Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Ways and means - Ecological intensification for production and saving the environment

Prof. Riccardo Bommarco
Swedish University of Agricultural Sciences

Bertebos conference, Falkenberg, 28 August 2018

Challenge

- ✔ Food, energy for 9 billion people by 2050
  ...from the same agricultural land
- ✔ We need productive, stable, resilient agriculture
  ...that is environmentally friendly

E.g. Godfray et al 2010 Science

Ecological intensification concept

Proc. Natl. Acad. Sci. USA
Vol. 96, pp. 5952–5959, May 1999
Colloquium Paper

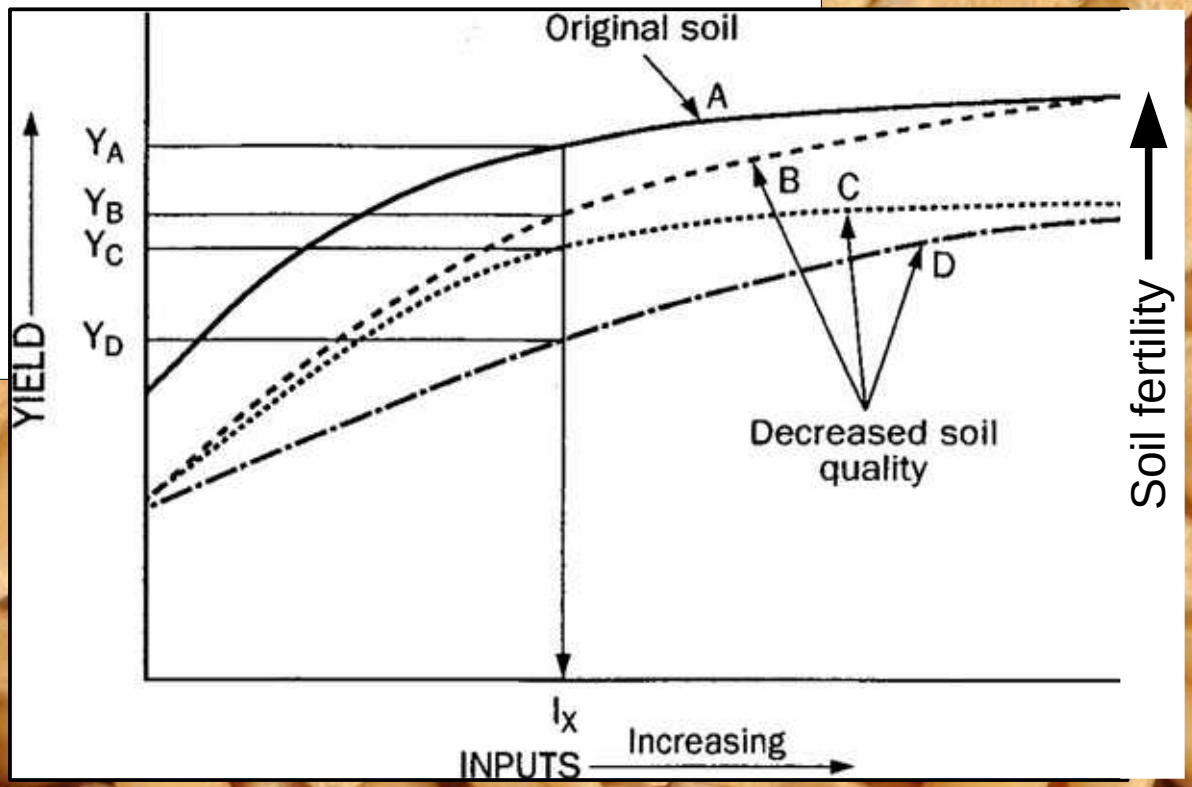
This paper held Decem

Ecological intensification of cereal production systems: Yield potential, soil quality, and precision agriculture

KENNETH G. CASSMAN

Department of Agronomy, University of Nebraska, Lincoln, NE 68583-0915

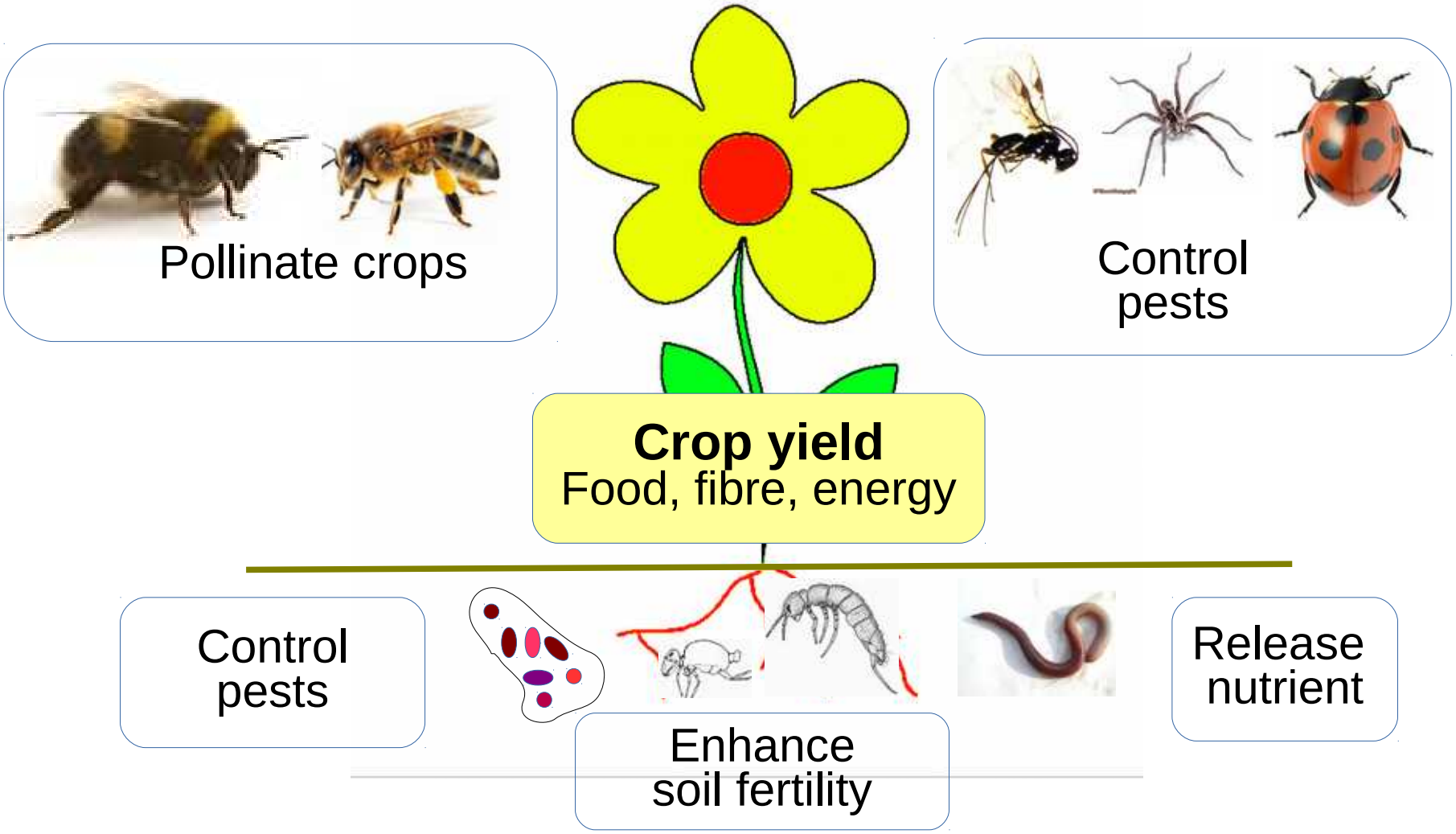
ABSTRACT Wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.), and maize (*Zea mays* L.) provide about two-thirds of all energy in human diets, and four major cropping systems in which these cereals are grown represent the foundation of human food supply. Yield per unit time and land has increased markedly during the past 30 years in these systems, a result of intensified crop management involving improved germ-



Cassman 1999 PNAS

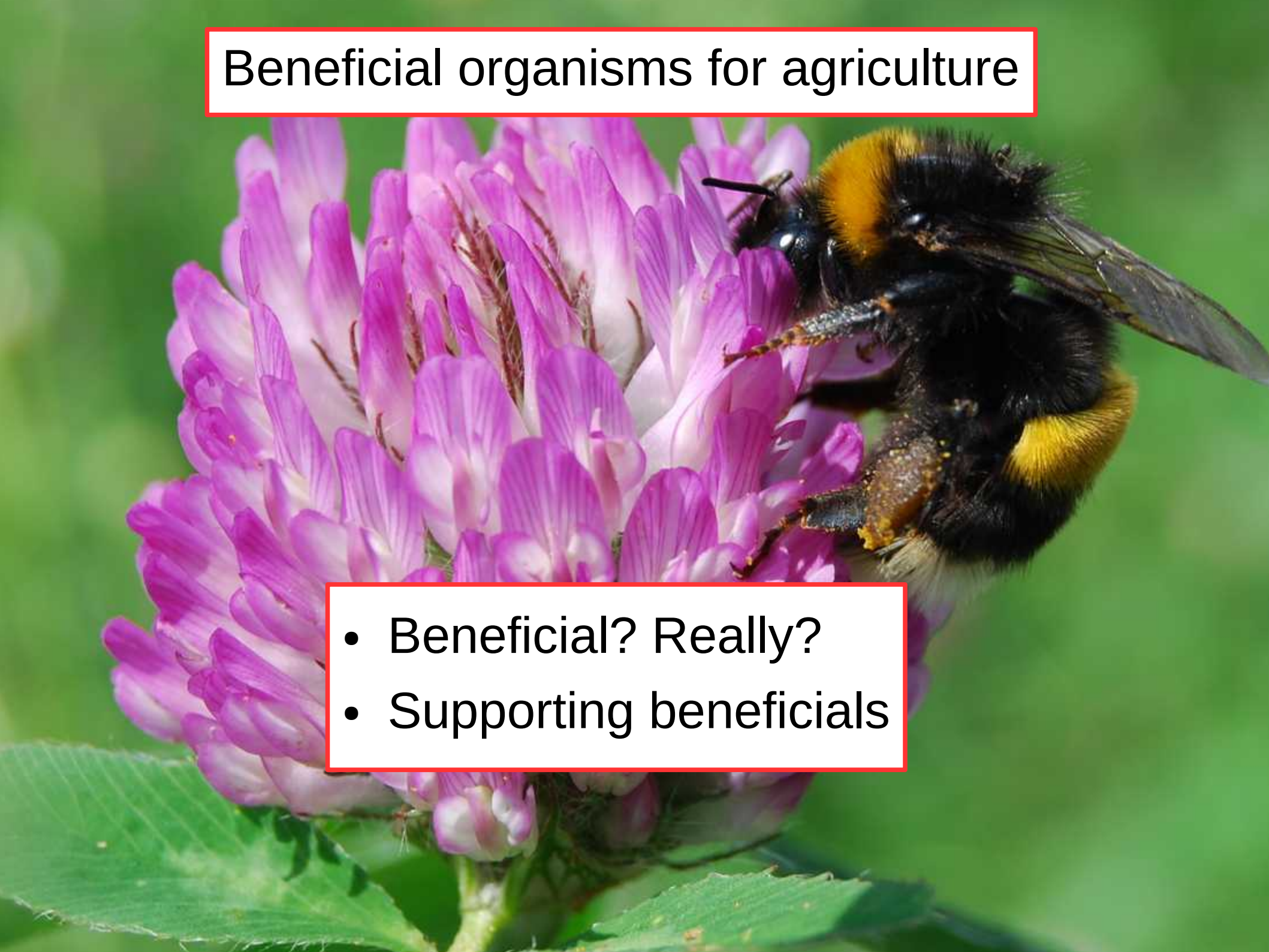
Ecological intensification concept

Adding boxes and opening them up



Bommarco, Potts, Kleijn 2013 Trends Ecol Evol
Bommarco, Vico, Hallin 2018 Glob Food Security

Beneficial organisms for agriculture

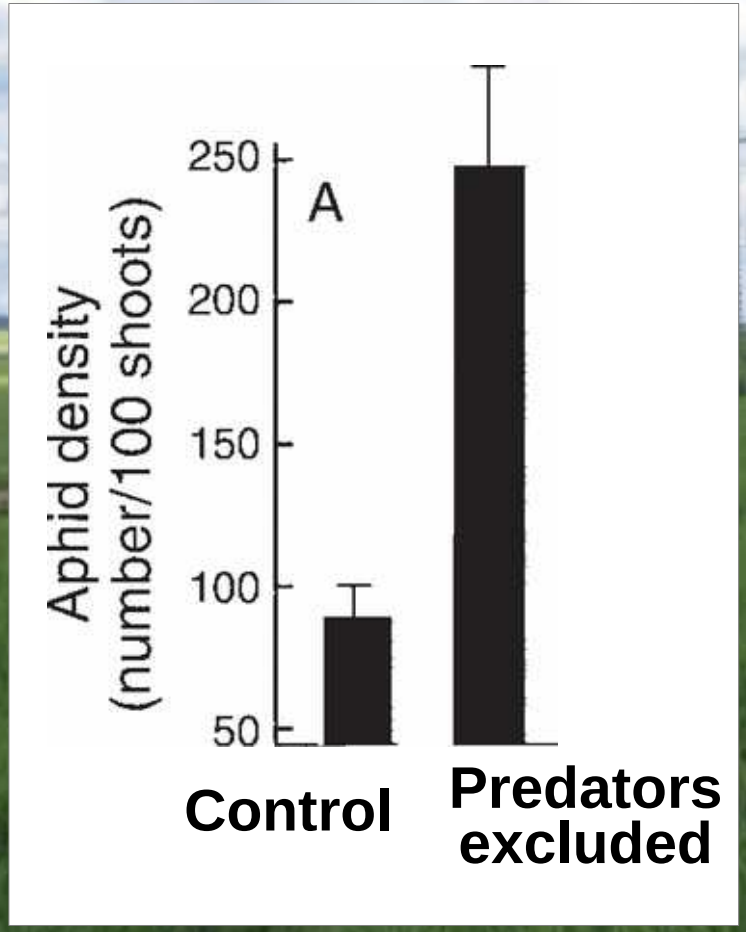


- Beneficial? Really?
- Supporting beneficials

Beneficial organisms for agriculture

- Beneficial? Really?
- Supporting beneficials

Cereal aphid pest control by natural enemies



5 European countries
8 conventional wheat fields per country

Thies et al 2011 Ecol Appl

Coccinella septempunctata © INRA, Bernard Chaubet

Tibor Bukovinszky, Wageningen University (Copyright 2008, BugsinthePicture.com)

Pollinators' contribution to yield

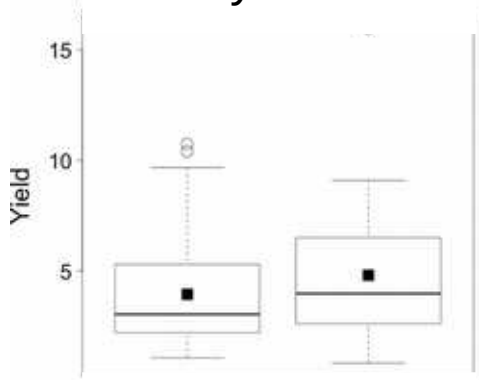
10 oilseed rape fields
Uppsala, Sweden

Bommarco et al. 2012
Oecologia

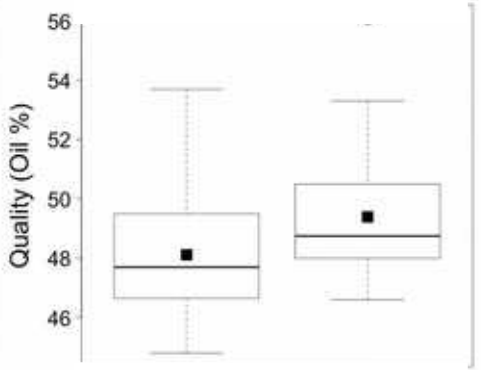
Pollinators' contribution to yield

Nacho Bartomeus

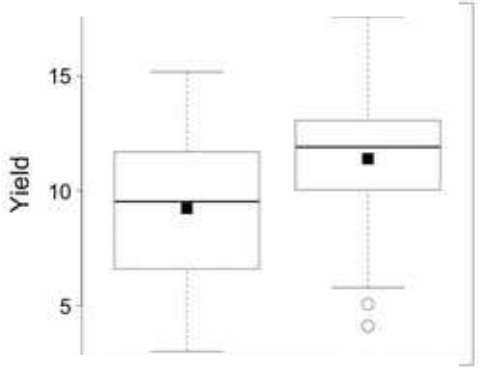
Oilseed rape yield



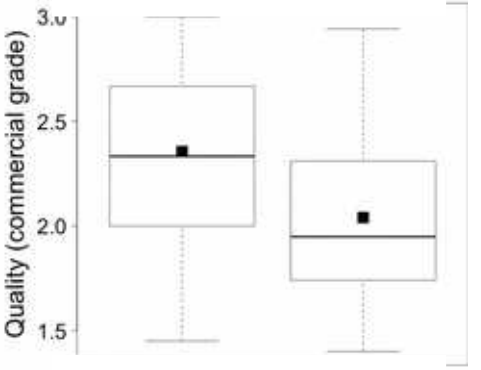
Oilseed rape quality



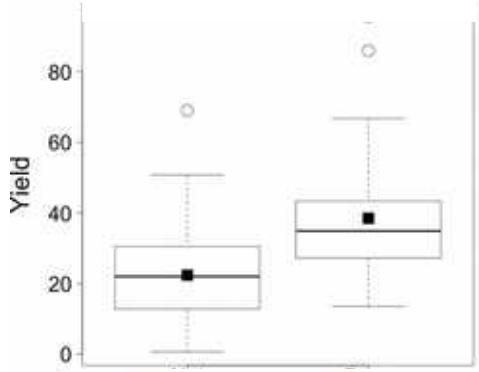
Strawberry yield



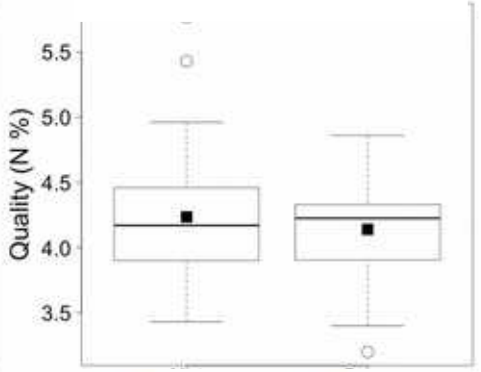
Strawberry quality



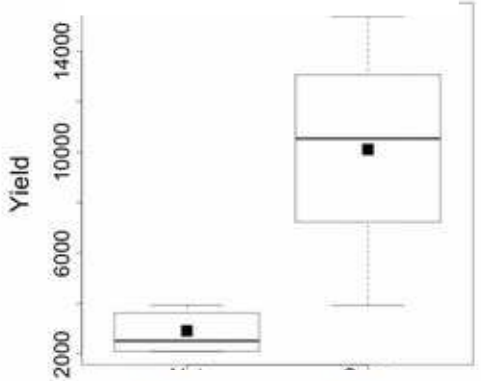
Field bean yield



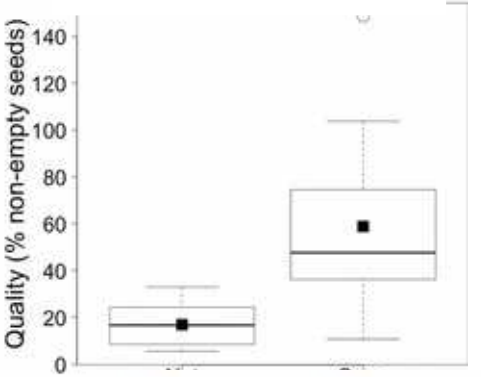
Field bean quality



Buckwheat yield



Buckwheat quality



Net Open

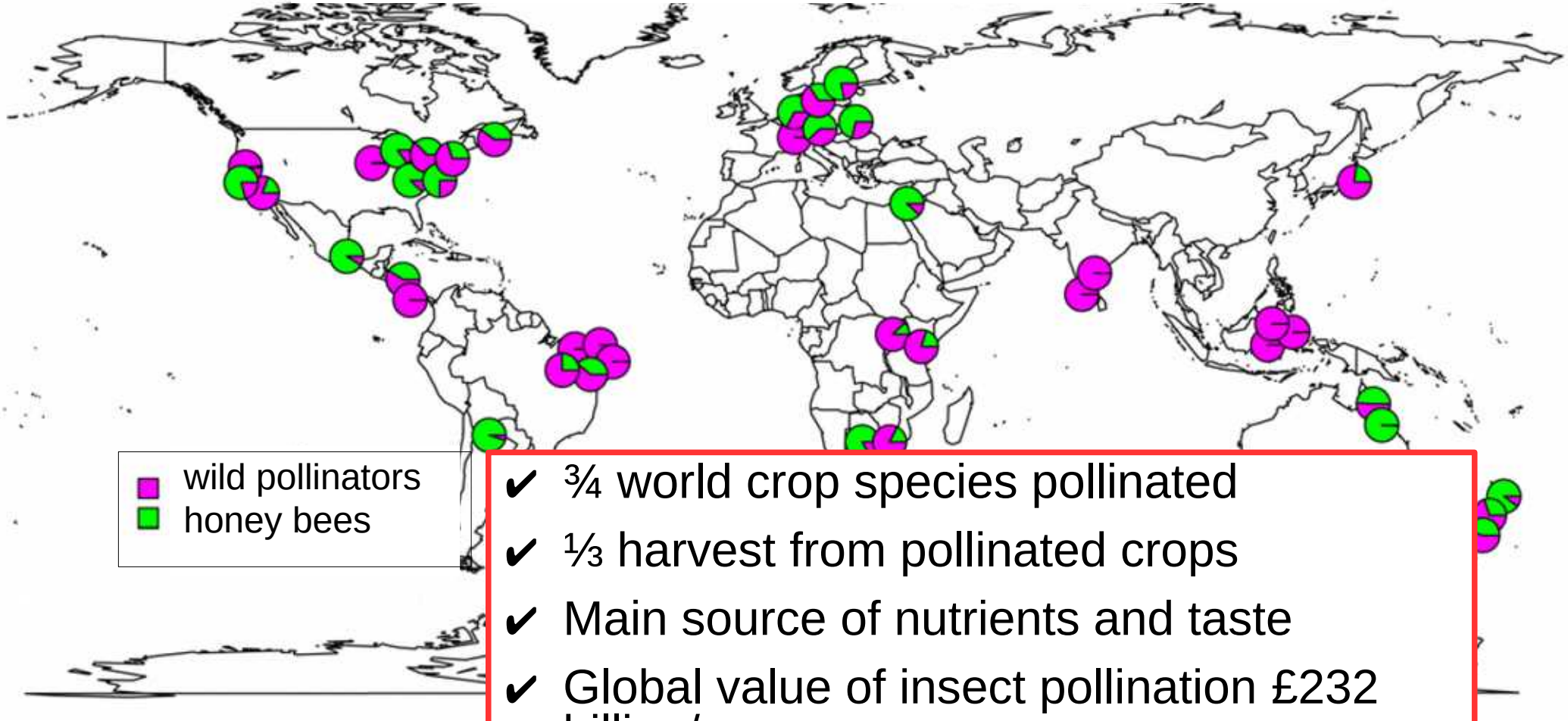
Net Open

Net Open

Net Open

Bartomeus et al 2014 PeerJ

Honey bees *and* wild insects pollinate our crops

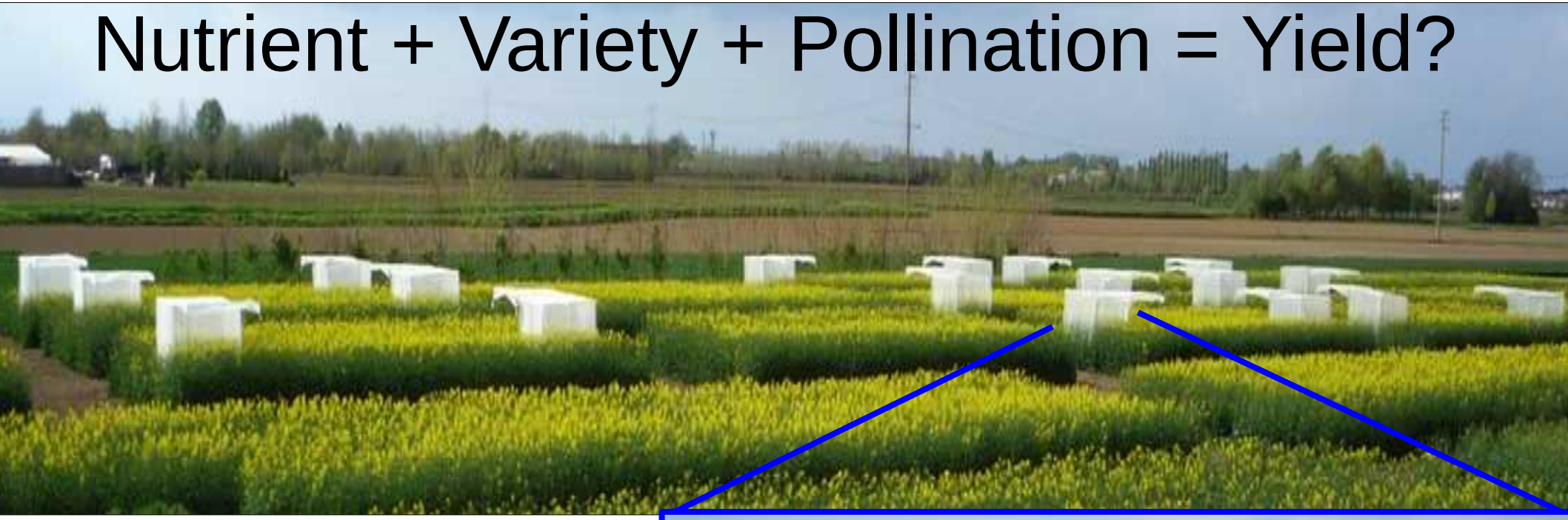


- ✔ ¾ world crop species pollinated
- ✔ ⅓ harvest from pollinated crops
- ✔ Main source of nutrients and taste
- ✔ Global value of insect pollination £232 billion/year

Garibaldi et al 2013 Science
Eilers et al 2011, Lautenbach et al 2012

Benefits are context dependent

Nutrient + Variety + Pollination = Yield?



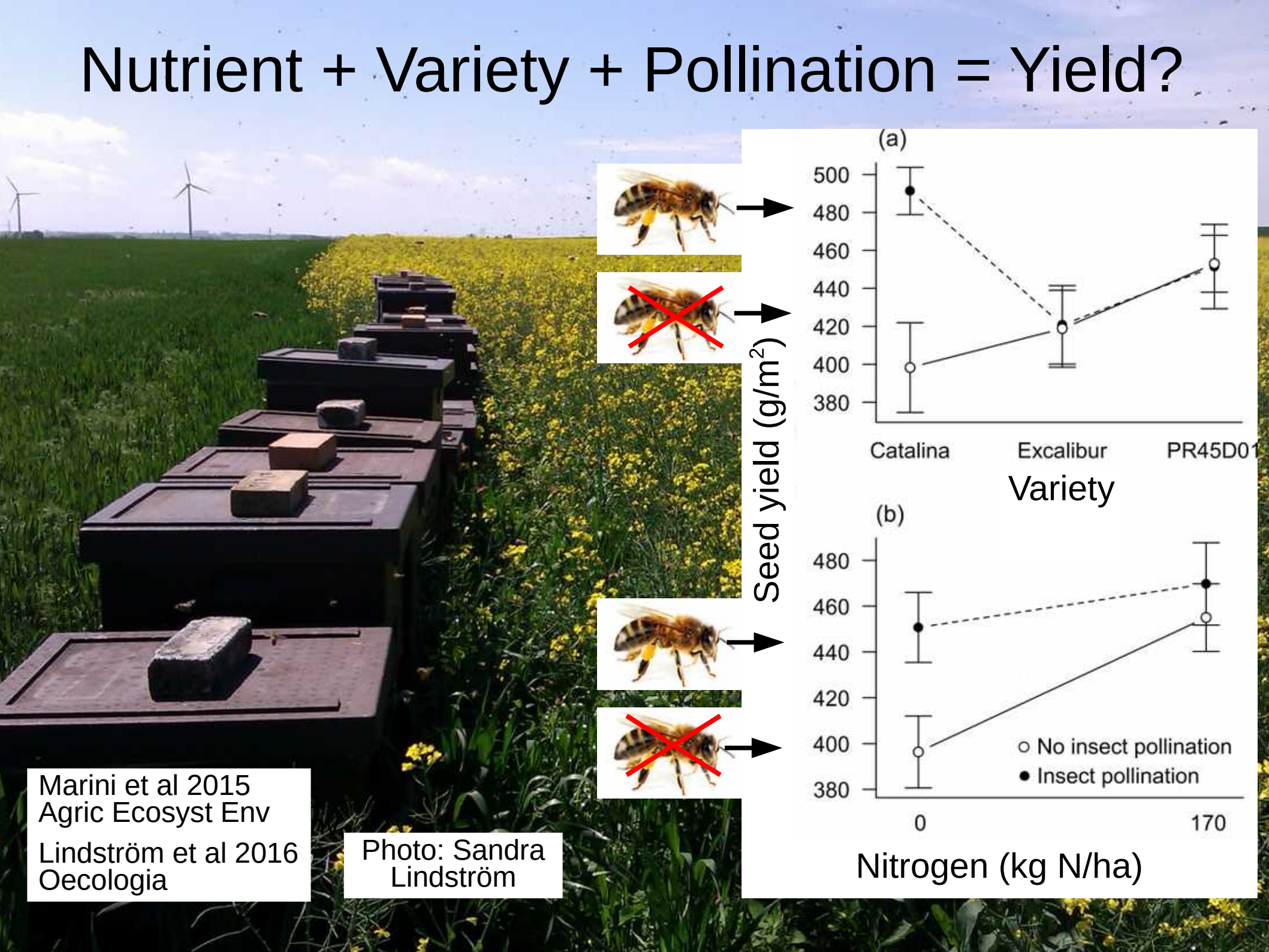
Sandra Lindström

Lindström et al 2016 Oecologia

Lorenzo Marini

Marini et al 2015 Agric Ecosyst Env

Nutrient + Variety + Pollination = Yield?



Marini et al 2015
Agric Ecosyst Env

Lindström et al 2016
Oecologia

Photo: Sandra Lindström

Context dependence of service benefits

POLLINATION

YIELD

ripening

PEST CONTROL

seed set %

flowers

SOIL SERVICES

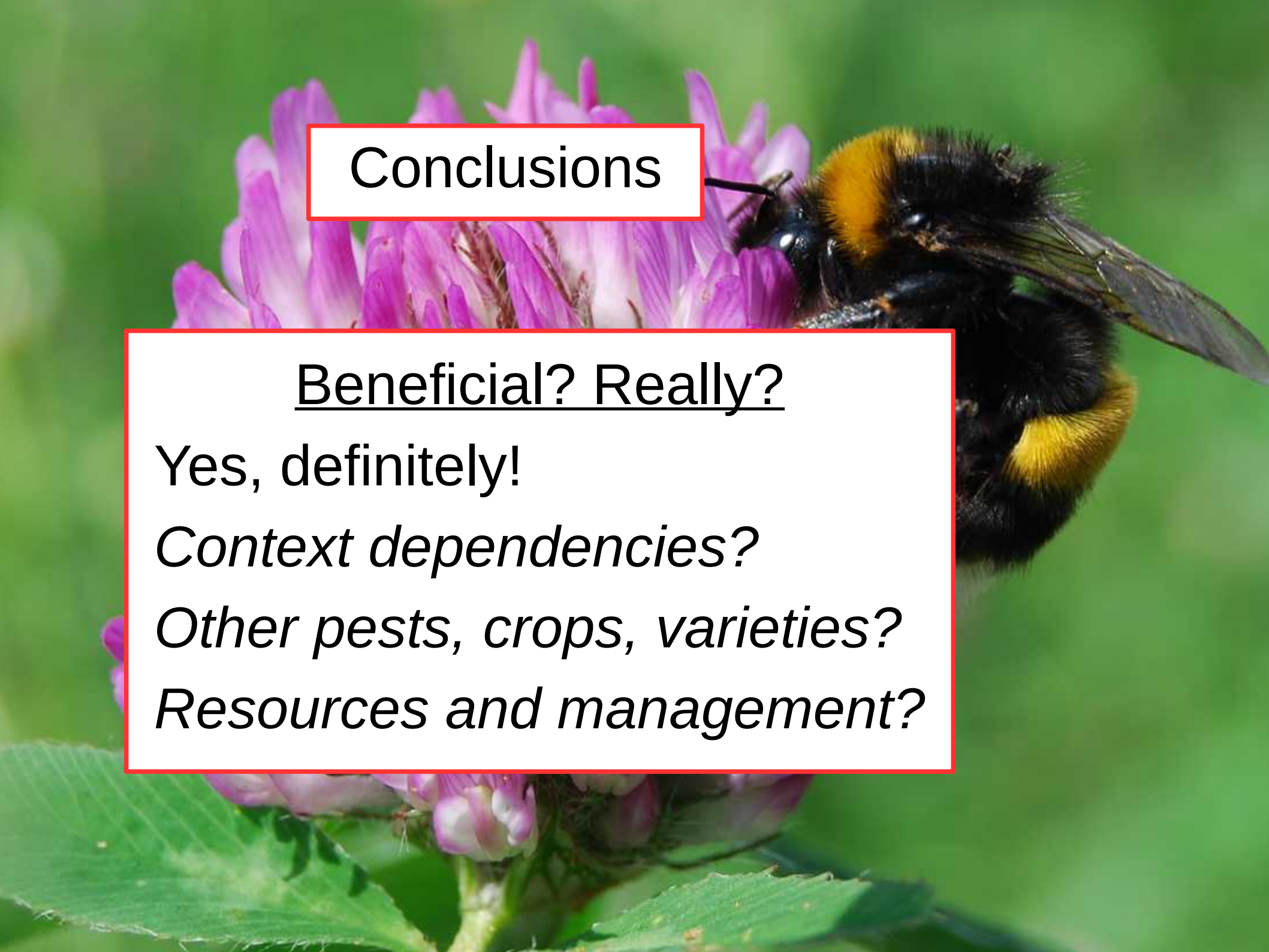
RESOURCE AVAILABILITY

(nutrients, water, C02)

CROP MANAGEMENT

(agrochemical inputs, crop rotation, genetic engeneering)

Tamburini et al submitted



Conclusions

Beneficial? Really?

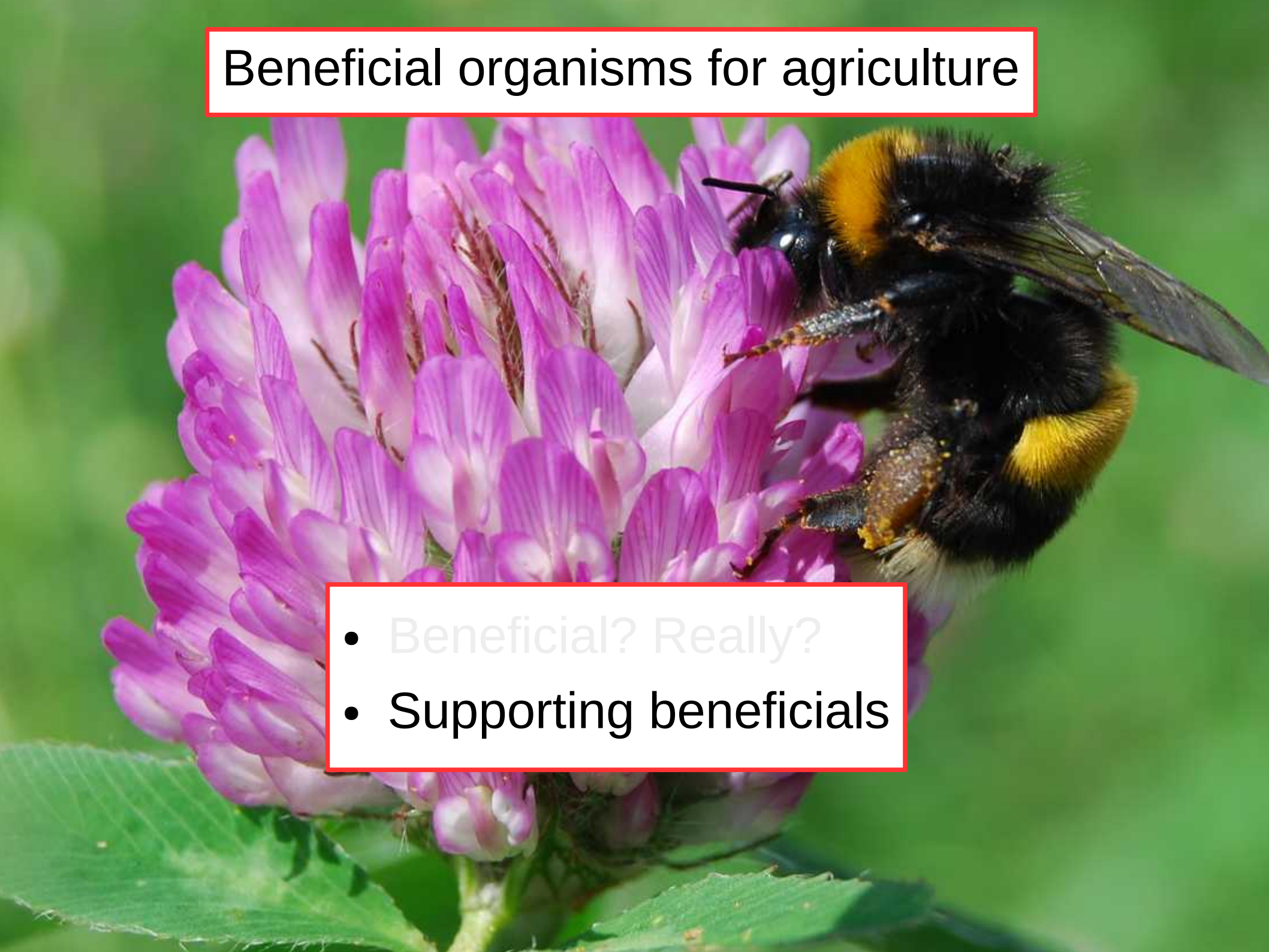
Yes, definitely!

Context dependencies?

Other pests, crops, varieties?

Resources and management?

Beneficial organisms for agriculture

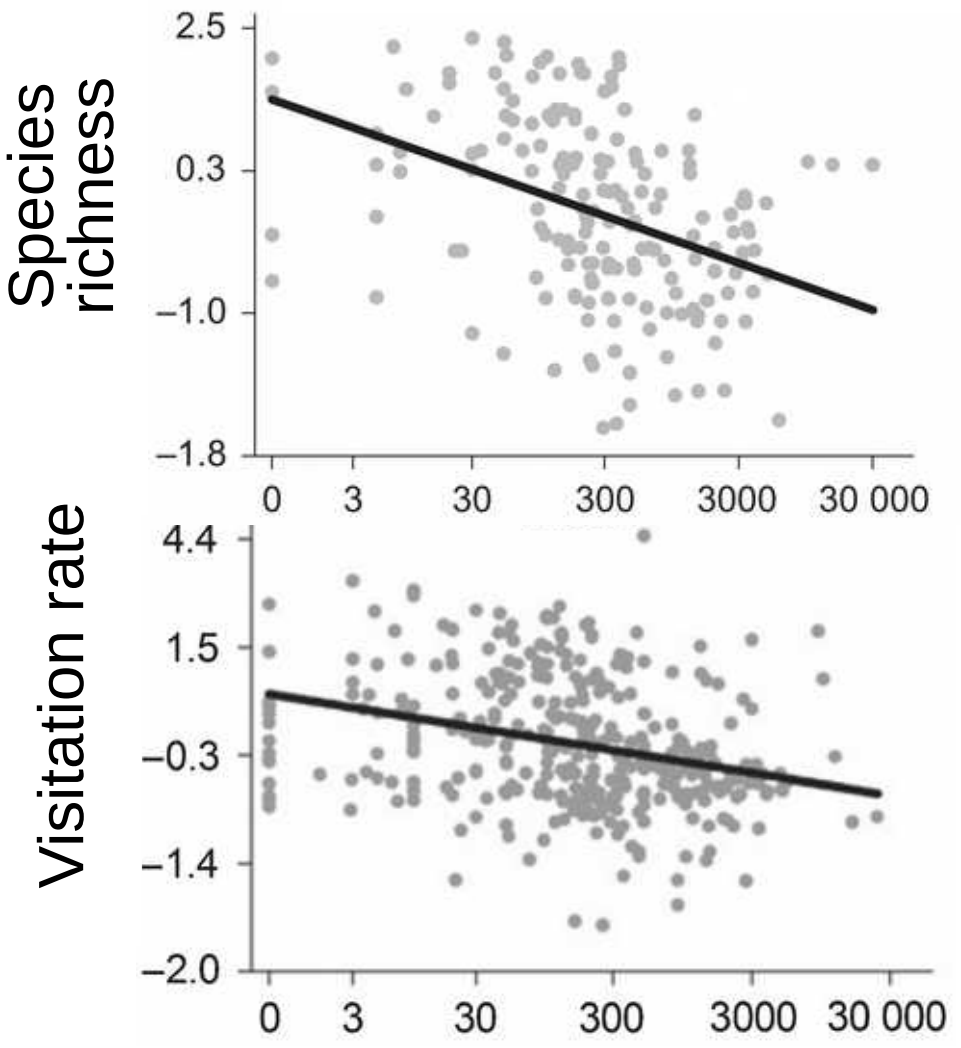


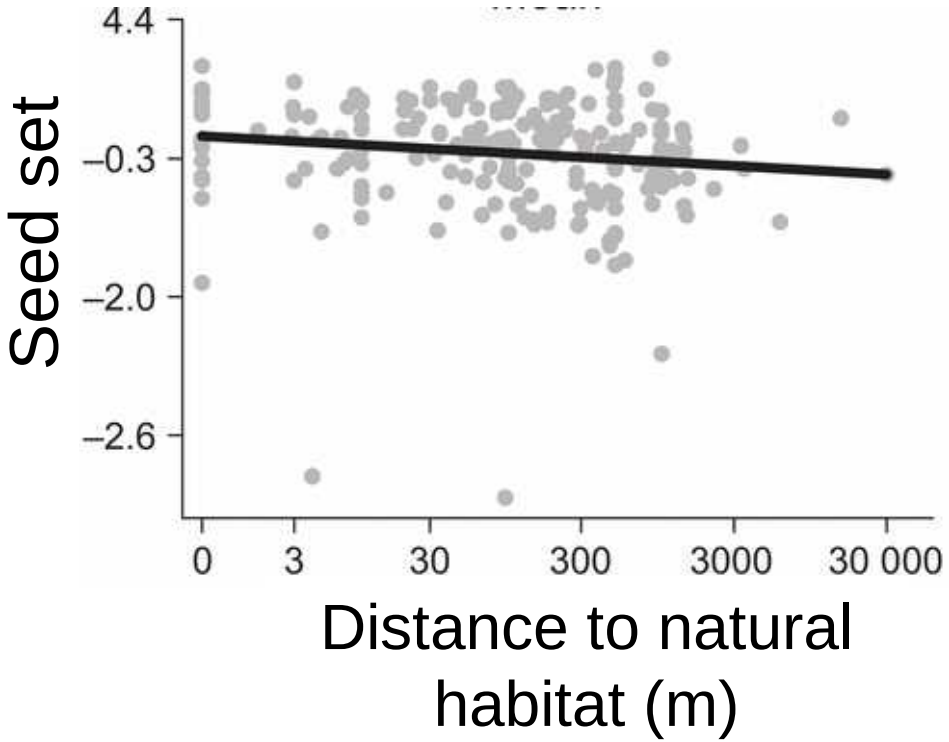
- Beneficial? Really?
- Supporting beneficials

Preserve natural habitat in the landscape

Photo: Diego Inclan

Global synthesis
Pollinators and farm landscapes

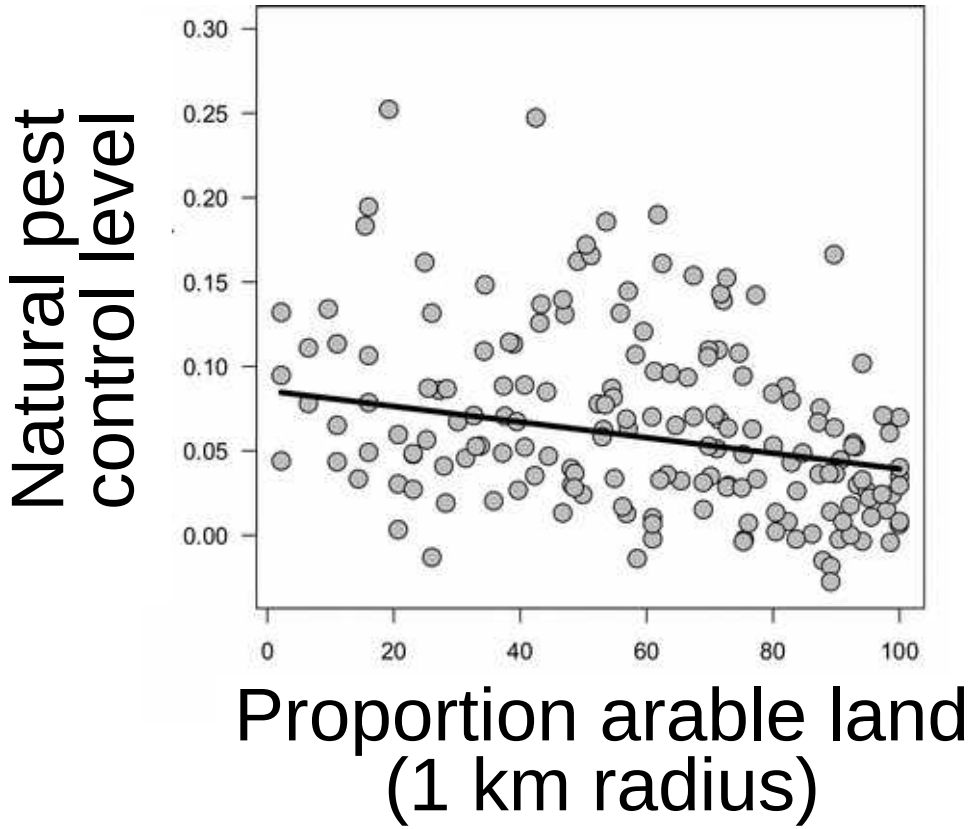




Global synthesis
primary data
29 studies

Garibaldi et al. 2011 Ecol Lett

Biological control of aphids in conventional wheat



5 countries 15 studies 175 fields in Europe and USA

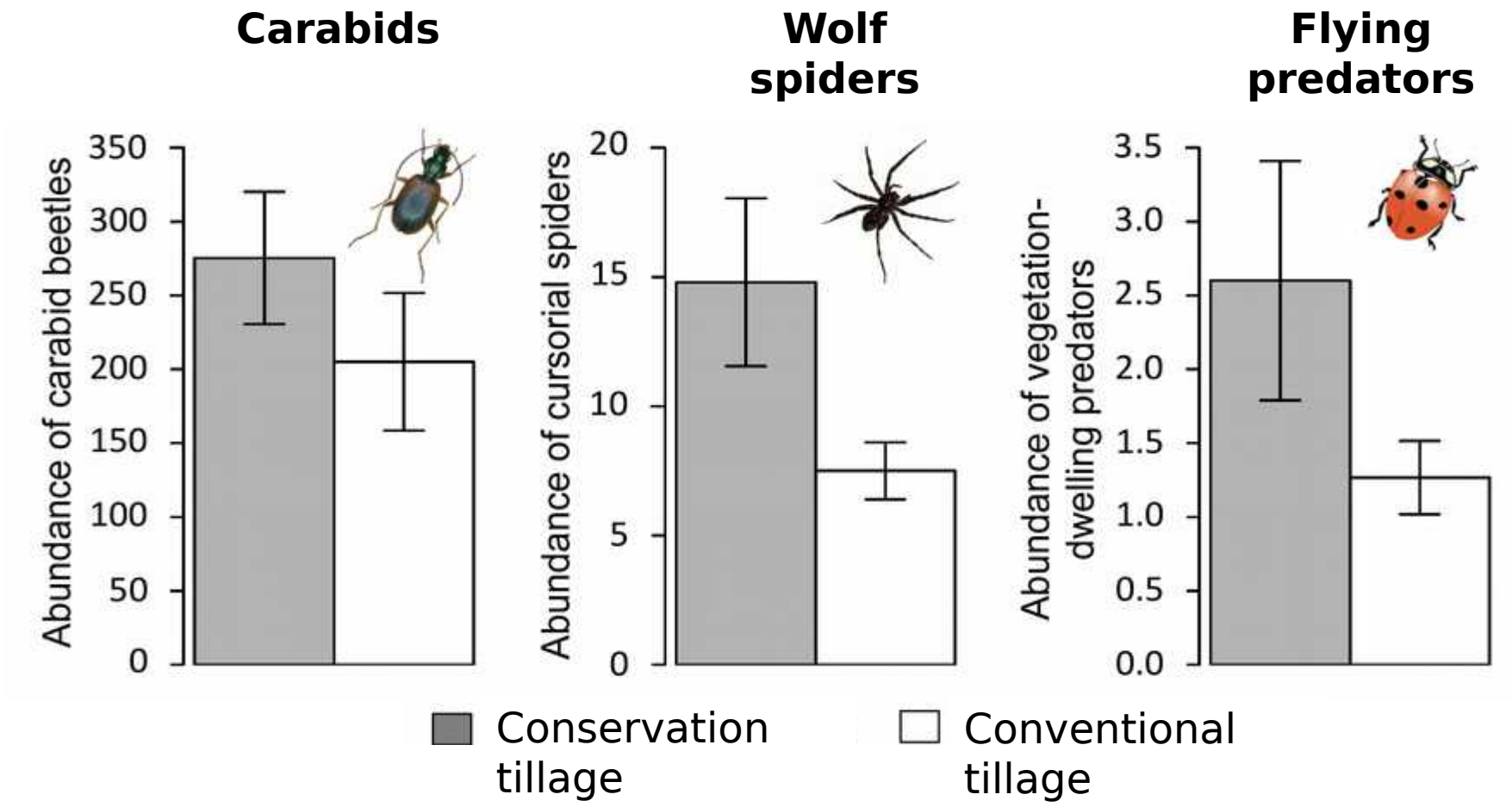
Rusch et al 2016 Agric Ecosyst Env

In-field management

- Set-aside
- Tillage
- Fertilizing
- Crop diversity
- ...etc

Rundlöf et al 2018 Ecol Evol

Soil fertility enhances predators and pest control

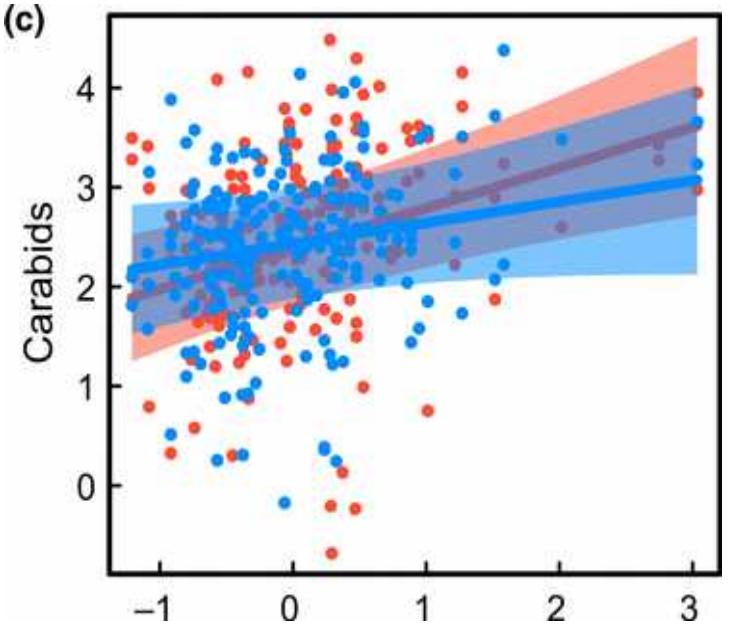


Tamburini et al 2015 J Appl Ecol
see also
Gagic et al 2017 Ecology letters
Riggi & Bommarco submitted

15 pairs of fields in NE Italy

Soil carbon and pest control

Carabid beetles



Soil organic carbon

With mineral fertiliser

No mineral fertiliser

7 European countries
114 fields with contrasting
Soil organic carbon

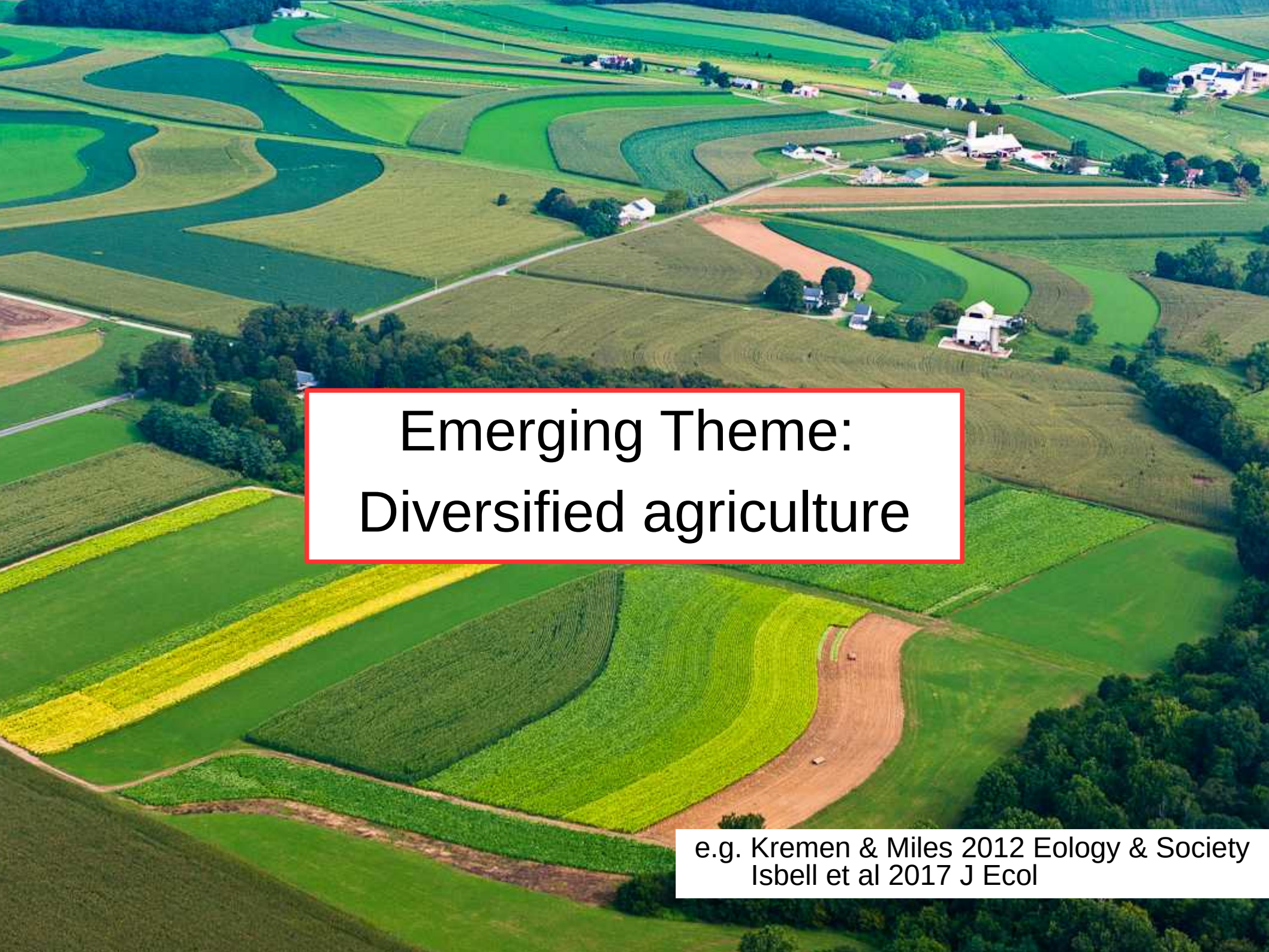
Vesna Gagic

Gagic et al 2017 Ecol Lett

Use other perennial habitats?

Erik Öckinger

Gardiner et al 2018
Frontiers Ecol Env



Emerging Theme: Diversified agriculture

e.g. Kremen & Miles 2012 Eology & Society
Isbell et al 2017 J Ecol

The ecological intensification concept is gaining ground

<u>Shows promise to:</u>

- Replace inputs
- Reduce pressure on environment
- Likely to spread risks
- Without compromising yield
- Agronomy + Ecology = True

<u>Knowledge gaps:</u>

- Management-biodiversity-services
- Stabilization of yield
- Diversification combinations
- Multiple services
- Technology needs

Thanks for listening!

www.slu.se/bommarco-lab
twitter: @BommarcoLab

SLU
Swedish University of Agricultural Sciences

SEVENTH FRAMEWORK PROGRAMME

biodiversa

Jordbruks verket

formas
Forskningsrådet Formas
Formas främjar framstående forskning för hållbar utveckling

Stiftelsen Lantbruksforskning

FACCEJPI
Agriculture, Food Security and Climate Change