FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

AGRILINKS

Bees, Bats, and Butterflies: The Importance of Pollinators for Global Food Security and Nutrition

Speakers: *Kate Gallagher, USAID Center for Environment, Energy, & Infrastructure*
Smitha Krishnan, Alliance of Bioversity International CIAT
Taylor Ricketts, Gund Institute for Environment, University of Vermont
Claire Kremen, Department of Zoology at University of British Columbia

Moderator: *Zachary Baquet, USAID Bureau for Resilience and Food Security*

Date: December 3rd, 2020

Kate Gallagher, AAAS Science and Technology Policy Fellow, USAID Center for Environment, Energy, & Infrastructure

Dr. Kate Gallagher is a AAAS Science & Technology Policy Fellow at the United States Agency for International Development (USAID). A pollination ecologist by training, Kate's graduate and post-graduate research addressed questions about the mechanisms governing how global climate change affects plant-pollinator interactions and the extent to which changes in the levels of pollination influence the ecology and evolution of plant populations. At USAID, Kate is applying her scientific and technical skills to support the implementation of USAID's Environmental and Natural Resource Management (ENRM) Framework, with the goal of building capacity and fostering networks of innovation and information exchanges to better integrate environment and natural resource management across development sectors.

Claire Kremen, President's Excellence Chair in Biodiversity, Professor at Institute for Resources, Environment, and Sustainability, Department of Zoology at University of British Columbia

Claire Kremen is President's Excellence Chair In Biodiversity with a joint appointment in IRES and Zoology at University of British Columbia. She is an ecologist and applied conservation biologist working on how to reconcile agricultural land use with biodiversity conservation. Before coming to UBC, she held faculty appointments first at Princeton University and then at University of California, Berkeley, where she was also founding Faculty Director for the Center for Diversified Farming Systems and the Berkeley Food Institute. Prior to those appointments, she worked for over a decade for the Wildlife Conservation Society and the Xerces Society, designing protected area networks and conducting biodiversity research in Madagascar, a biodiversity hotspot. Her work both then and now strives to develop practical conservation solutions while adding fundamentally to biodiversity science. She is a member of the Scientific Advisory Board of Conservation International, Field Chief Editor for Frontiers in Sustainable Food Systems, and, since 2014, has been noted as a highly-cited researcher.

Smitha Krishnan, Scientist, Agrobiodiversity and Ecosystem Services, Alliance of Biodiversity International and CIAT

Smitha joined the Alliance of Bioversity International CIAT in Bangalore, India, in 2019 as an expert in Agrobiodiversity and Ecosystem services. Smitha's research interests broadly include ecosystem services, pollination biology, plant-animal interactions, restoration, soil-plant relationships and sustainable livelihoods. Since joining, Smitha conducted a review on current knowledge and gaps with regard to management practices that support pollination services within forests and surrounding landscapes with the Forest Genetic Resources and Restoration Team, for FAO Forestry. Currently, she is developing proposals focused on crop pollination services and restoration of agricultural landscapes. Meanwhile she is co-ordinating a study on Mapping Ecosystem Services for Human Well-being in India and will be leading the study pertaining to pollination services. She is also involved with the Asia Coffee Cacao Nexus of the Alliance.

Taylor Ricketts, Scientist, Gund Professor and Director of the Gund Institute for Environment, University of Vermont

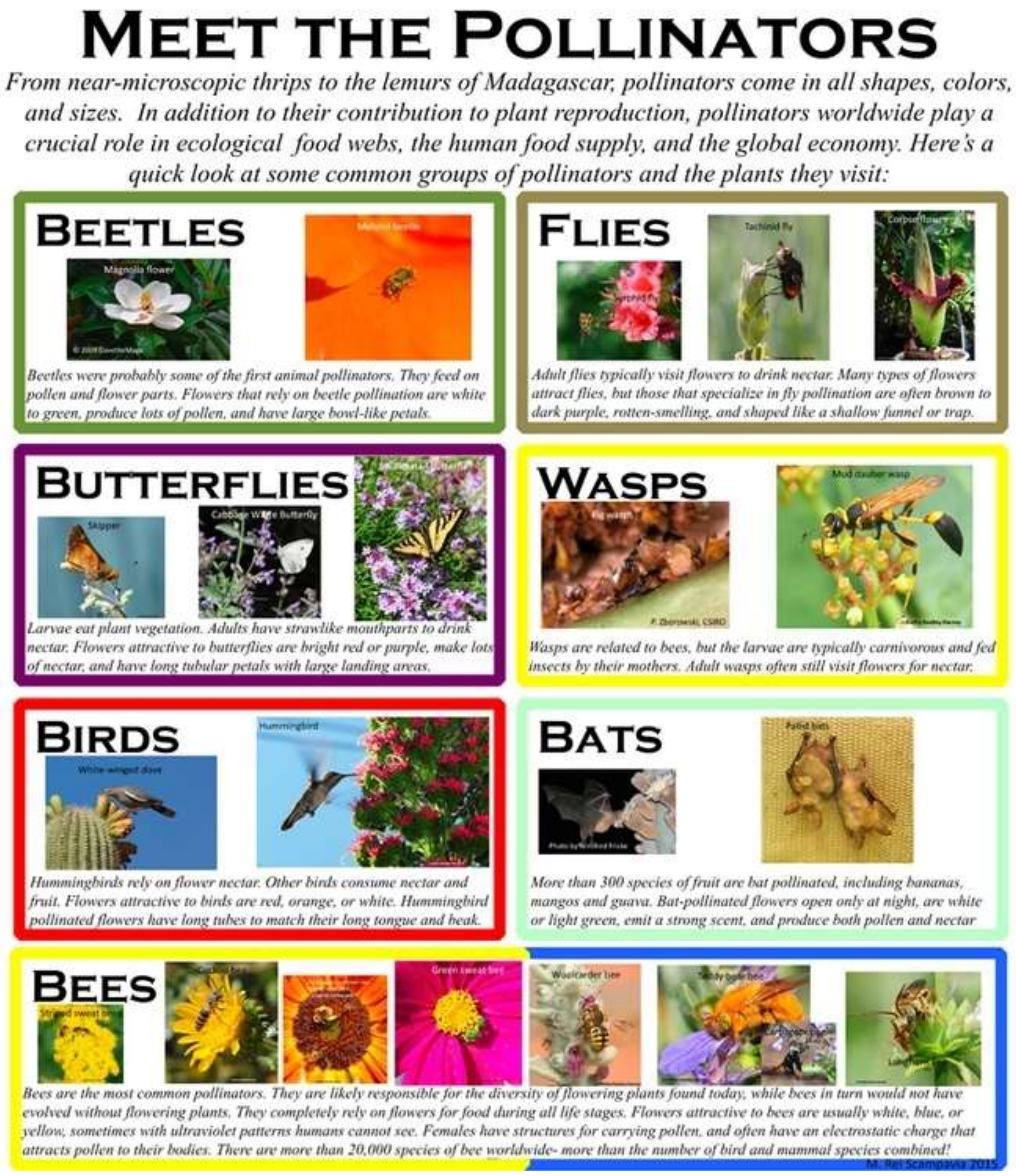
Taylor Ricketts is Gund Professor and Director of the Gund Institute for Environment at the University of Vermont. Taylor's research centers on the overarching question: How do we meet the needs of people and nature in an increasingly crowded, changing world? His recent work has focused on the economic and health benefits provided to people by forests, wetlands, reefs, and other natural areas. He is co-founder of the Natural Capital Project, a partnership among universities and NGOs to map and value these natural benefits. Taylor has also served as an author and editor for two UN-sponsored efforts to assess global ecosystems and their contributions to human wellbeing. These and other collaborations are part of a continuing effort to link rigorous research with practical conservation and policy efforts worldwide. Before arriving at UVM in 2011, Taylor led World Wildlife Fund's Conservation Science Program for nine years. He was elected as a Fellow of the Ecological Society of America in 2020, and Thompson-Reuters has named him one of the world's most cited and influential scientists.

Restoring Pollinators and Crop Pollination Services in Agricultural Landscapes

AGRILINKS WEBINAR
Claire Kremen
Professor and President’s Excellence Chair in Biodiversity
Institute for Resources, Environment and Sustainability
University of British Columbia

Key managed pollinator for crop production

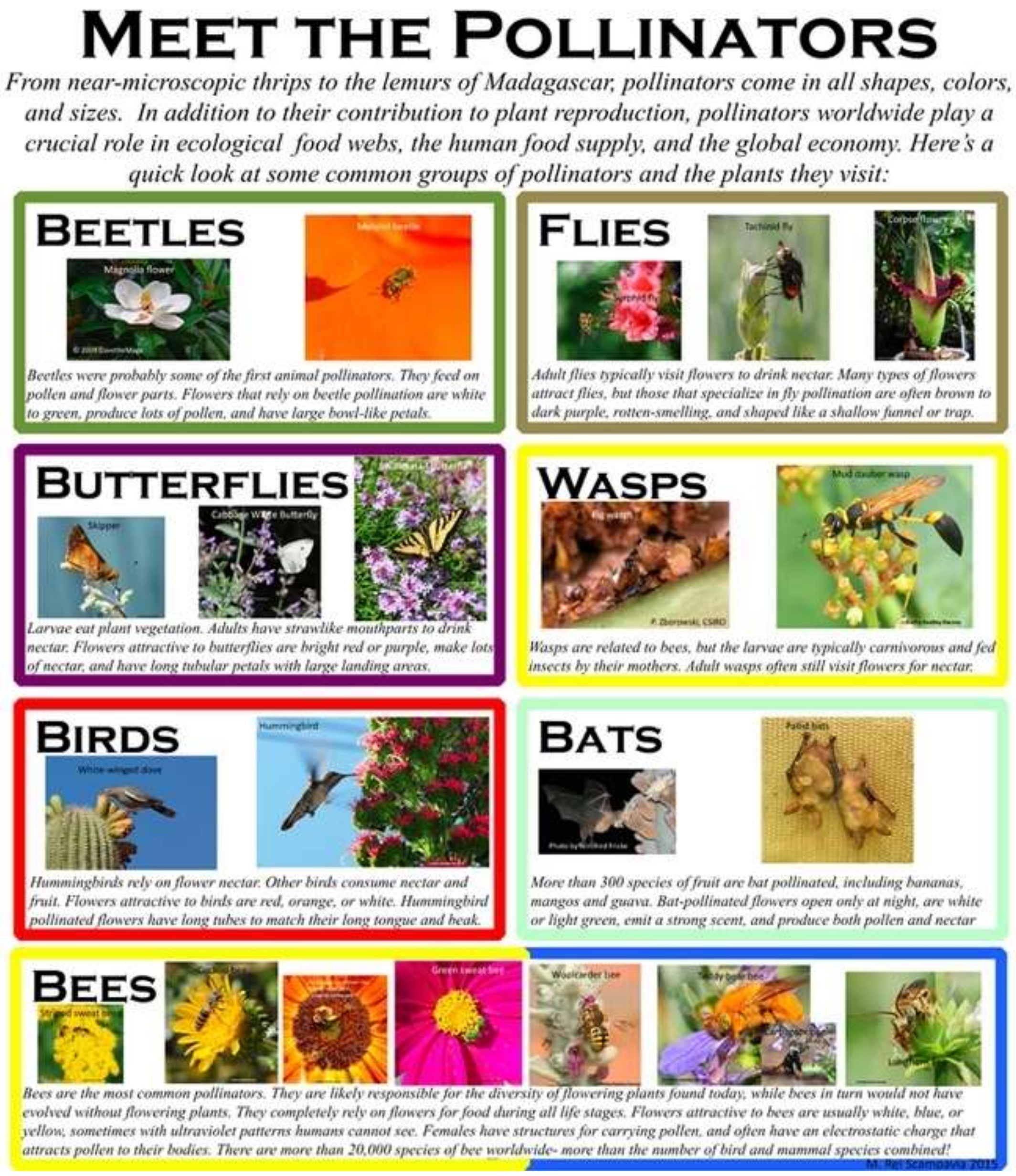
Key managed pollinator for crop production



Wild pollinators, especially bees

~ 20,000 bee species globally!

~ 13% visit crops



Wild pollinators, especially bees

~ 20,000 bee species globally!

~ 13% visit crops

KEY RECENT FINDING

- ~50% of the crop pollination service value comes from wild (unmanaged) pollinators, not the honey bee

Kleijn et al. 2016; Garibaldi et al. 2013; Rader et al. 2015

Examples: Why native bees are needed too

SUBSTITUTE
"insurance"
Kremen et al. 2000

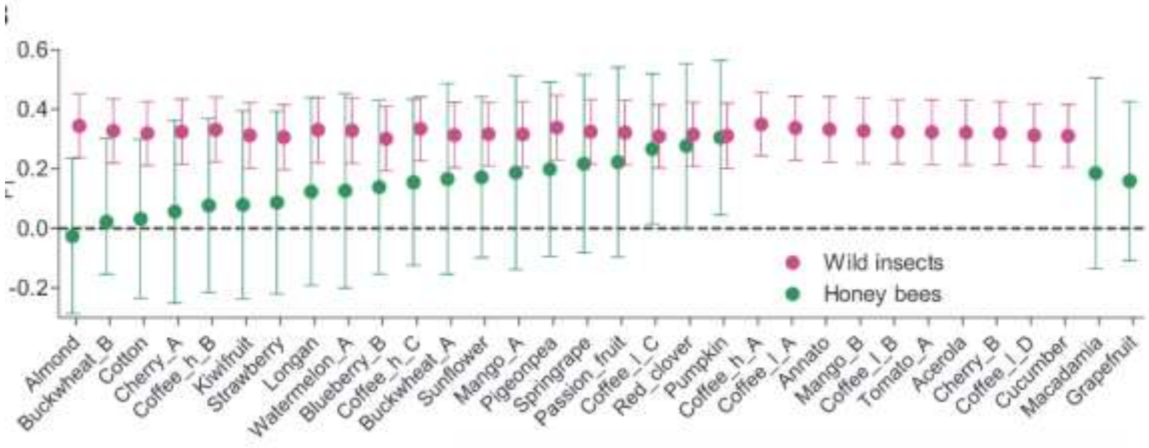
ENHANCE
Greenleaf and Kremen 2006b, Brittain et al. 2013

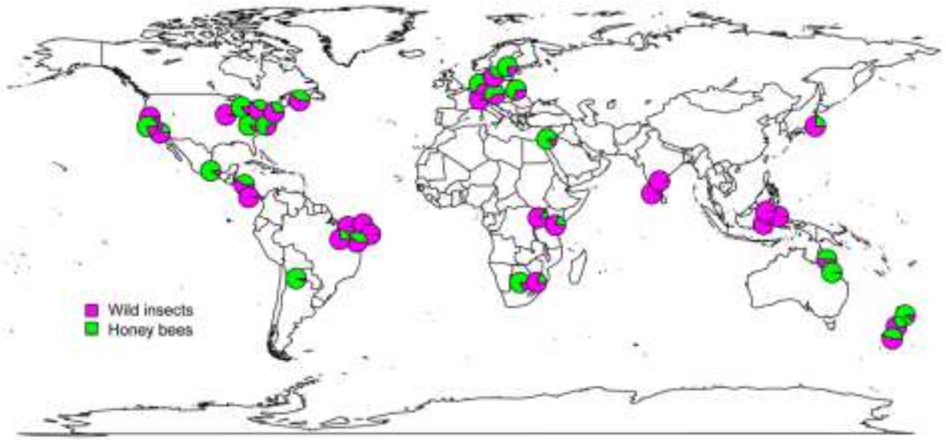
REPLACE
Greenleaf and Kremen 2006a

COMPLEMENT
Sciligo, M'Gonigle and Kremen, in prep.

Sciencexpress

Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance *Garibaldi et al. 2013*





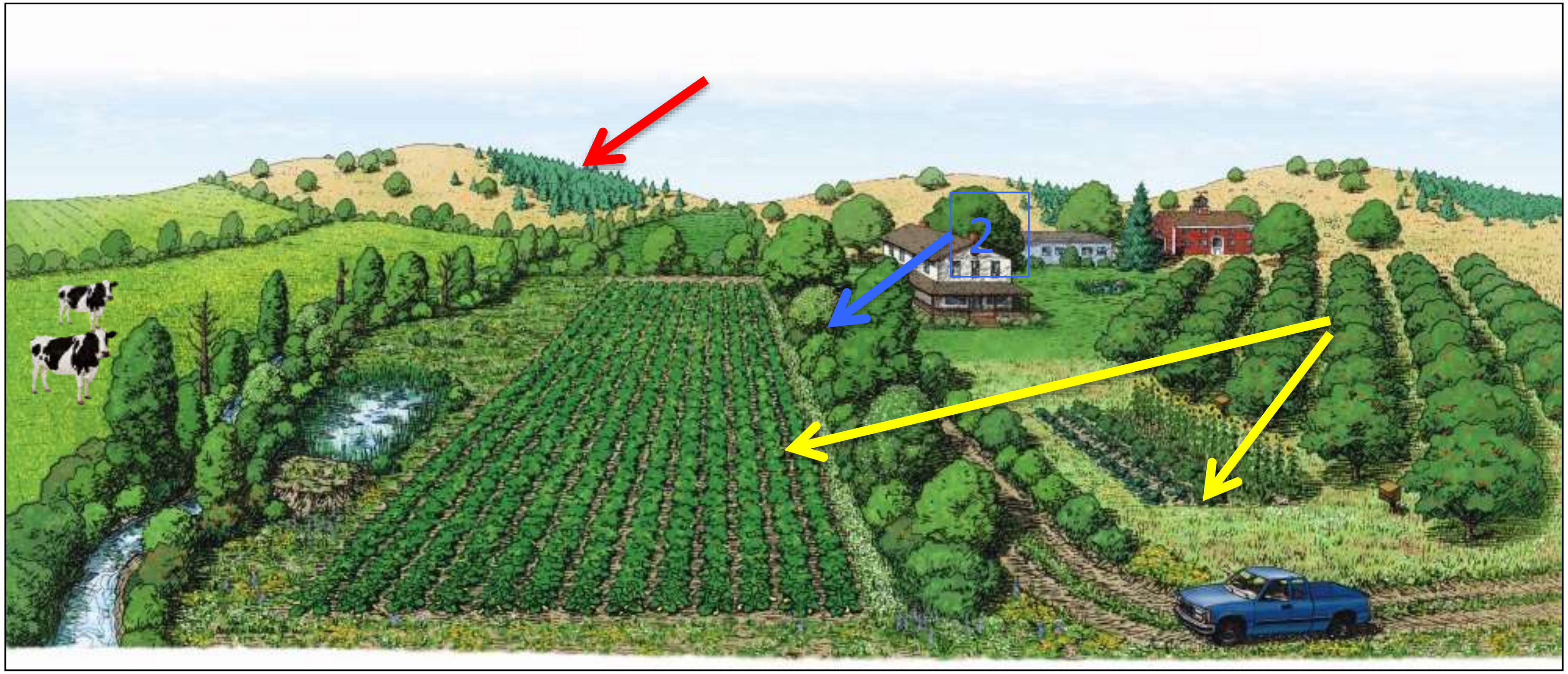
41 crop systems around the world

Generalizable, global finding

Trends towards simplification and chemicalintensification around the world.

Ramankutty et al. 2018

Biologically-Diversified Farming System



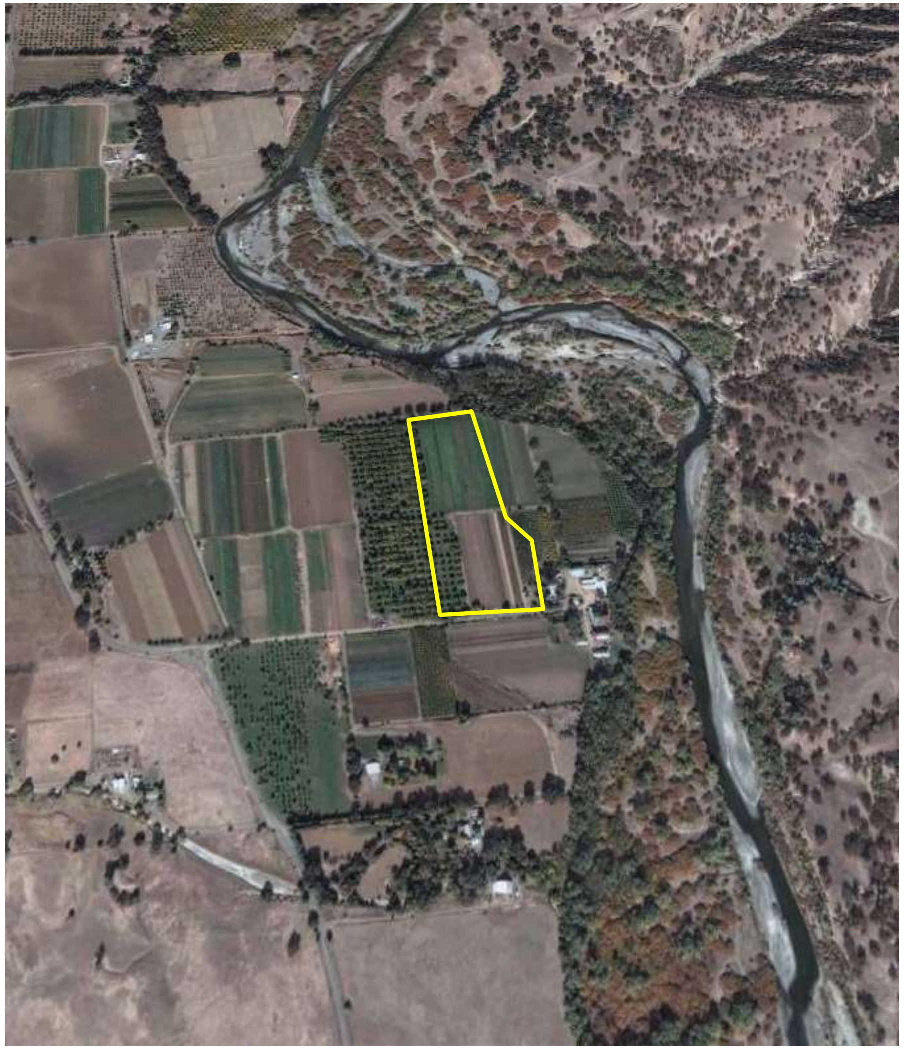
Natural habitat patches

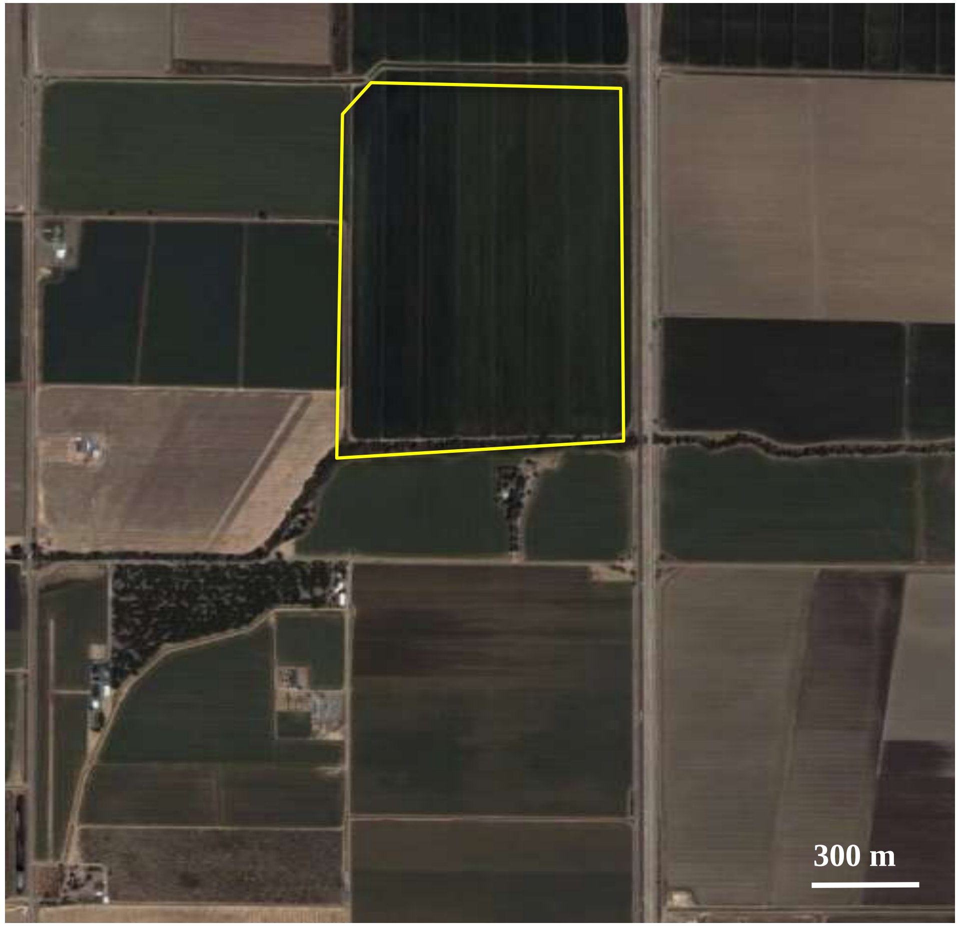
Klein et al. 2012

Generalizable (89 studies around the world)

Landscape complexity ->diverse pollinators-> improved pollination > increased yield

Dainese et al. 2019

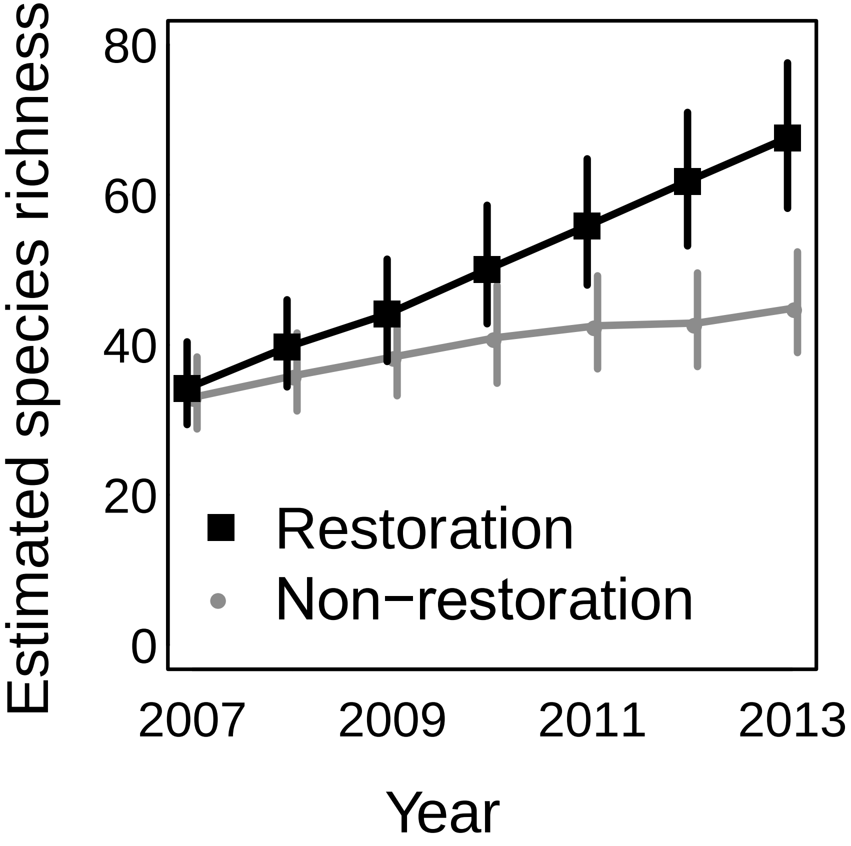




Argument for habitat conservation

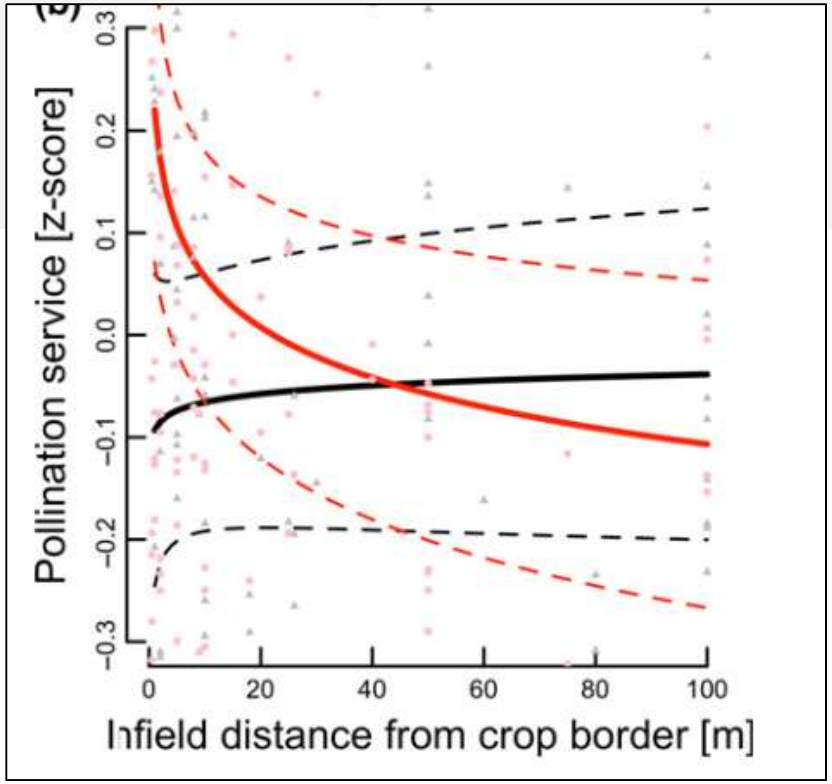
But..doesn't help individual farmers

Hedgerows and flower strips

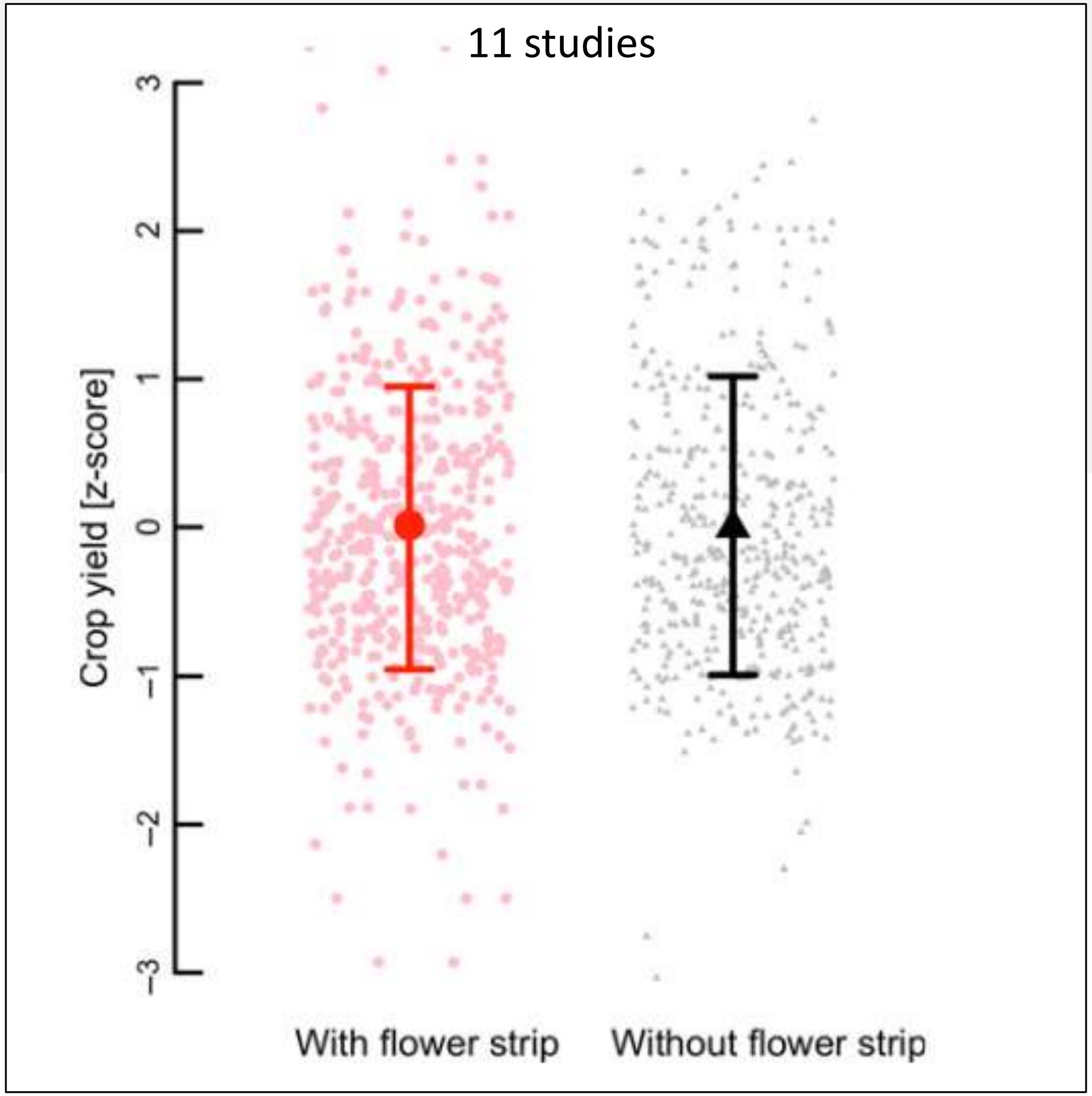


Generalizable: Flower strips and hedgerows support crop pollinators and other pollinating species (Kremen et al. 2019; Nicholson et al. 2020)

Variable: improvements in pollination services don't always increase yields

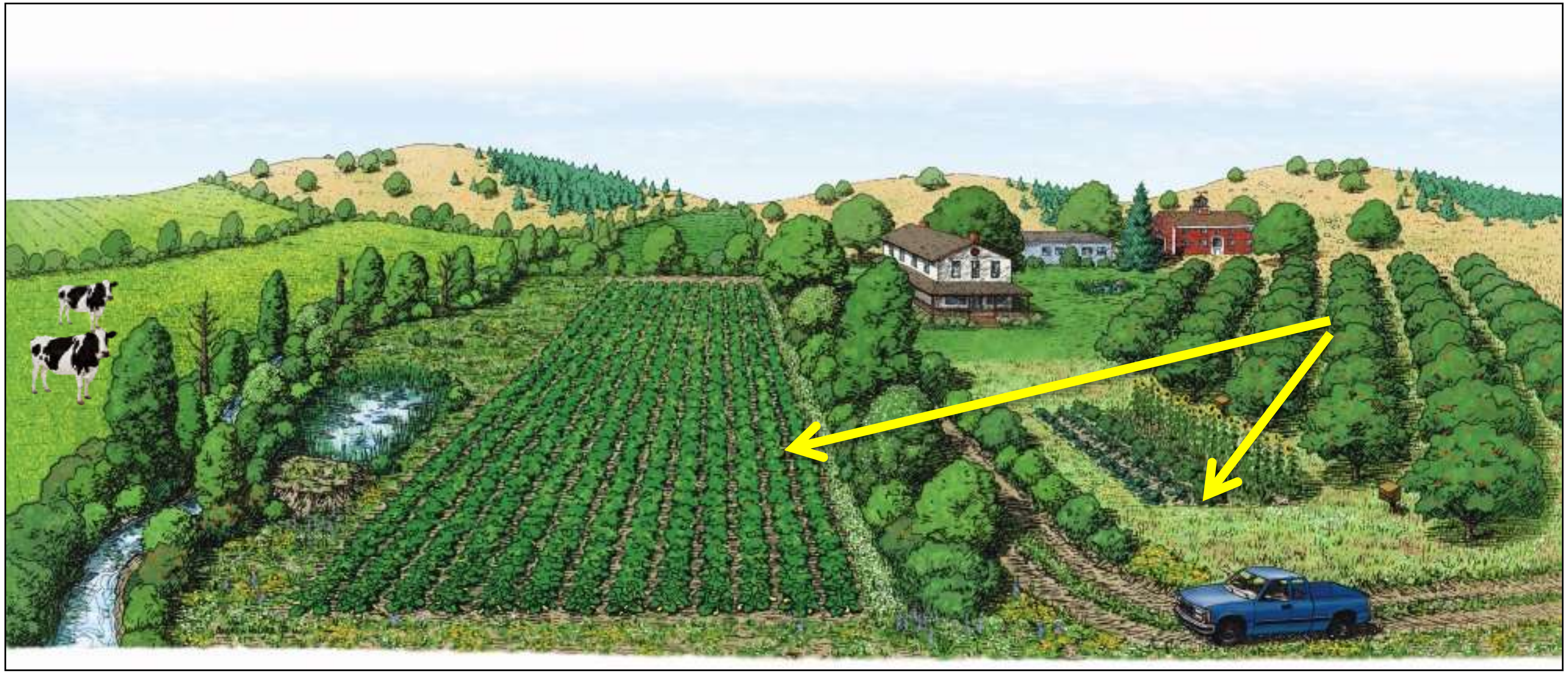


Albrecht et al. 2020



Border plantings alone not enough

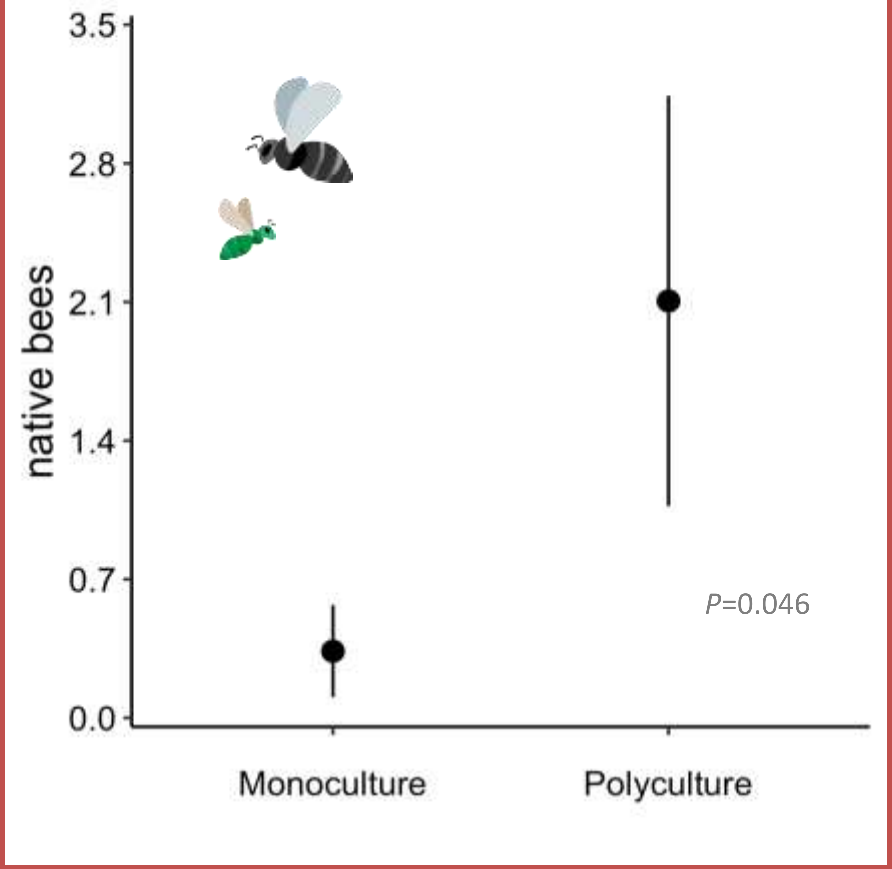
Crop diversity



Comparing monoculture and polyculture plantings

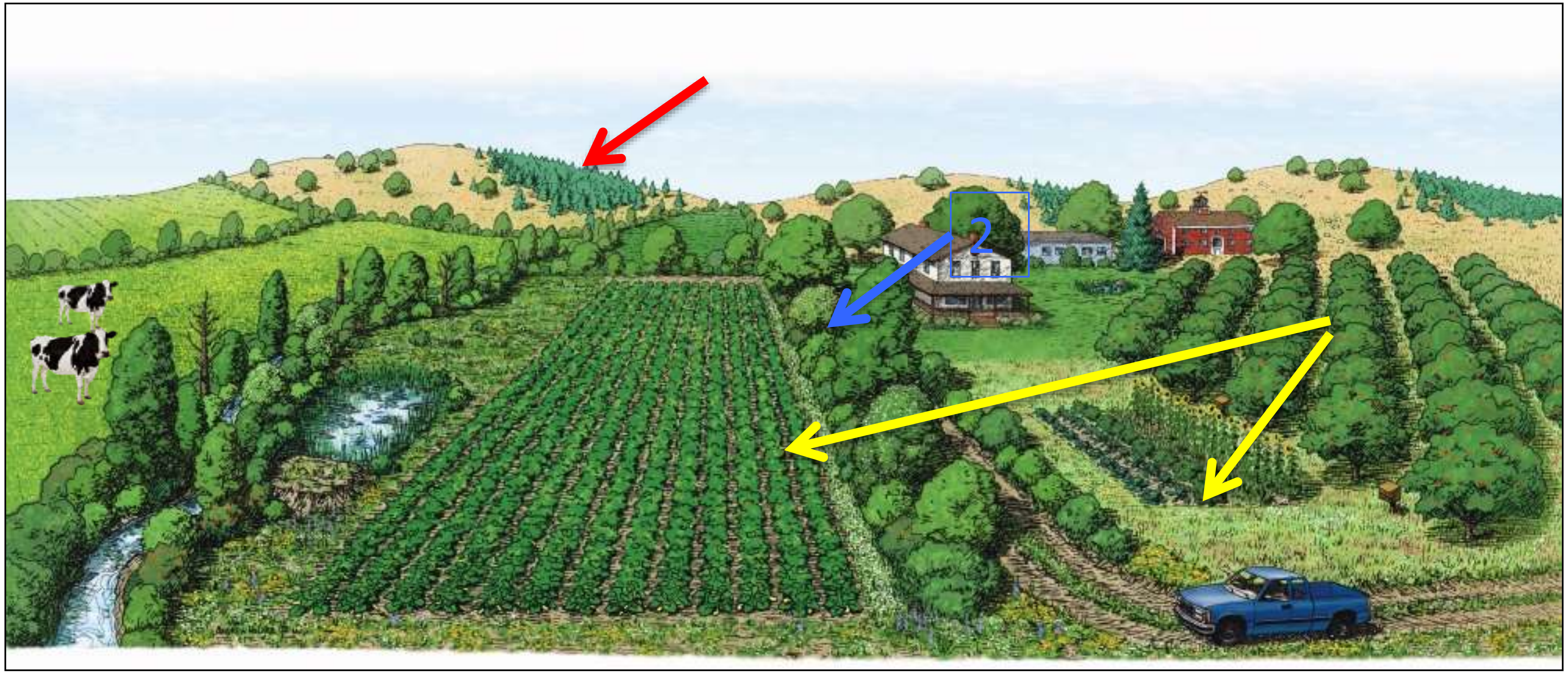
Only a few studies exist.

More species and individuals on polyculture farms



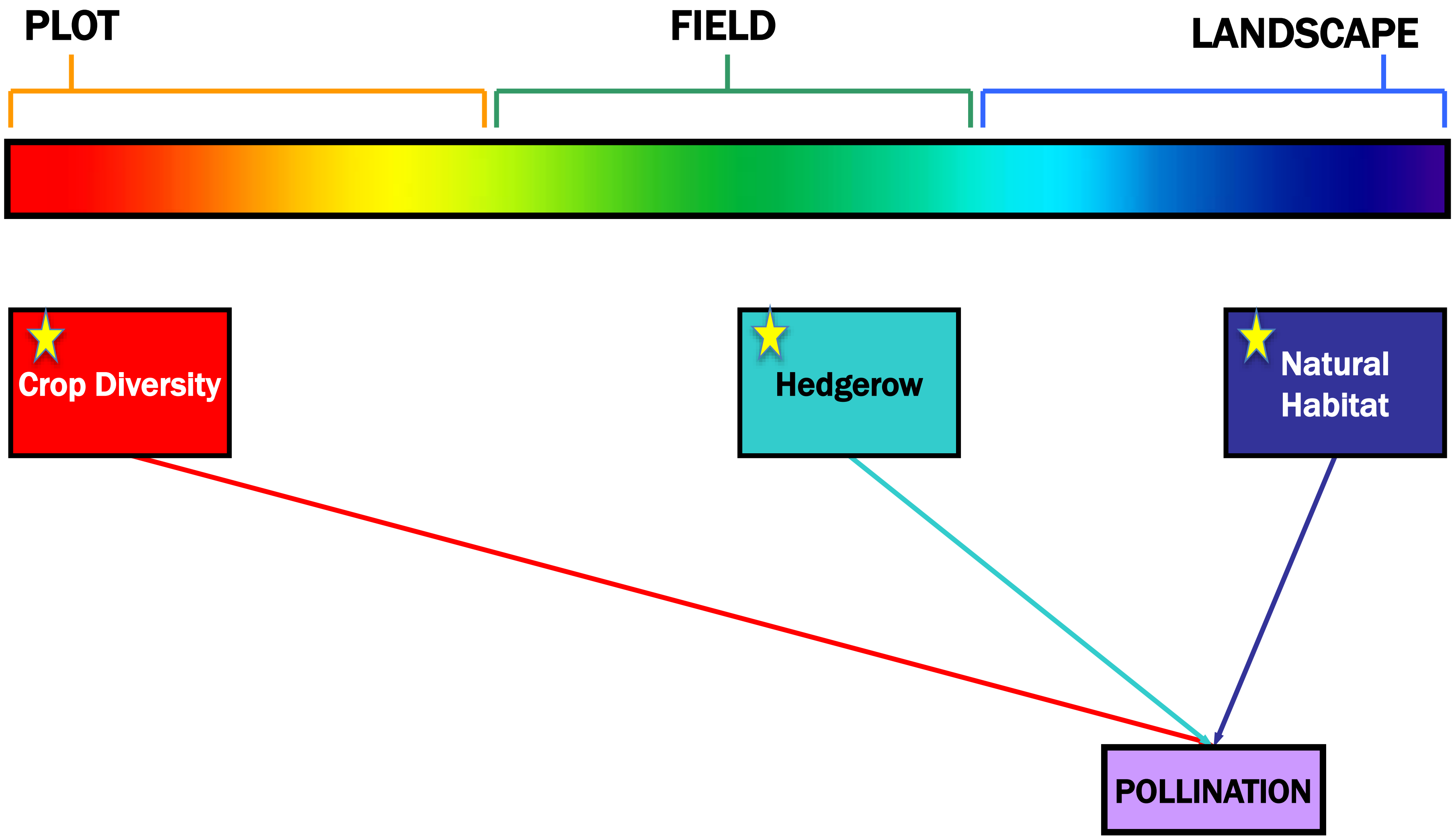
Guzman et al. 2019

Biologically-Diversified Farming System

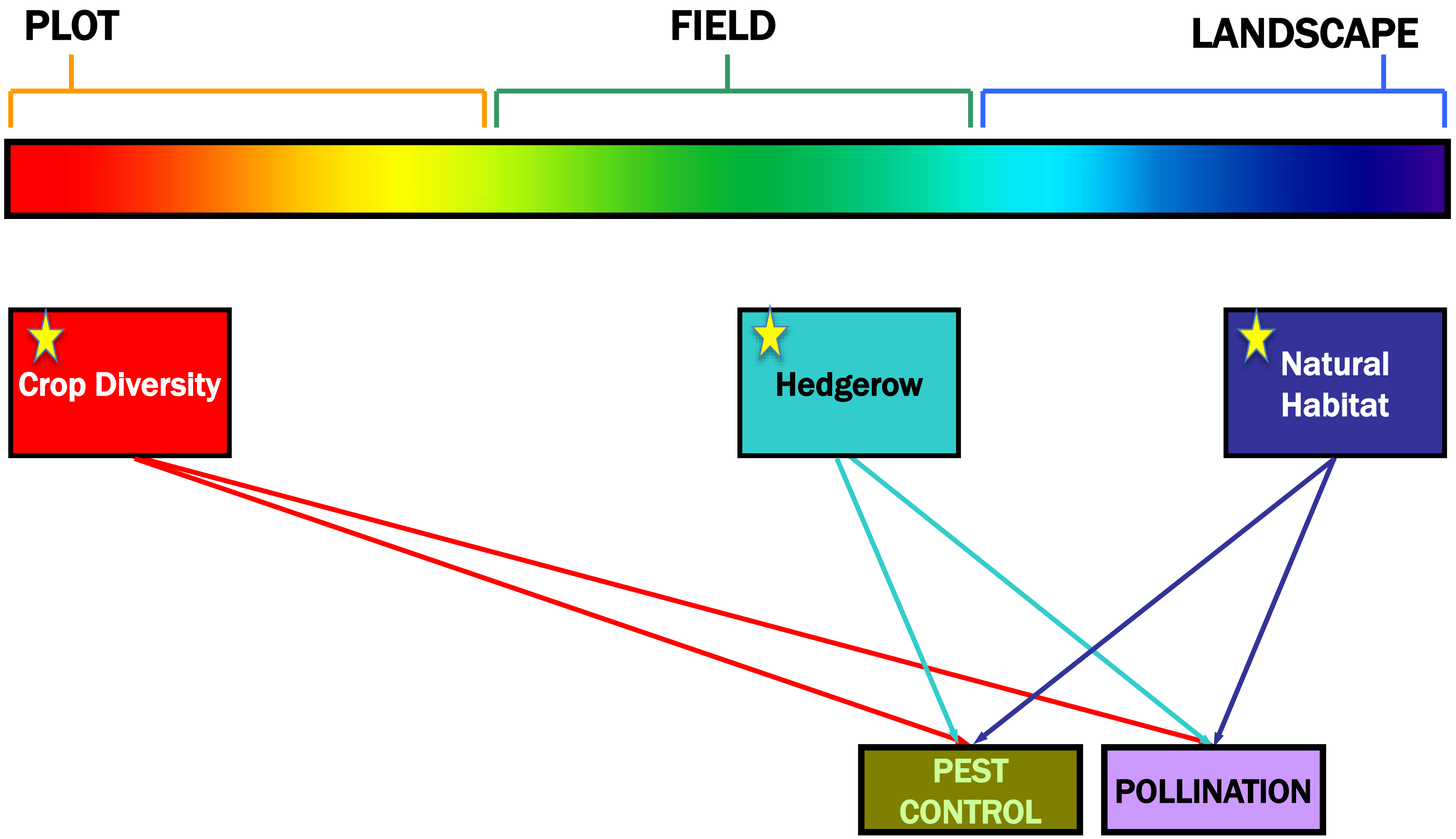


Evidence exists that these effects build on each other (*Kennedy et al 2013*) or interact positively (*Scheper et al. 2015*)

Biologically-Diversified Farming Systems



Co-Benefit: Pest Control



Take Home Points for USAID

- Providing a **diversity of pollinating insects** is important for crop production, food security and livelihoods and provides an ‘**insurance policy**’ relative to relying on managed honey bees alone.
- Small and large farmers can benefit greatly from enhanced pollination by using **diversification techniques** that **promote pollinators *and* reduce need for pesticides.**
- These methods include diversifying crops through polyculture and rotation; planting flower borders; maintaining patches of natural habitat.
- These methods have many **co-benefits**: soil fertility; pest/disease control; flood and erosion control; water quality; carbon storage; biodiversity.
- Let the pollinators show us the way to a **sustainable agriculture** by supporting diversified farming practices!

Thanks!

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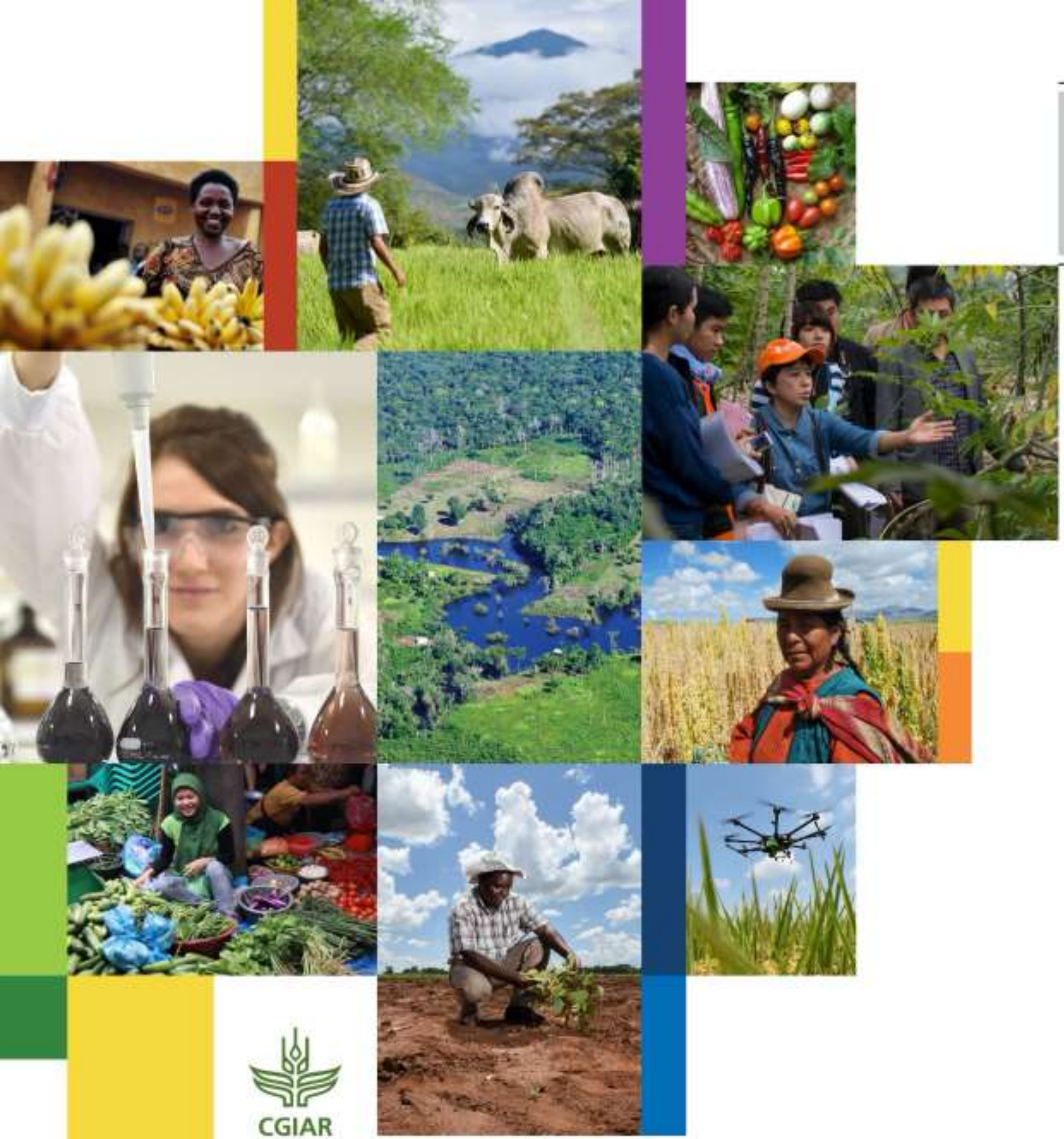

Alliance | Bioversity International | CIAT International Center for Tropical Agriculture Since 1967 *Science to cultivate change*

Lifting the buzz out of provisioning pollination services- A review on role of forest management practices on pollination services

Smitha Krishnan[1]

Co-authors: Gabriela Wiederkehr Guerra[2] Damien Bertrand[3], Sheila Wertz[3] and Christopher Kettle[2]

[1]Bioversity International, Bangalore, India, [2]Bioversity International, Rome, Italy, [3]FAO, Rome, Italy

03 December 2020

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@BiovIntCIAT_esp

#Alliance4Science

CGIAR

Bioversity International and the International Center for Tropical Agriculture (CIAT) are CGIAR Research Centers.
CGIAR is a global research partnership for a food-secure future.

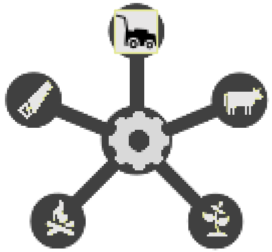
Approach

Identify the links between forest, landscape management and pollination services

The report- Pollination services of forests: https://doi.org/10.4060/ca9433en

Synthesis- Main drivers affecting pollinator abundance and diversity:

Forest management practices



Habitat modification

Climate change

Synthesis- Main drivers affecting pollinators

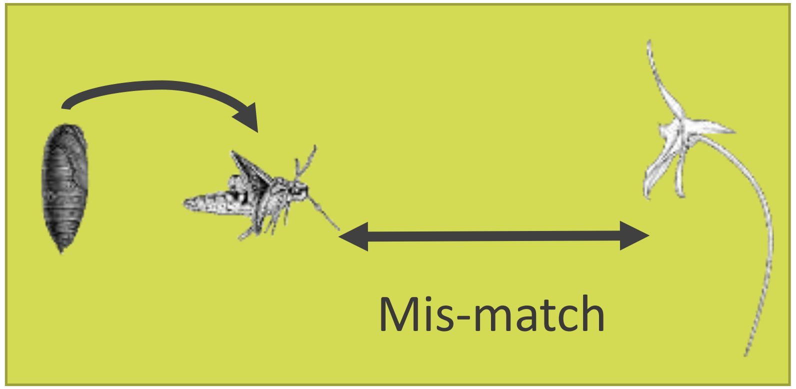
1. **Forest management practices**

- Logging
- Dead wood retention
- Fire
- Grazing and mowing
- Restoration

…..Synthesis- Main drivers affecting pollinators

2. **Habitat modification**
   - Forest fragmentation
   - Change in land use

3. **Climate change -** alters the time, quality and duration of phenological events

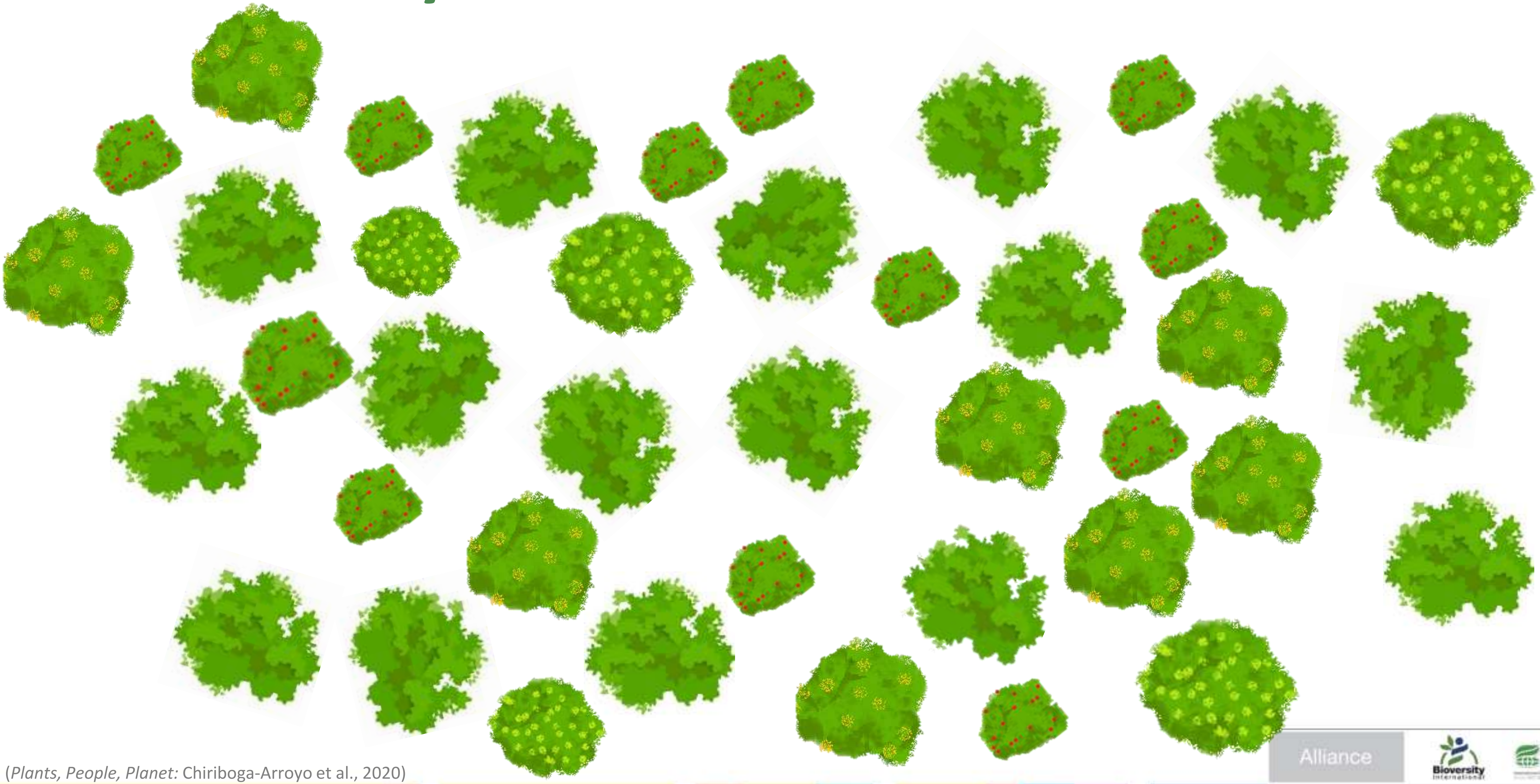


Habitat modification: Case study - Brazil nut trees

Alliance Bioversity International CIAT

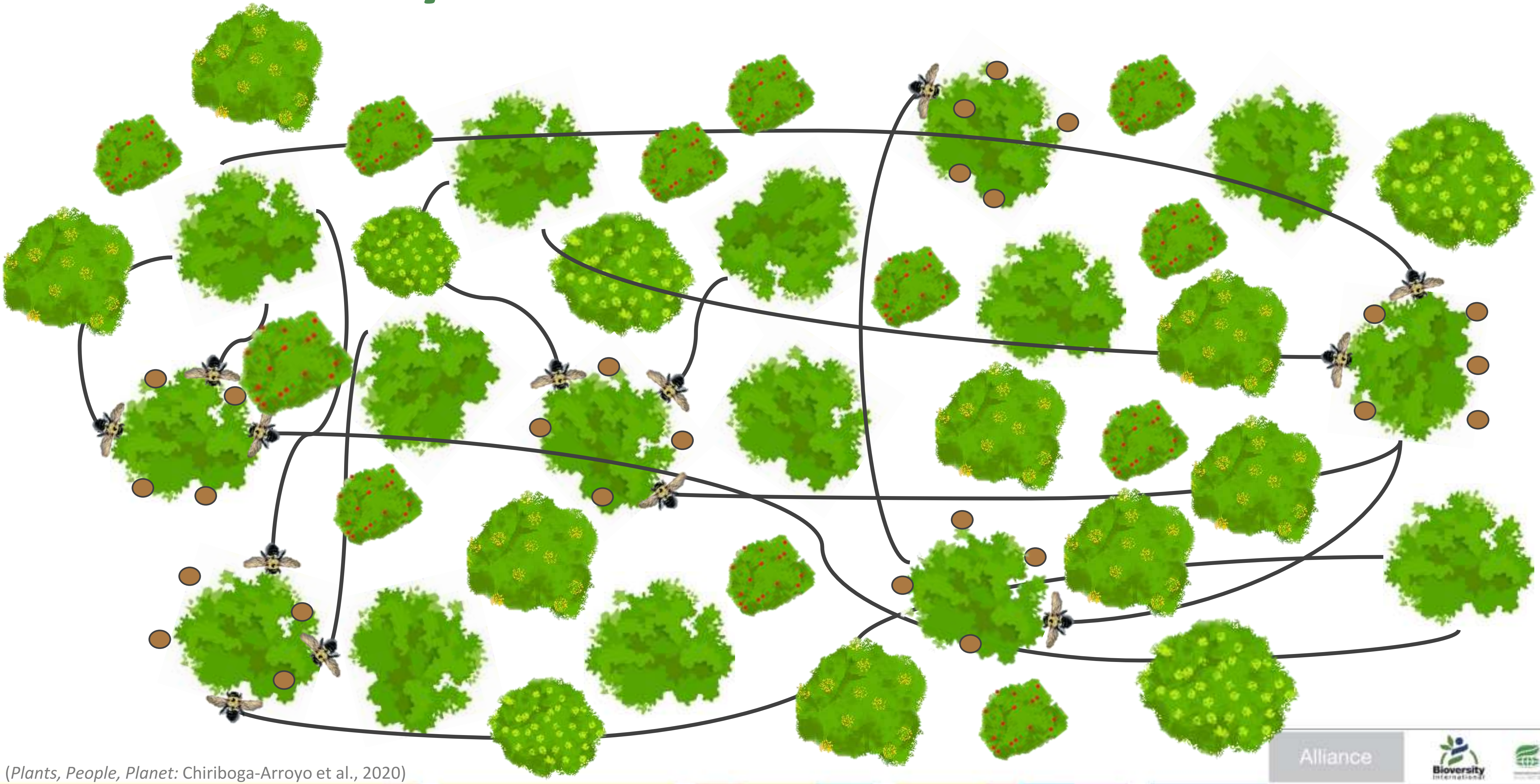
Case study: Cross-pollination of Brazil nut trees - Risky buzziness

Case study 1: Brazil nut trees in Forests



(*Plants, People, Planet:* Chiriboga-Arroyo et al., 2020)

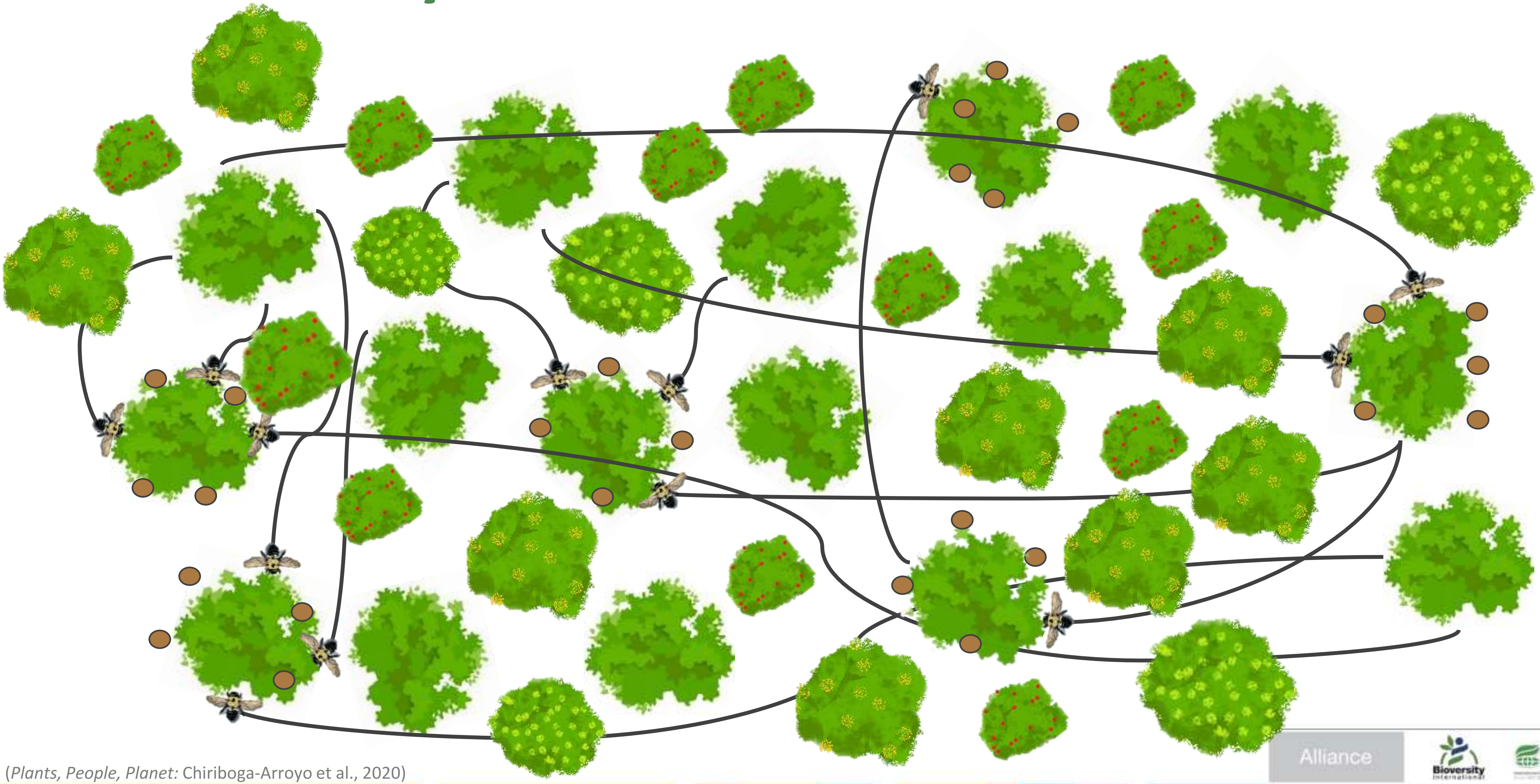
Case study 1: Brazil nut trees in Forests



(*Plants, People, Planet:* Chiriboga-Arroyo et al., 2020)

Case study1 : Cross-pollination of Brazil nut trees

Case study 1: Brazil nut trees in Forests



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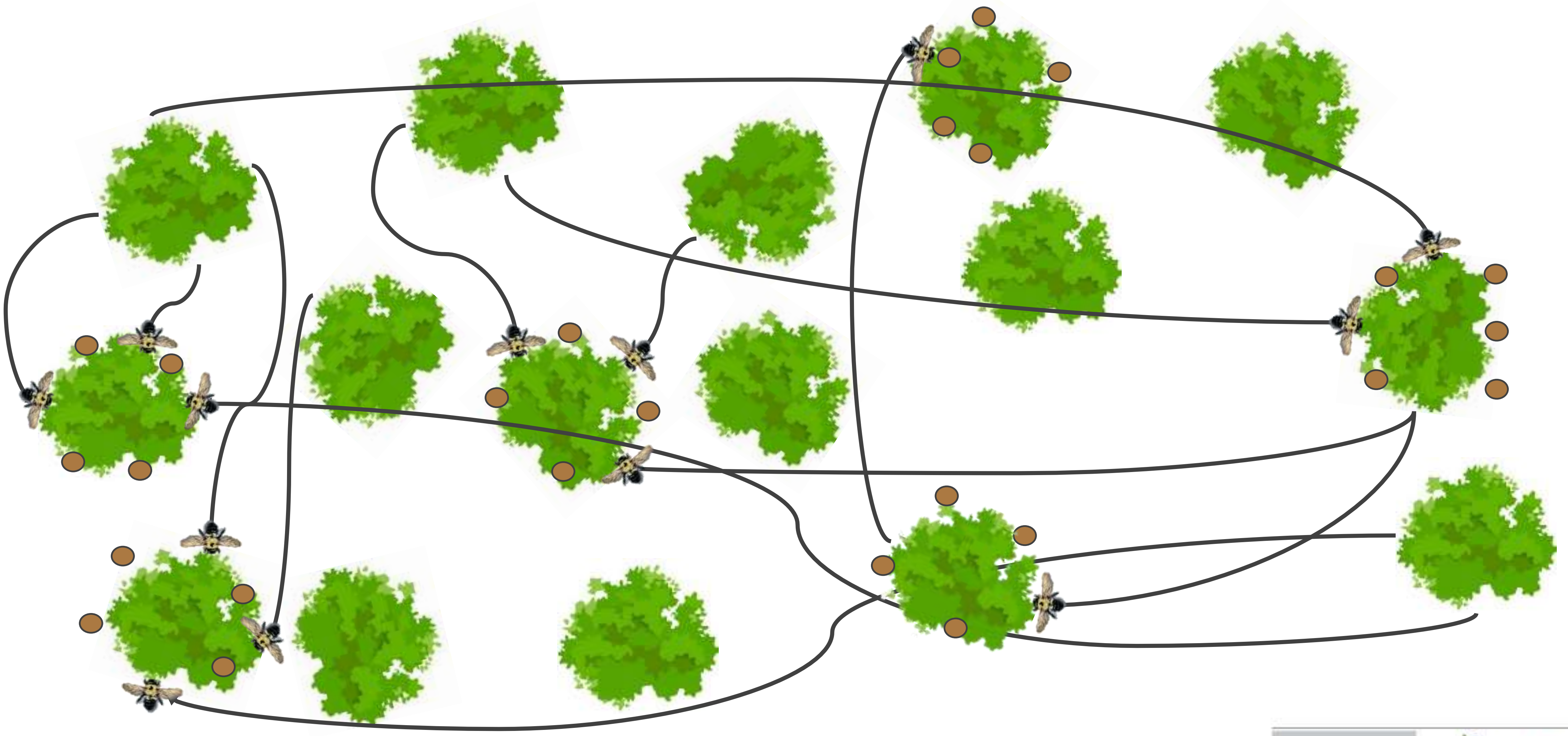

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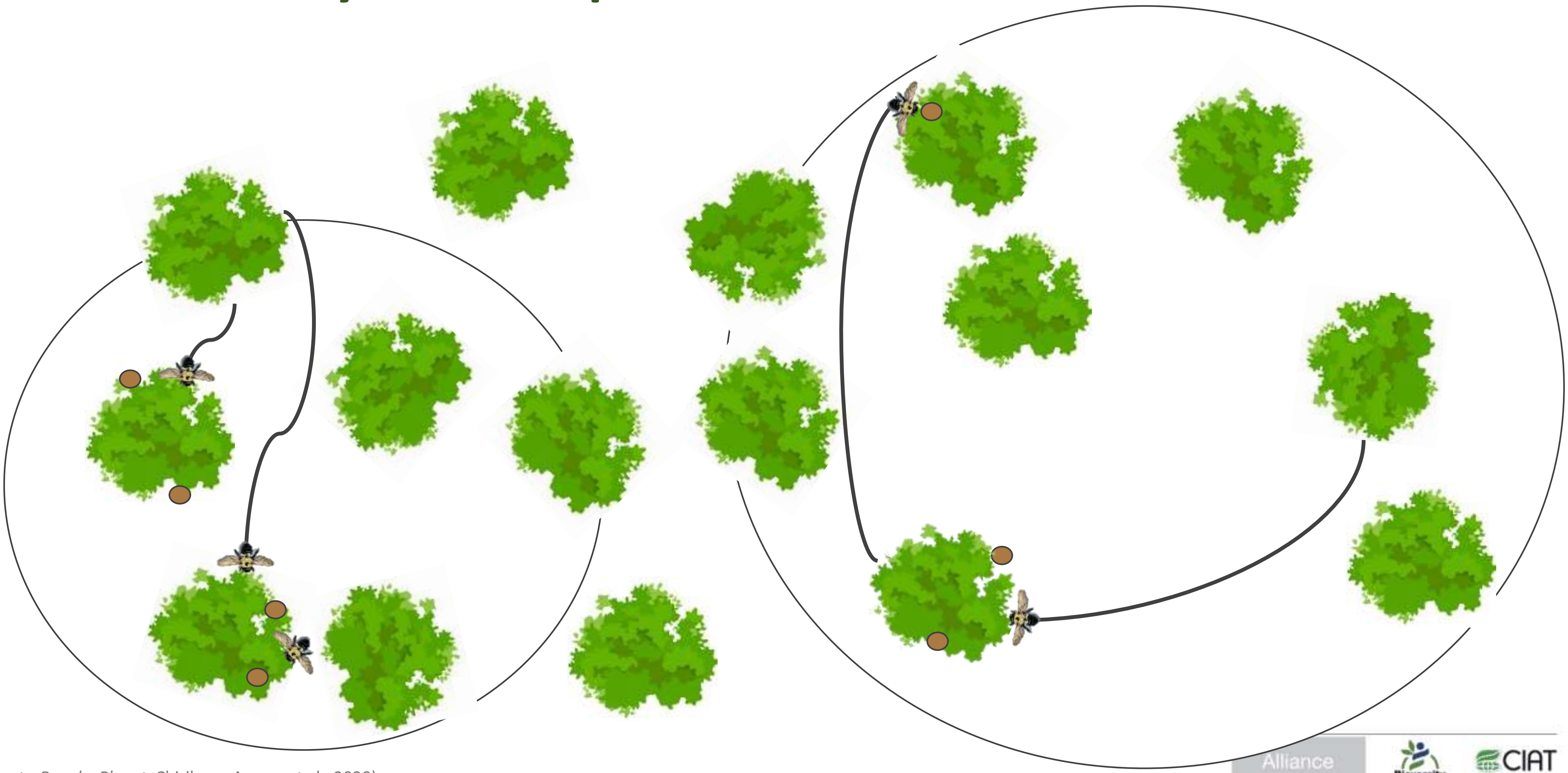
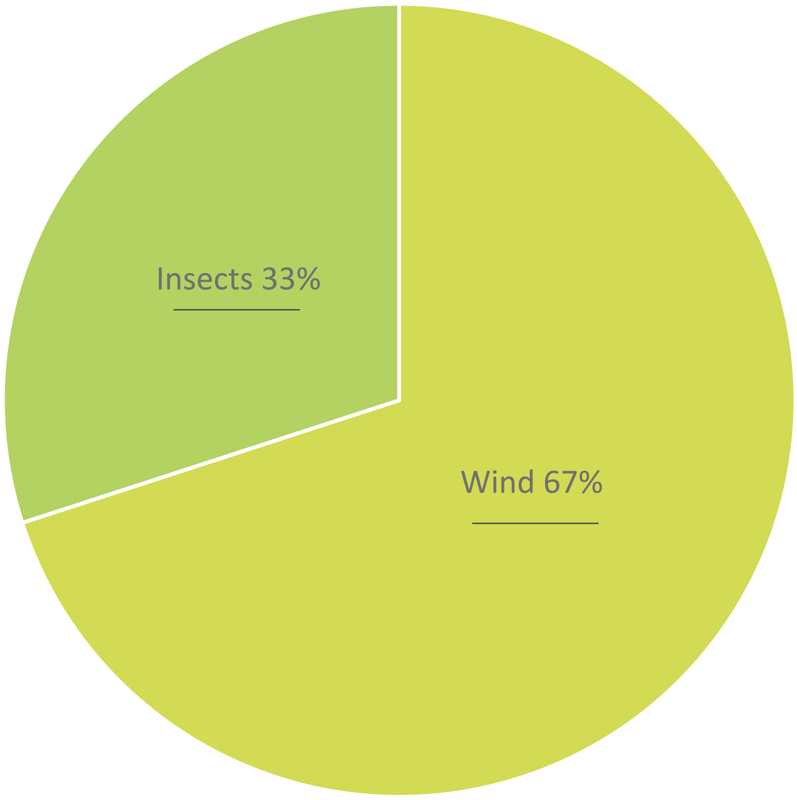


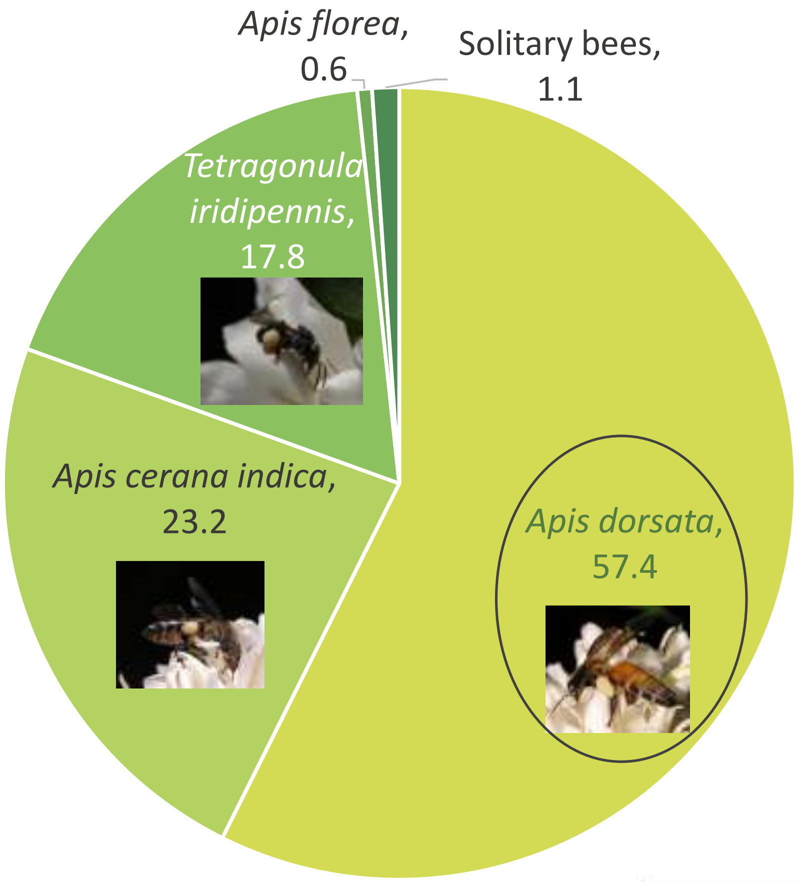
(*Plants, People, Planet:* Chiriboga-Arroyo et al., 2020)

Habitat modification - Case study –Coffee landscapes

Contribution to coffee fruit-set

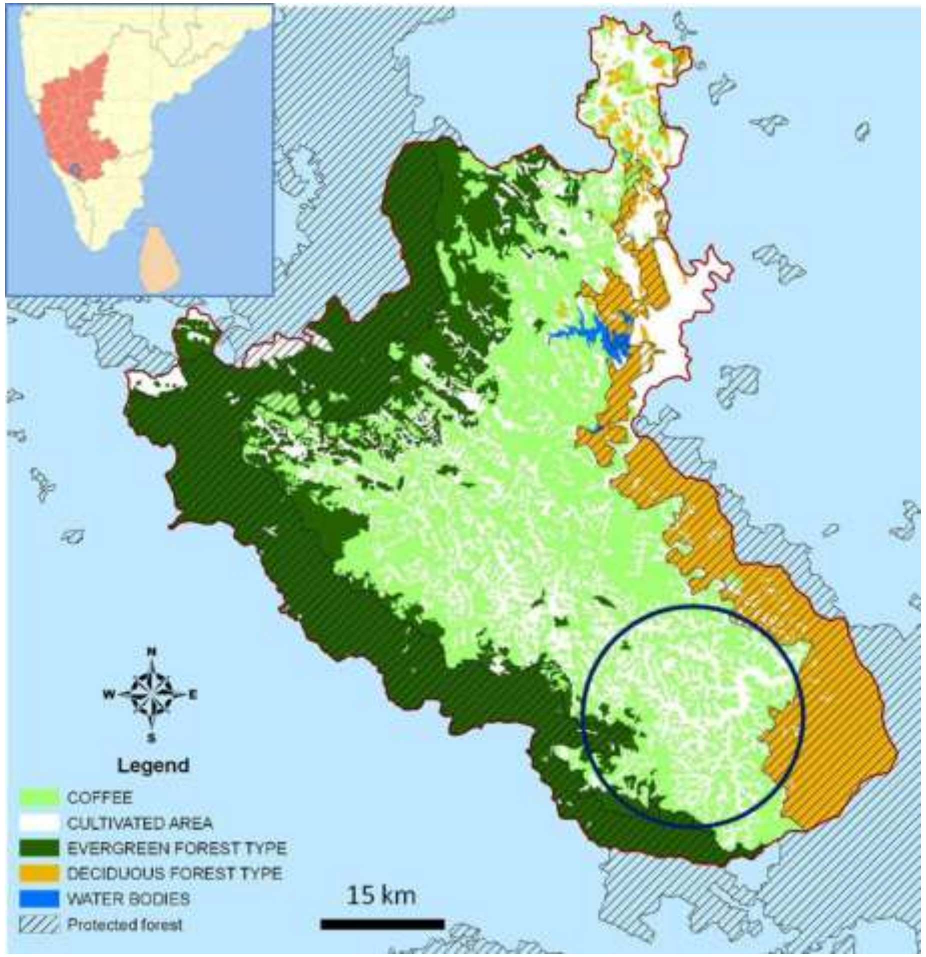


Pollinators of coffee



Krishnan et al. (2013) *Basic and Applied Ecology*

Study Area



Source: French Institute of Pondicherry

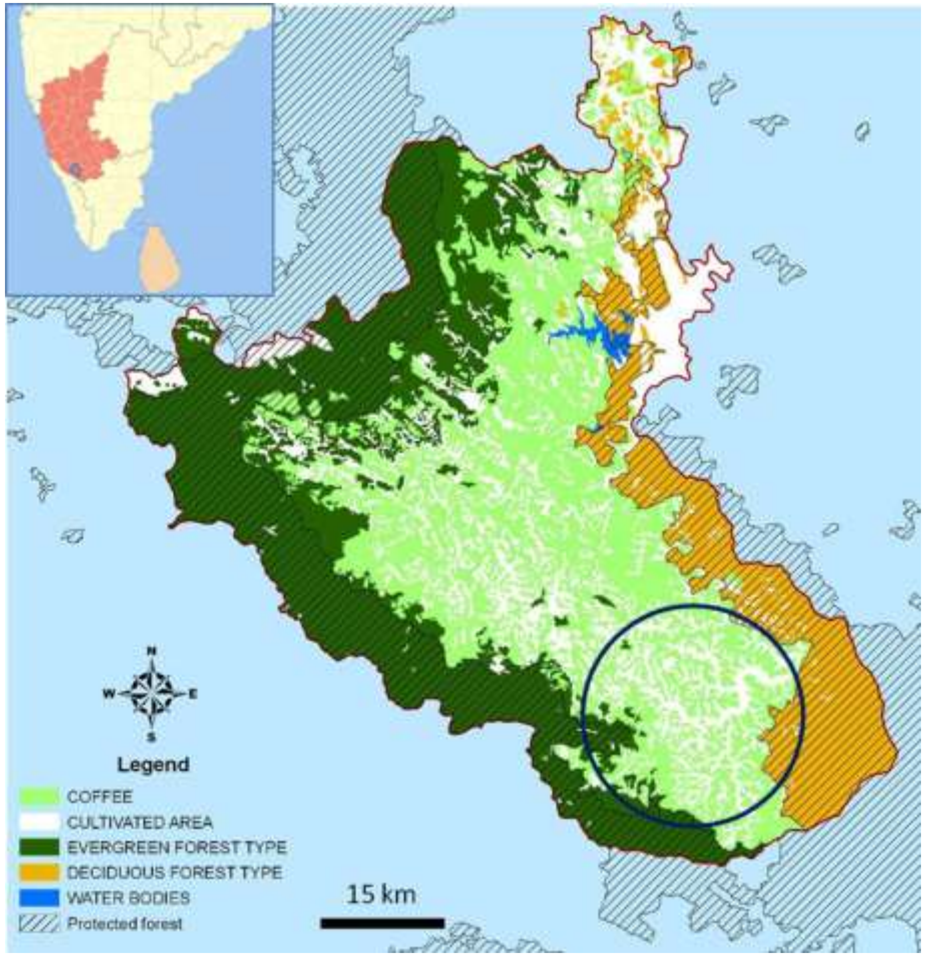
Kodagu area: 4106 km^2

Land use types	
Forest	46%
Coffee	32.5%
Paddy, Water bodies, human settlements	21.5%

Over 1200 remnant forests dispersed in coffee-paddy matrix

1 forest remnant/ 3 km^2

Study Area



Source: French Institute of Pondicherry




Apis dorsata prefer to nest in forest fragments on large trees with a huge crown!

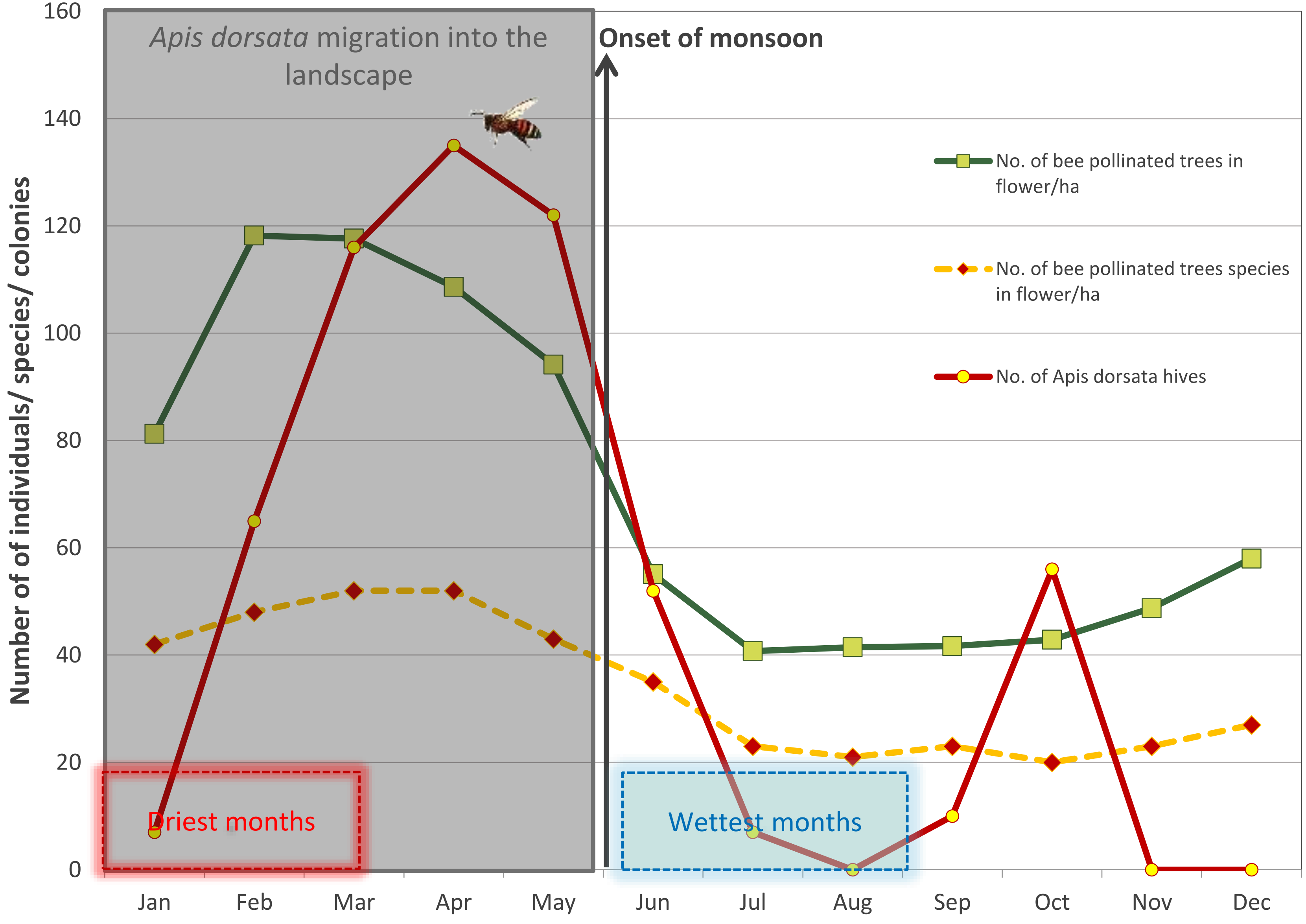
Habitat modification- Coffee landscapes

Matrix predominantly paddy

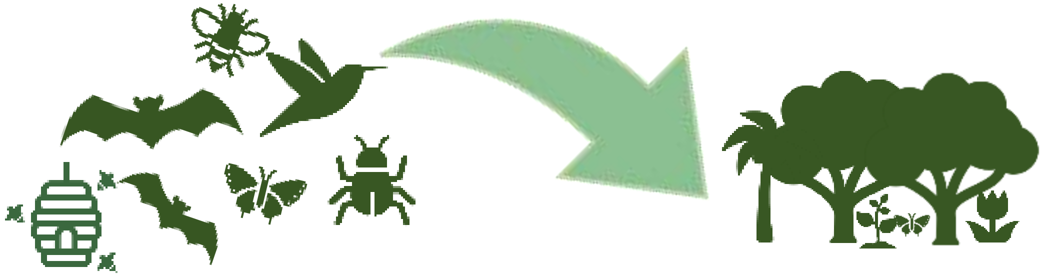
Matrix predominantly coffee

Forest size and the quality of matrix habitat mattered!

Bee trees flowering calendar



Why does this matter



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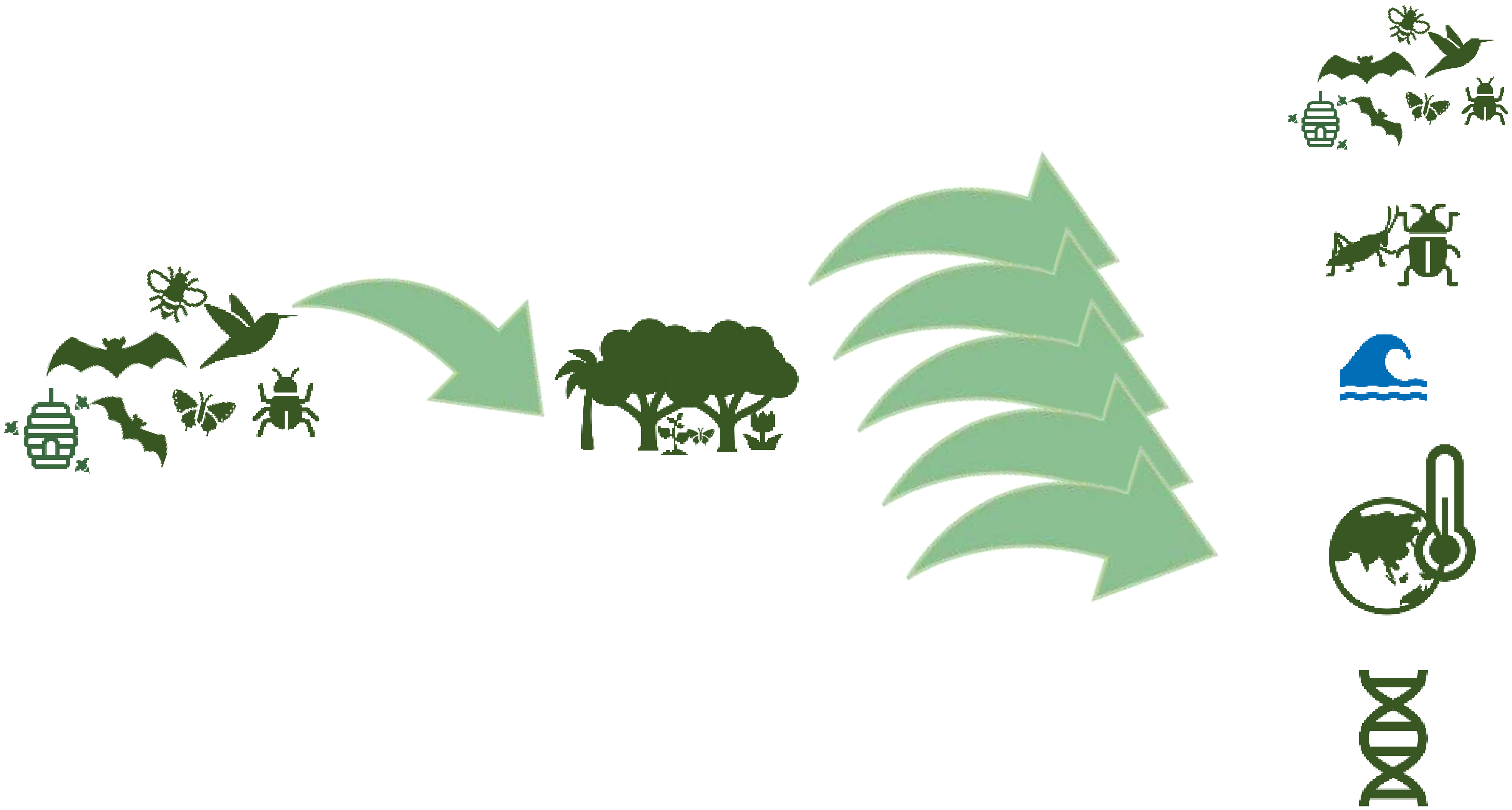

Why does this matter

Alliance

Bioversity International

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

Thanks to Gaby and Fidel for sharing slides

Thank you!

Smitha Krishnan

Funded by the FAO and Forests, Trees and Agroforests program of CGIAR

CGIAR

Bioversity International and the International Center for Tropical Agriculture (CIAT) are CGIAR Research Centers.
CGIAR is a global research partnership for a food-secure future.

Pollinators and global nutrition

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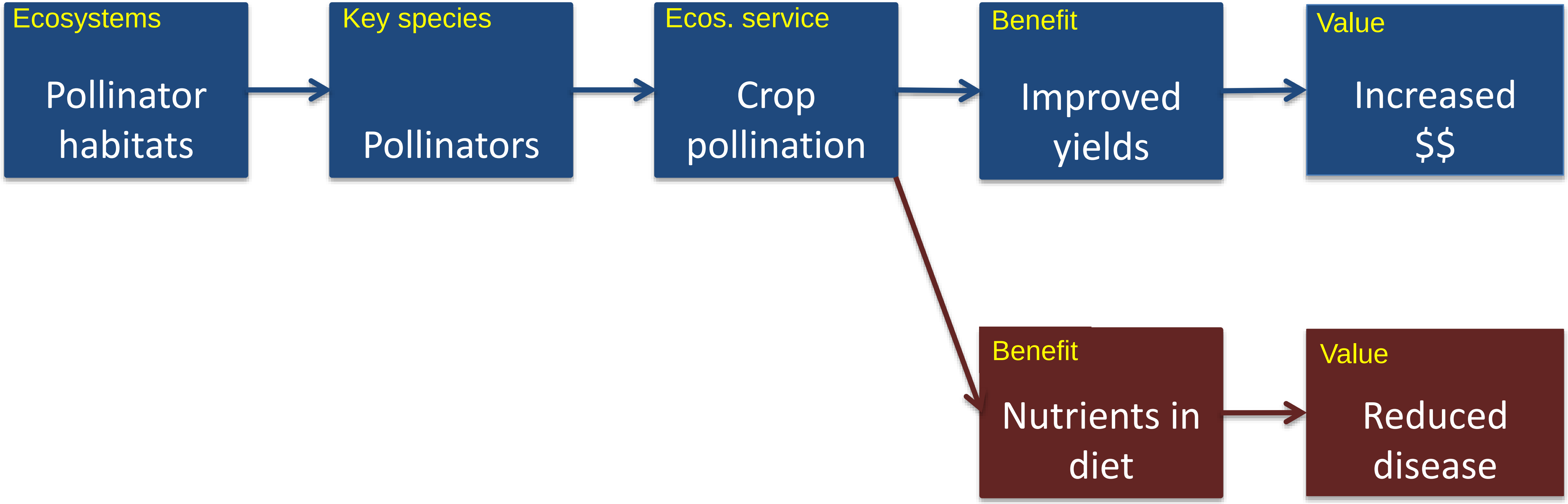
Bees provide more than economic values



Pollinated crops supply micronutrients

Pollinators important

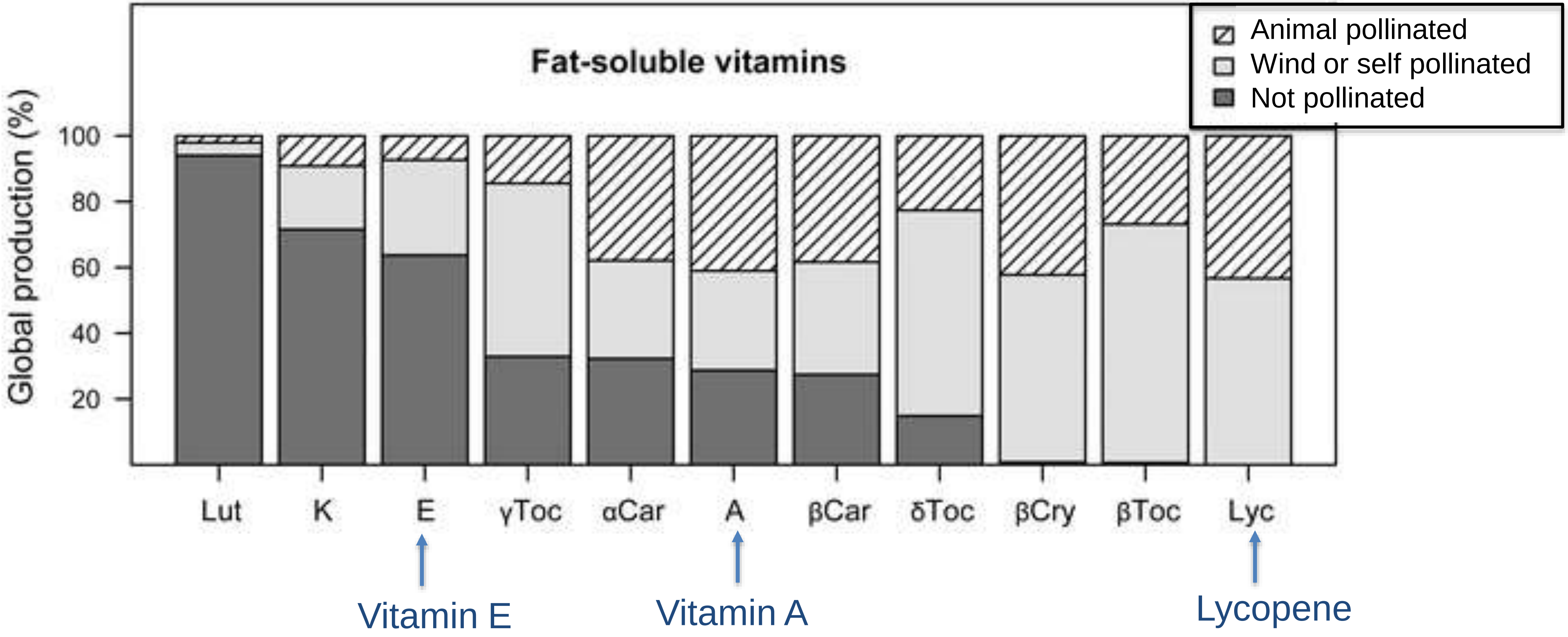
Pollinators *not* important

(Klein et al. 2007. *Proc Royal*
(Eilers et al. 2011. *PLOS ONE*.)

“The hidden hunger”

- Micronutrient deficiencies
  – Affects 1 in 4 people globally
- Effects:
  – Anemia, scurvy, other diseases
  – Blindness, lower IQ, lost productivity
  – Worsens other diseases
- Huge contributor to global burden of disease

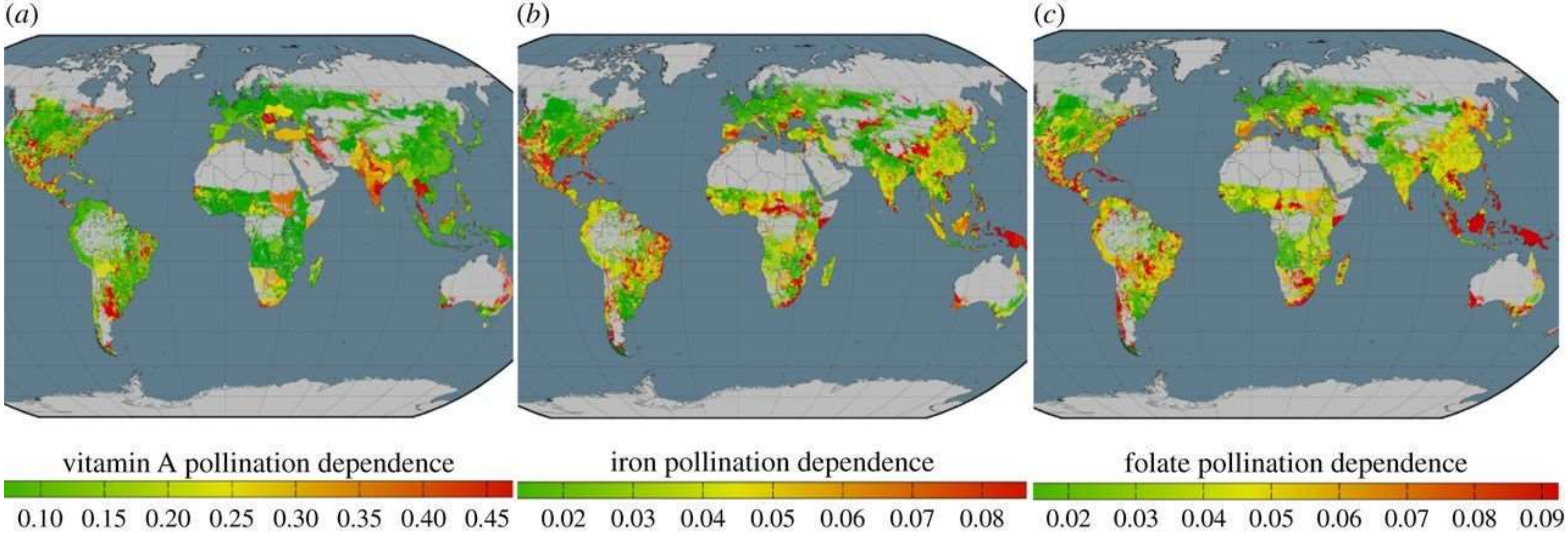
Global dependence on pollinators



(Eilers, et al. 2011. *PLOS ONE)*

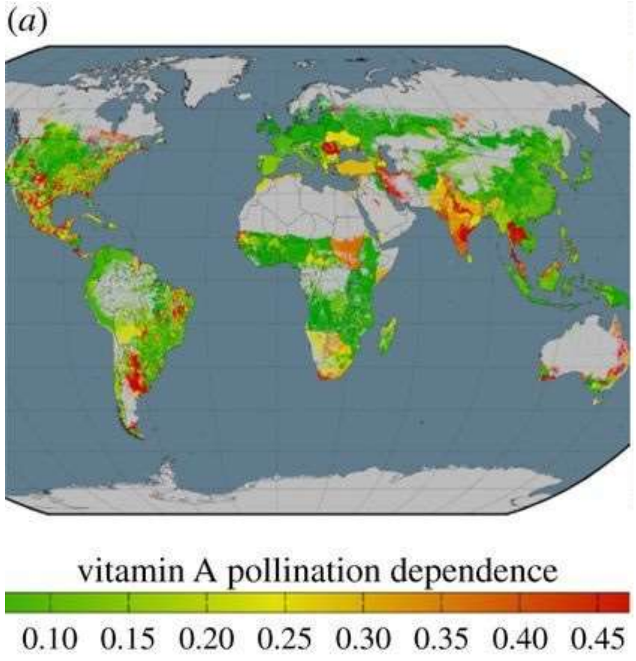
Mapping pollination-dependence

Vitamin A | Iron | Folate



(Chaplin-Kramer, et al. 2014. *PRSLB)*

Potential dependence vs. actual intake

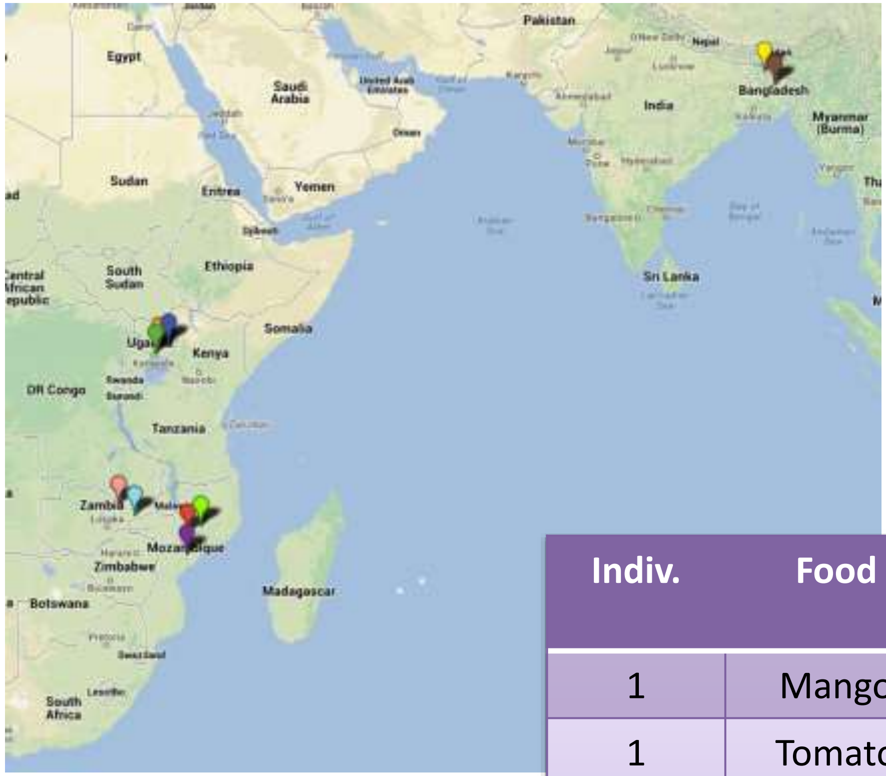


Aggregate nutrient production
Potential scale of issue

What are people actually getting?
From what foods?
Is it enough?

Examining actual diets

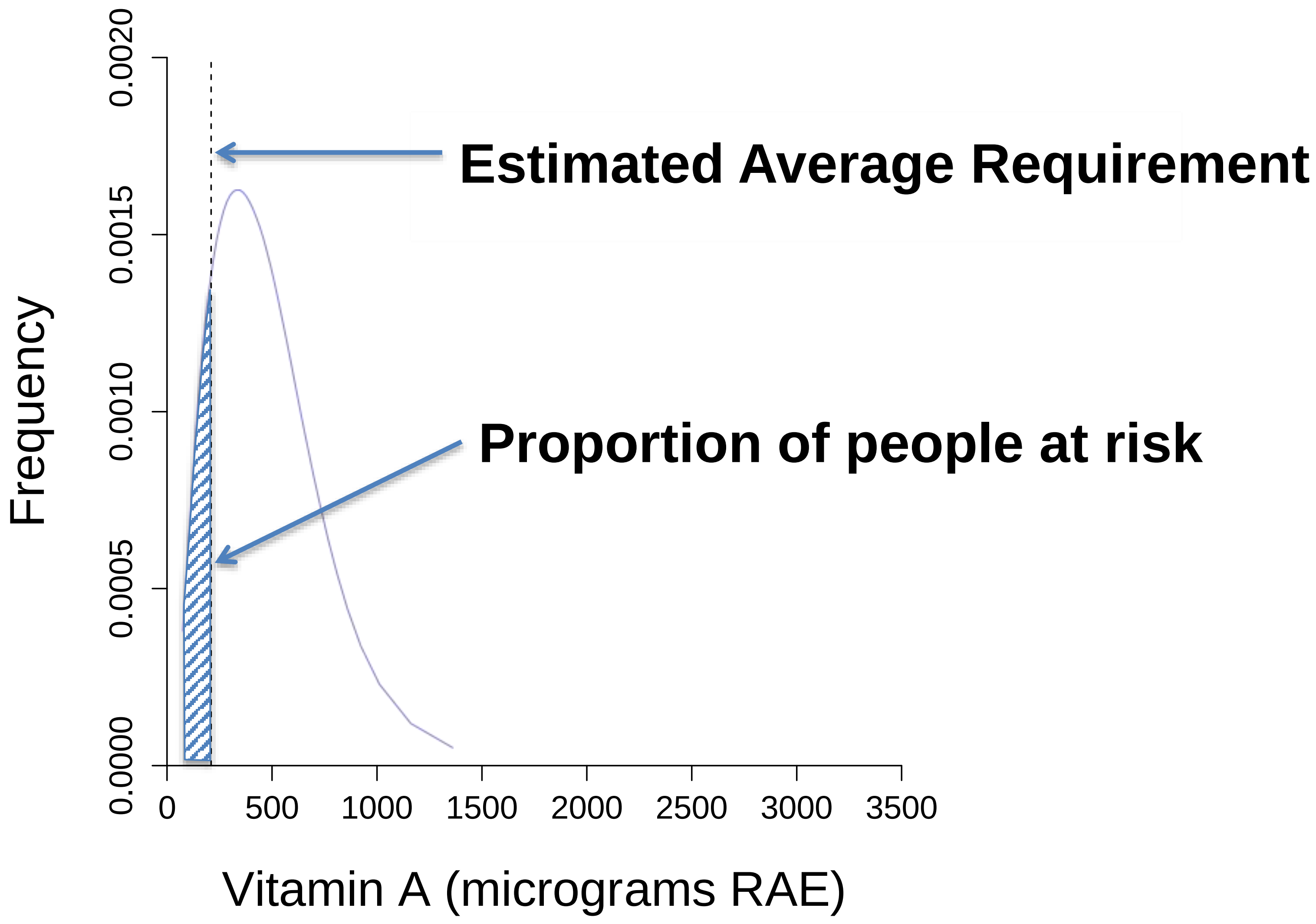
- Diet recall surveys
- 10 sites in 4 countries
  - Bangladesh
  - Mozambique
  - Uganda
  - Zambia
- 5 nutrients
  - Vitamin A
  - Calcium
  - Folate
  - Iron
  - Zinc



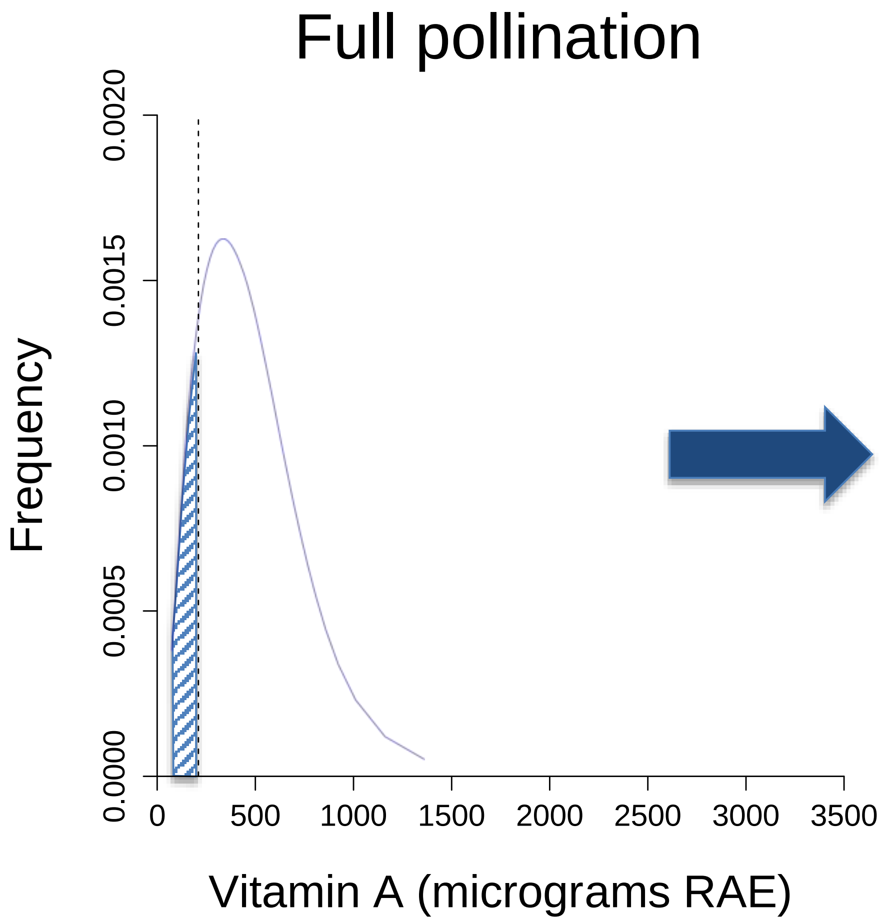
Indiv.	Food	Weight (g)	Vitamin A (RAE)
1	Mango	10.1	3.5
1	Tomato	5.3	2.1
1	Rice	60	0
2	Rice	42	0
2	Bean	9.6	3.05
2	Onion	1.5	0

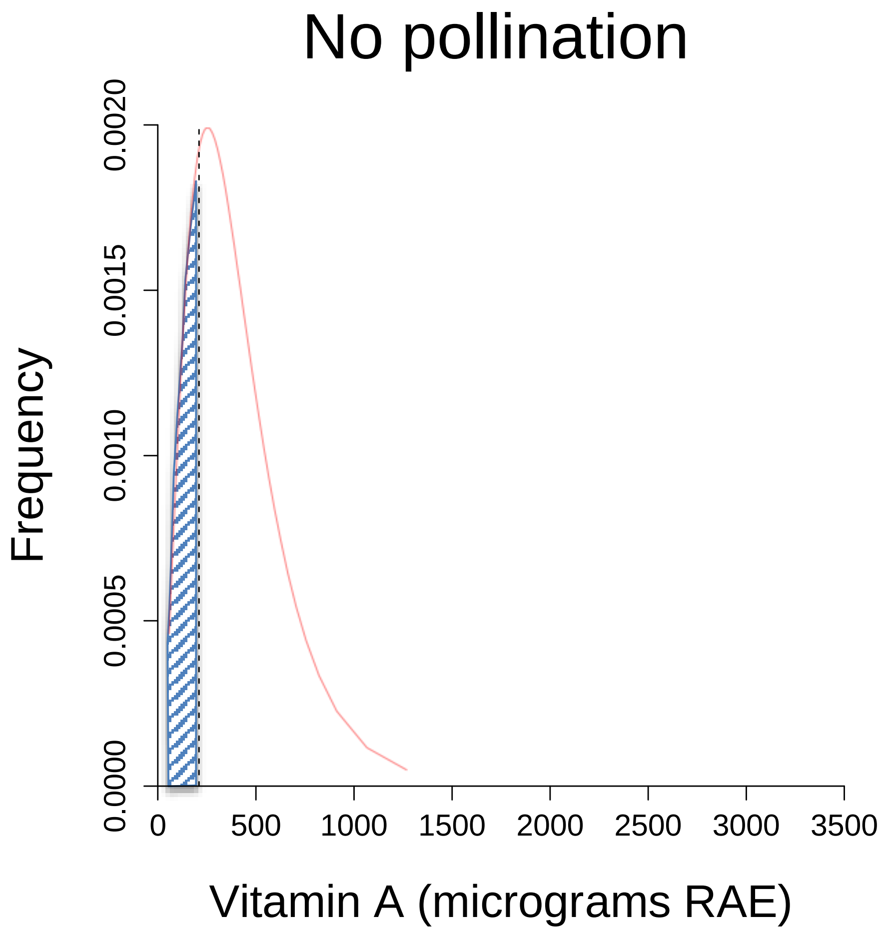
(Ellis et al. 2015. *PLoS ONE)*

Risk of nutritional disease



Remove pollinators – how does risk change?





Four countries, two nutrients

Percent of population newly at risk without pollinators

Nutrient	Bangladesh	Mozam-bique	Uganda	Zambia
Vitamin A	2%	**56%**	**15%**	5%
Folate	1%	**23%**	4%	0%

(Ellis et al. 2015. *PLoS ONE)*

What does this mean?

- Pollinator loss can have big health impacts
  - Vitamin A alone: 800k deaths, doubles other risks
- Not all populations are equally at risk
  - Depends on diet, not just production
- More vulnerable populations:
  - Nutrient sources depend on pollinators
  - Many people close to threshold
  - Less able to substitute

Big picture

- Pollinators are important to nutrition
- Not everywhere all the time
- We can figure out where
- Biodiversity underpins food security and health

Thanks

NSF-NCEAS
NSF-SESYNC
USDA-SCRI
Moore Foundation
Rockefeller Foundation
Knobloch Foundation
Gund Institute

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Thank you!

Q&A...