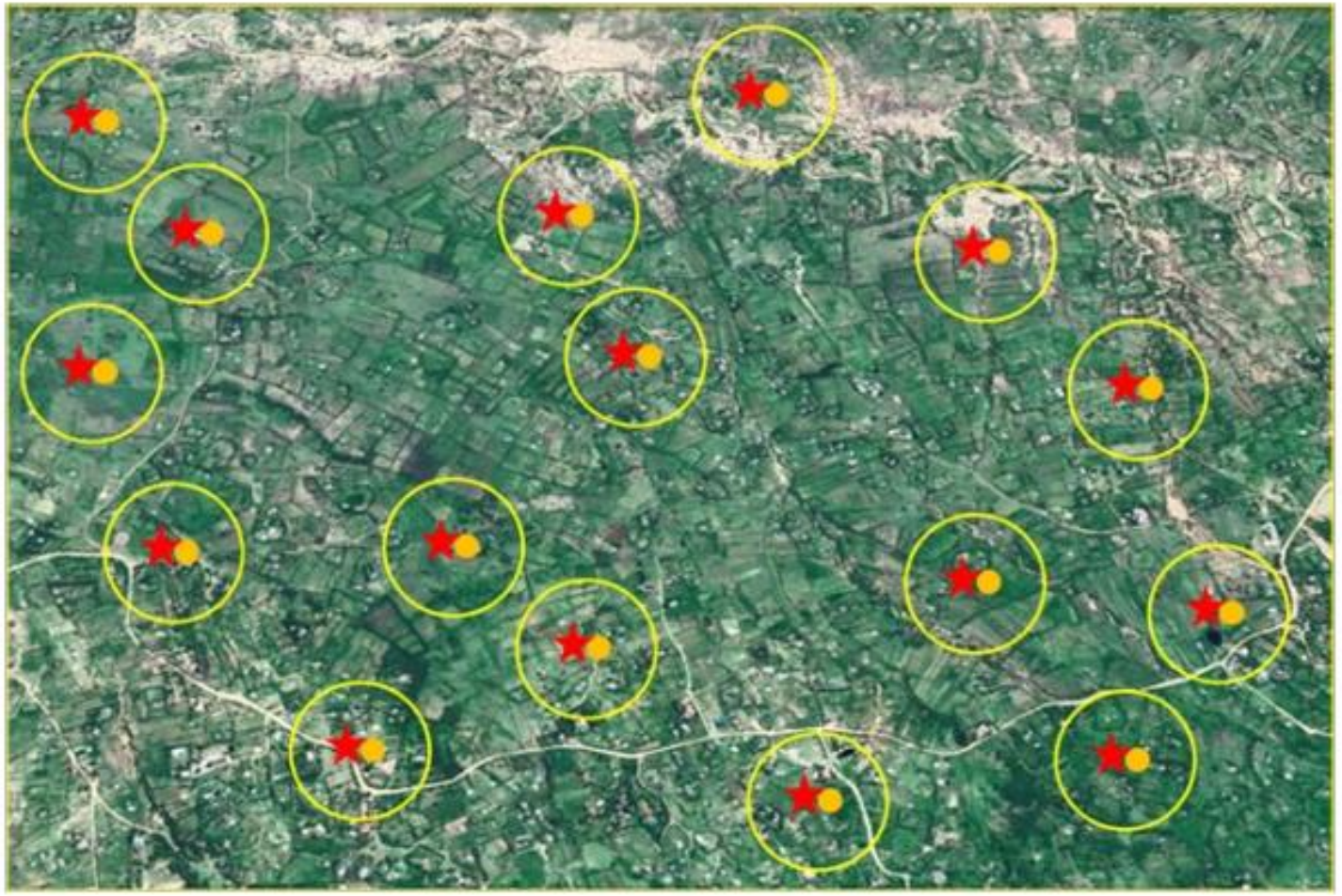
The UPSCALE project

Objectives





The UPSCALE project



Sampled non push-pull field

Sampled push-pull field

1 km² landscape sectors

The UPSCALE project

Planned sampling in 40 fields

10*→	C	C
20*→	C	PP
10*→	PP	PP

P

M

P: Push-pull field

M: Monocrop field

The UPSCALE project

UPSCALE

UPSCALING THE BENEFITS OF PUSH-PULL TECHNOLOGY FOR SUSTAINABLE AGRICULTURAL INTENSIFICATION IN EAST AFRICA

https://upscale-h2020.eu/