

# Towards agroecological landscapes and food systems

Budapest, 19 September 2019

Pablo Tittone

Grupo Interdisciplinario de Agroecología, Ambiente y Sistemas de Producción  
IFAB (INTA-CONICET) - EEA Bariloche, Argentina



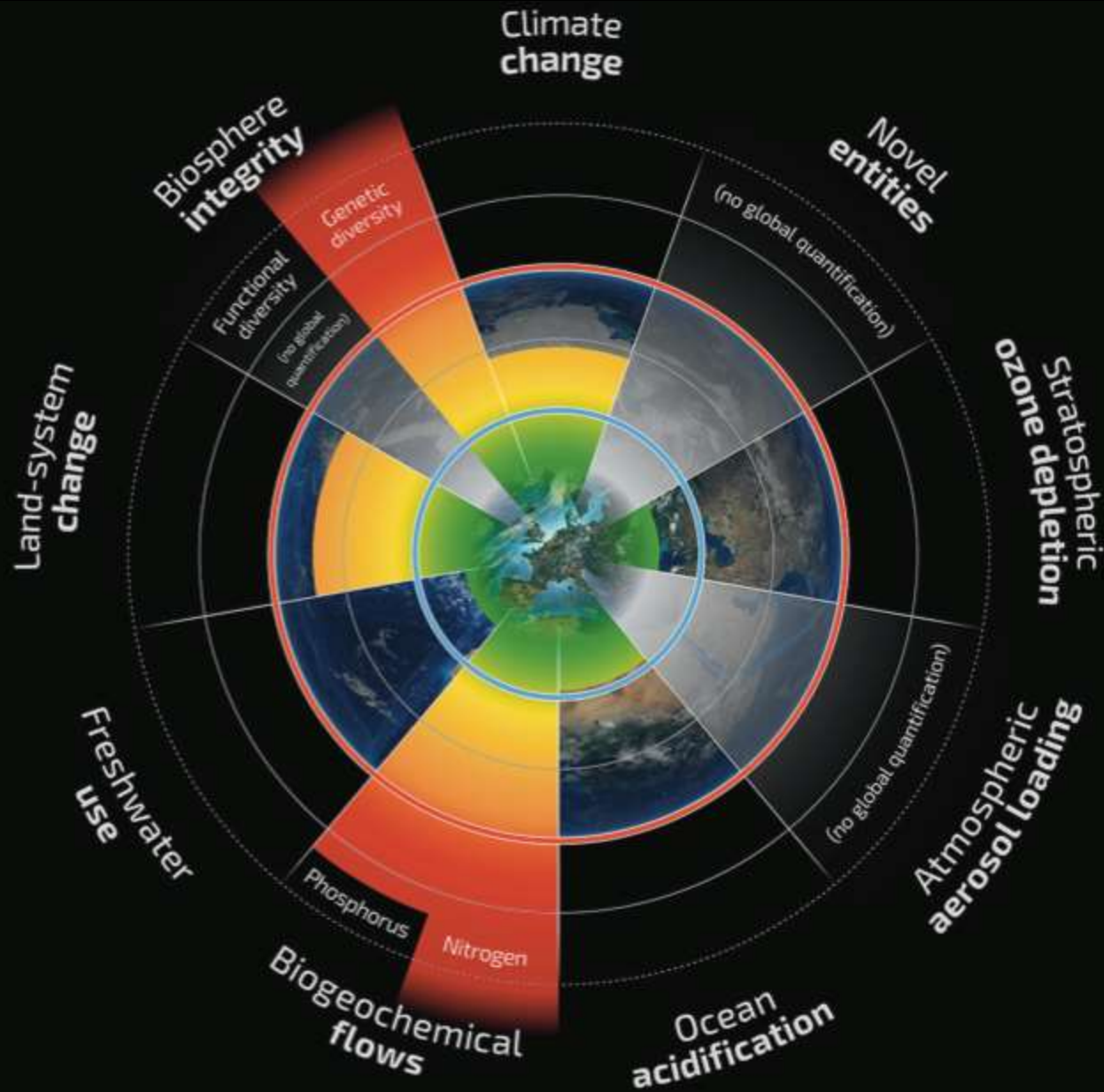




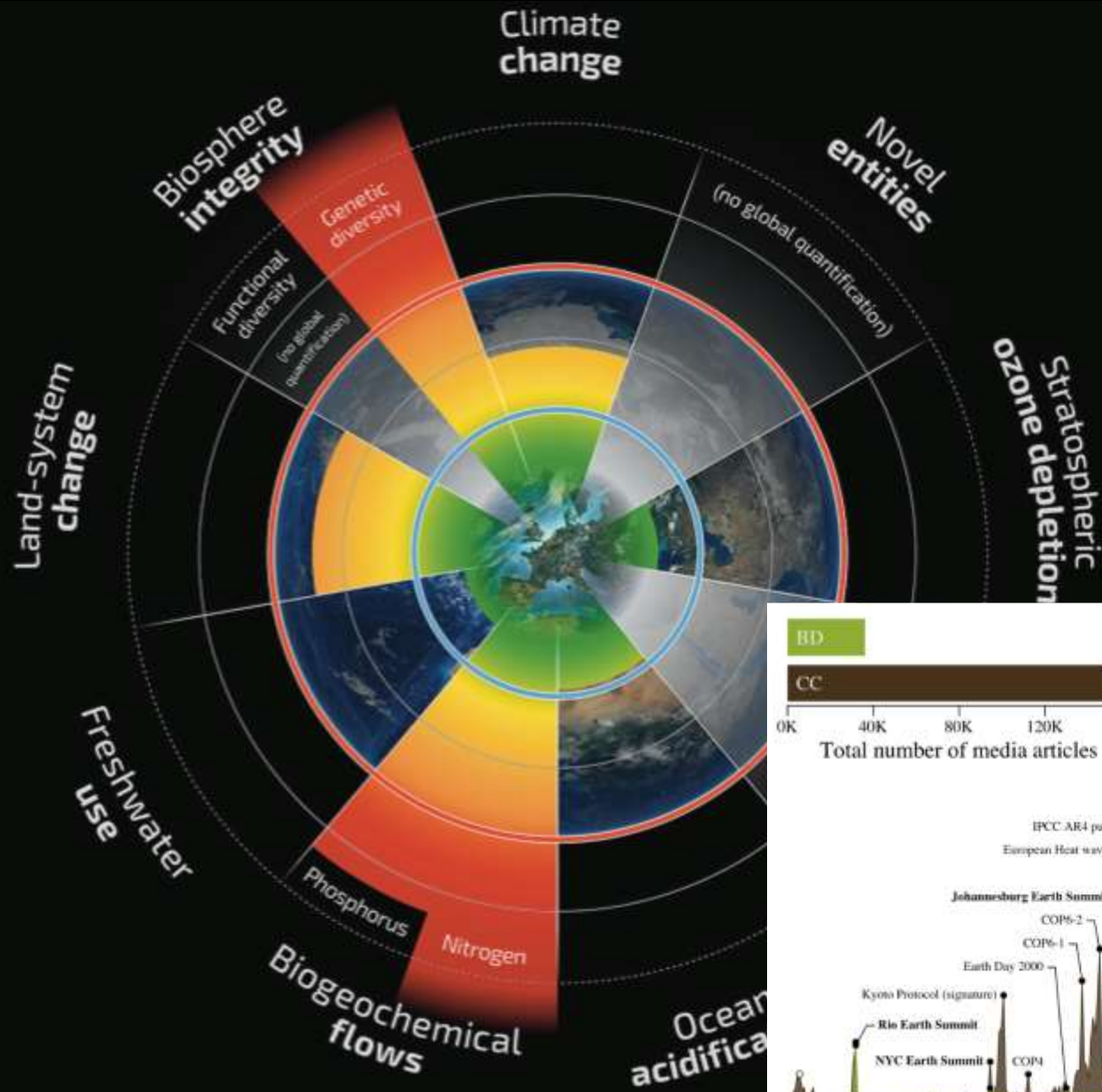




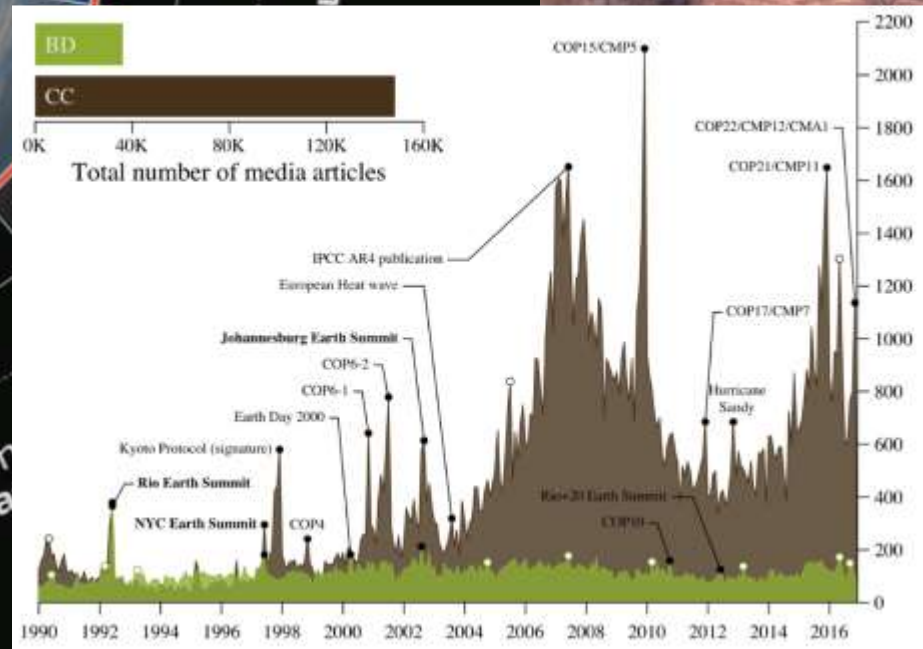
# The planetary boundaries



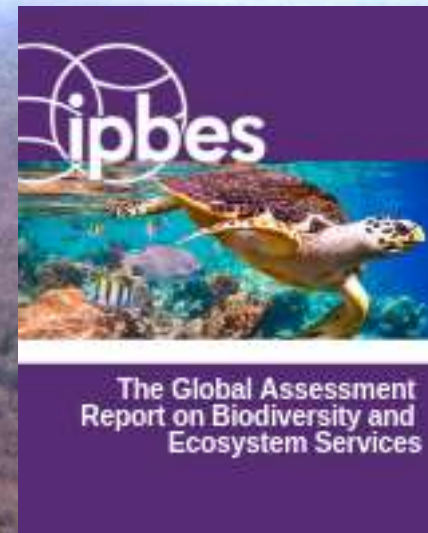
# The planetary boundaries



(Legagneux et al. 2018)









1) Changes in land and sea use



2) Direct exploitation of organisms



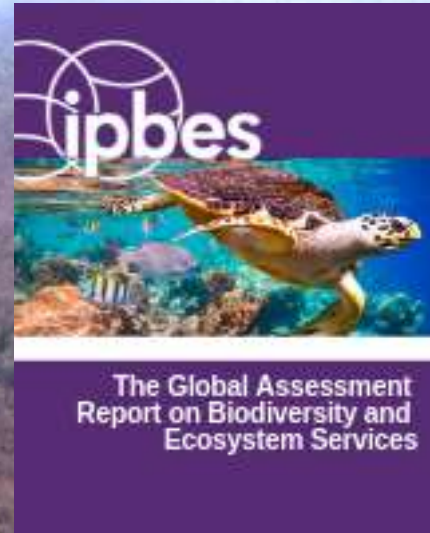
3) Climate change



4) Pollution



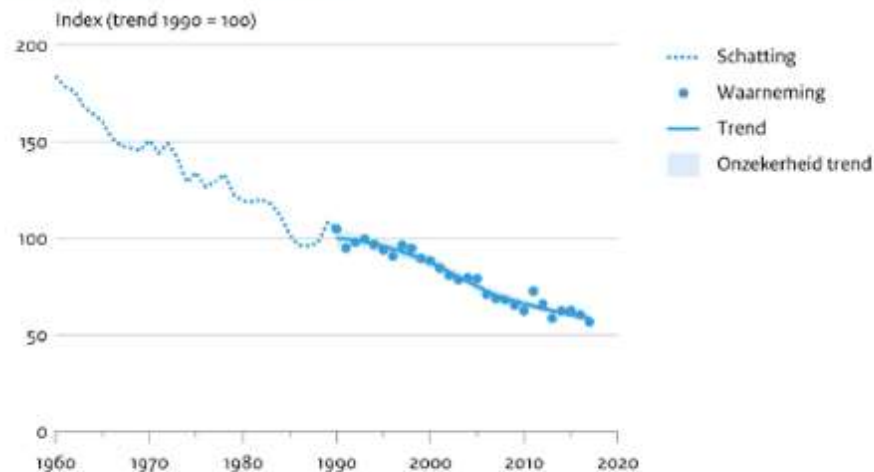
5) Invasive alien species



# Decrease of biodiversity on farmland

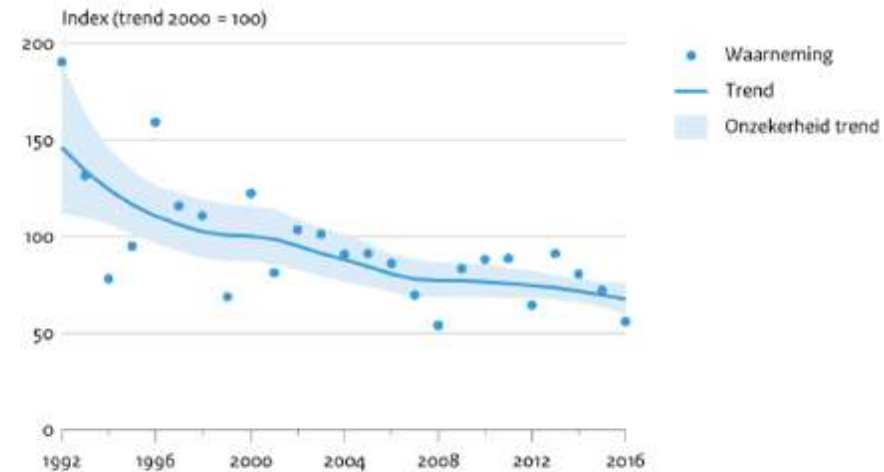


Boerenlandvogels in Nederland



Bron: NEM (Sovon, CBS)

Dagvlinders in grasland



Bron: NEM (Vlinderstichting, CBS)

CBS/sep18  
[www.clo.nl/nh47910](http://www.clo.nl/nh47910)

[www.clo.nl](http://www.clo.nl)



# Decrease of biodiversity on farmland

Support The Guardian

Subscribe Find a job Sign in Search

International edition

News Opinion Sport Culture Lifestyle More

# The Guardian

Environment Climate change Wildlife Energy Pollution

## Birds

## Europe faces 'biodiversity oblivion' after collapse in French birds, experts warn

Authors of report on bird declines say intensive farming and pesticides could turn Europe's farmland into a desert that ultimately imperils all humans



▲ A red-legged partridge in Burgundy. Eight in 10 partridges have disappeared from France in 23 years, a study

Patrick Barkham

@patrick\_barkham

Wed 21 Mar 2018 15.31 GMT



This article is over 2 months old

### most viewed



**Live** Golden State Warriors 101-92 Houston Rockets: NBA Western Conference finals Game 7 - as it happened



'Spider-Man' of Paris to get French citizenship after child rescue



Rockets blow big lead again as Warriors set up Cavaliers NBA finals rematch



Roman Abramovich granted Israeli citizenship

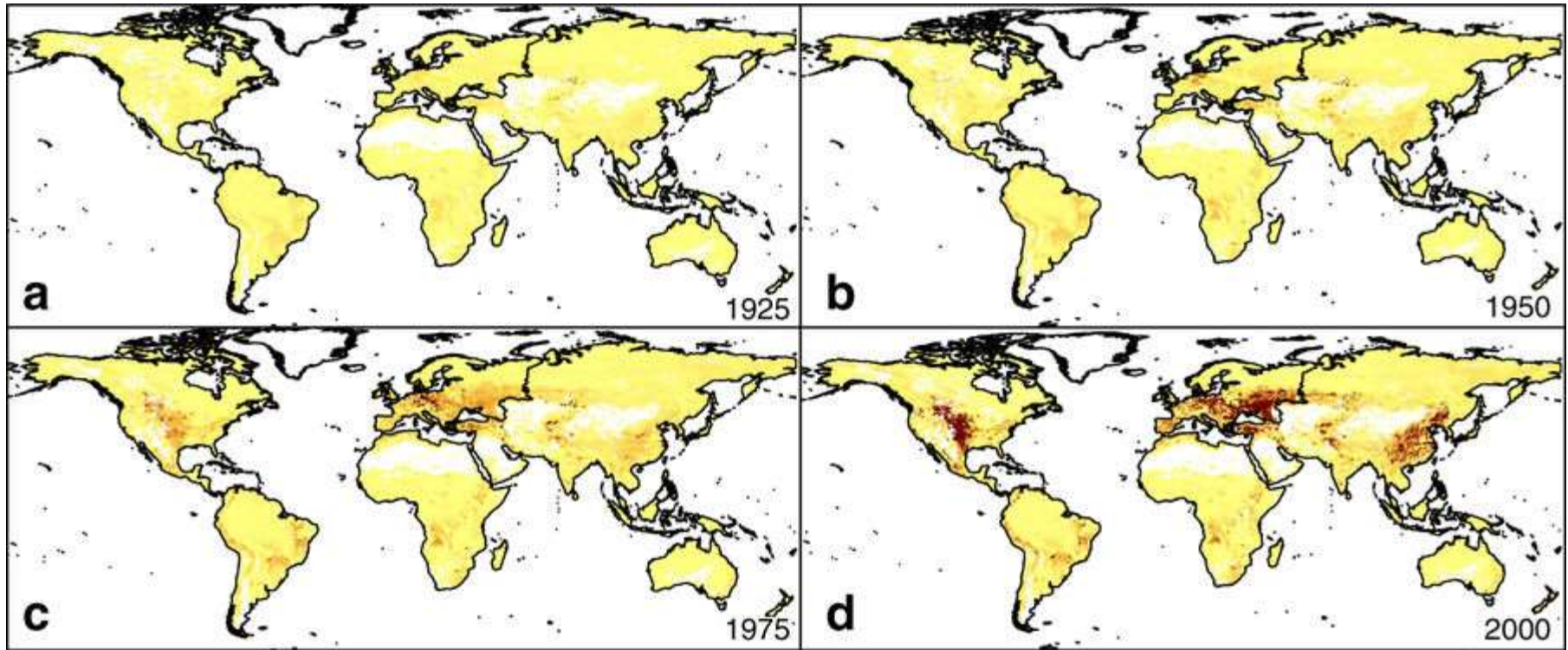


US flight instructors kidnapped and tried to deport trainee to China, say police

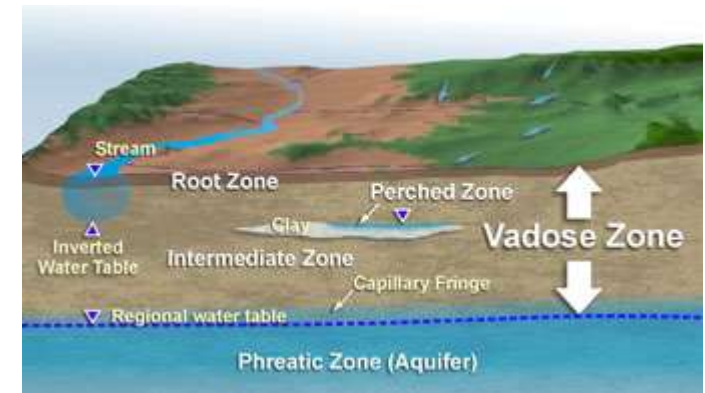
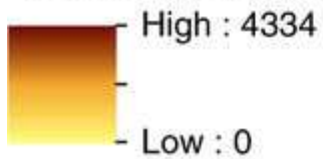


# Pollution with excess nutrients

## Vadose zone N storage



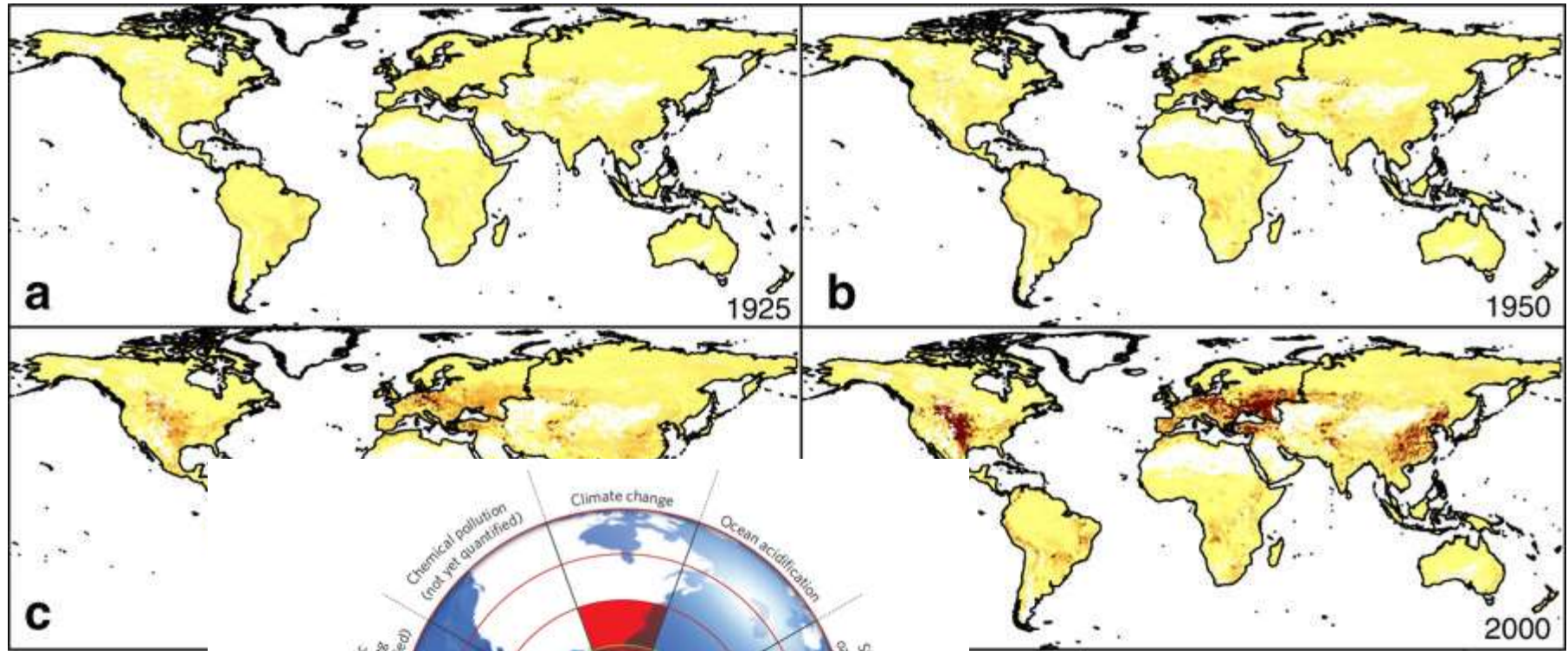
Vadose zone N storage ( $\text{kg N ha}^{-1}$ )



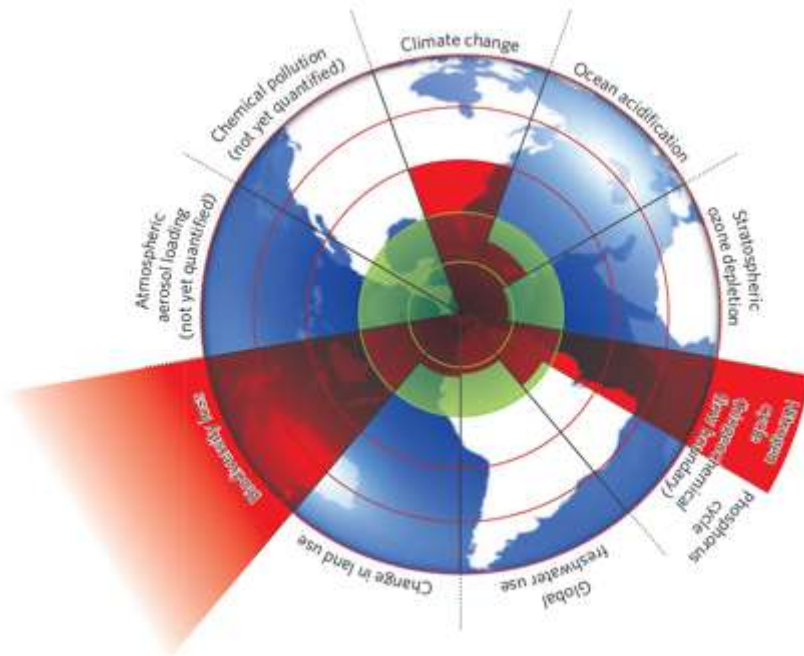


# Pollution with excess nutrients

## Vadose zone N storage



Vadose zone N  
High :  
Low :





# Herbicide-resistant weeds

Replace more-toxic herbicides  
Reduce total amount of herbicide use  
Simplify and improve weed management  
Unlikely weeds would develop resistance



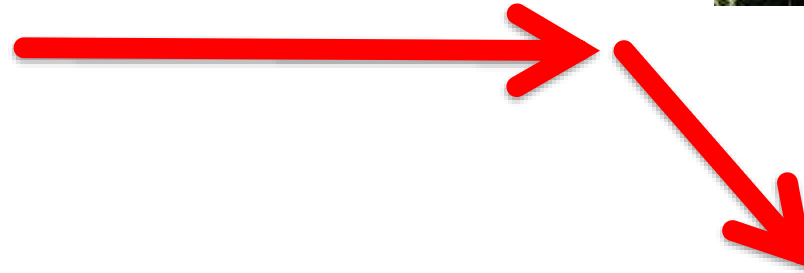
Dave Mortensen

Ecology Inter College Graduate Degree Program and  
Department of Plant Sciences, Pennsylvania State University, [dmortensen@psu.edu](mailto:dmortensen@psu.edu)



# Herbicide-resistant weeds

Replace more-toxic herbicides  
Reduce total amount of herbicide use  
Simplify and improve weed management  
Unlikely weeds would develop resistance



Herbicide use increases  
and resistance is widespread



Dave Mortensen

# Herbicide-resistant weeds

Replace more-toxic herbicides  
Reduce total amount of herbicide use  
Simplify and improve weed management  
Unlikely weeds would develop resistance



Herbicide use increases  
and resistance is widespread

Return to older, more problematic herbicides  
Stacked traits and new recommendations will increase total herbicide use  
Facilitates resistance by increasing selection pressure



Dave Mortensen



# Herbicide-resistant weeds

Replace more-toxic herbicides  
Reduce total amount of herbicide use  
Simplify and improve weed management  
Unlikely weeds would develop resistance



Moving forward

- or -

Herbicide use increases  
and resistance is widespread



backward?

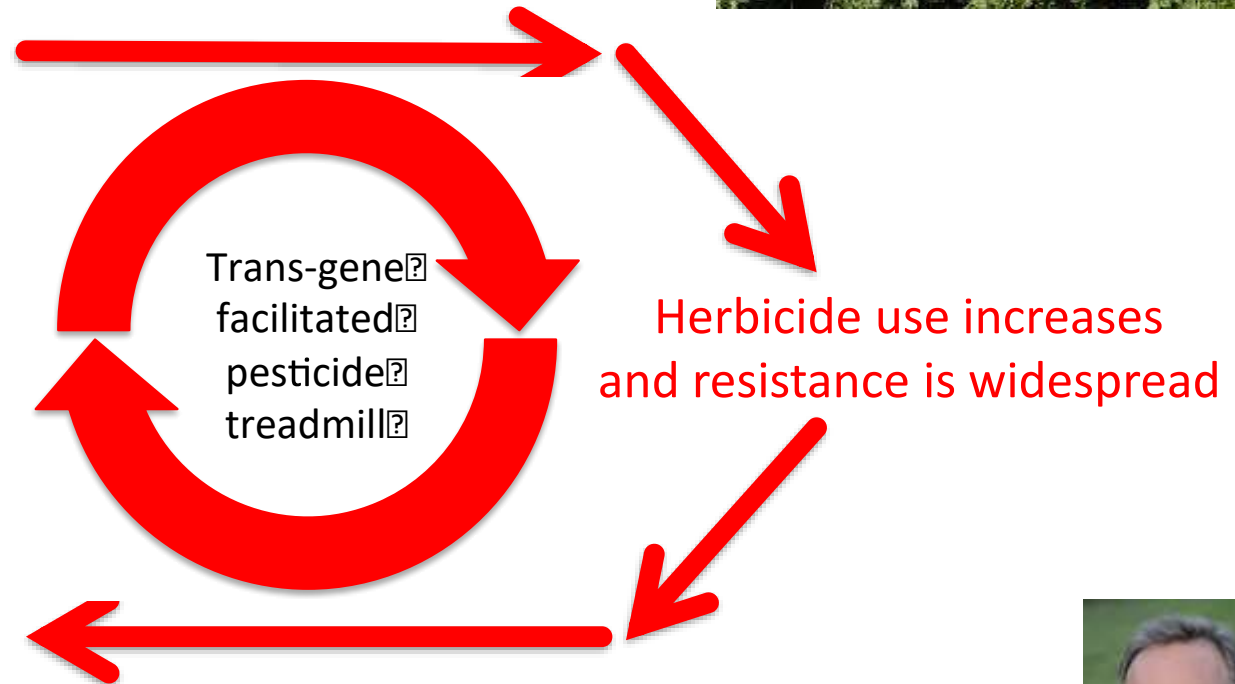
Return to older, more problematic herbicides  
Stacked traits and new recommendations will increase total herbicide use  
Facilitates resistance by increasing selection pressure



Dave Mortensen

# Herbicide-resistant weeds

Replace more-toxic herbicides  
Reduce total amount of herbicide use  
Simplify and improve weed management  
Unlikely weeds would develop resistance



Return to older, more problematic herbicides  
Stacked traits and new recommendations will increase total herbicide use  
Facilitates resistance by increasing selection pressure

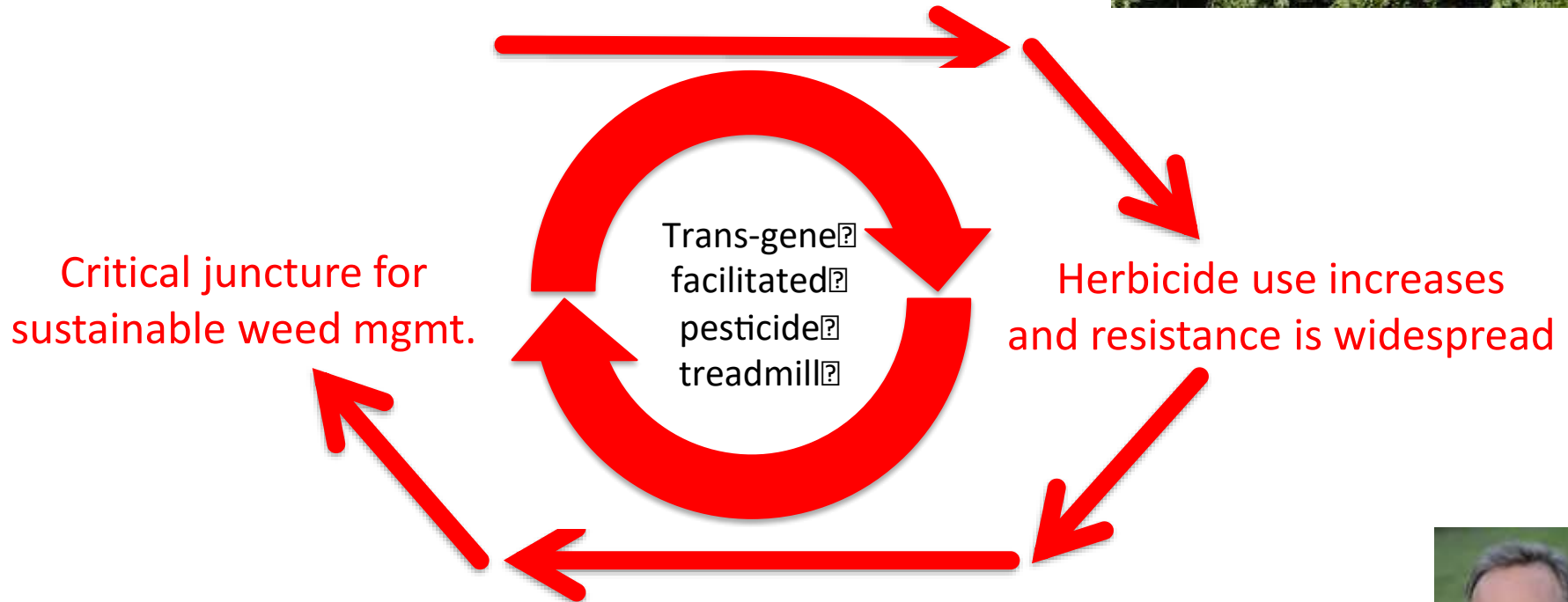


Dave Mortensen



# Herbicide-resistant weeds

Replace more-toxic herbicides  
Reduce total amount of herbicide use  
Simplify and improve weed management  
Unlikely weeds would develop resistance



Return to older, more problematic herbicides  
Stacked traits and new recommendations will increase total herbicide use  
Facilitates resistance by increasing selection pressure



Dave Mortensen

# Herbicide-resistant weeds



Integrated  
weed  
management

Replace more-toxic herbicides  
Reduce total amount of herbicide use  
Simplify and improve weed management  
Unlikely weeds would develop resistance

Critical juncture for  
sustainable weed mgmt.

Herbicide use increases  
and resistance is widespread

Return to older, more problematic herbicides  
Stacked traits and new recommendations will increase total herbicide use  
Facilitates resistance by increasing selection pressure

Trans-gene?  
facilitated?  
pesticide?  
treadmill?

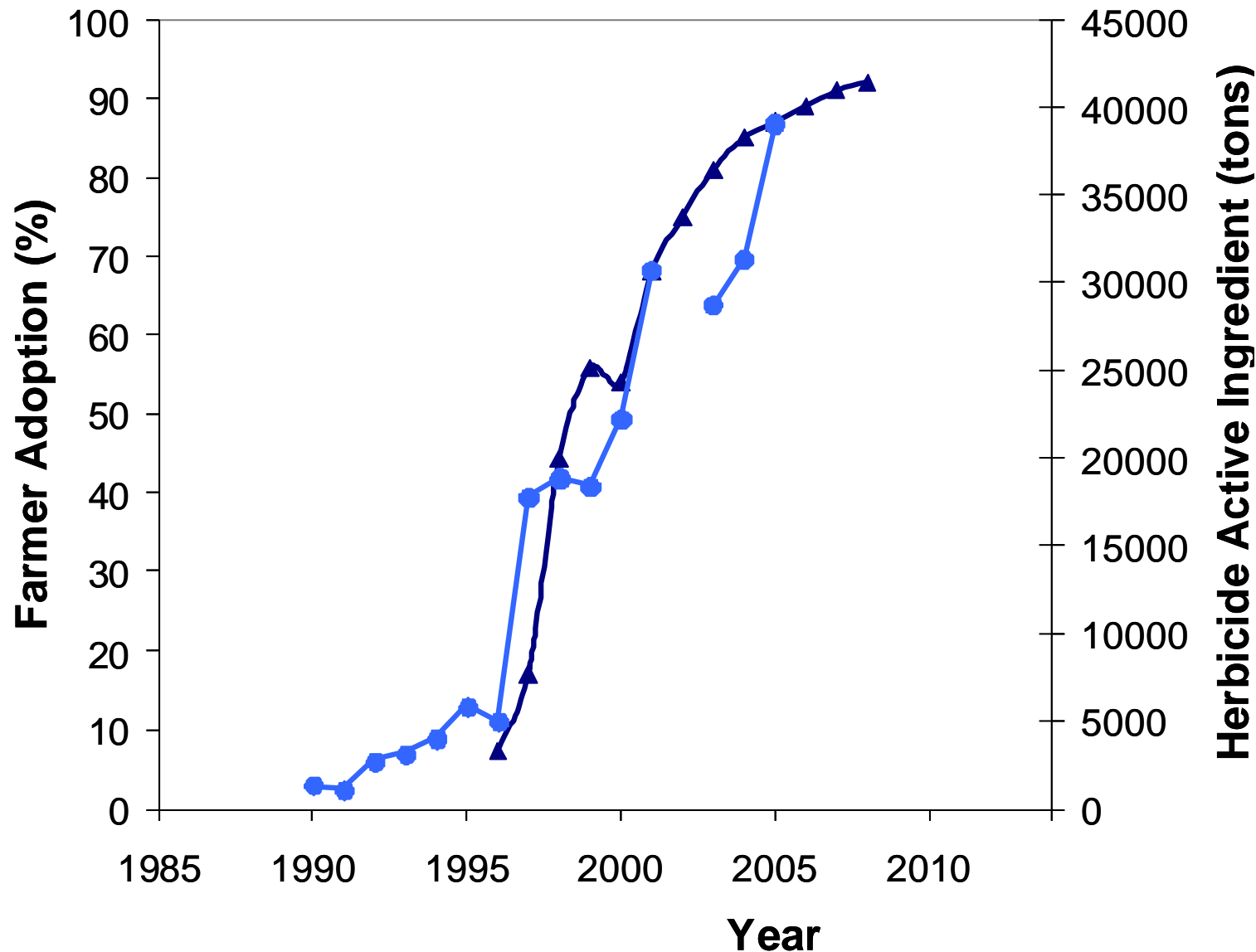


Dave Mortensen



# Herbicide-resistant weeds

- ▲ Glyphosate Resistant Soybean Adoption
- Glyphosate Usage



increases  
widespread

use

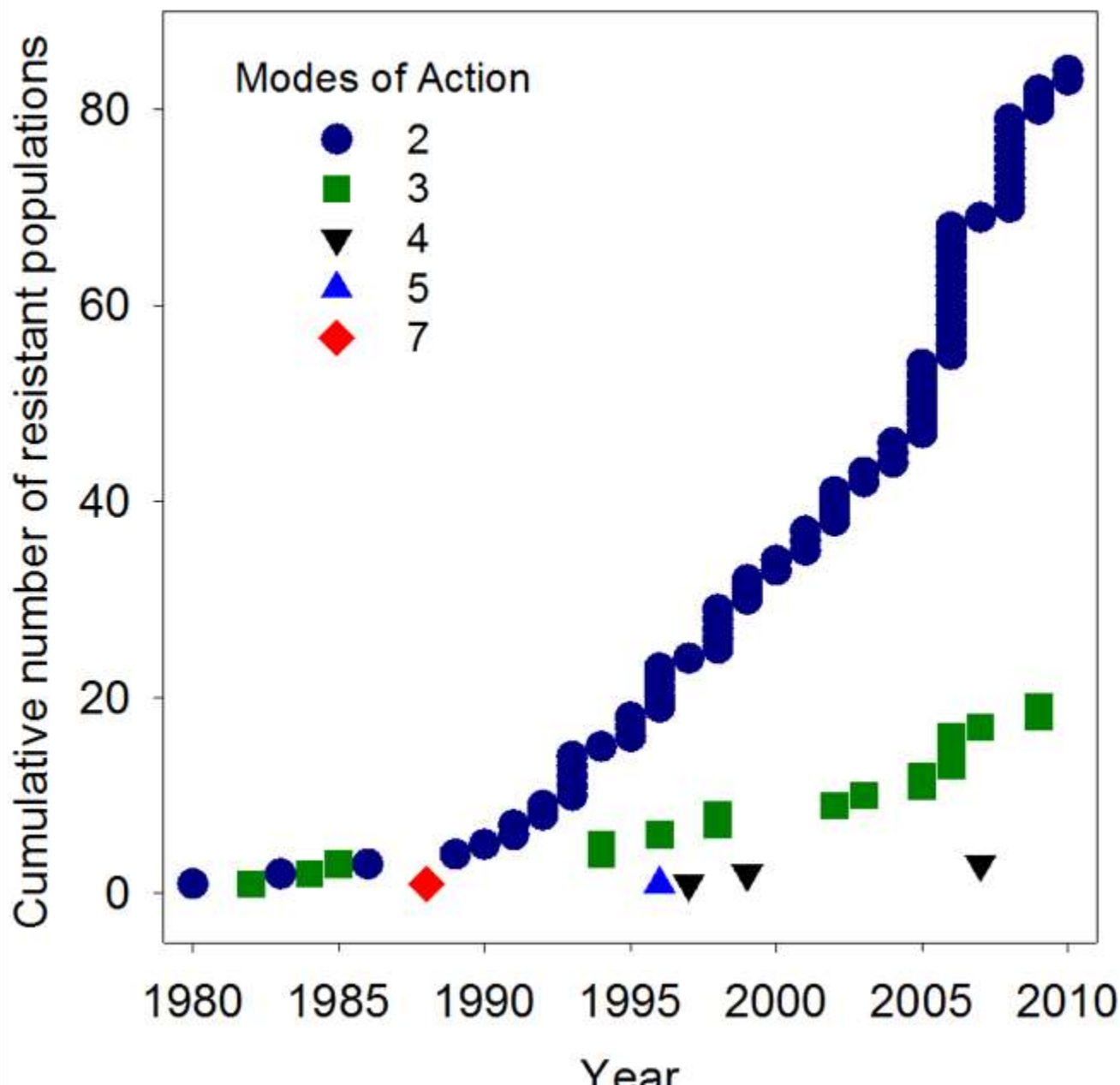


Dave Mortensen

ate Degree Program and

Department of Plant Sciences, Pennsylvania State University, [dmortensen@psu.edu](mailto:dmortensen@psu.edu)

# Herbicide-resistant weeds



Herbicide use increases  
Resistance is widespread

Herbicide use  
increases

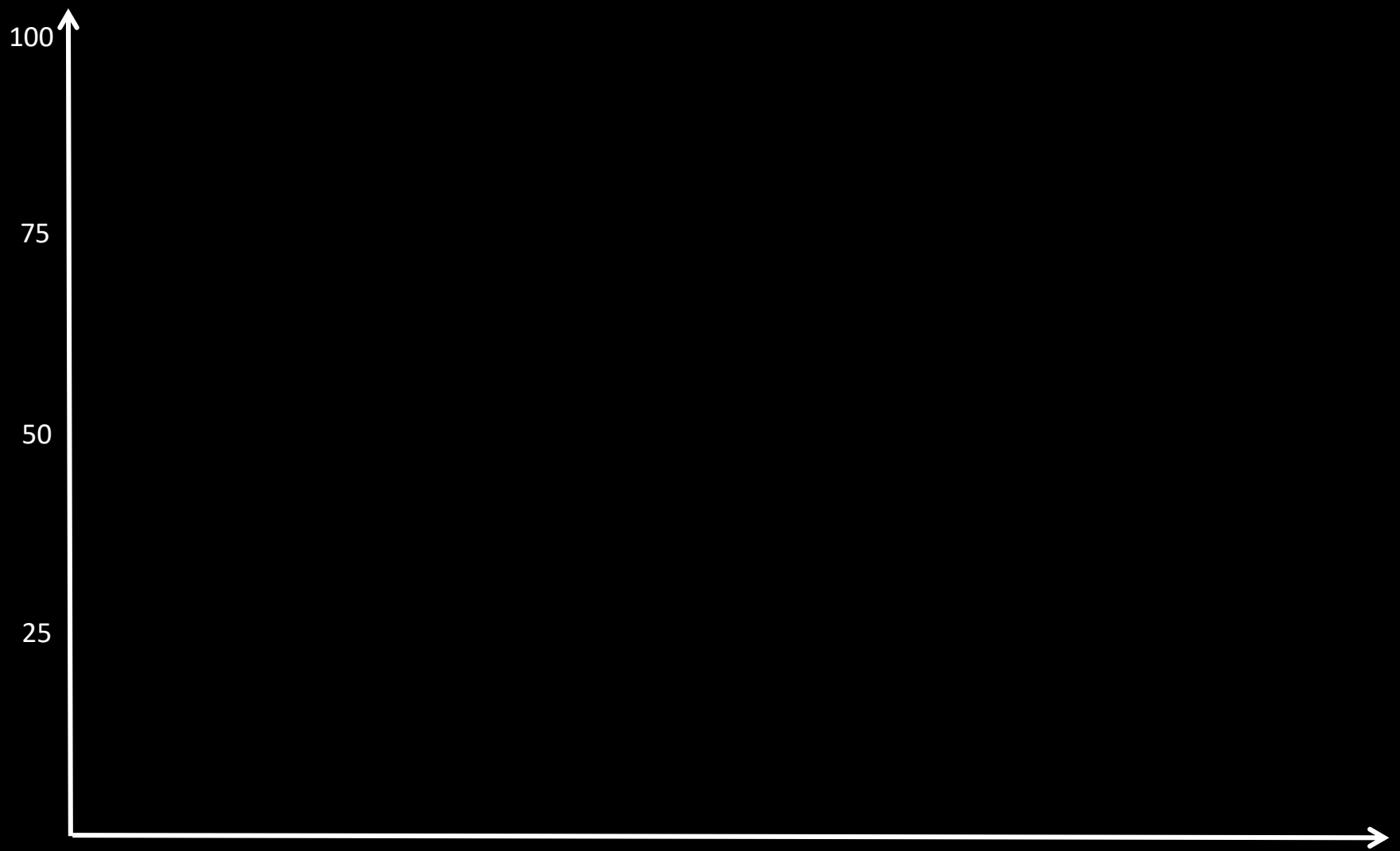


Dave Mortensen

College Graduate Degree Program and  
State University, [dmortensen@psu.edu](mailto:dmortensen@psu.edu)

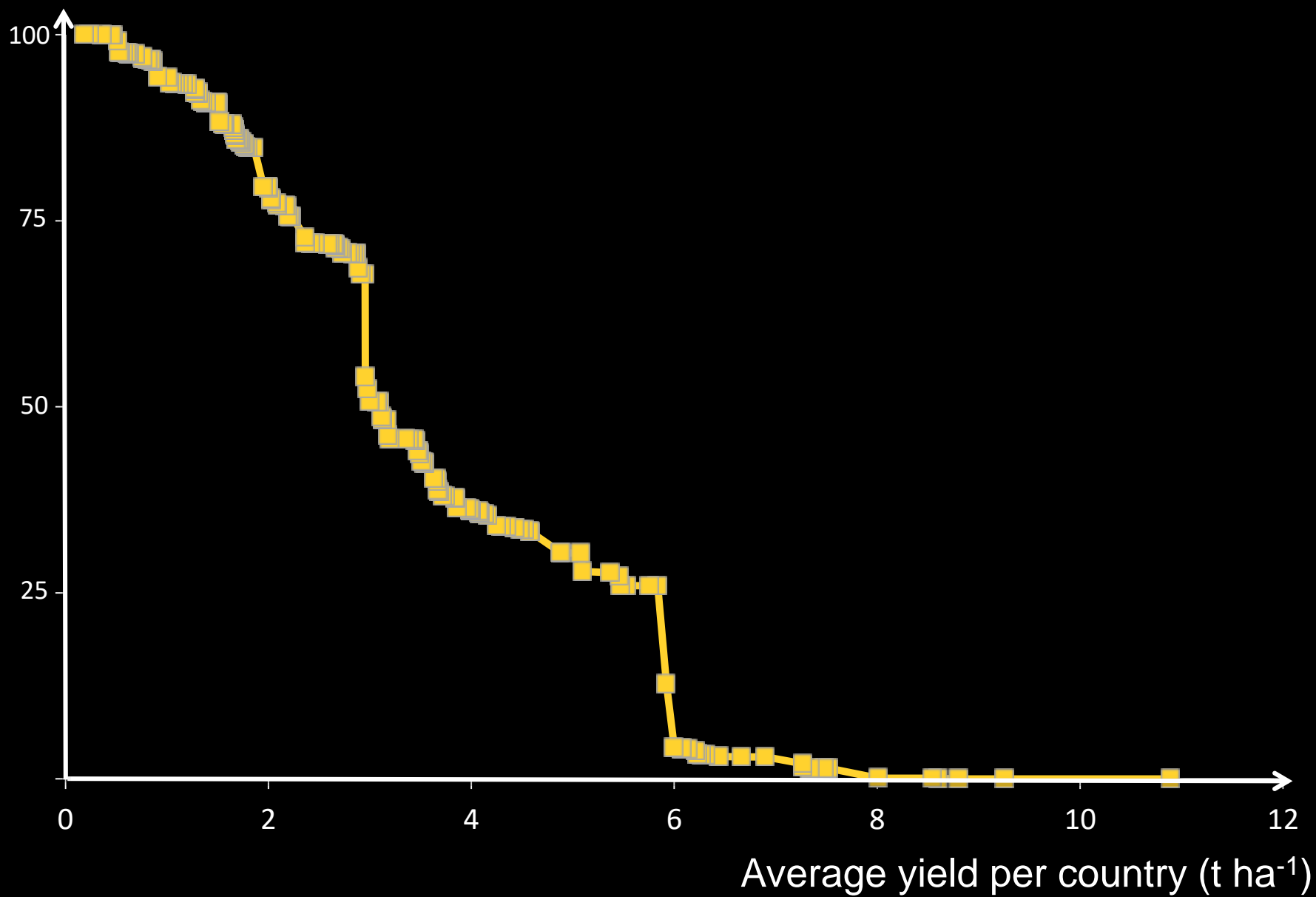


Contribution to world  
production (%)



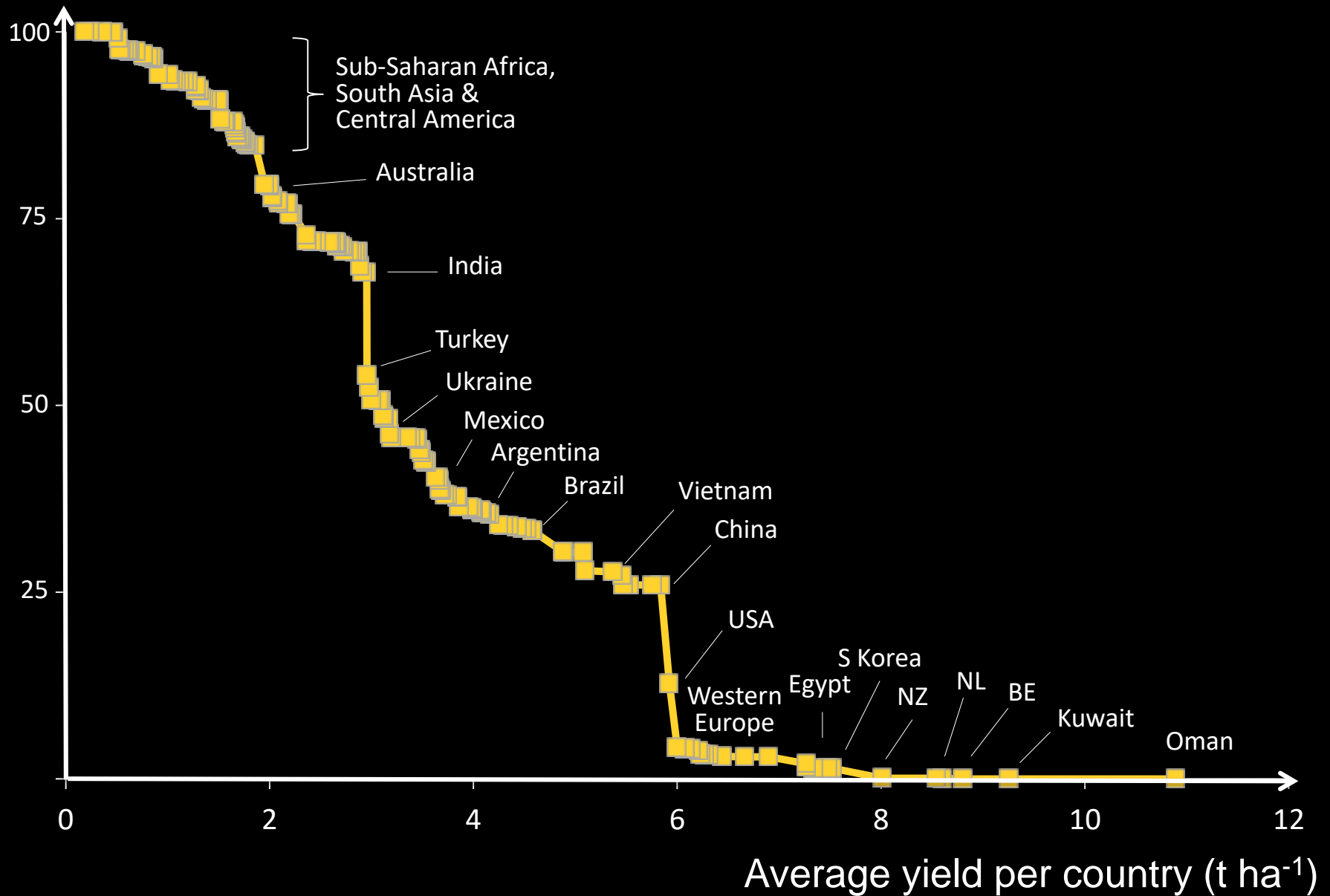
Average yield per country (t ha<sup>-1</sup>)

Contribution to world  
production (%)

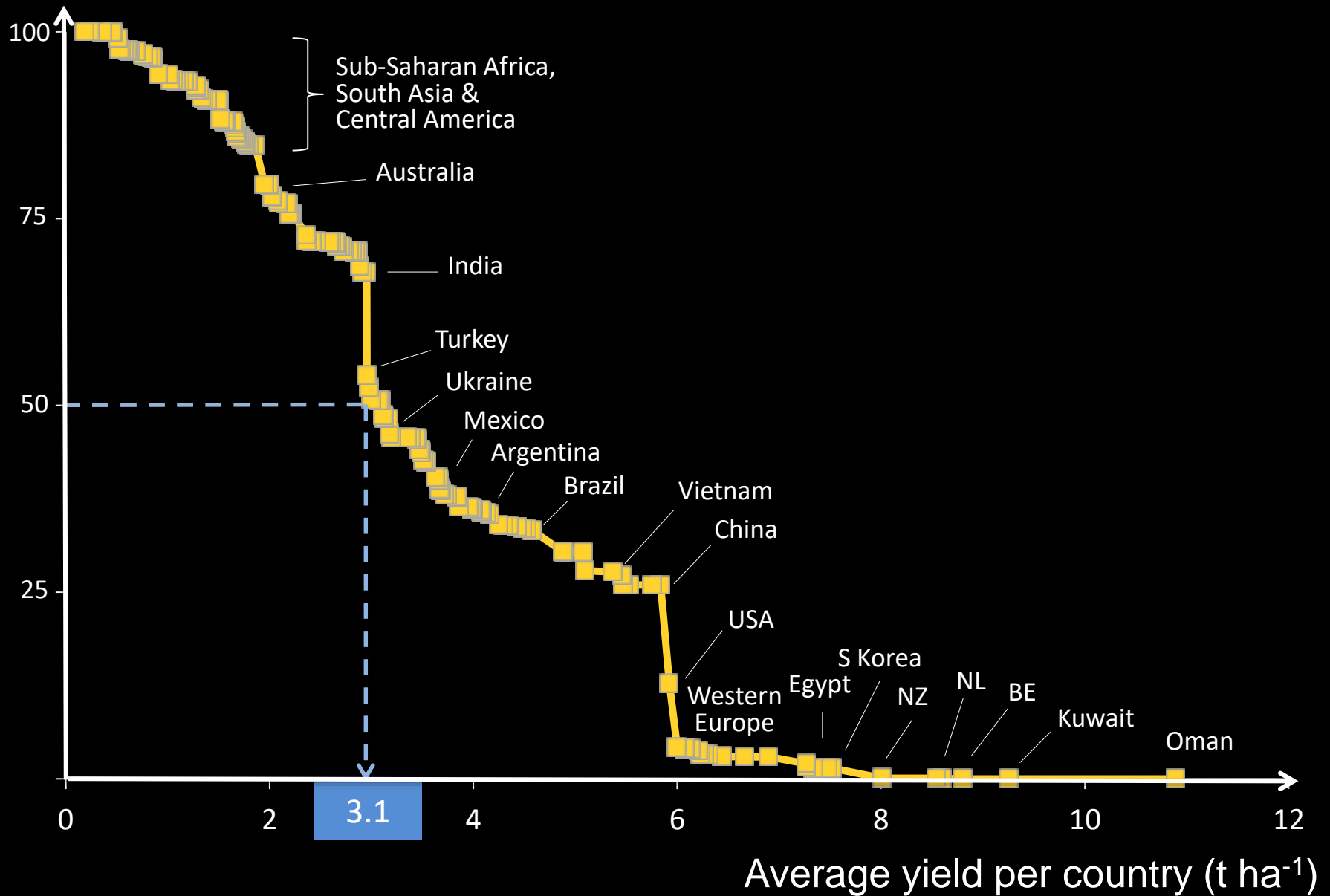




# Contribution to world production (%)



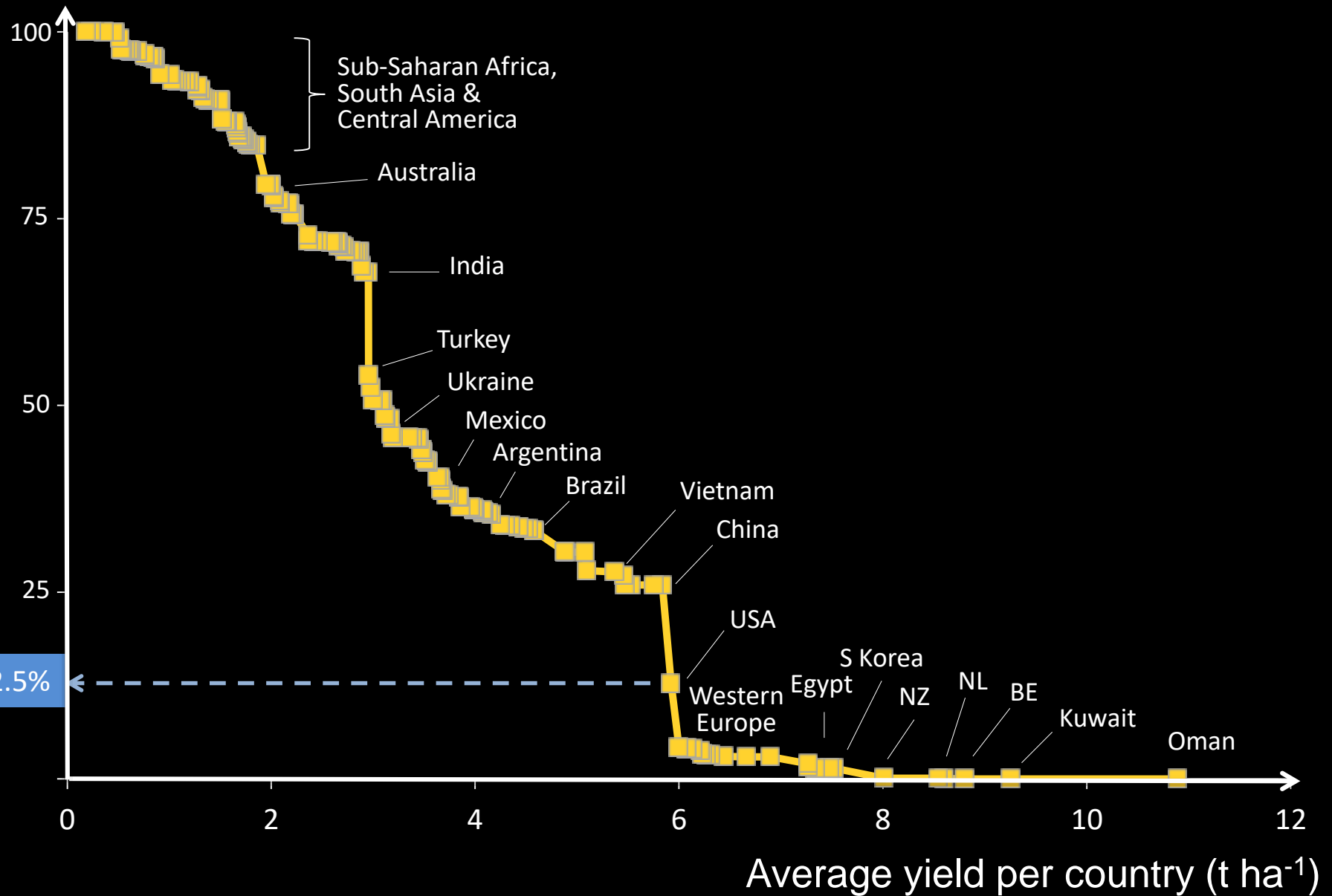
# Contribution to world production (%)



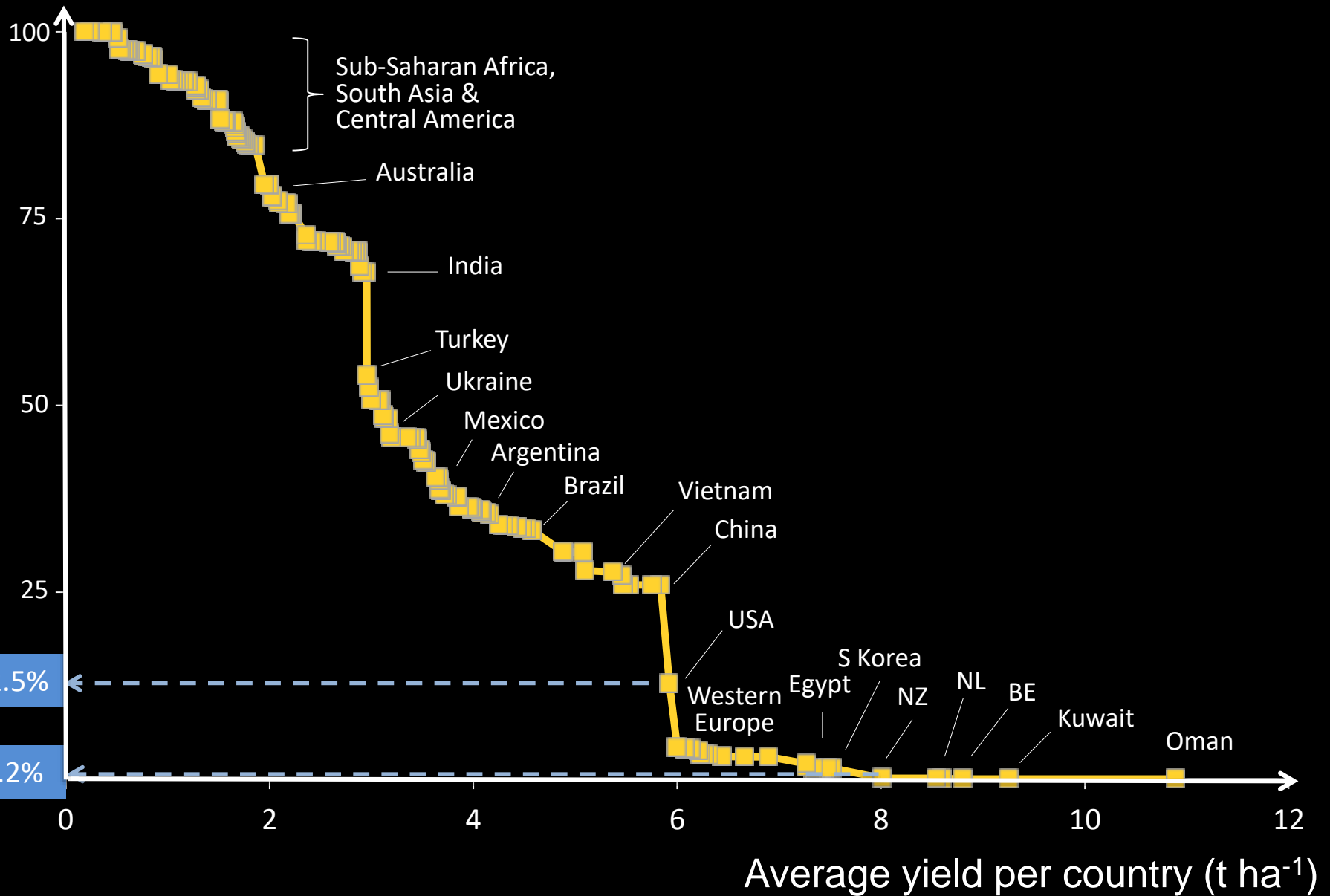
Tittonell et al., 2016. Data source: FAOSTAT



# Contribution to world production (%)



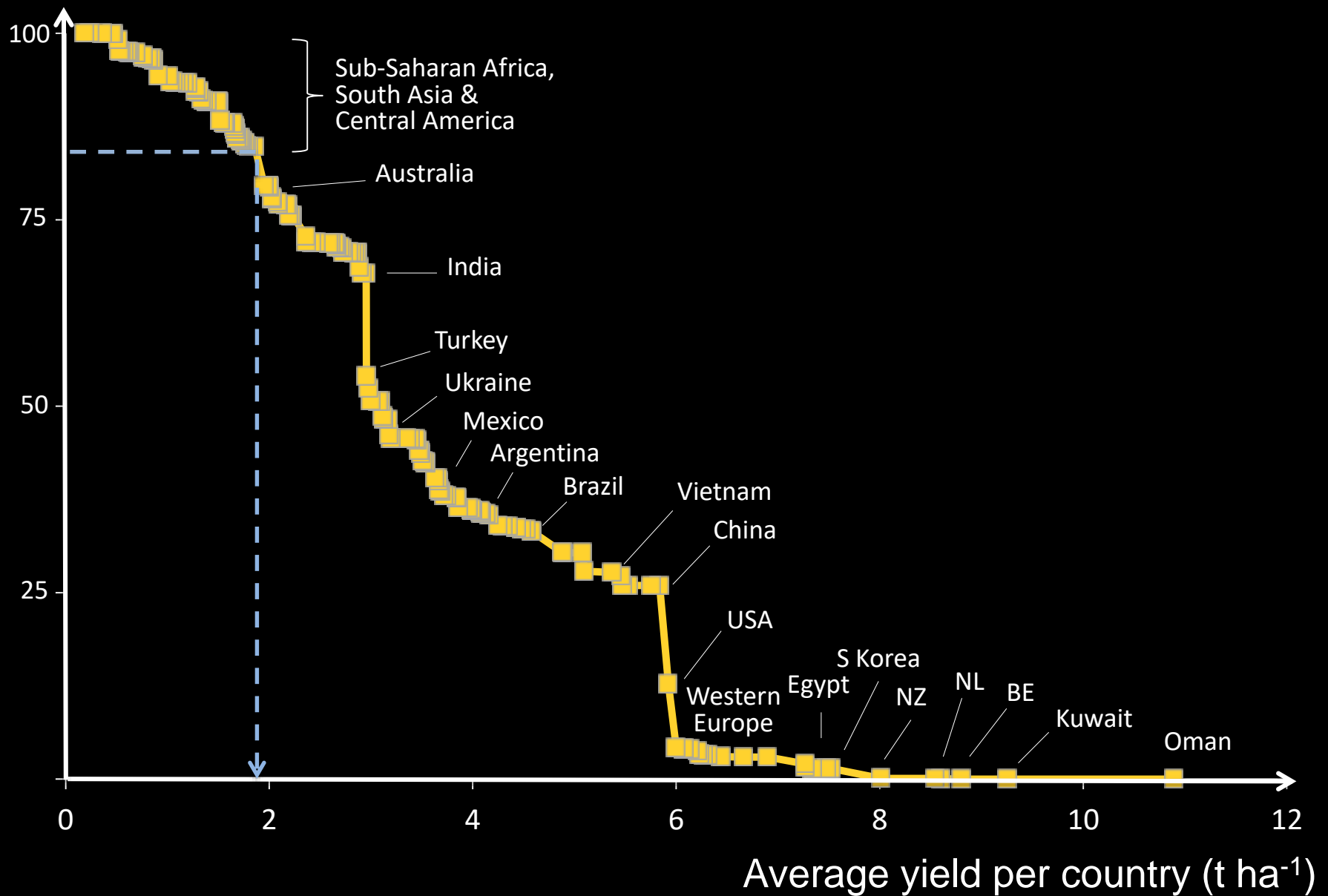
# Contribution to world production (%)



Tittonell et al., 2016. Data source: FAOSTAT

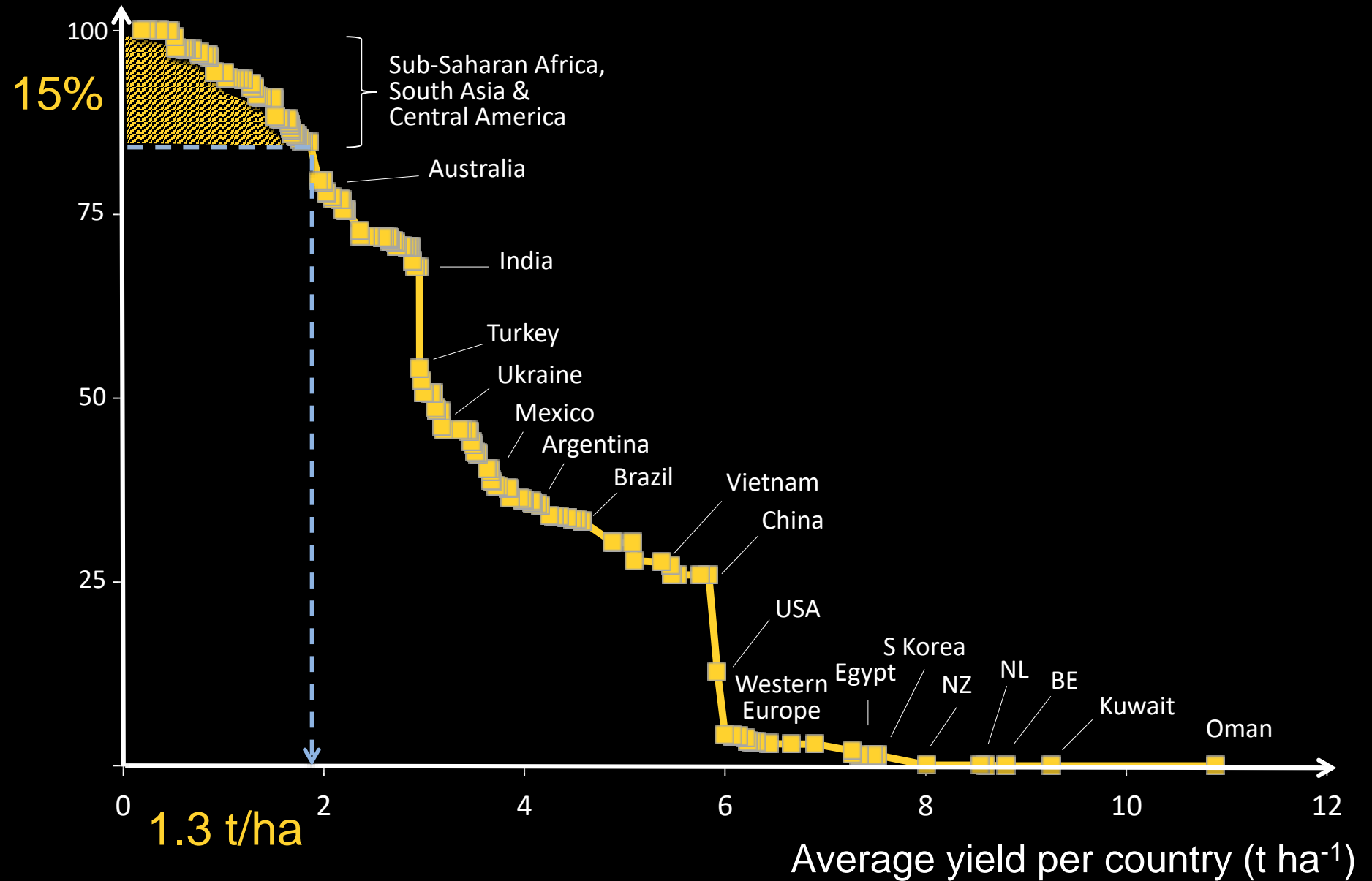


# Contribution to world production (%)



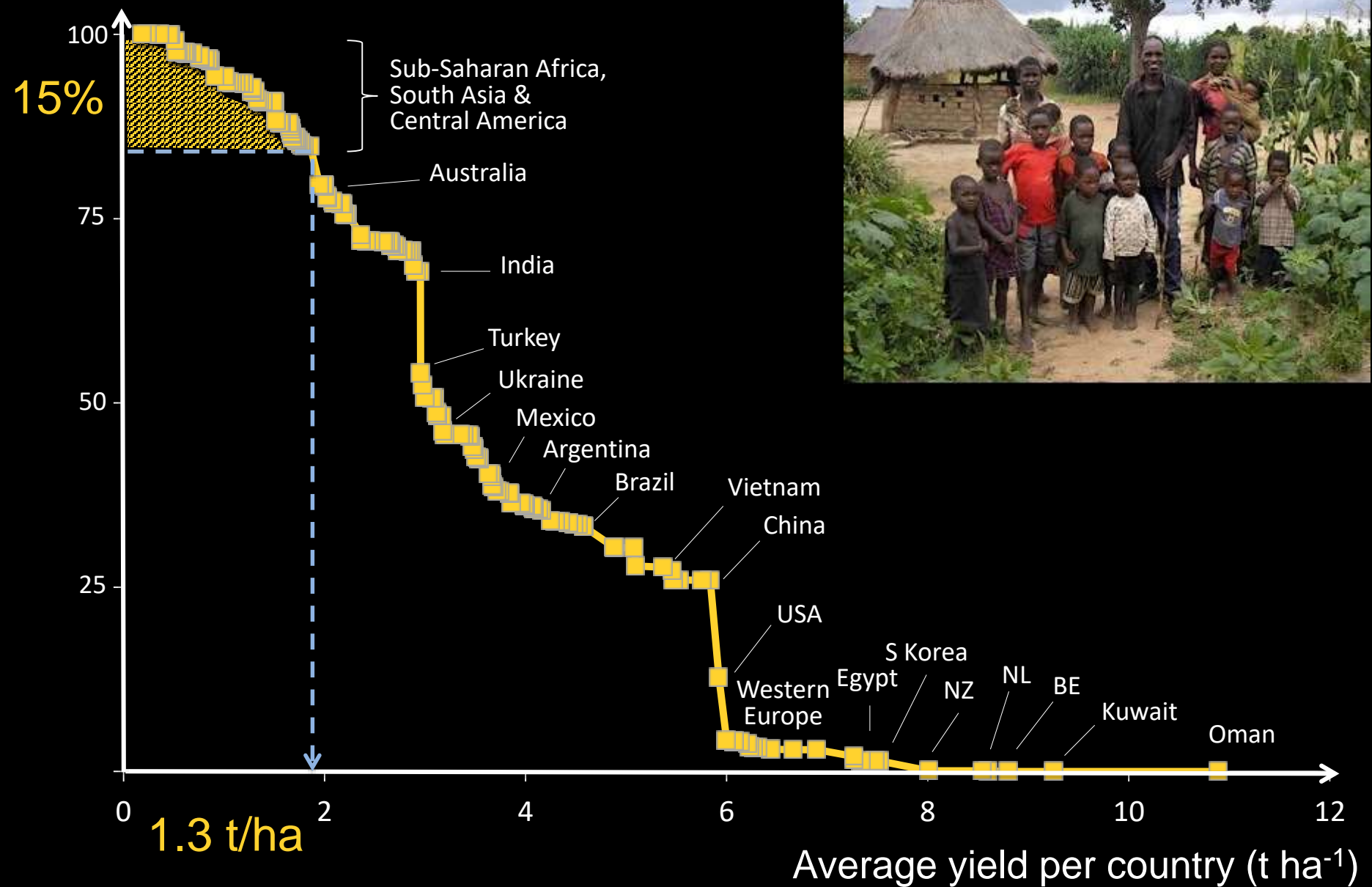
Tittonell et al., 2016. Data source: FAOSTAT

# Contribution to world production (%)



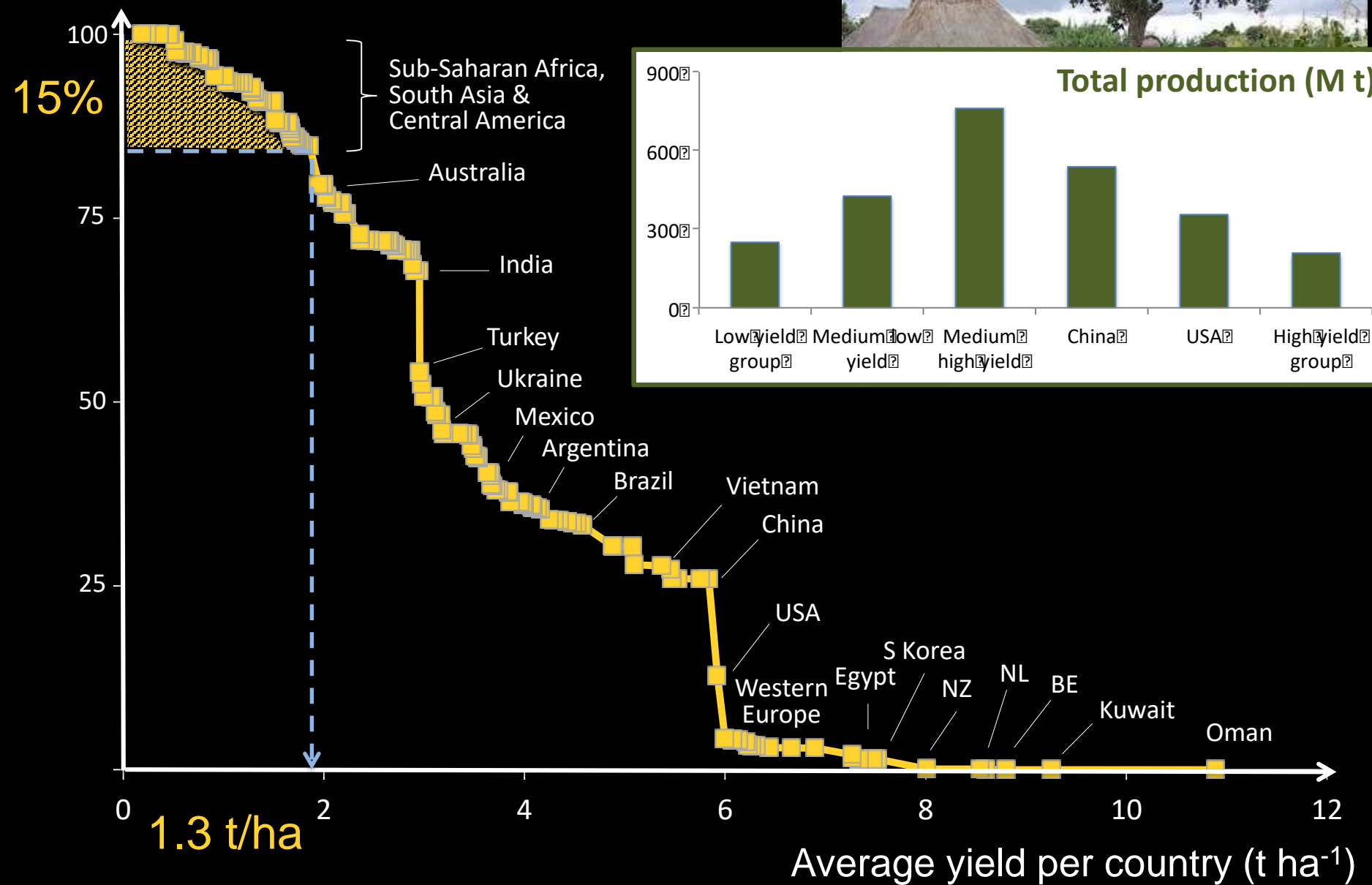
Tittonell et al., 2016. Data source: FAOSTAT

# Contribution to world production (%)

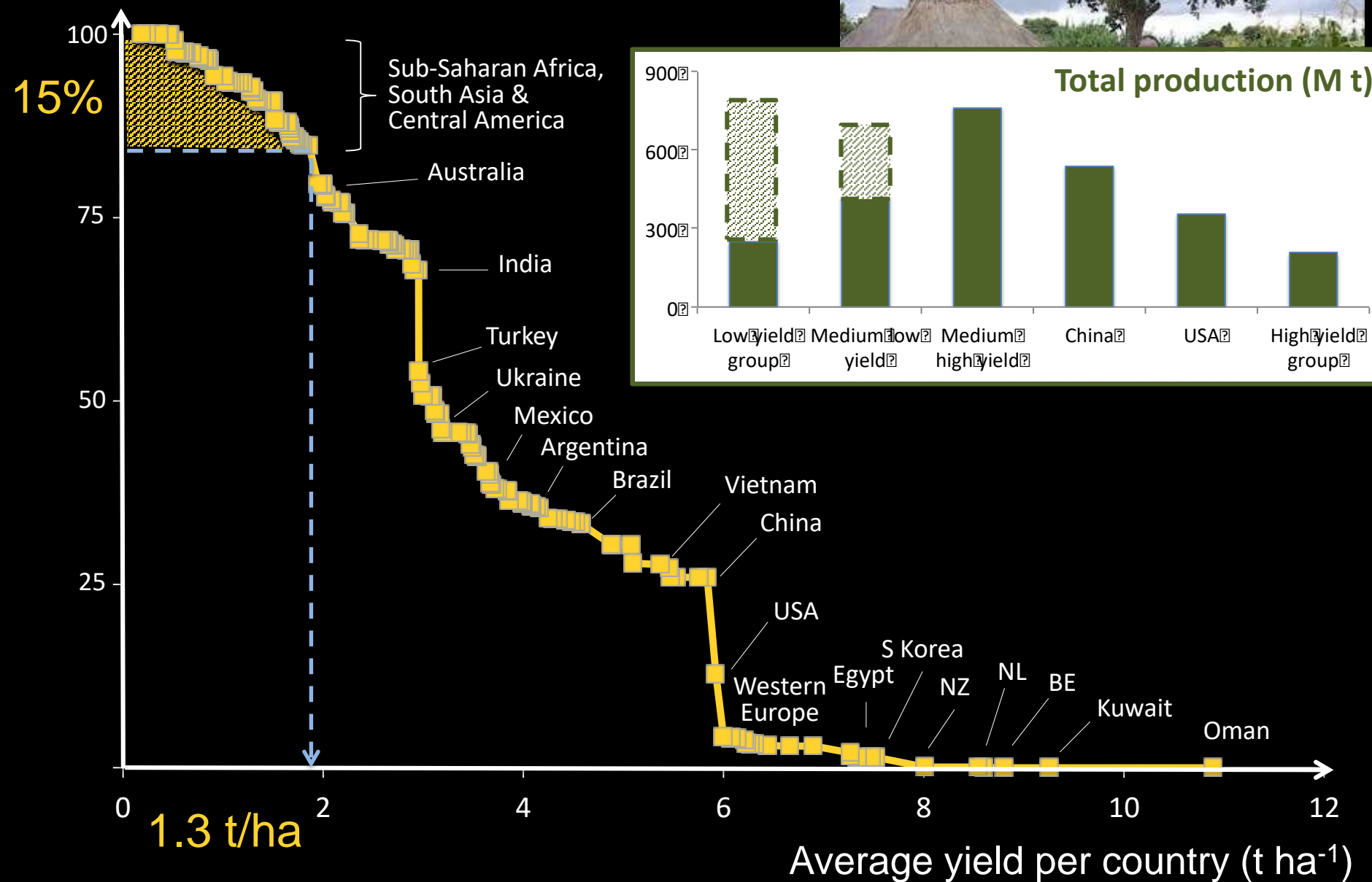




# Contribution to world production (%)

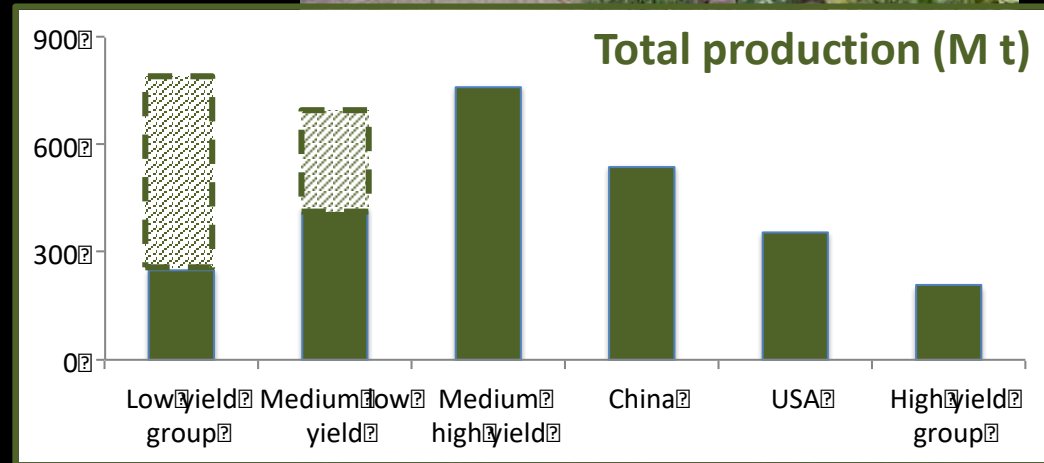
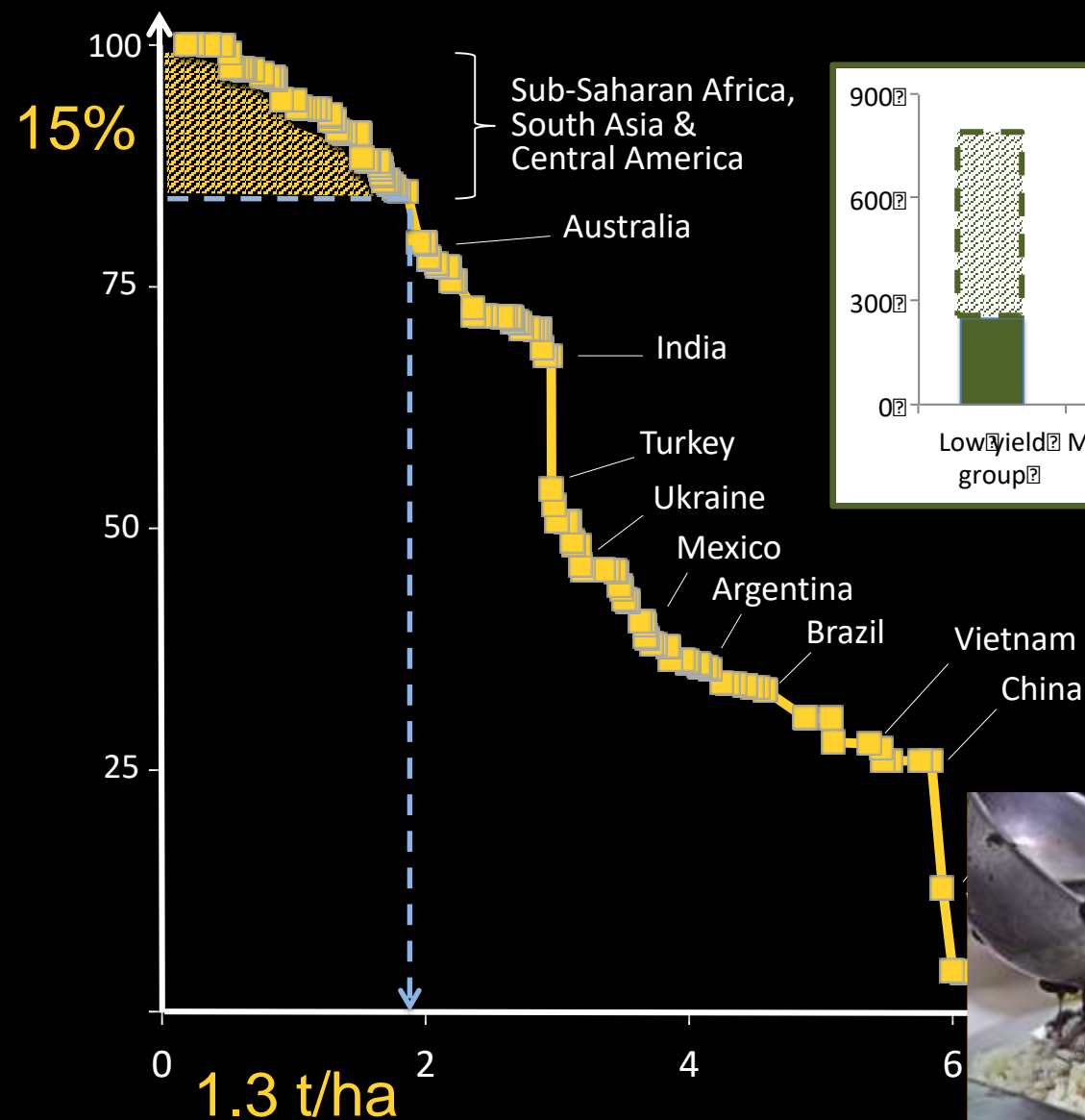


# Contribution to world production (%)



Tittonell et al., 2016. Data source: FAOSTAT

# Contribution to world production (%)



## Food security

- ✓ Availability
- ✓ Access
- ✓ Stability
- ✓ Utilisation



# Food security: localized solutions to a global problem





Food localized solutions to a global problem

**American  
corn belt**

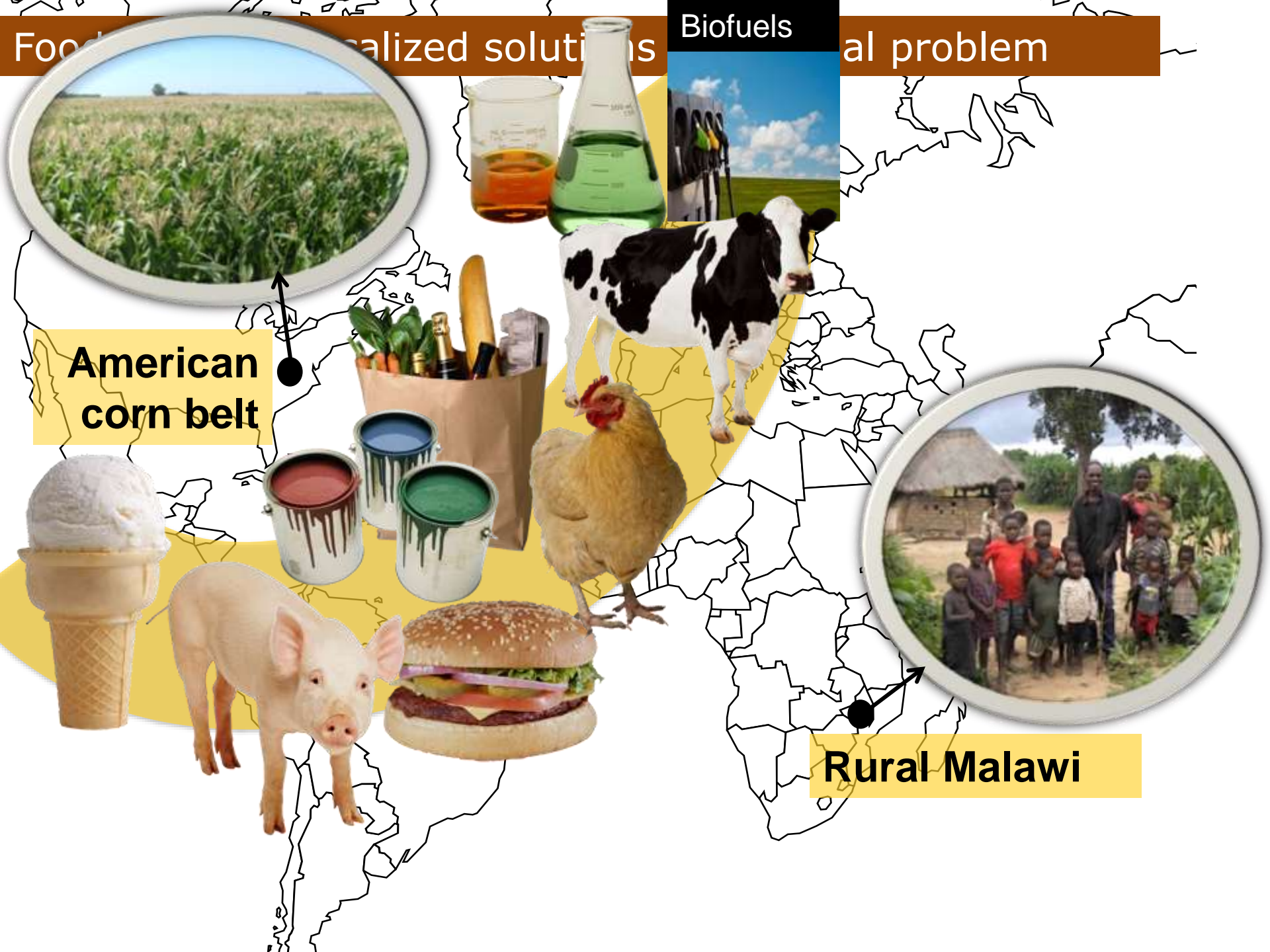


# Food localized solutions to a global problem

**American  
corn belt**

**Rural Malawi**





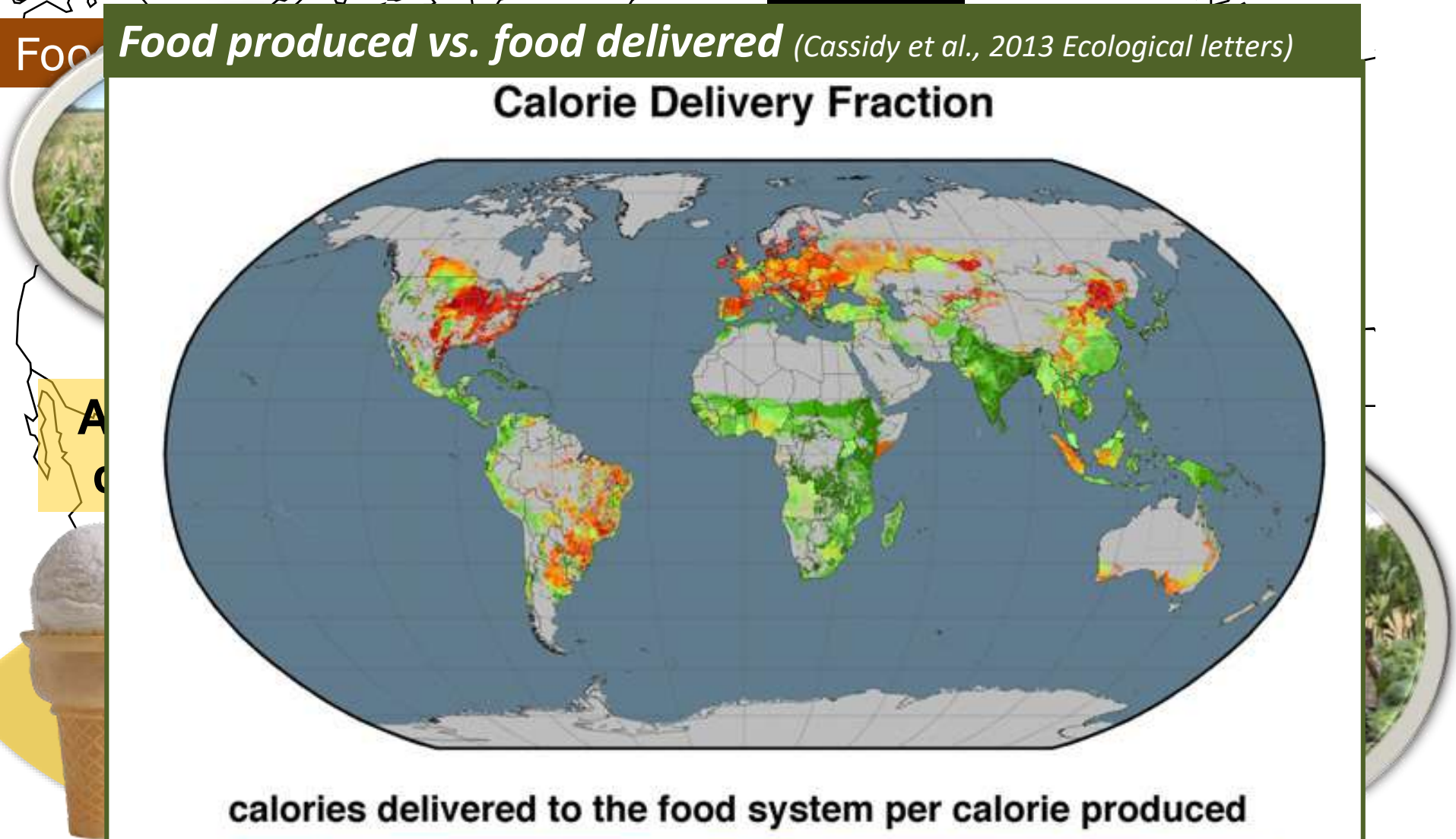
Food vs. Biofuels: Globalized solutions

Biofuels

Global problem

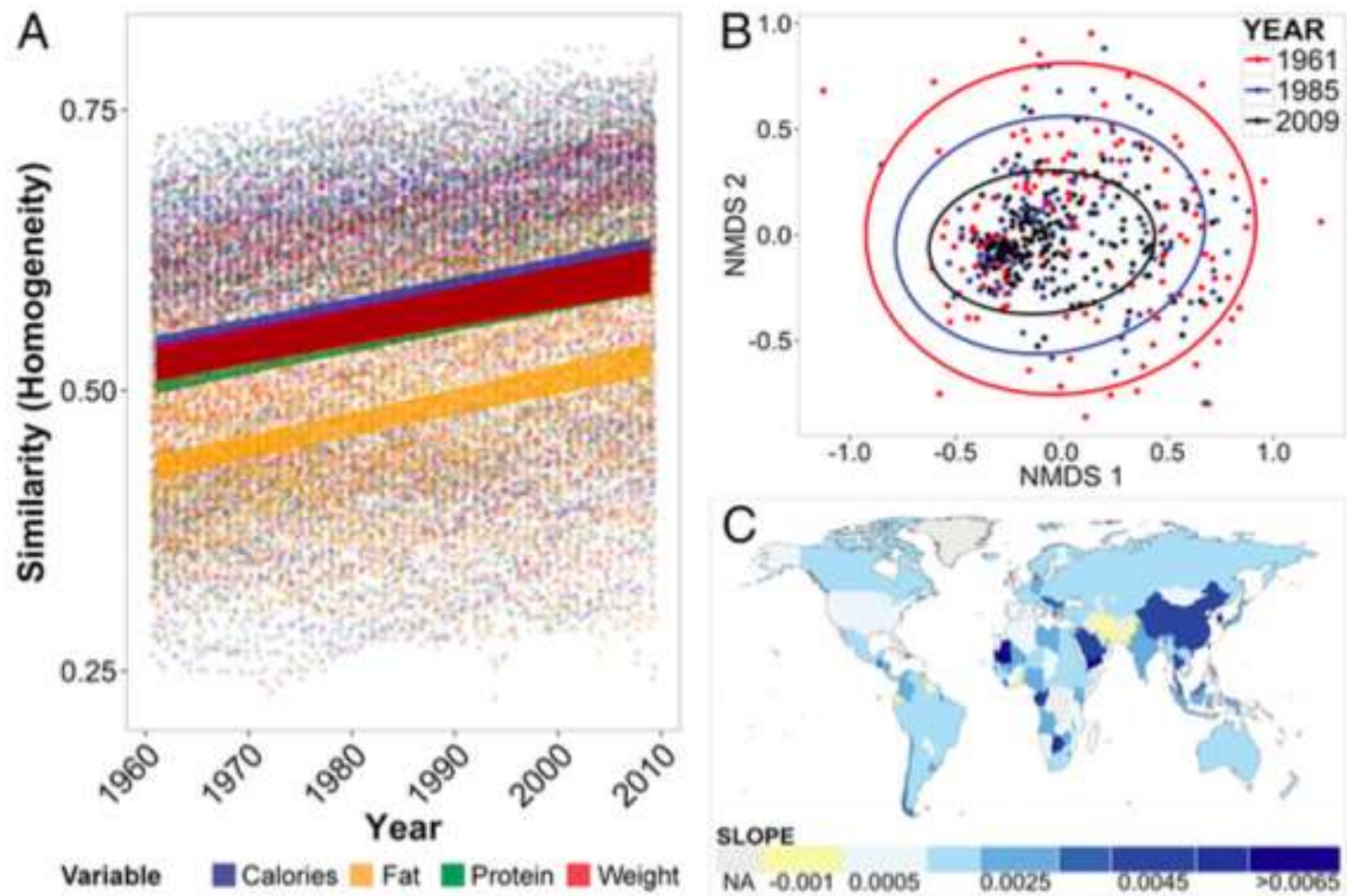
American corn belt

Rural Malawi

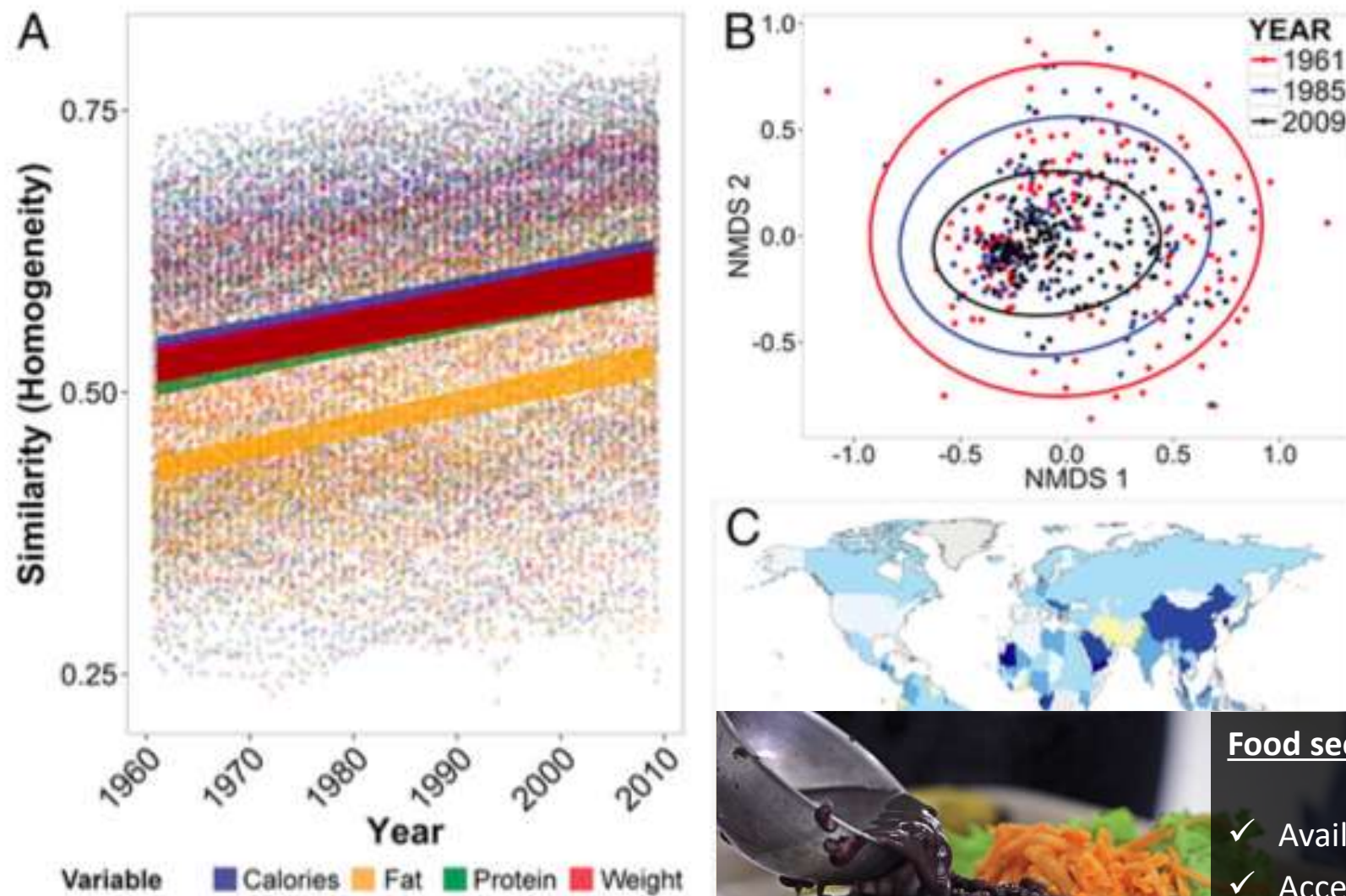


**Figure 1.** Calorie delivery fraction per hectare. The proportions of produced calories that are delivered as food are shown.





**Figure 1.** Calorie delivery fraction per hectare. The proportions of produced calories that are delivered as food are shown.



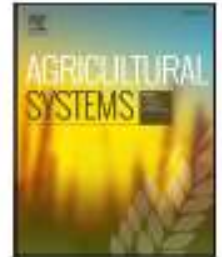
**Figure 1.** Calorie delivery fraction produced calories that are delivered



#### Food security

- ✓ Availability
- ✓ Access
- ✓ Stability
- ✓ Utilisation





# Agriculture, nutrition and the green revolution in Bangladesh☆

Derek D. Headey<sup>a,\*</sup>, John Hoddinott<sup>b</sup>

<sup>a</sup> International Food Policy Research Institute, USA

<sup>b</sup> Cornell University, USA

## Feature Article

# Critical review of the emerging research evidence on agricultural biodiversity, diet diversity, and nutritional status in low- and middle-income countries

Andrew D. Jones

*The declining diversity of agricultural products have important implications for global diets.*

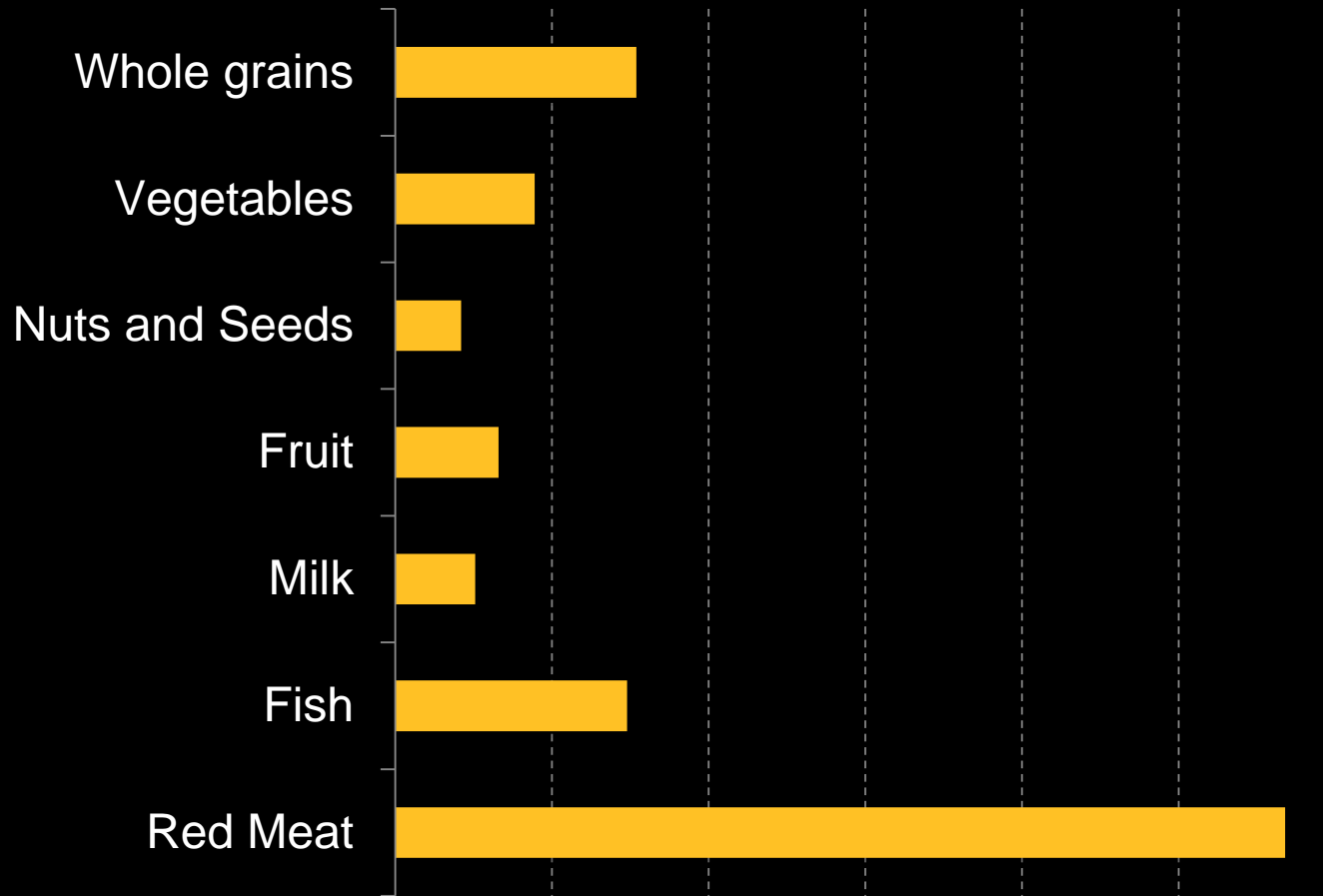
Figure 1. Caloric delivery fraction: produced calories that are delivered



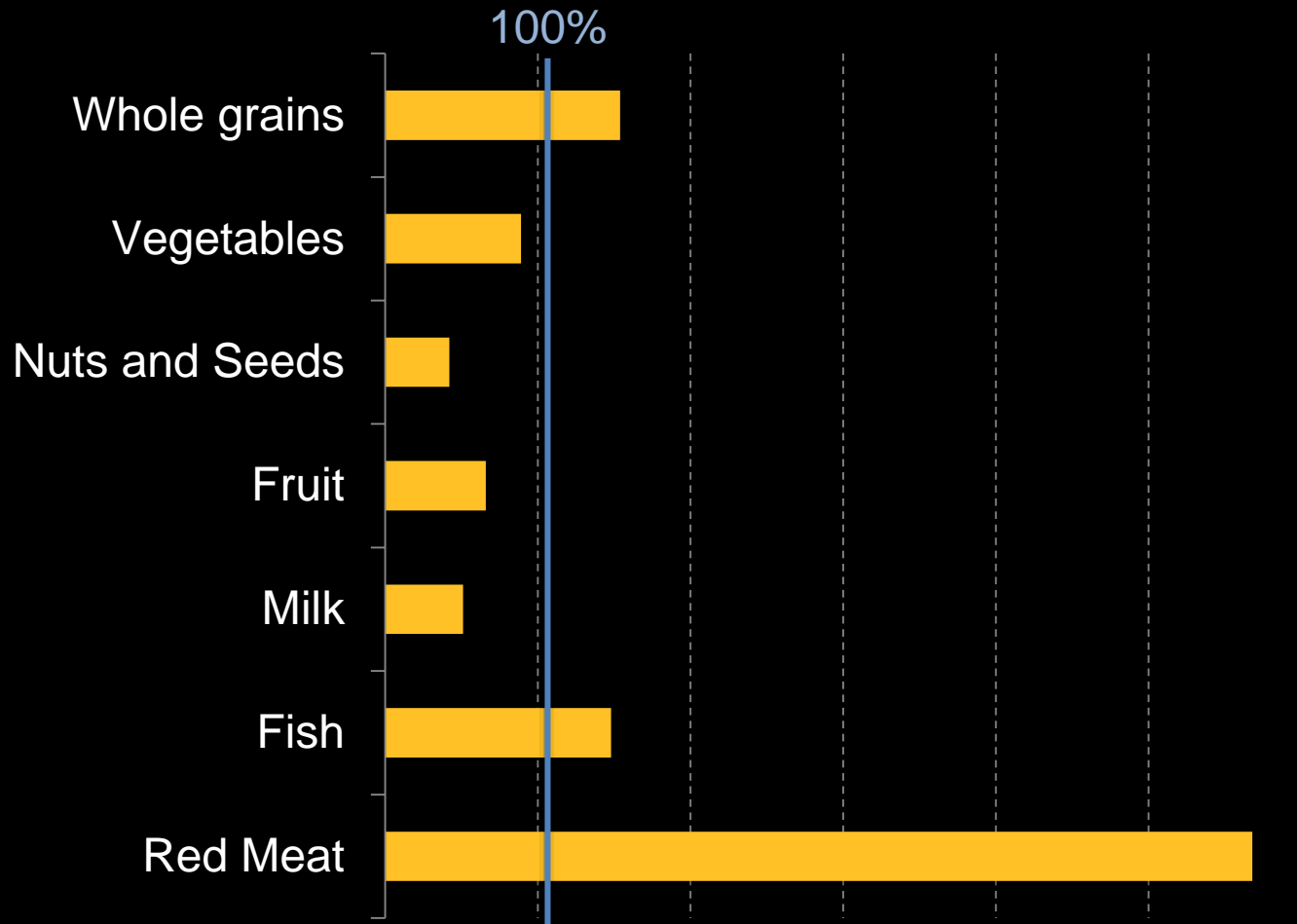
## Food security

- ✓ Availability
- ✓ Access
- ✓ Stability
- ✓ Utilisation

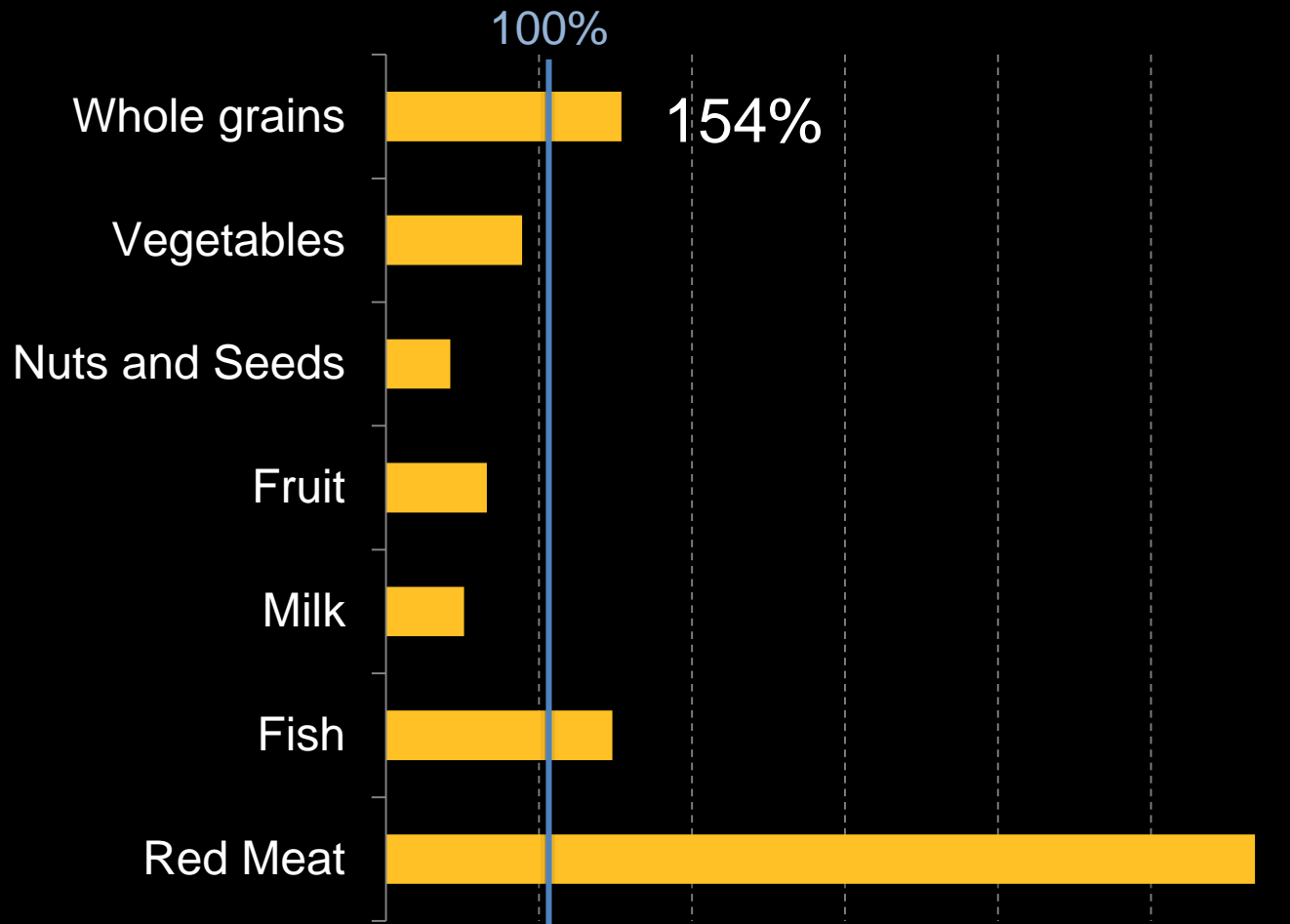
# Globally available food (% of what we need)



# Globally available food (% of what we need)

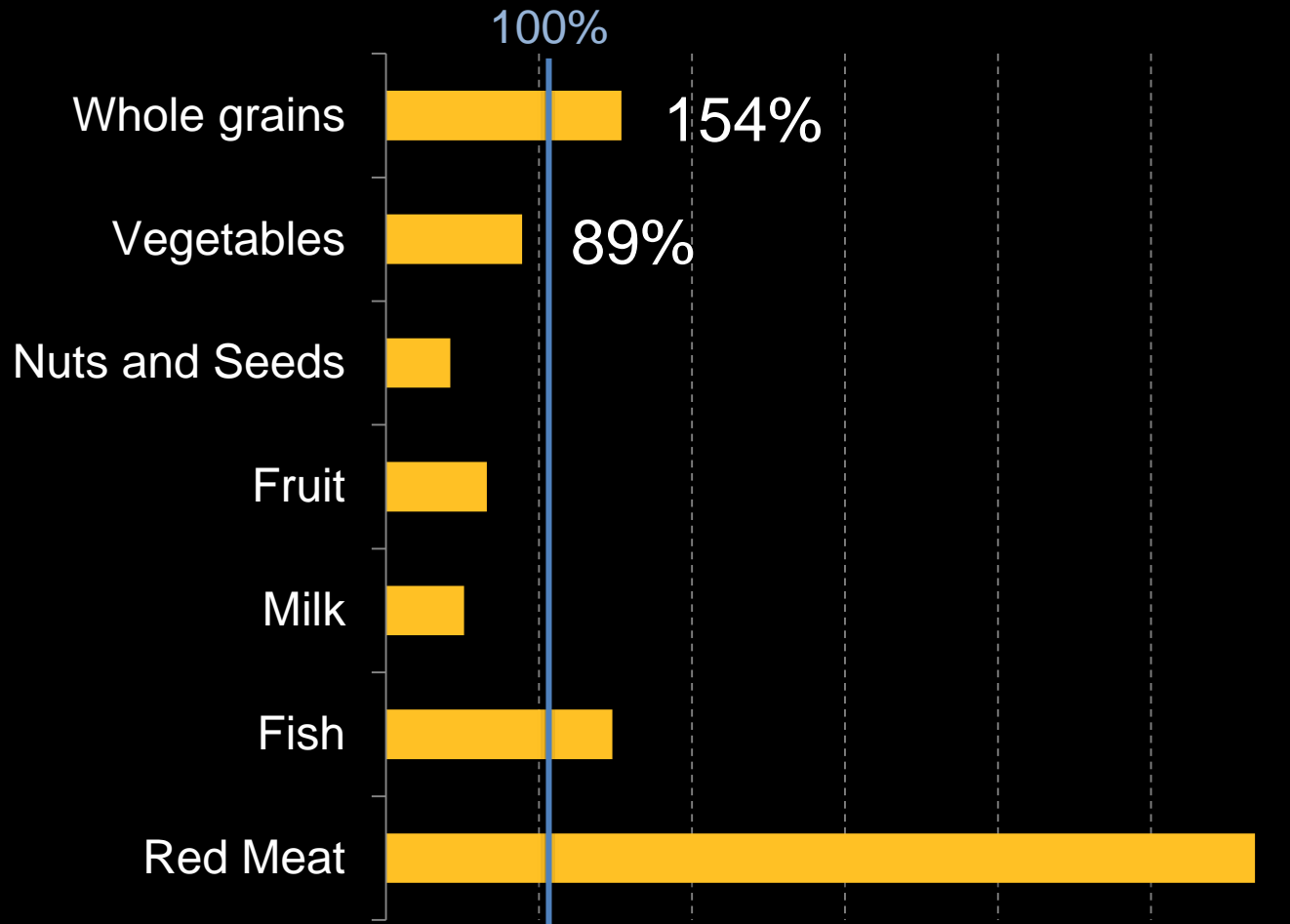


# Globally available food (% of what we need)

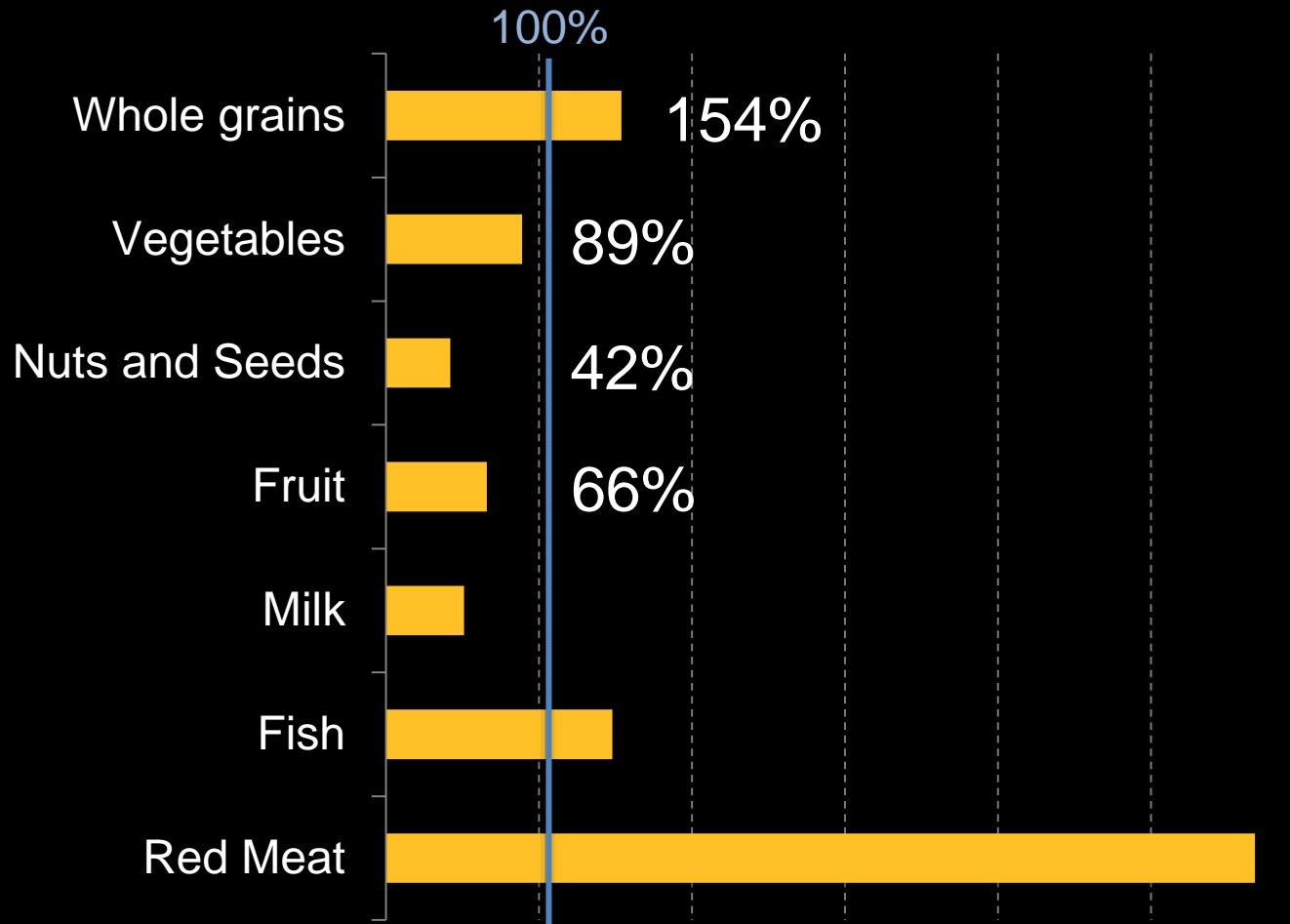




# Globally available food (% of what we need)



# Globally available food (% of what we need)

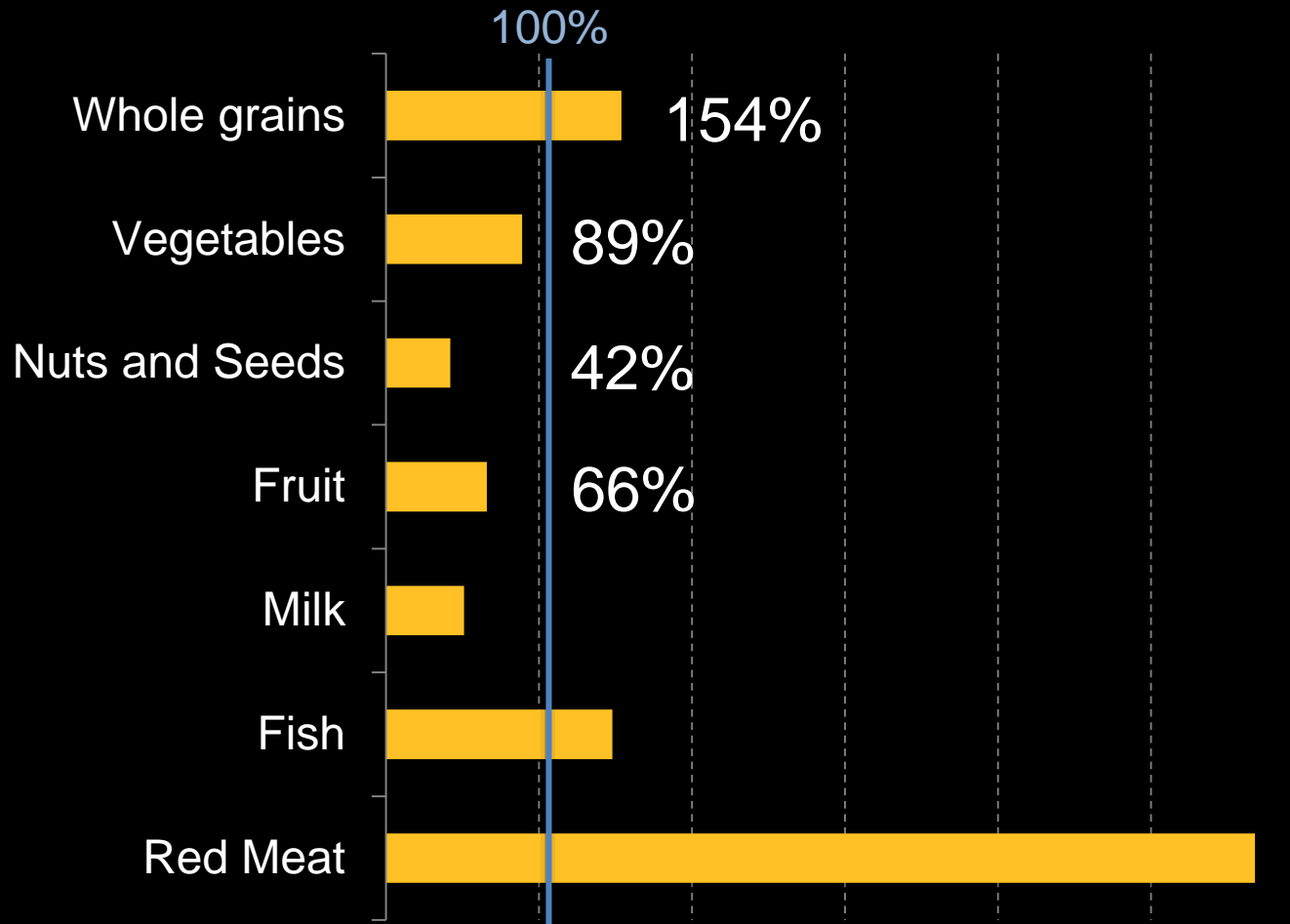


# Agroforestry



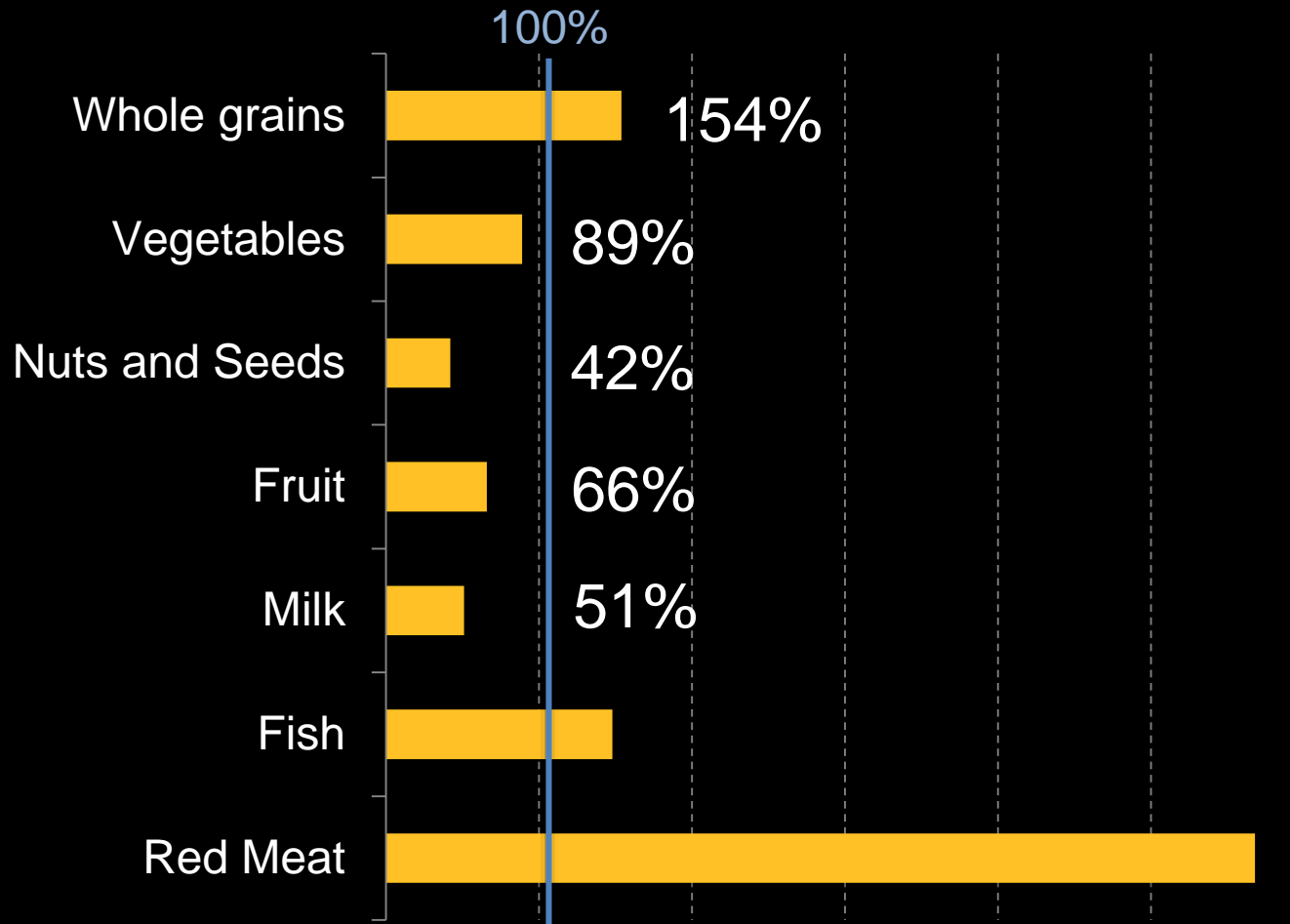
Photo credits: Project SAFE (INRA 2005) and P. Tittone

# Globally available food (% of what we need)

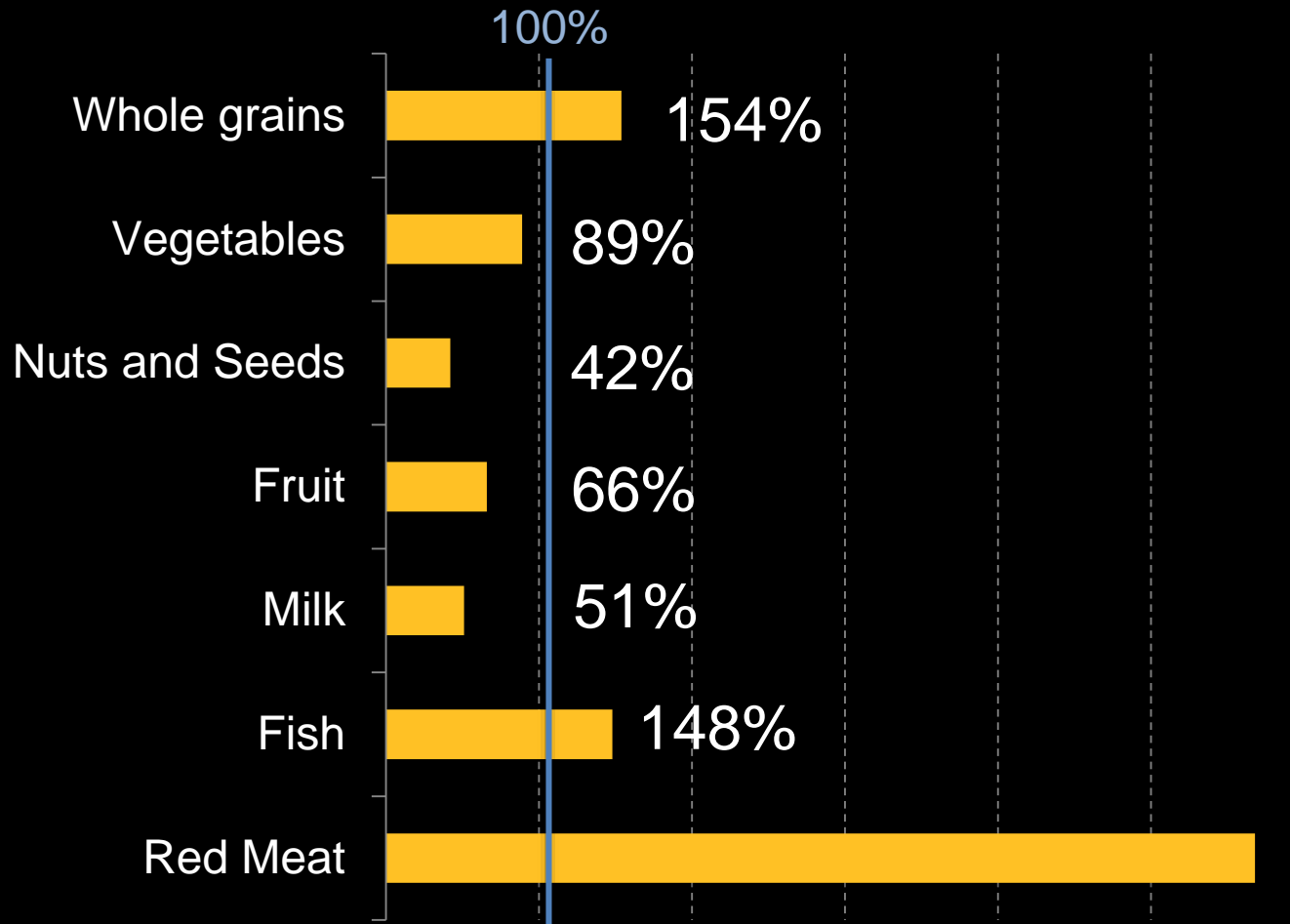




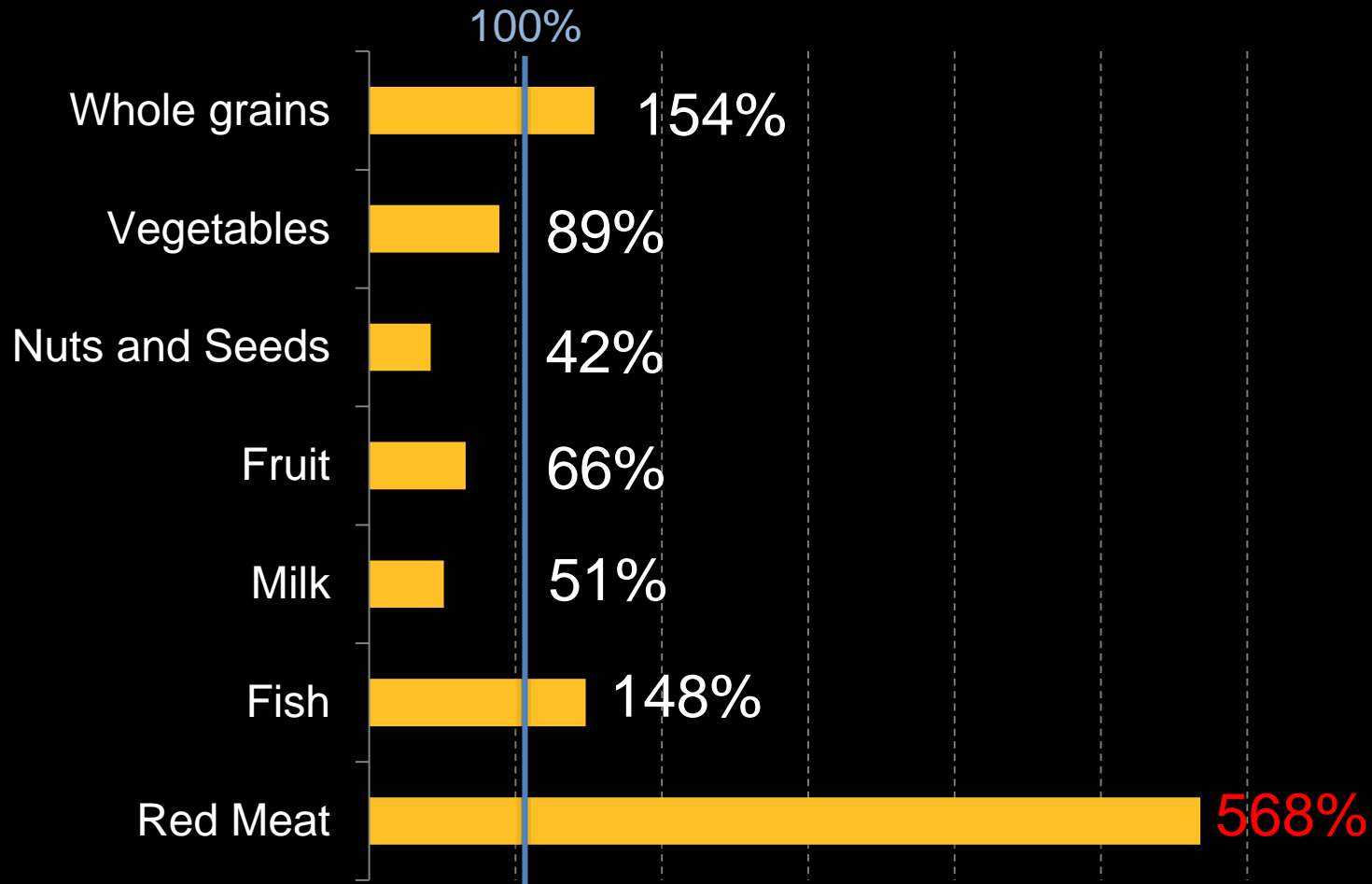
# Globally available food (% of what we need)



# Globally available food (% of what we need)



# Globally available food (% of what we need)



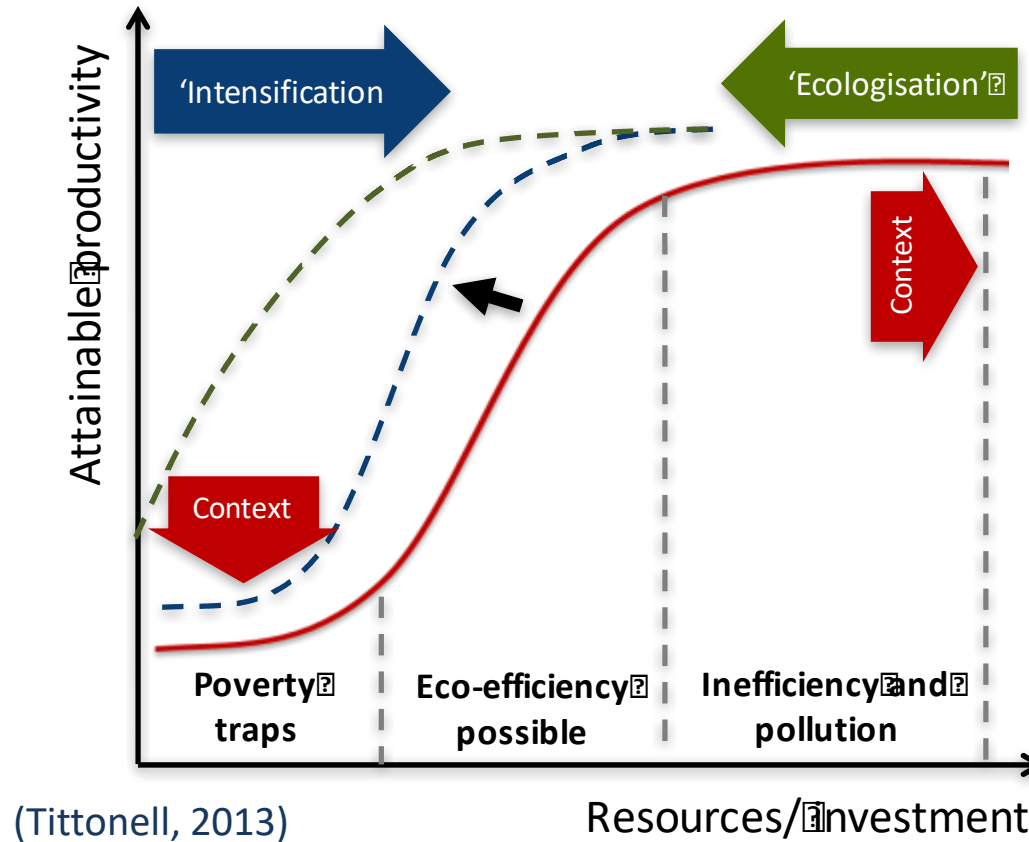
Do we need to increase production?



# Do we need to increase production?

**Yes!** But not anywhere, not at any cost, not just cereals, etc...

# Do we need to increase production?

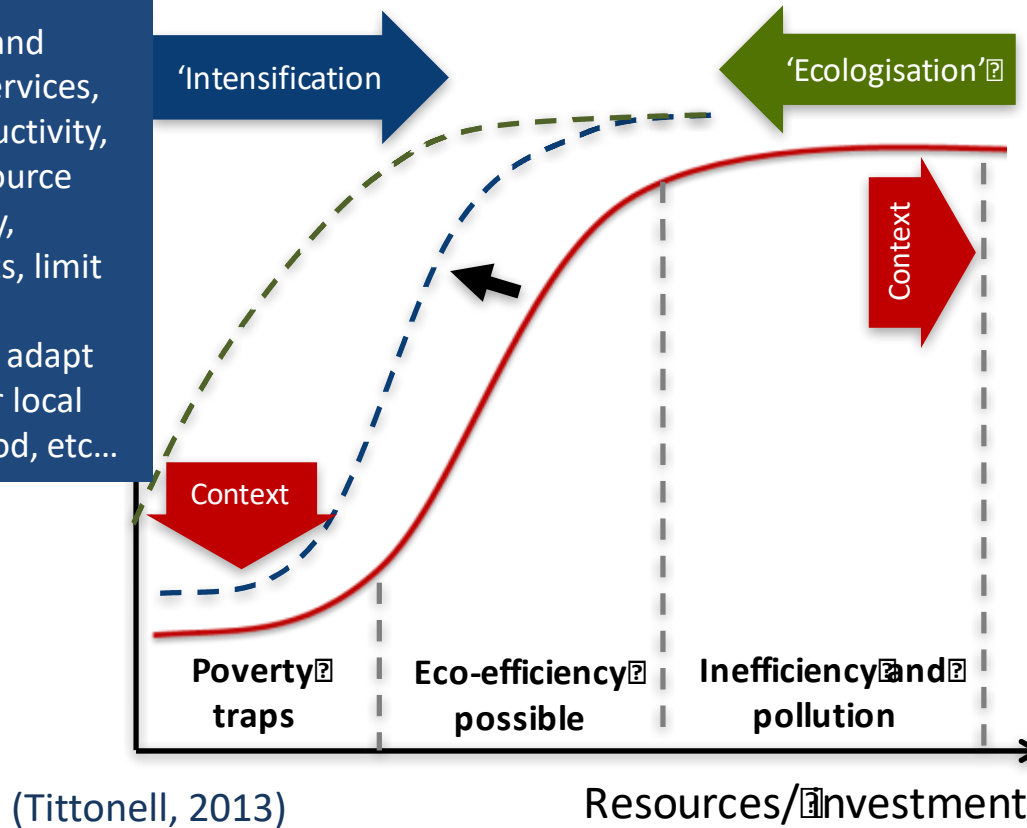


**Yes!** But not anywhere, not at any cost, not just cereals, etc...

# Do we need to increase production?

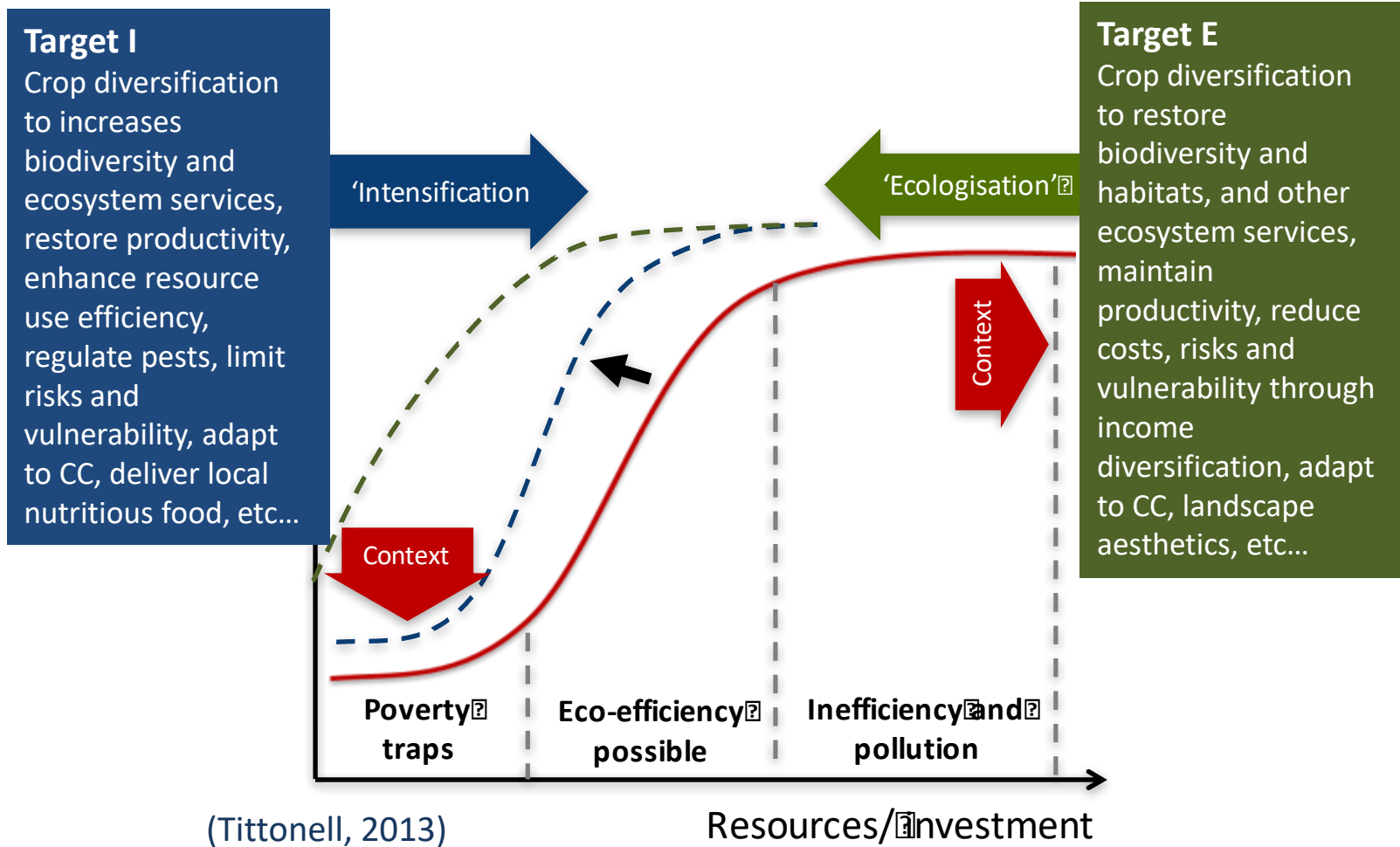
## Target I

Crop diversification to increase biodiversity and ecosystem services, restore productivity, enhance resource use efficiency, regulate pests, limit risks and vulnerability, adapt to CC, deliver local nutritious food, etc...



**Yes!** But not anywhere, not at any cost, not just cereals, etc...

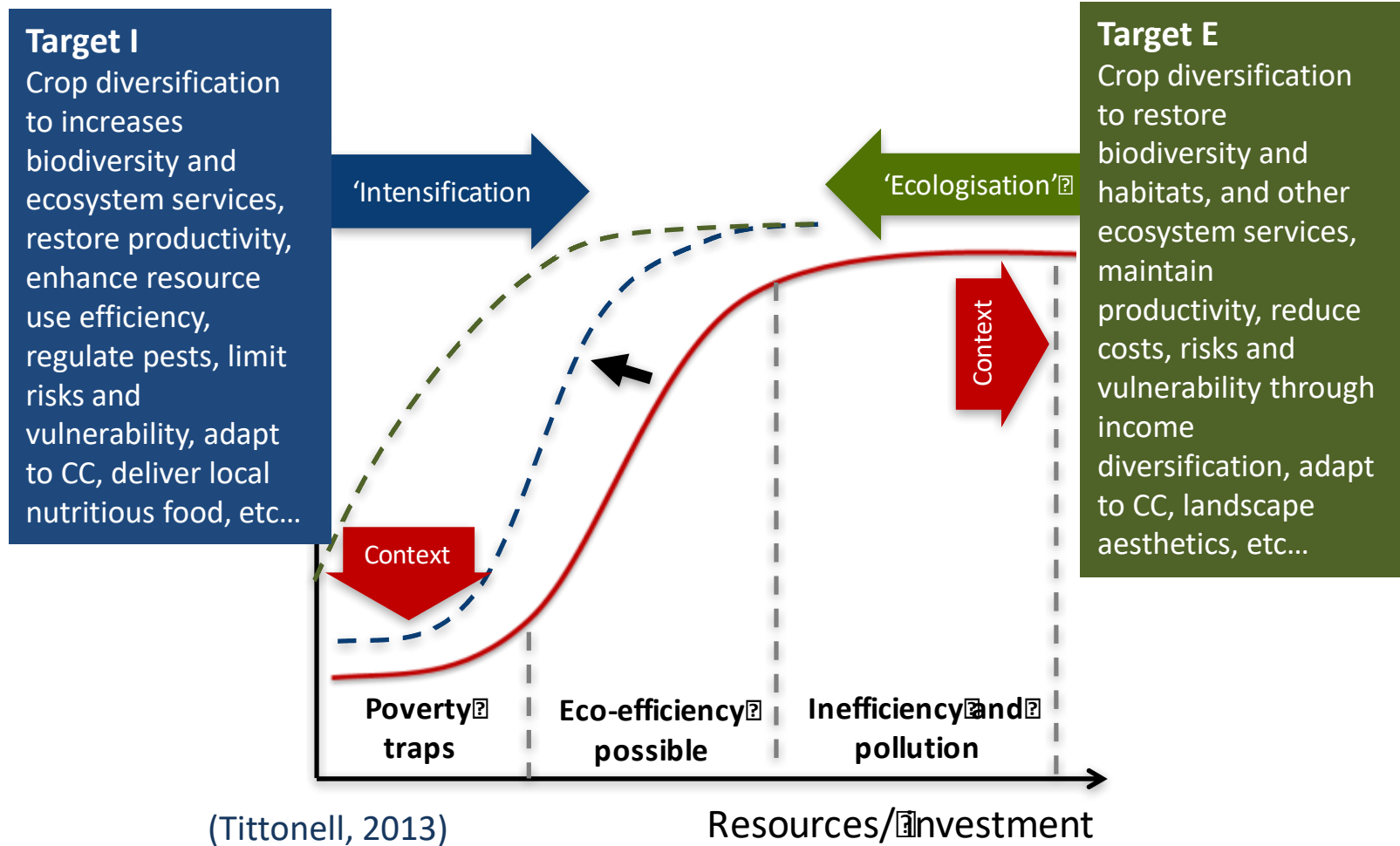
# Do we need to increase production?



**Yes!** But not anywhere, not at any cost, not just cereals, etc...



# Do we need to increase production?



## What diversification strategy?

Diverse monocultures or polycultures? Only annuals or annuals + perennials? Integrated animal production?

**Yes!** But not anywhere, not at any cost, not just cereals, etc...

# Soil restoration

# Restoring degraded soils



Oumar Diabaté, Mali



# Restoring degraded soils



Oumar Diabaté, Mali



# Restoring degraded soils



Oumar Diabaté, Mali



# Restoring degraded soils





# Restoring degraded soils





# Restoring degraded soils



Oumar Diabaté, M





ded soils



Oumar Diabaté, M



ded soils

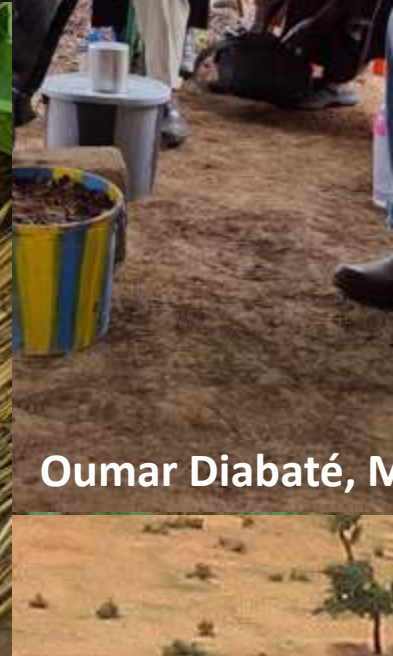
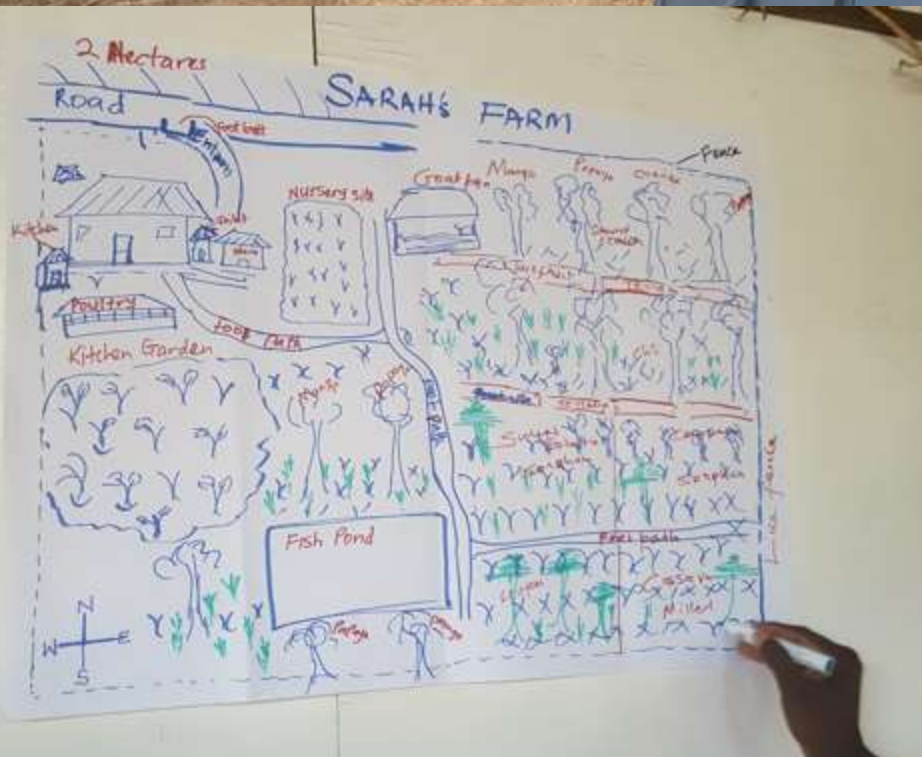


Oumar Diabaté, M





ded soils



Oumar Diabaté, M



# ded soils

## Yield-increasing potential of agroecological innovations in Africa

**Table 3** Summary of productivity outcomes from African case studies (Pretty et al. 2011)

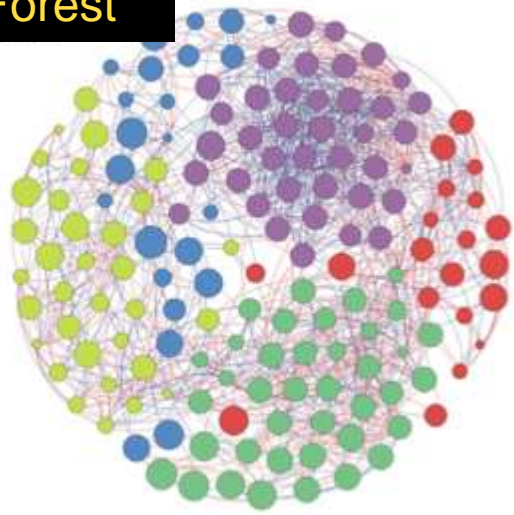
Thematic focus	Area improved (ha)	Mean yield increase (ratio)
Crop variety and system improvements	391,060	2.18
Agroforestry and soil conservation	3,385,000	1.96
Conservation agriculture	26,057	2.20
Integrated pest management	3,327,000	2.24
Horticulture and very small-scale agriculture	510	nd
Livestock and fodder crops	303,025	nd
Novel regional and national partnerships and policies	5,319,840	2.05
Aquaculture	523	nd
Total	12,753,000	2.13

Oumar Diabate, M





Forest



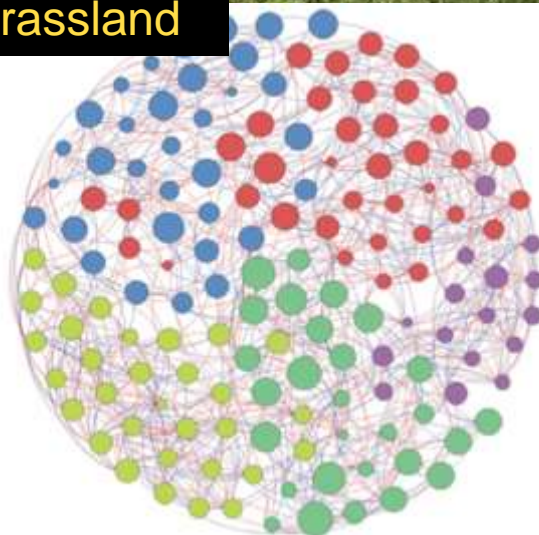
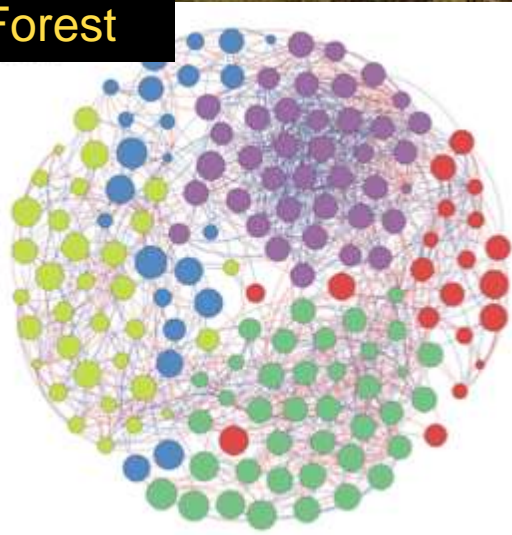




Forest



Grassland







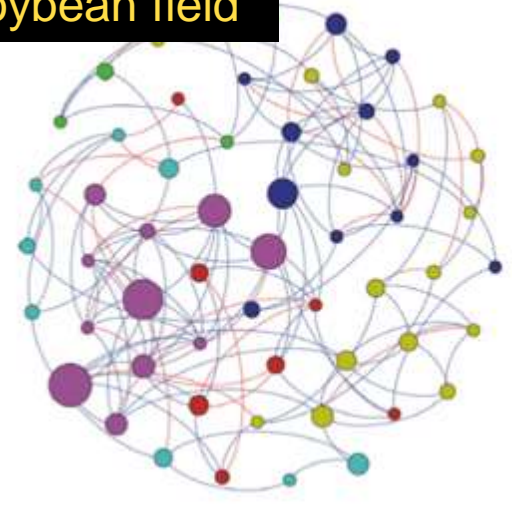
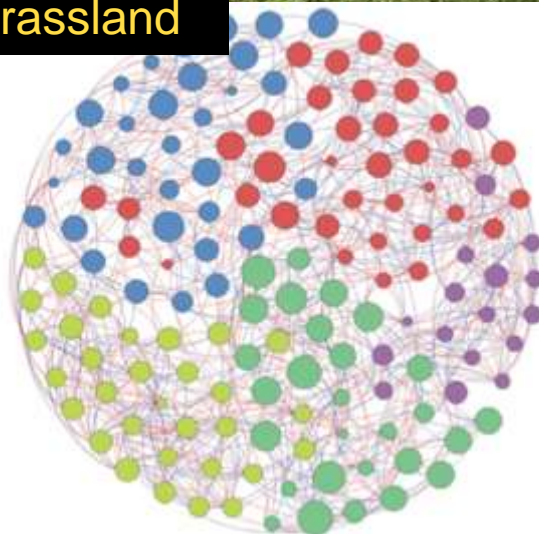
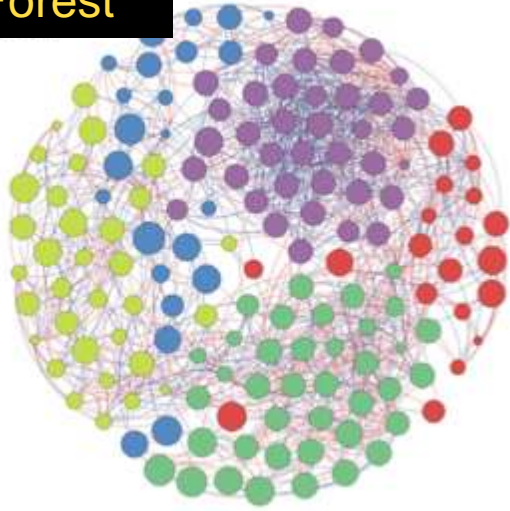
Forest



Grassland



Soybean field







Coastal Drylands of Peru



# Agroecology: synergies between crops, trees and livestock



Coastal Drylands of Peru



# Agroecology: synergies between crops, trees and livestock



Coastal Drylands of Peru



# Agroecology: synergies between crops, trees and livestock



Coastal Drylands of Peru



# Agroecology: synergies between crops, trees and livestock



Coastal Drylands of Peru



# Agroecology: synergies between crops, trees and livestock



Coastal Drylands of Peru



# Agroecology: synergies between crops, trees and livestock



	SOTO BOSQUE	CROTA LARIA	MAIZ
LOMBRICES	2	16	13
ISOPODOS	17	7	39
NEMATODOS	6	2	6
OTROS	9	13	1
TOTAL/mu <sup>2</sup>	34	38	59
N. GRUPOS	6	9	6
<hr/>			
m/m <sup>2</sup>	544	608	944



Coastal Drylands of Peru



# Crop diversification

# Agroecological intensification (Argentina)

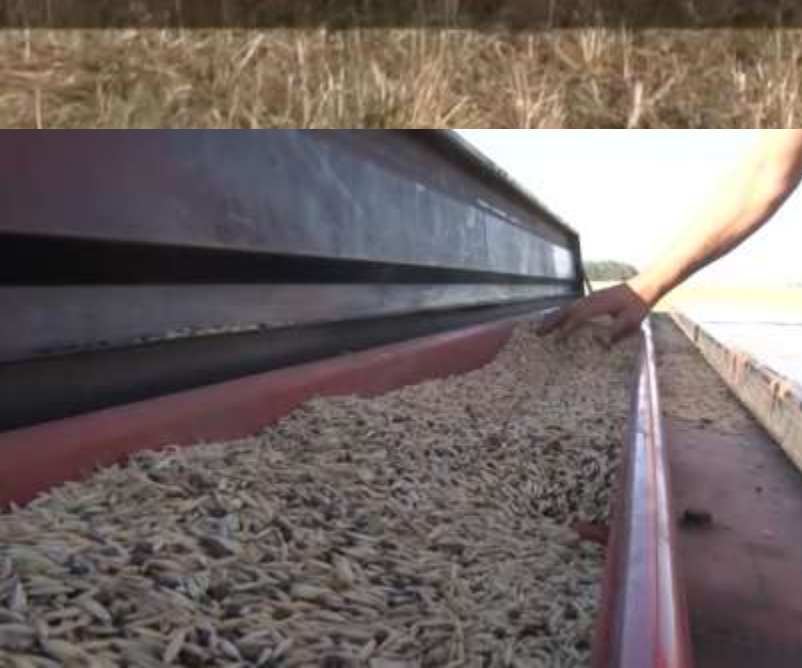


SUPERFICIE: 650 Has

186 has DE BAJOS

152 has DE CERROS

297 has DE SUELOS AGRÍCOLAS



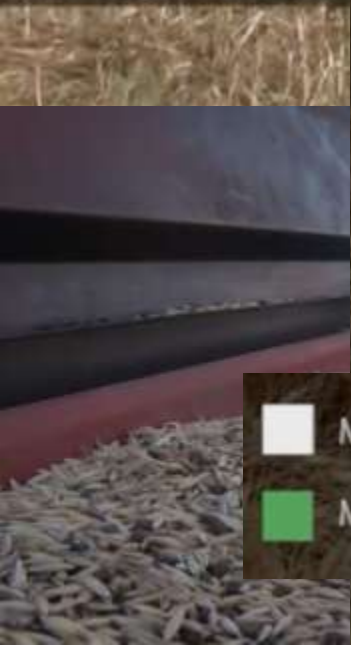
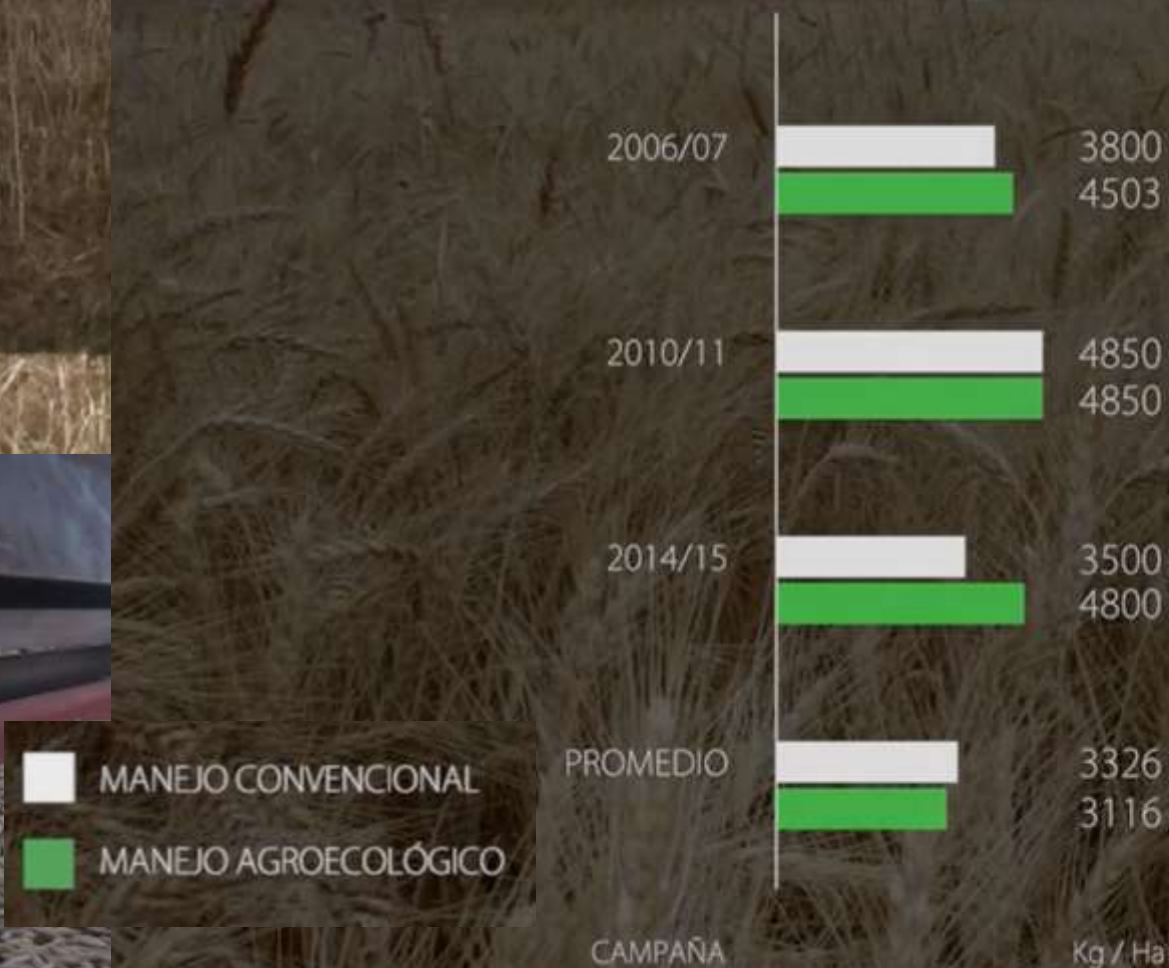
Yo desde que estoy acá trabajando, siempre que implanté un trigo o algún cereal para cosechar, siempre lo implanté con tréboles.

JUAN KIEHR  
PRODUCTOR AGROECOLÓGICO

# Agroecological intensification (Argentina)



## Wheat production (kg/ha)

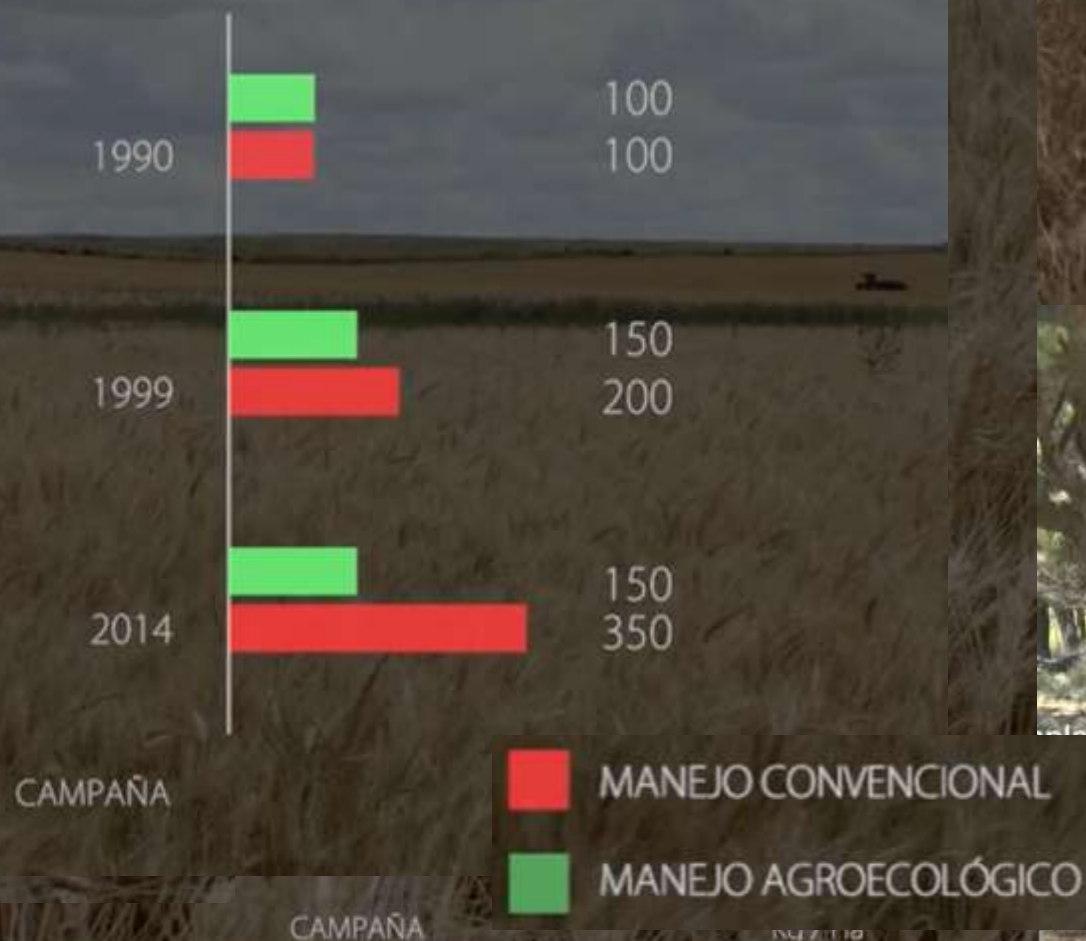


AN KIEHR  
AGROECOLÓGICO



# Agroecological intensification (Argentina)

## Production costs (US\$/ha)



planté un trigo  
tréboles.

KIEHR  
ECOLÓGICO



# Ecological infrastructure in agricultural landscapes

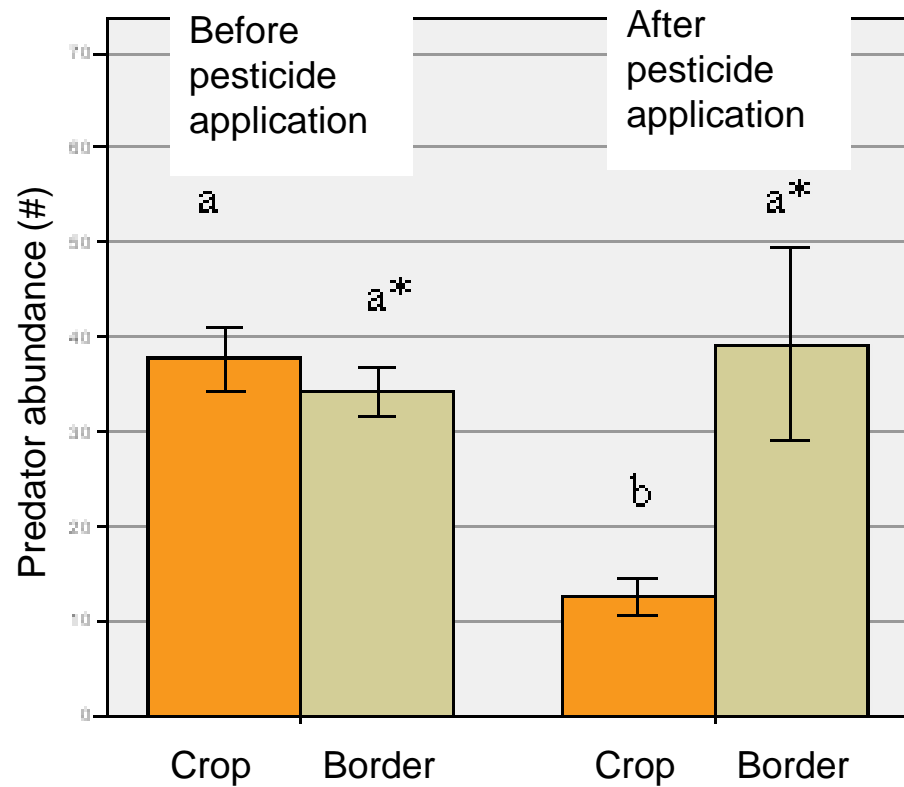


Effect of habitat loss is more important than the effect of pesticide use



# Ecological infrastructure in agricultural landscapes

Predator abundance (Varni et al., 2007)



Effect of habitat loss is more important than the effect of pesticide use



# Ecological infrastructure in agricultural landscapes

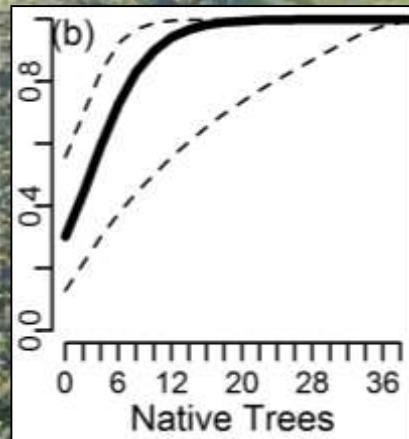


Effect of habitat loss is more important than the effect of pesticide use

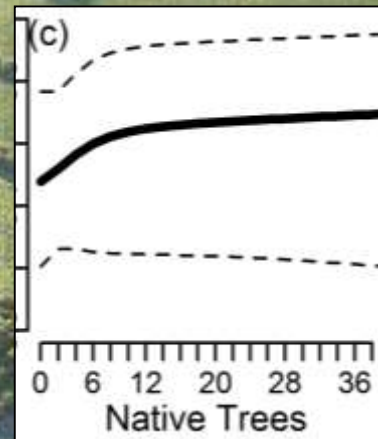


# Ecological infrastructure in agricultural landscapes

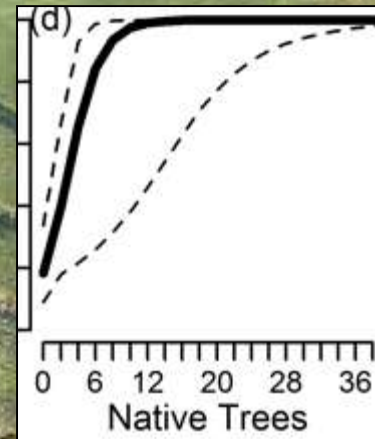
Occupancy



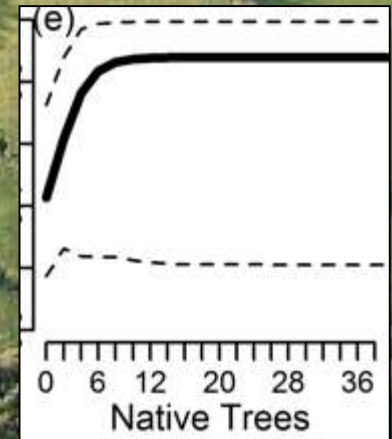
Granivore foliage gleaners



Ground nesting Granivore foliage gleaners



Insectivore foliage gleaners



Insectivore aerial foragers and salliers



Goijman, 2014

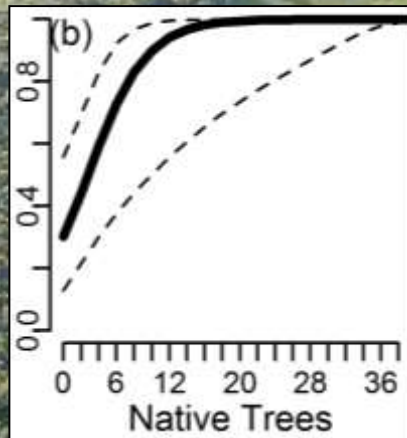
Effect of habitat loss is more important than the effect of pesticide use



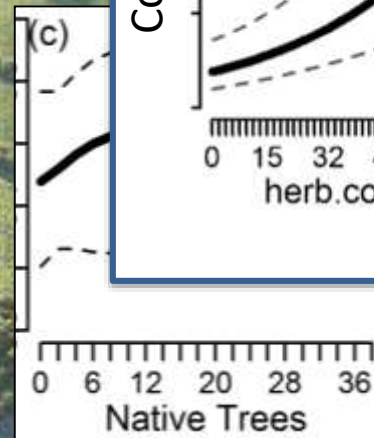
# Ecological infrastructure in agricultural landscapes

## Estructura del borde vs. diversidad de artrópodos consumidos

Occupancy



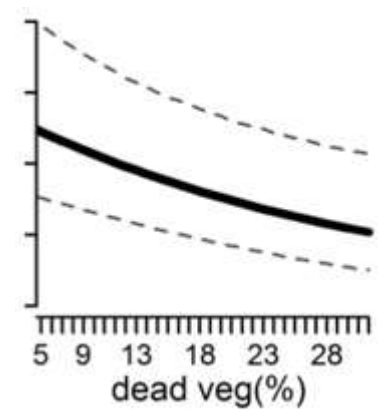
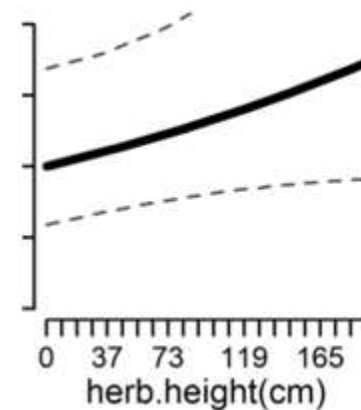
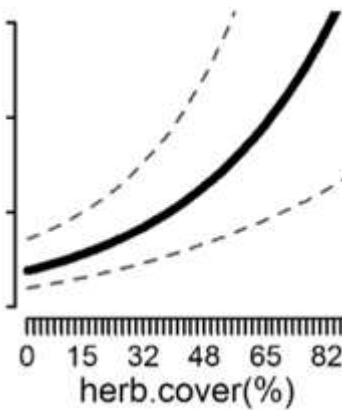
Granivore foliage gleaners



Ground nesting Granivore foliage gleaners



Counts



Insectivore foliage gleaners



Insectivore aerial foragers and salliers



Goijman, 2014

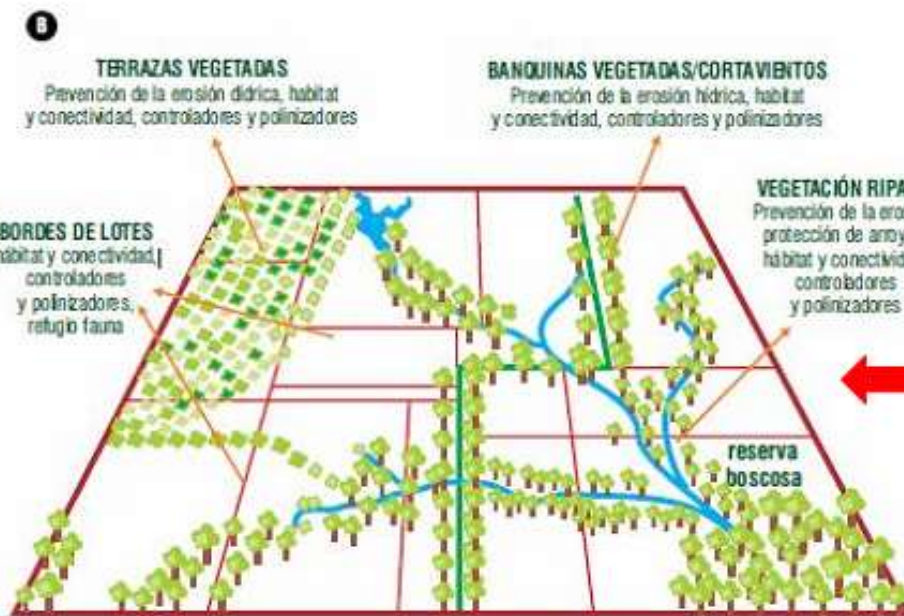
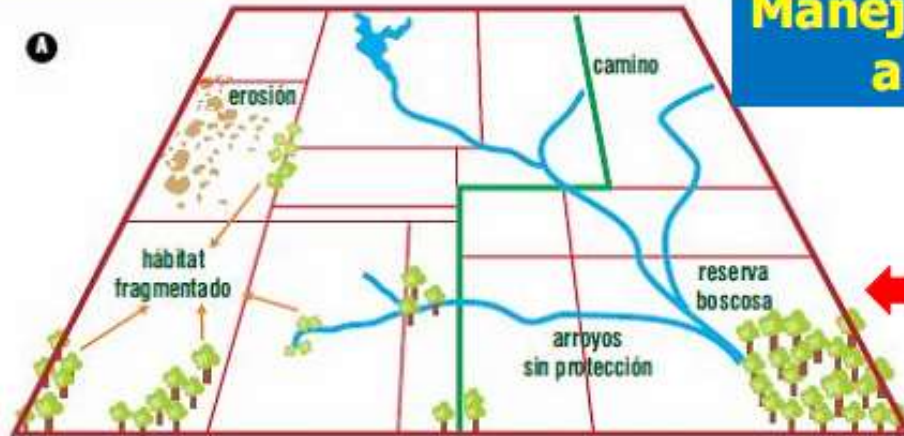
Effect of habitat loss is more important than the effect of pesticide use



# Ecological infrastructure in agricultural landscapes

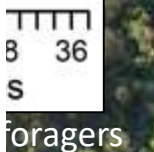
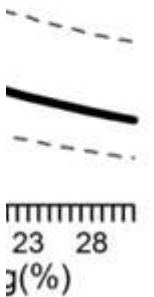
## How to design an ideal landscape?

### Manejo de bordes y terrazas a escala de paisaje



- Sin banquetas vegetadas
- Sin vegetación riparia
- **Resultado:** Sedimentación y turbidez por erosión y contaminación por escorrentía de agroquímicos
- Escases de hábitats

- Con cortavientos y banquetas vegetadas,
- Vegetación riparia,
- Terrazas vegetadas
- Bordes de lotes
- **Resultado:** aumento heterogeneidad ambiental, menor fragmentación y reserva de bosque conectada al paisaje
- Mayor disponibilidad de hábitats



n, 2014

icide use



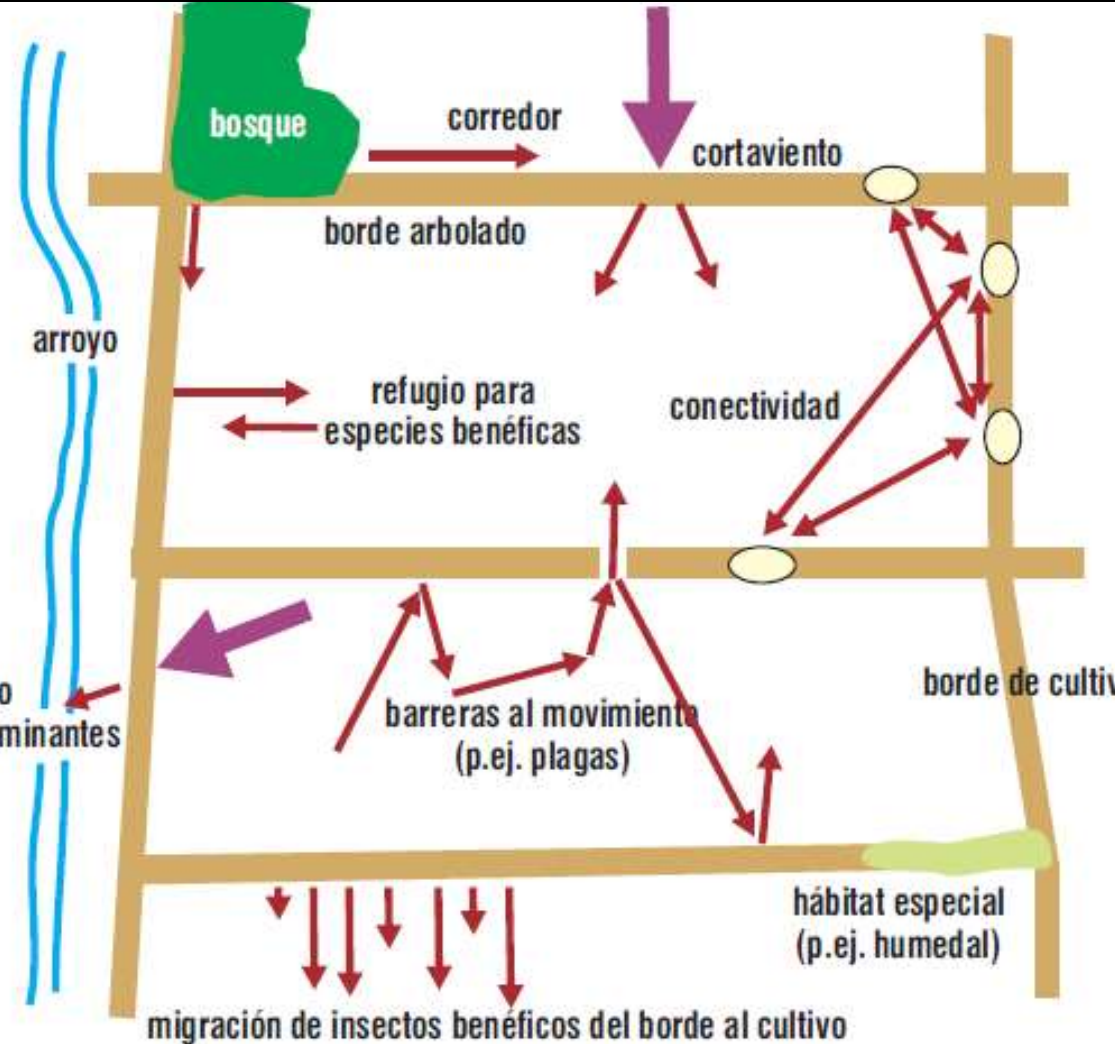
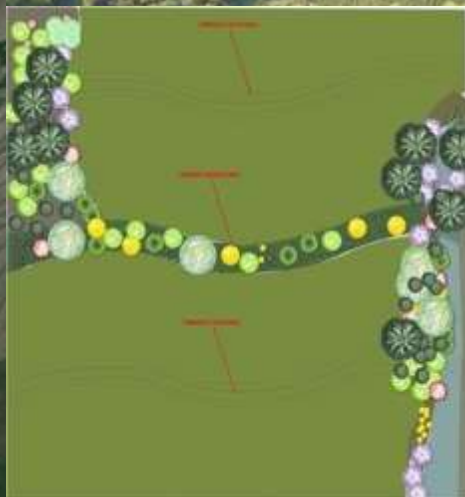
# Landscape-level innovation





# Landscape-level innovation

## Ecosystem services from linear landscape elements





# Landscape-level innovation

## Ecosystem services from linear landscape elements

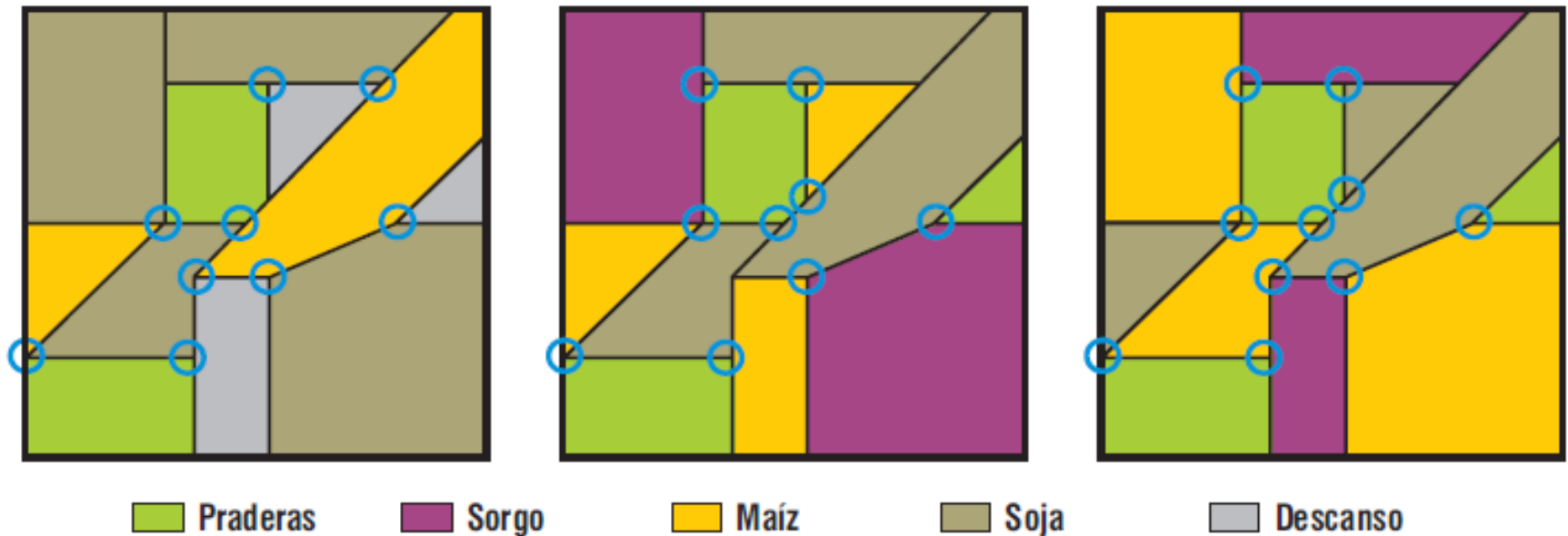




# Landscape-level innovation

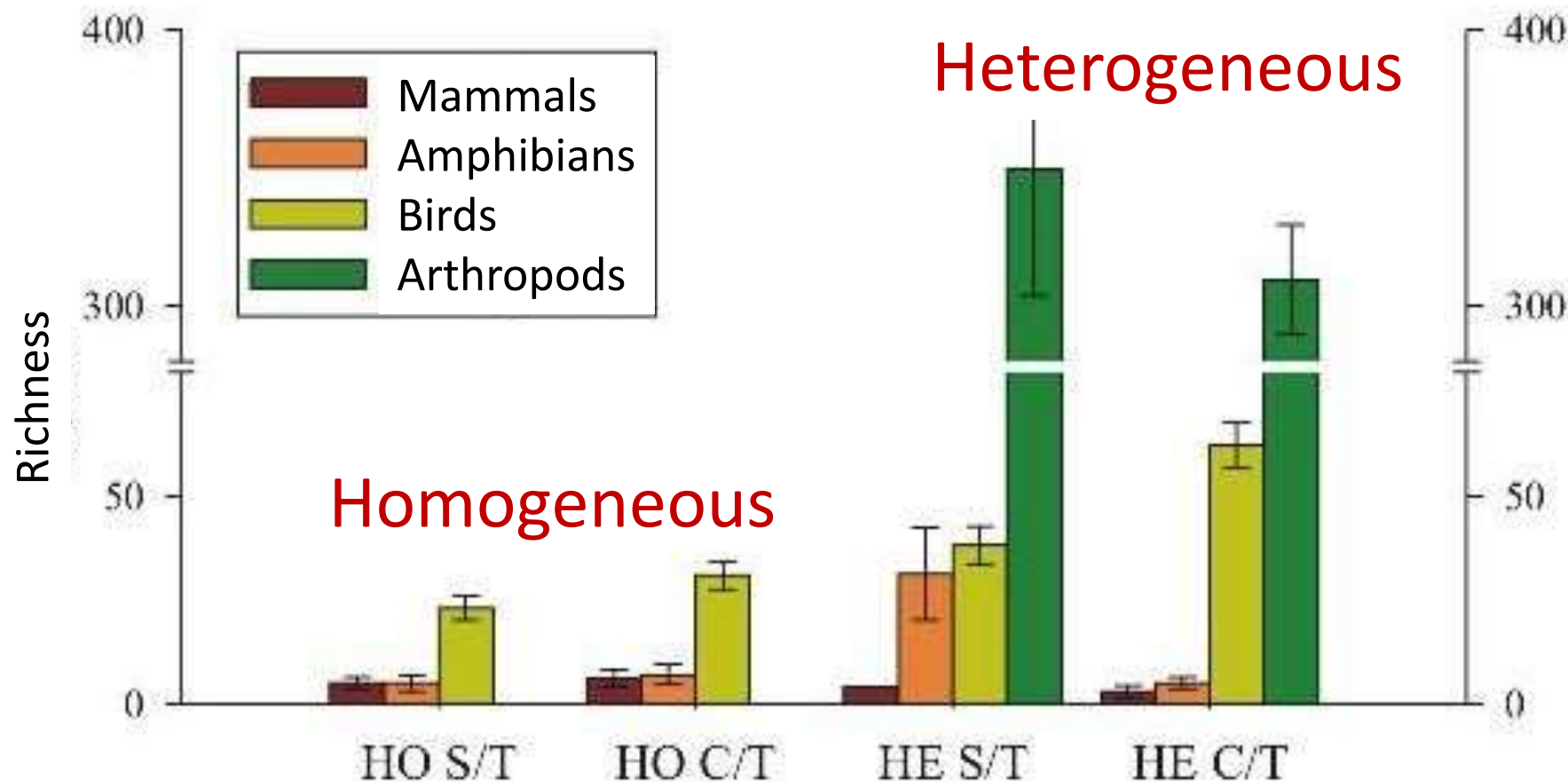


## Spatial and temporal heterogeneity



# Landscape-level innovation

## Greater species diversity (Zacagnini et al., 2013)

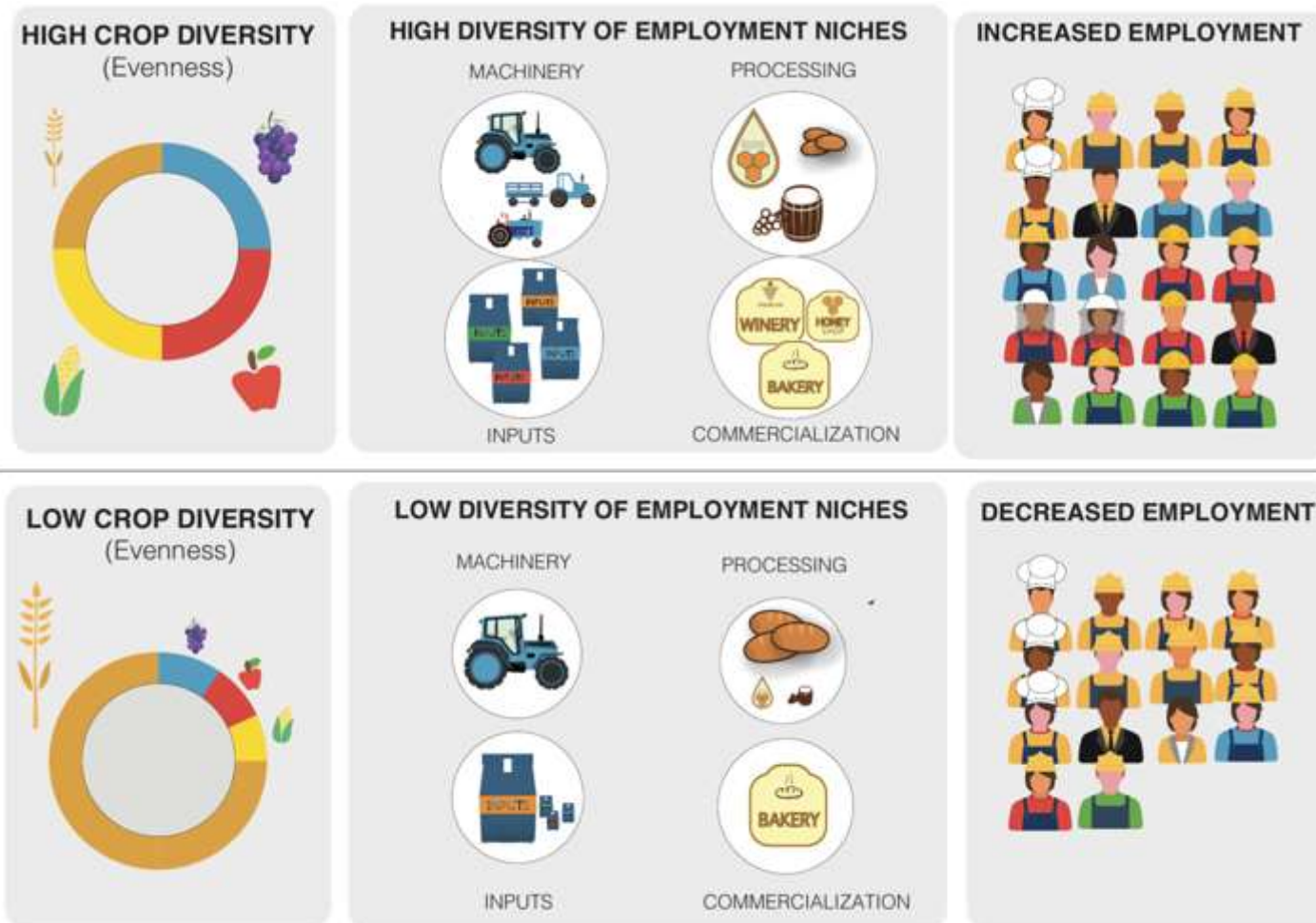


**Figura 1.** Riqueza de especies estimada por el índice Jackknife modificado. HO: matriz homogénea, HE: matriz heterogénea, S/T: lotes sin terrazas, C/T: lotes con terrazas.



Social aspects

# Diversification and employment





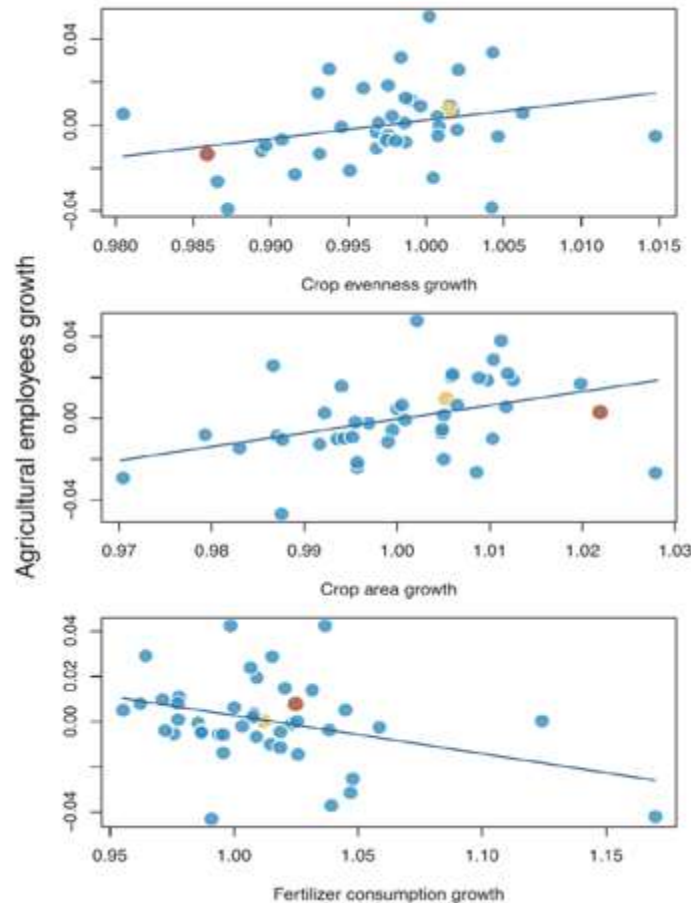
# Diversifi

t

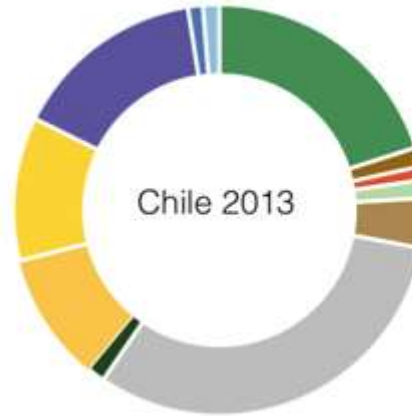
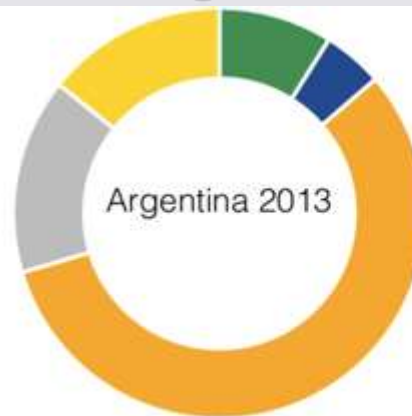
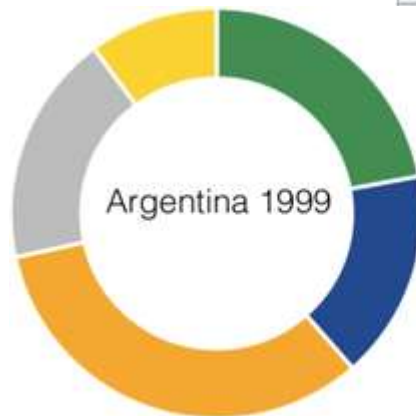
**HIGH CROP DIVERSITY**  
(Evenness)



**LOW CROP DIVERSITY**  
(Evenness)



# Diversifi





# Markets and Diversification





# Women and agrobiodiversity





# Women and agrobiodiversity





# Women and agrobiodiversity





# Women and agrobiodiversity



- Los **ingresos** producidos por 1 ha de quinta equivalen a al menos 2 ha de café, sin considerar los costos de producción, que son mayores en el café y casi cero en la quinta
- **1 ha de quinta produce 3 a 15 salarios mínimos por año**
- Mayor tenor de nutrientes en suelos de quintas
  - (Monteiro, 2018)



*Transition or transformation?*

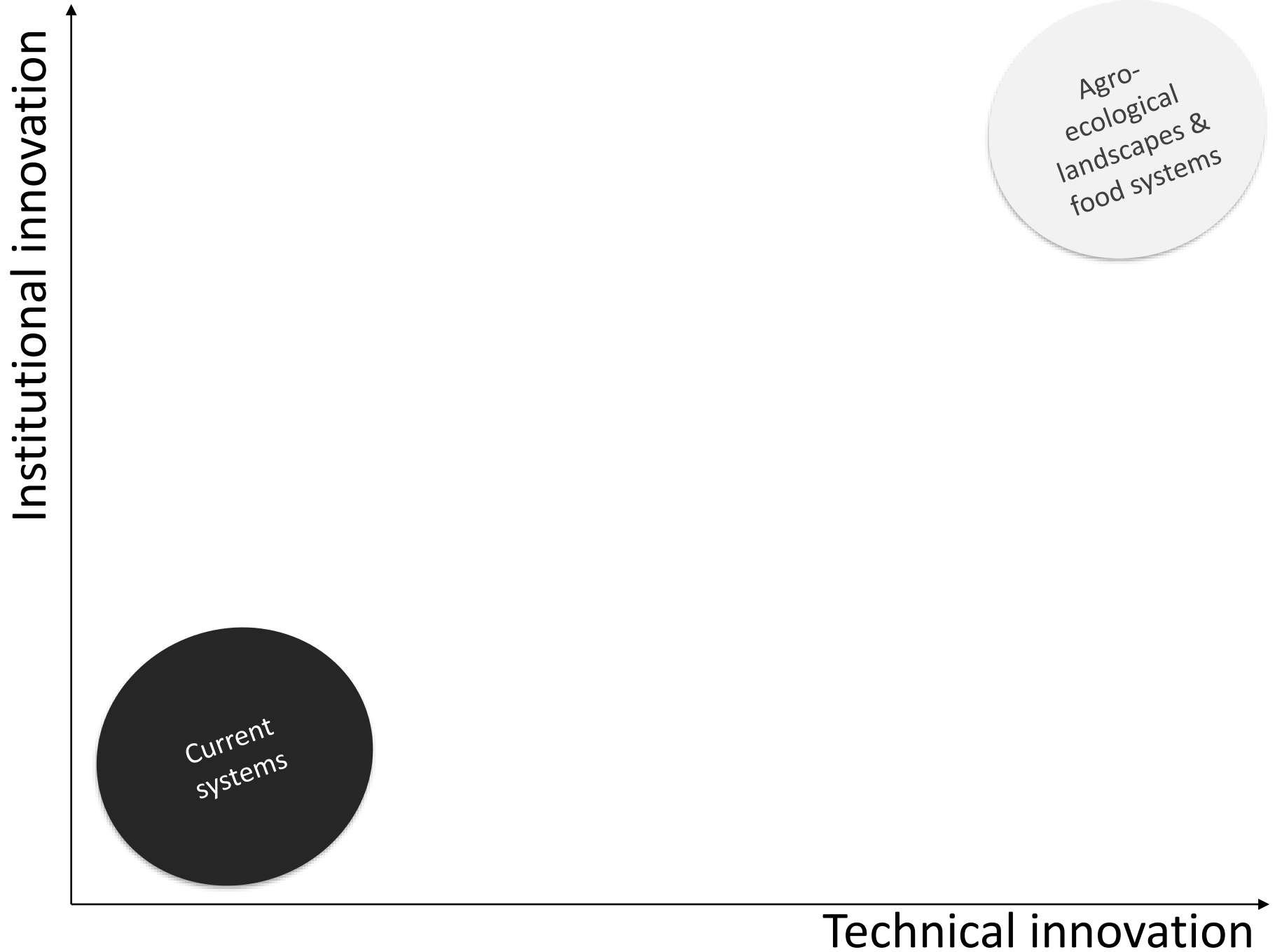
Institutional innovation



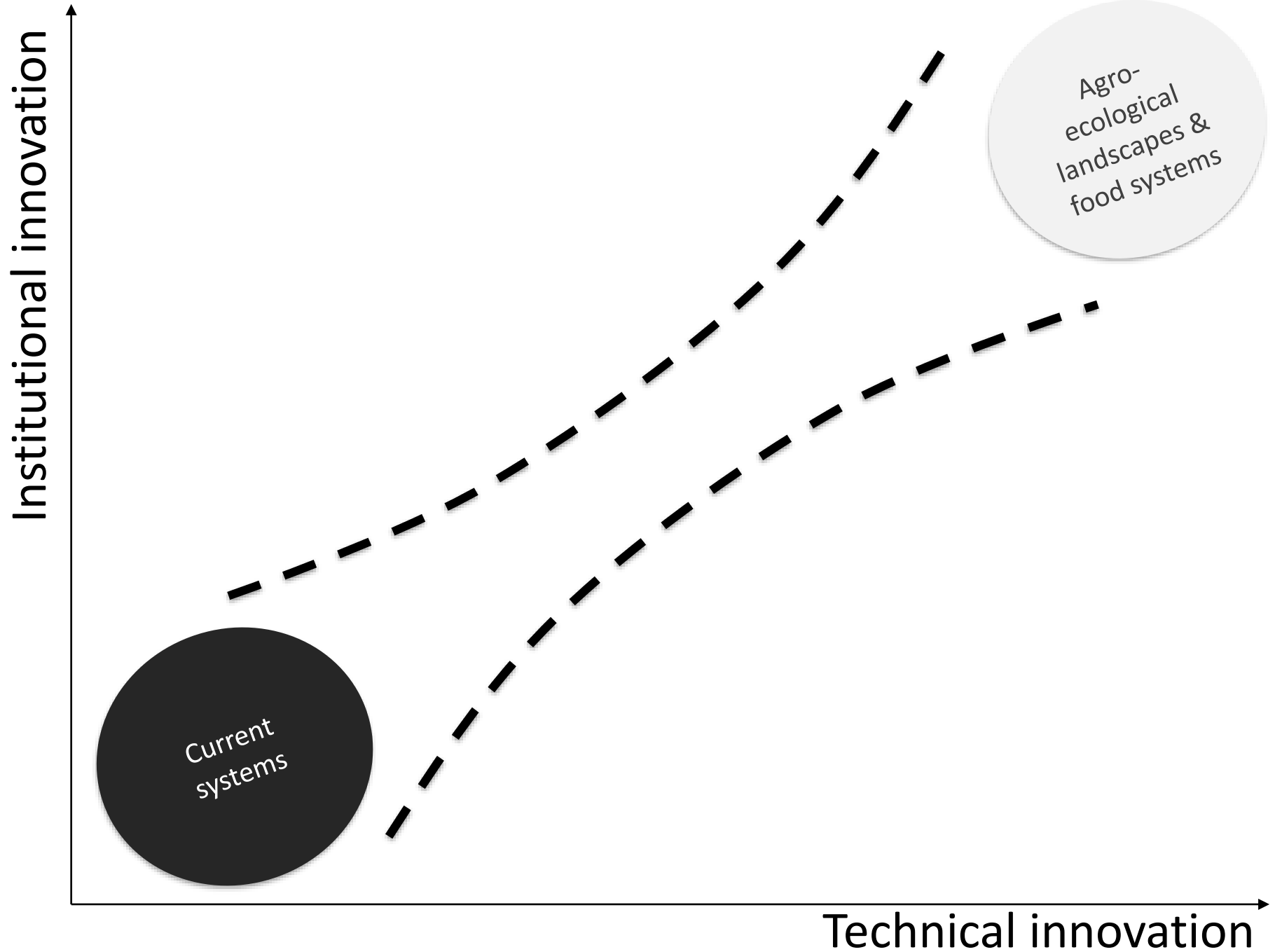
Technical innovation



*Transition or transformation?*

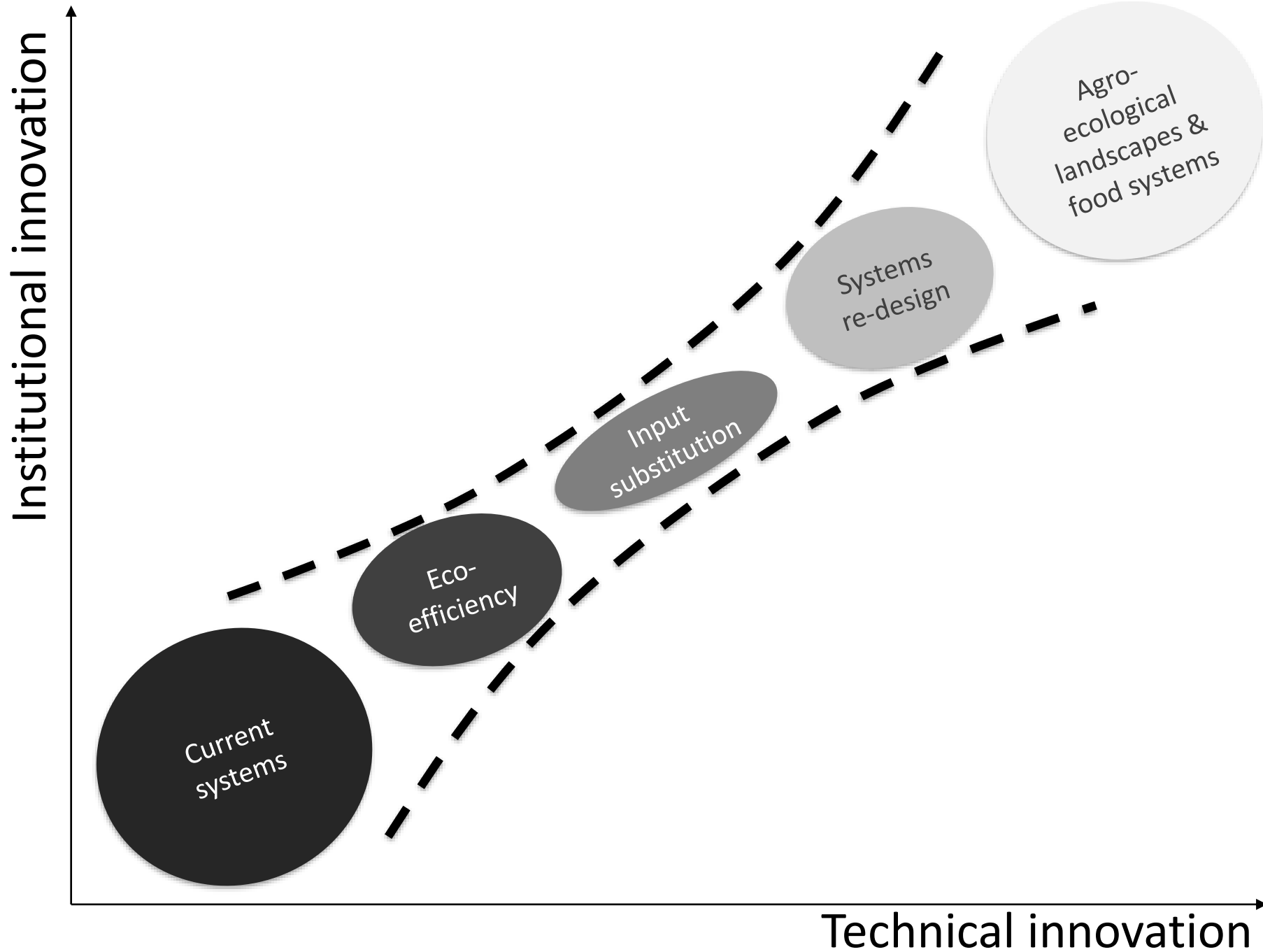


*Transition or transformation?*

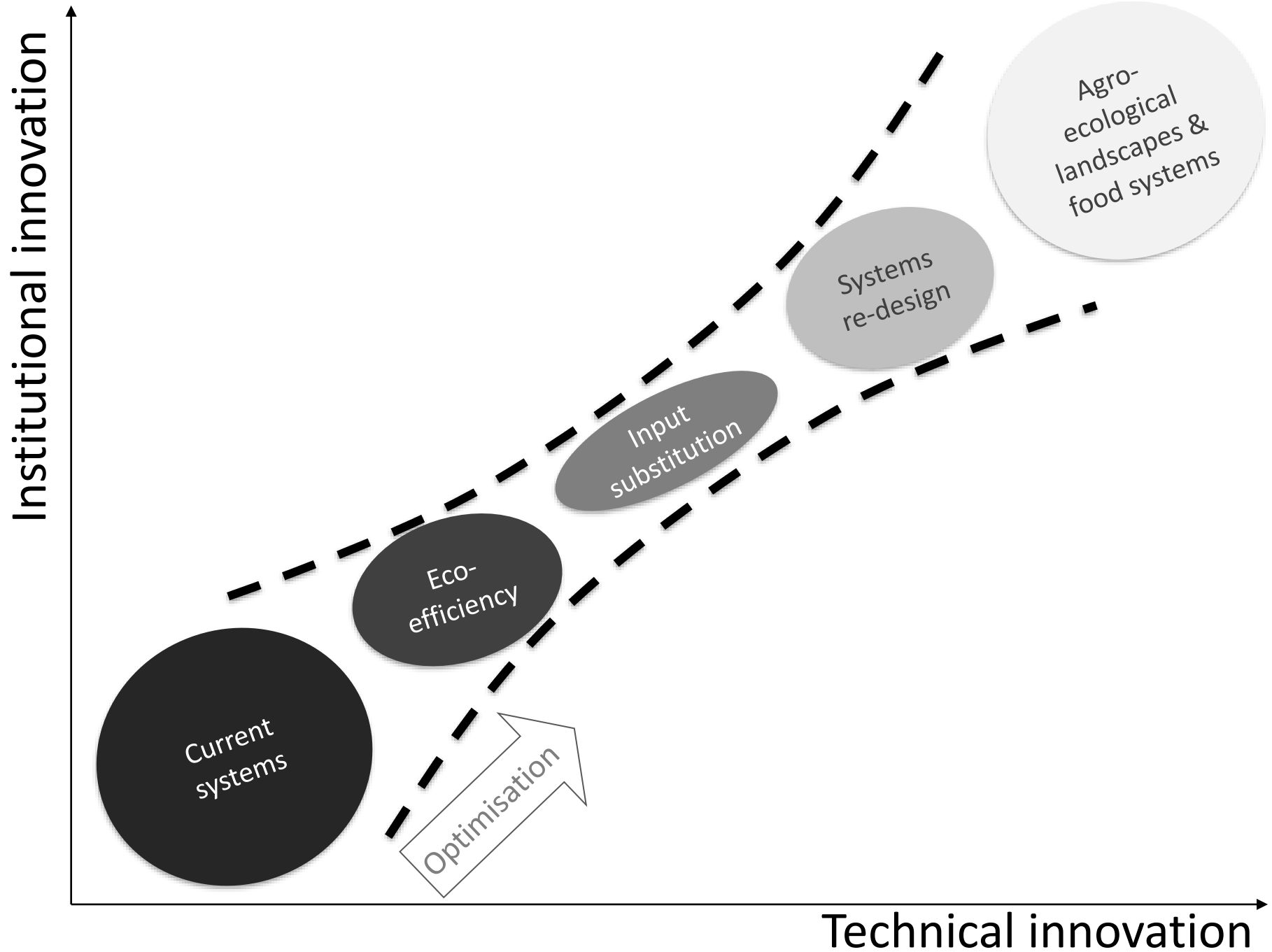




*Transition or transformation?*

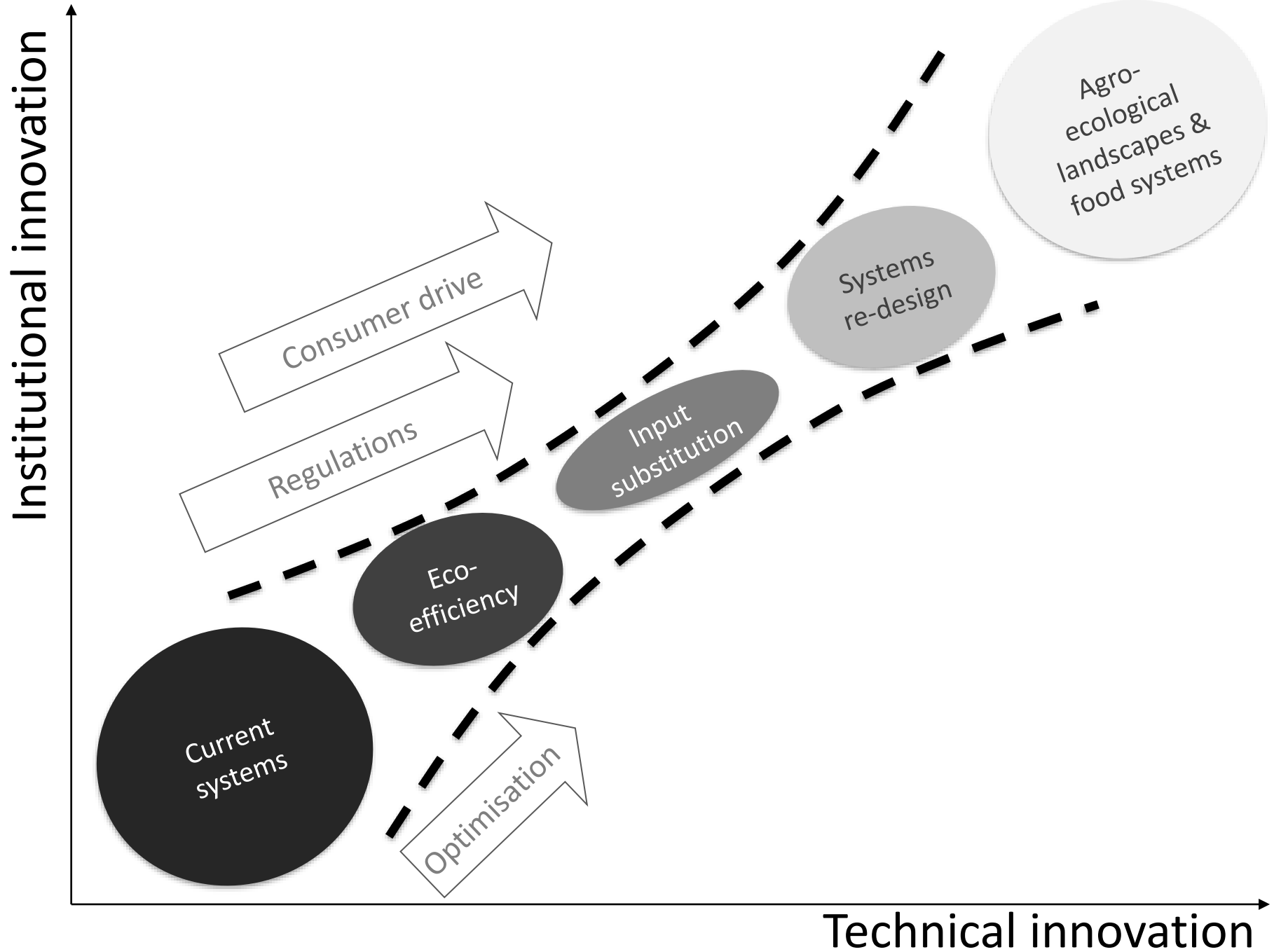


*Transition or transformation?*

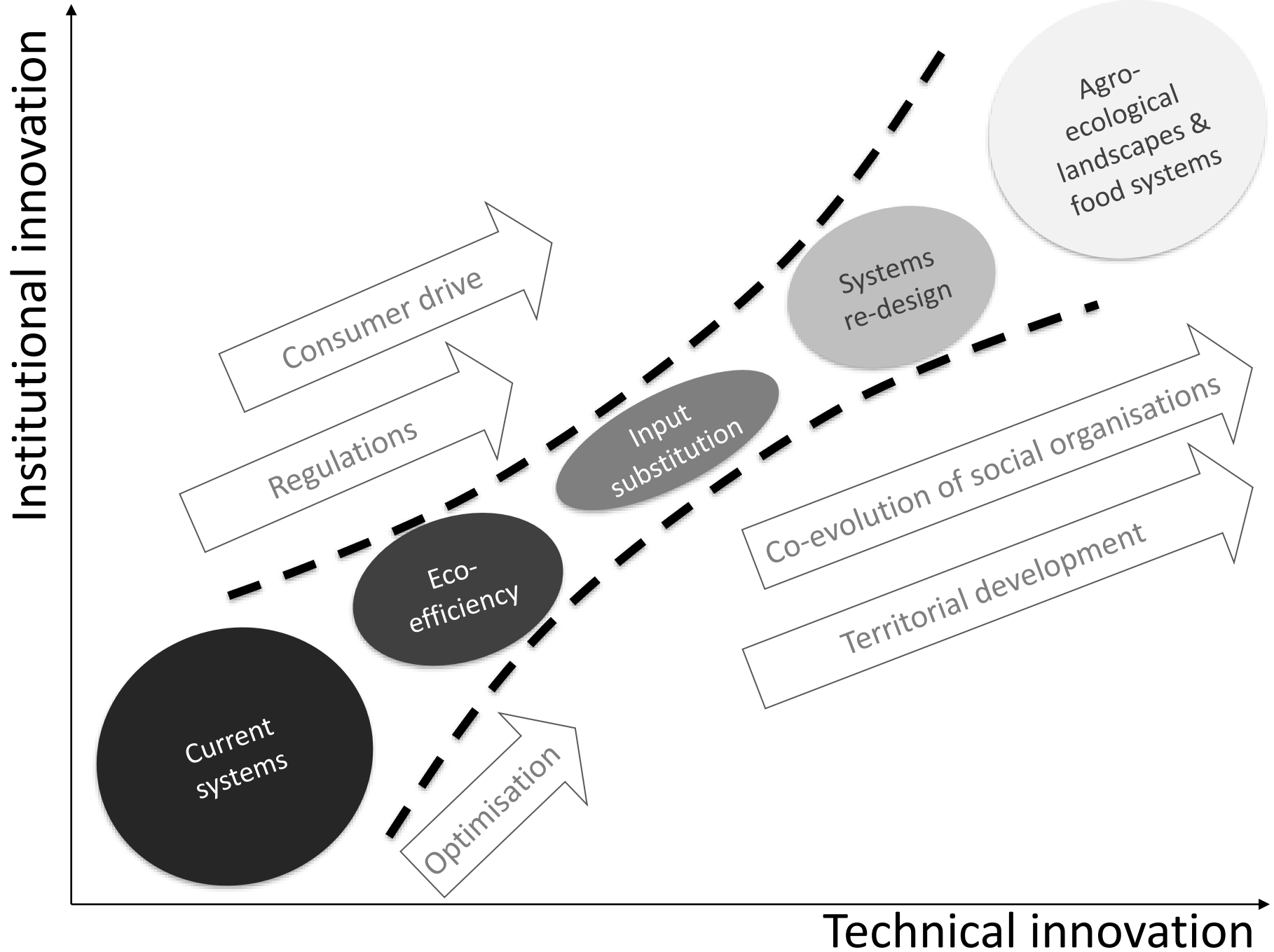




*Transition or transformation?*

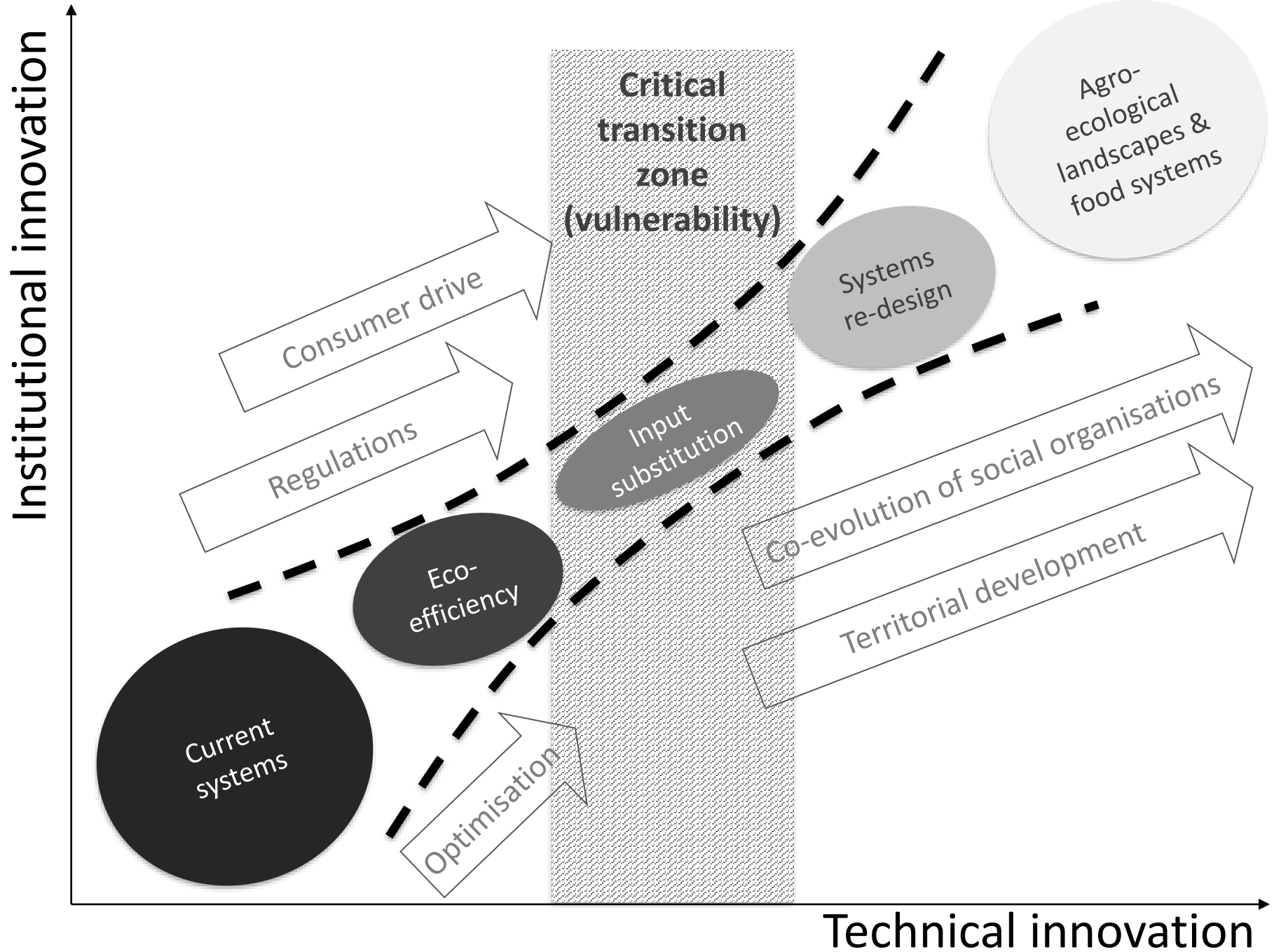


*Transition or transformation?*





*Transition or transformation?*



# Thanks for your attention



Proefboerderij Kollumerwaard in  
Munnekezijl

[www.pablotittonell.net](http://www.pablotittonell.net)

