Diversification of crops in the landscape

Systems approaches for sustainable agriculture – Part I

Brussels, 5-6 December 2016

Walter Rossing, Farming Systems Ecology

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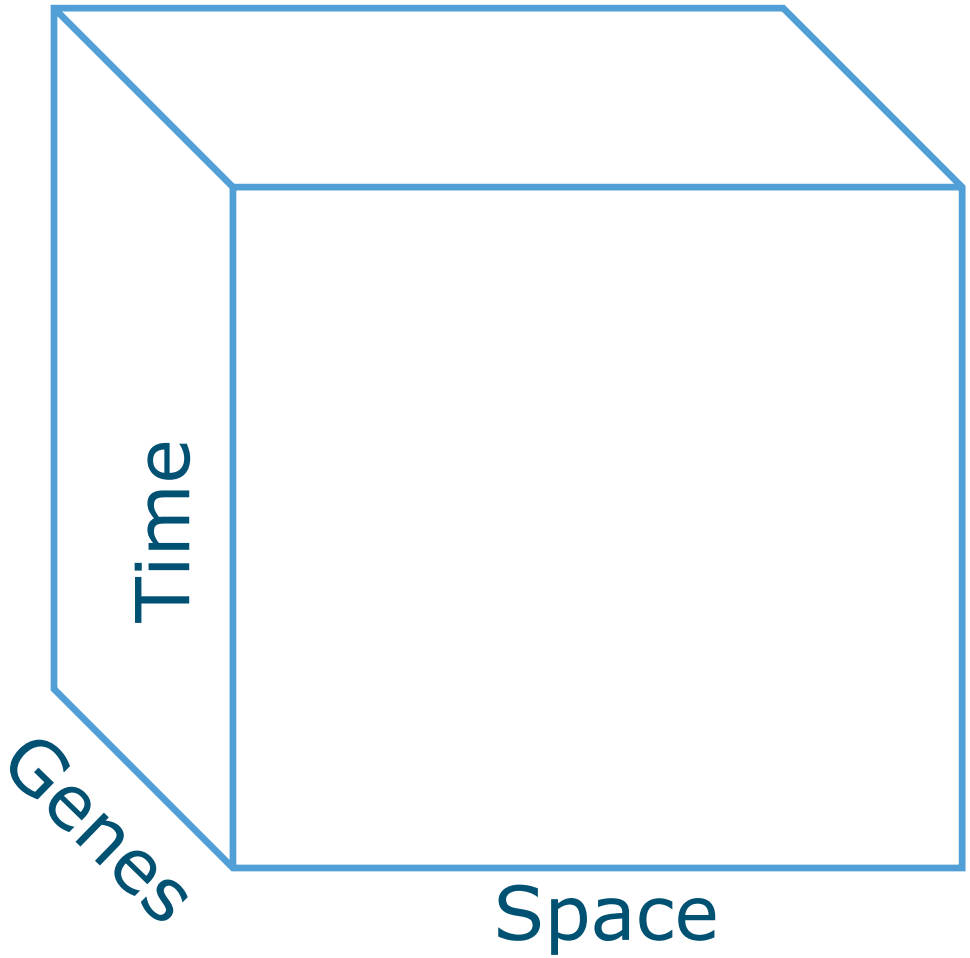
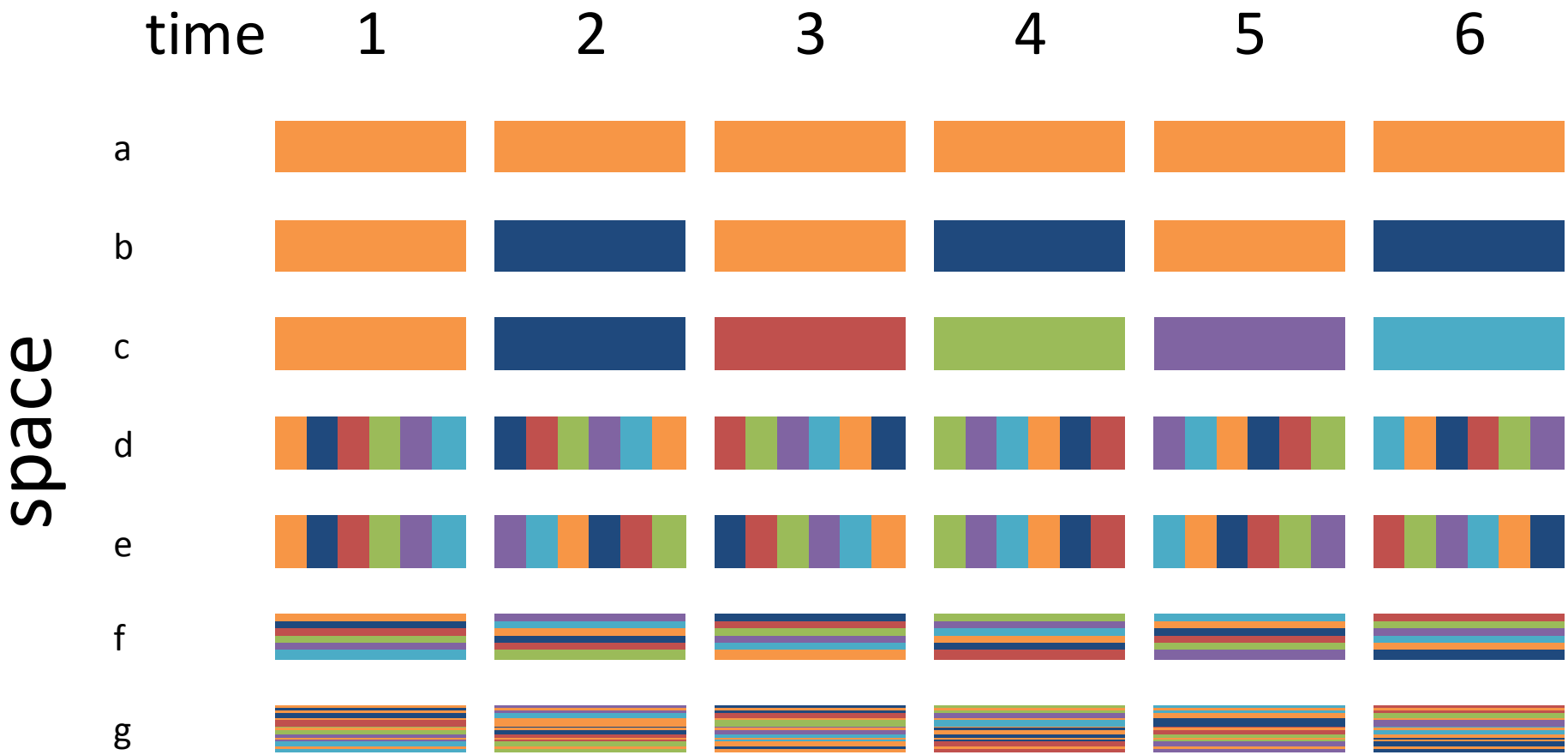
Outline

- Threats and opportunities towards sustainability
- Complexity, lock-ins and path dependencies
- Solutions, transitions, re-designs, systems approaches

Dimensions of crop diversity



Combining dimensions of diversity @farm



Different colours = different 'genes'

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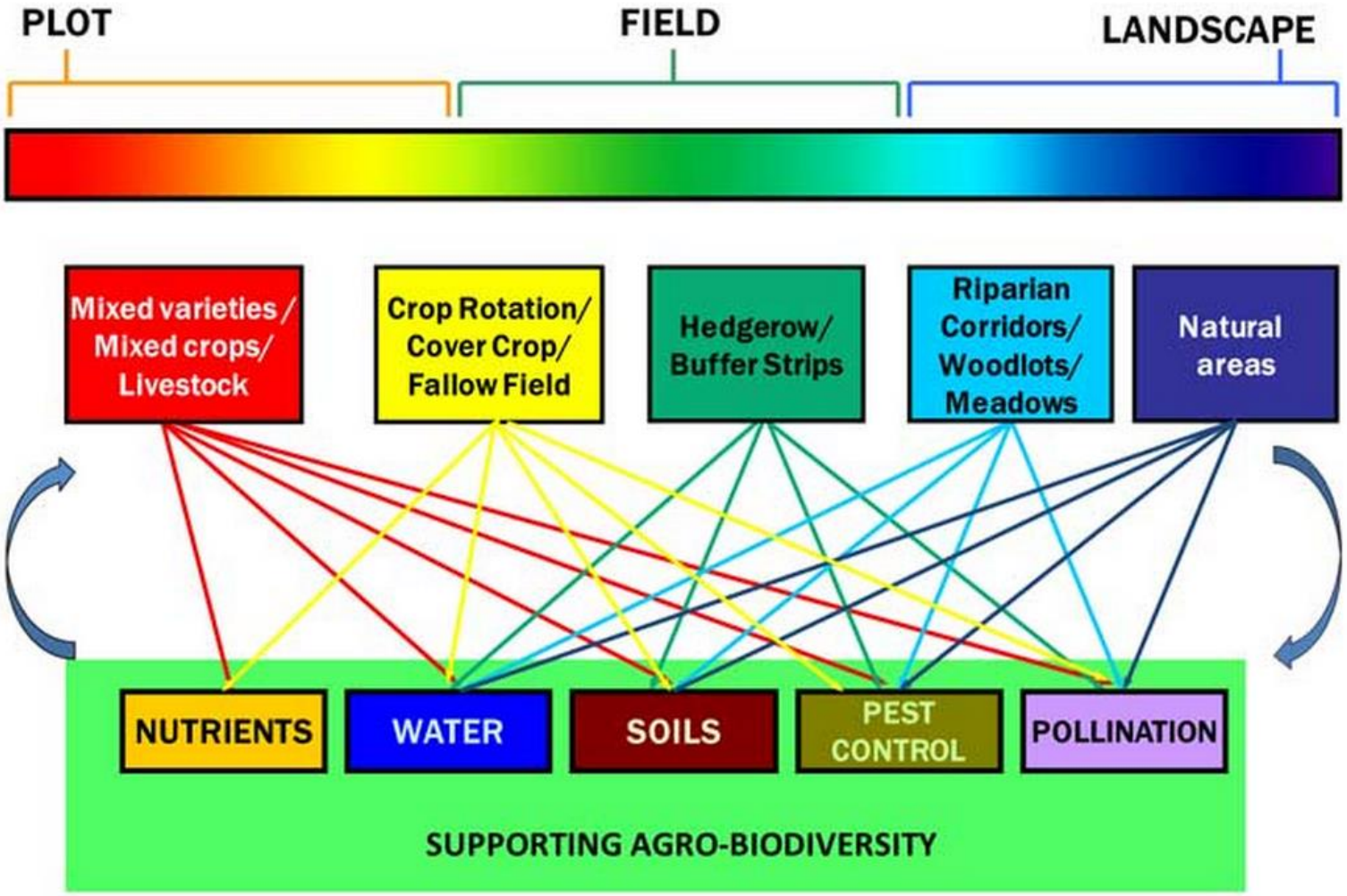
Diversity beyond the farm



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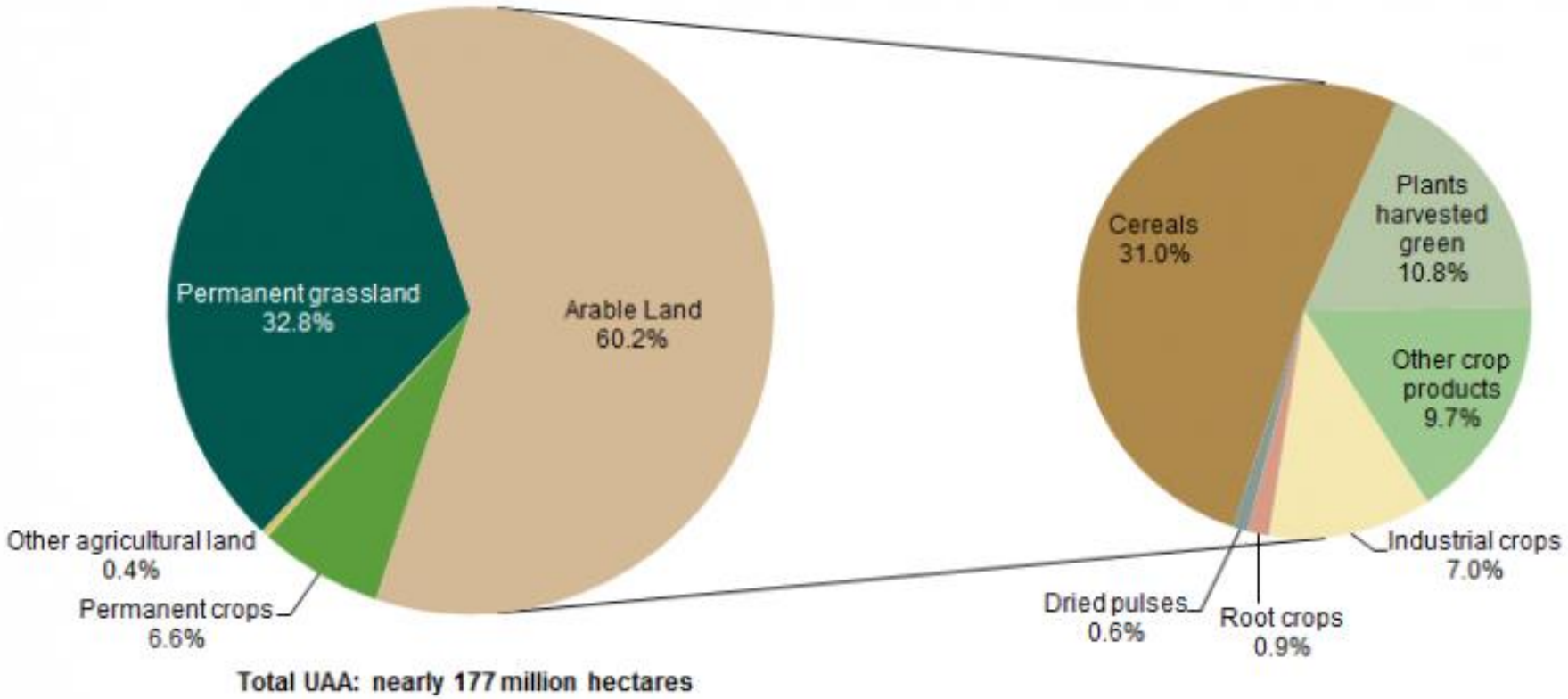
Kremen et al., 2012; Ecology and Society

Crop diversity in Europe



Eurostat database:

[wheat, barley, maize, rice], pulses, [potato, sugarbeet], [field peas, broad beans], main oil seed crops

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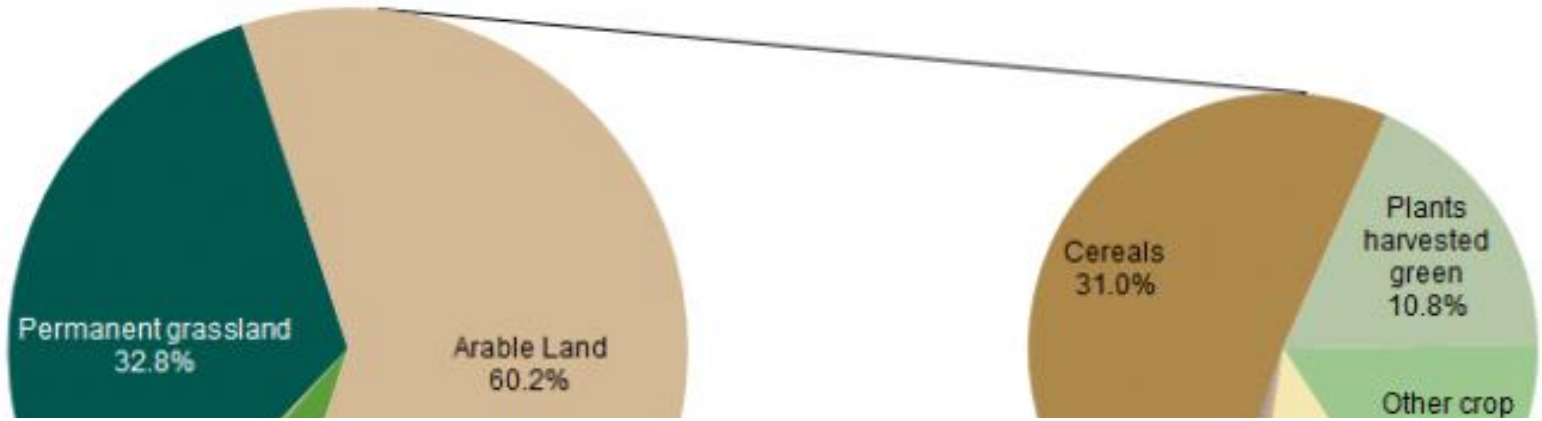
Crop diversity in Europe



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Meeting the demand for crop production: the challenge of yield decline in crops grown in short rotations

Amanda J. Bennett, Gary D. Bending, David Chandler, Sally Hilton, Peter Mills

First published: 1 June 2011 Full publication history

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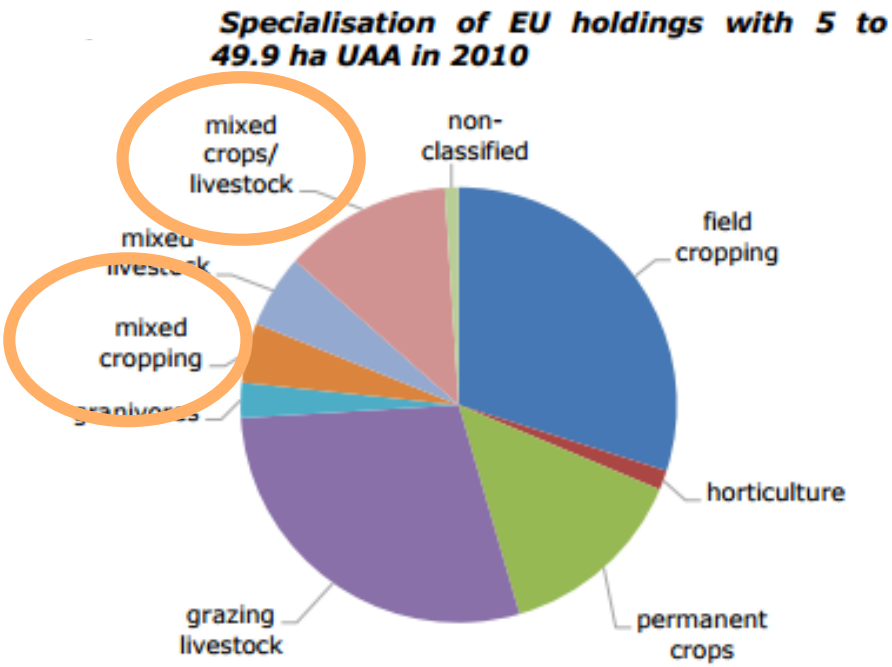
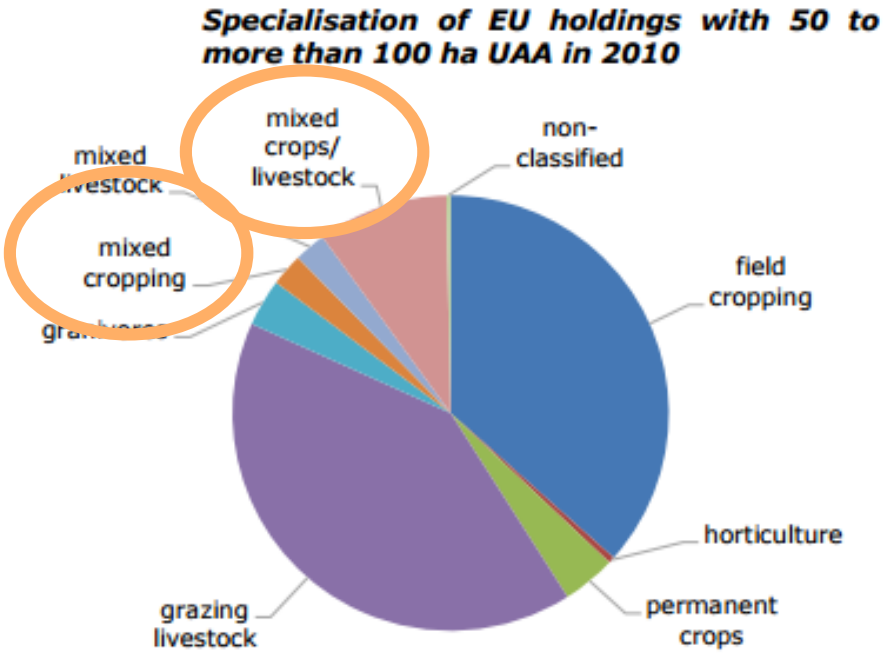
Crop diversity in Europe ~ farm size



Source: Eurostat, FSS (online data code: ef_kvftaa).



Source: Eurostat, FSS (online data code: ef_kvftaa).

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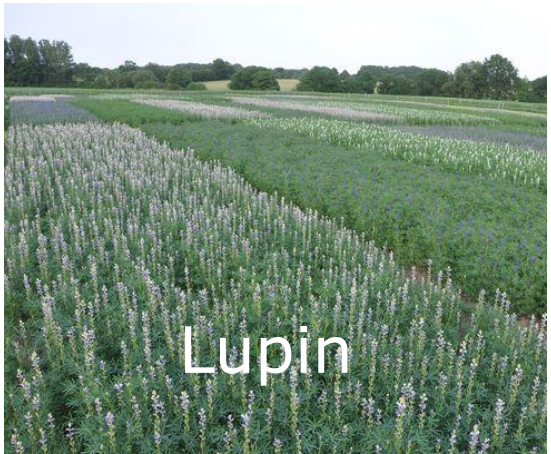
Diversity gap – growing season



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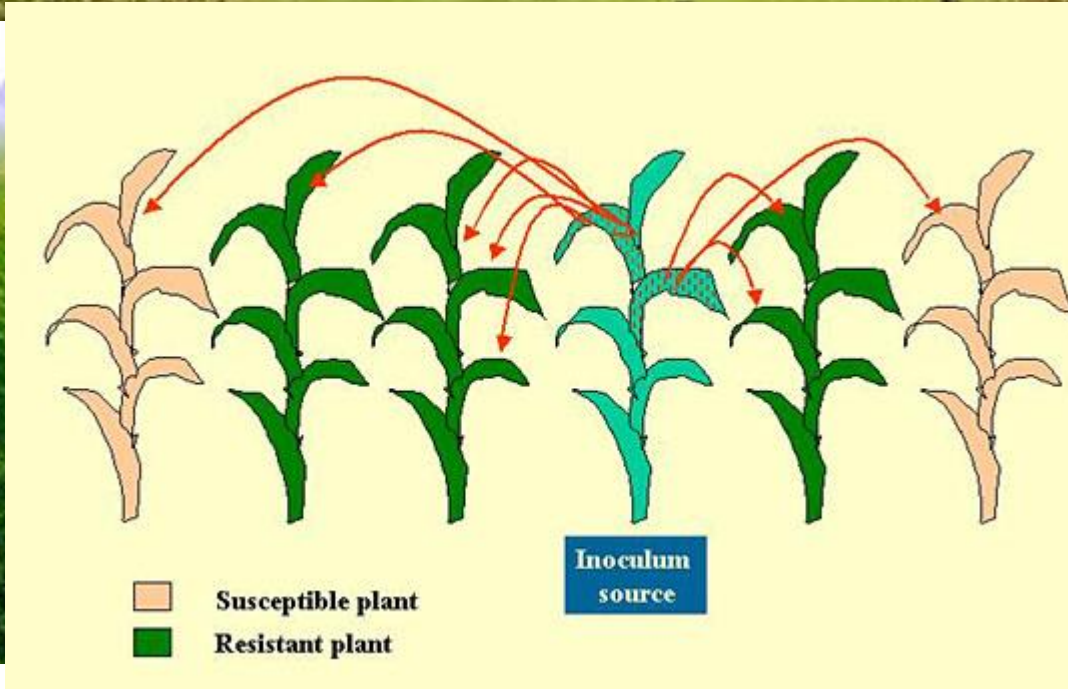
Diversity gap – off-season

Diversity gap – genetic mixtures in space



Benefits of diversity in agro-ecosystems

Indicator/ES
Biodiversity
SOM
Soil quality (phys., biol., erosion)
C-sequestration <30cm
Water holding capacity
Nutrient retention
N, P leaching
Weed control
Plant pathogen control
Energy use efficiency
Resilience to envir. disturbance

Indicator/ES
Pest control ~ yield
Pollination ~ yield
Global warming potential
Monoculture yields (org-conv)
Intensive agriculture
Developing countries

Gattinger et al., 2012. PNAS
Tuomisto et al. 2012. J. Envir. Manag.
Kremen and Miles, 2012. Ecology and Society
Ponisio et al., 2015. Proc. R. Soc. B
Seufert et al. 2012. Nature
Badgley et al., 2007. Renew. Agric. Food Syst.

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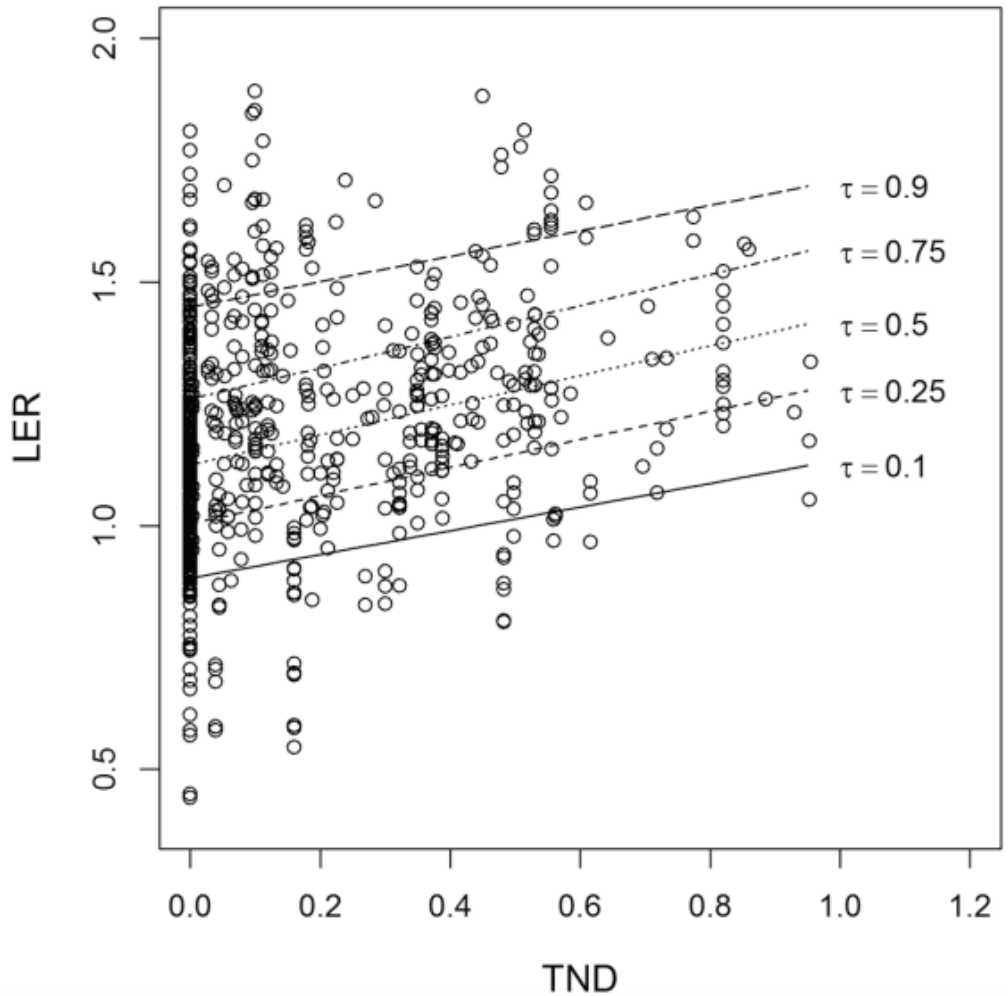
Yield benefits of diversity in space-time

LER: Fraction of yield in intercrop compared to component monocrops.

LER > 1 in 70% of cases for TND=0

LER = 1.7 in ecological systems



1 - Fraction of time crops overlap

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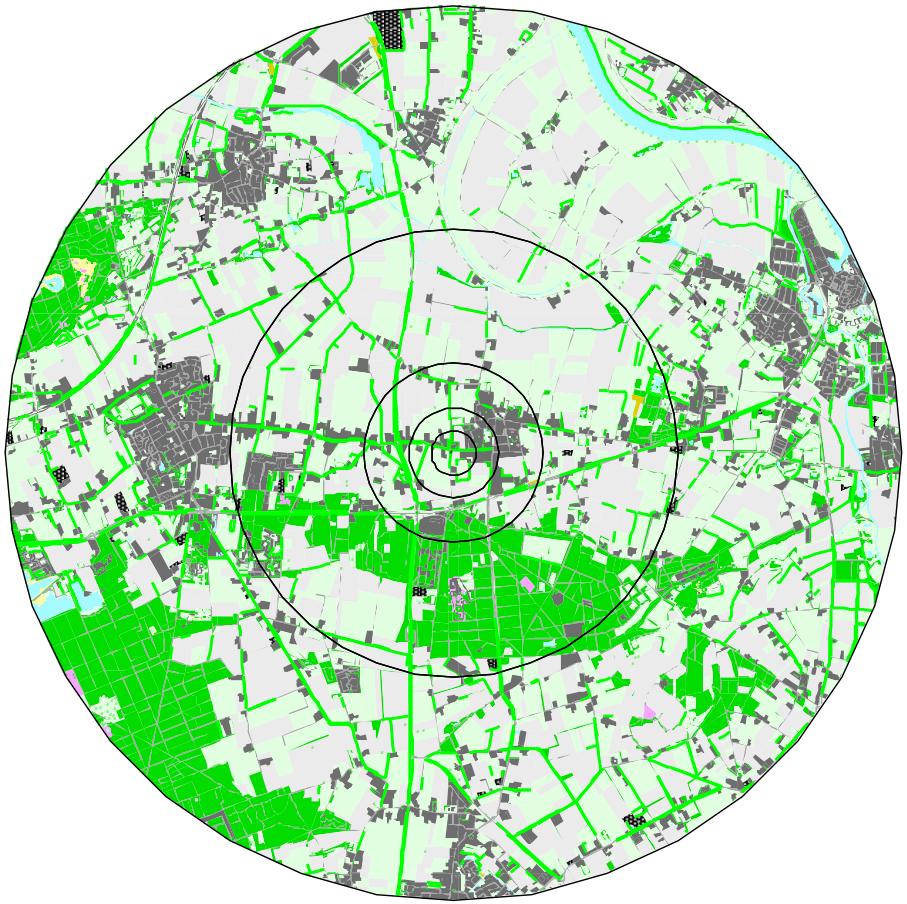
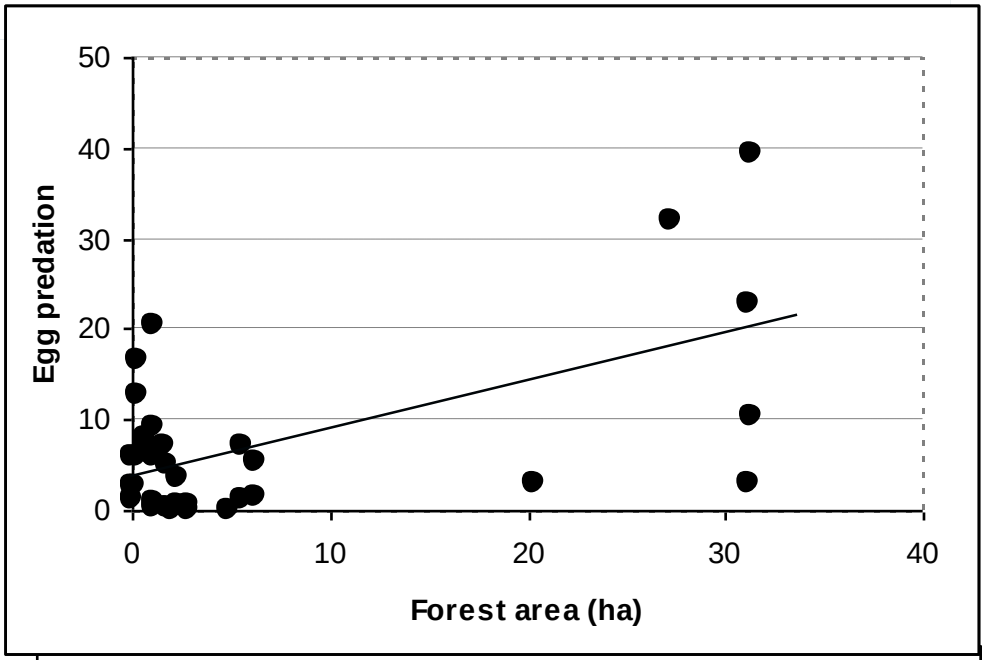
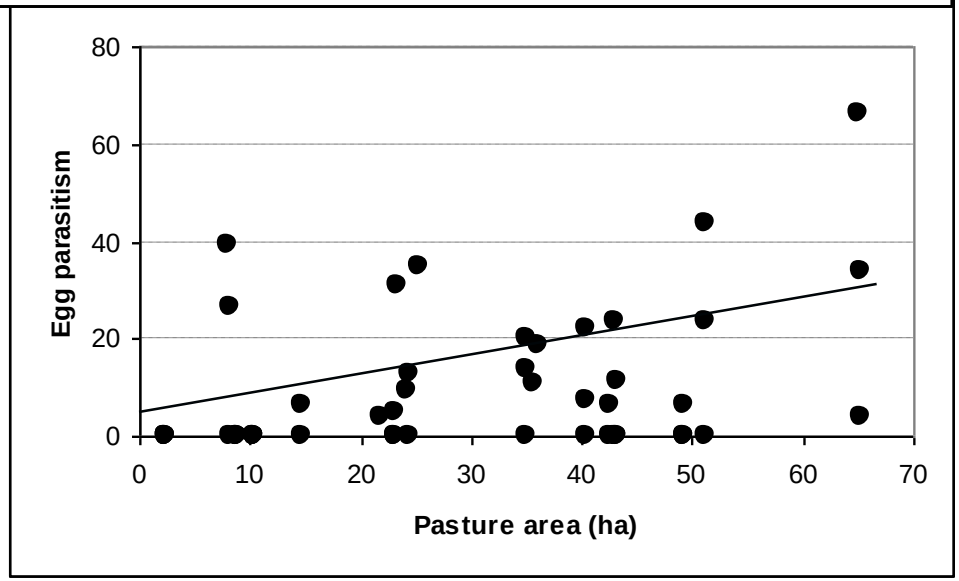
Yu et al. 2015. Agron. J.
Cardinale et al. 2007. PNAS

Environmental and landscape factors







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Bianchi et al. 2005. Agric. Ecosyst. Environ.

Lock-in on uniform agro-systems

- Dominant technology excludes competing alternatives
- Path dependency: initial conditions shape success
- Provides stability, but excludes superior technologies

Research Policy 38 (2009) 971–983

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

How agricultural research systems shape a technological regime that develops genetic engineering but locks out agroecological innovations

Gaëtan Vanloqueren*, Philippe V. Baret

Earth and Life Institute, Université catholique de Louvain, Belgium

Lock-in on uniform agro-systems

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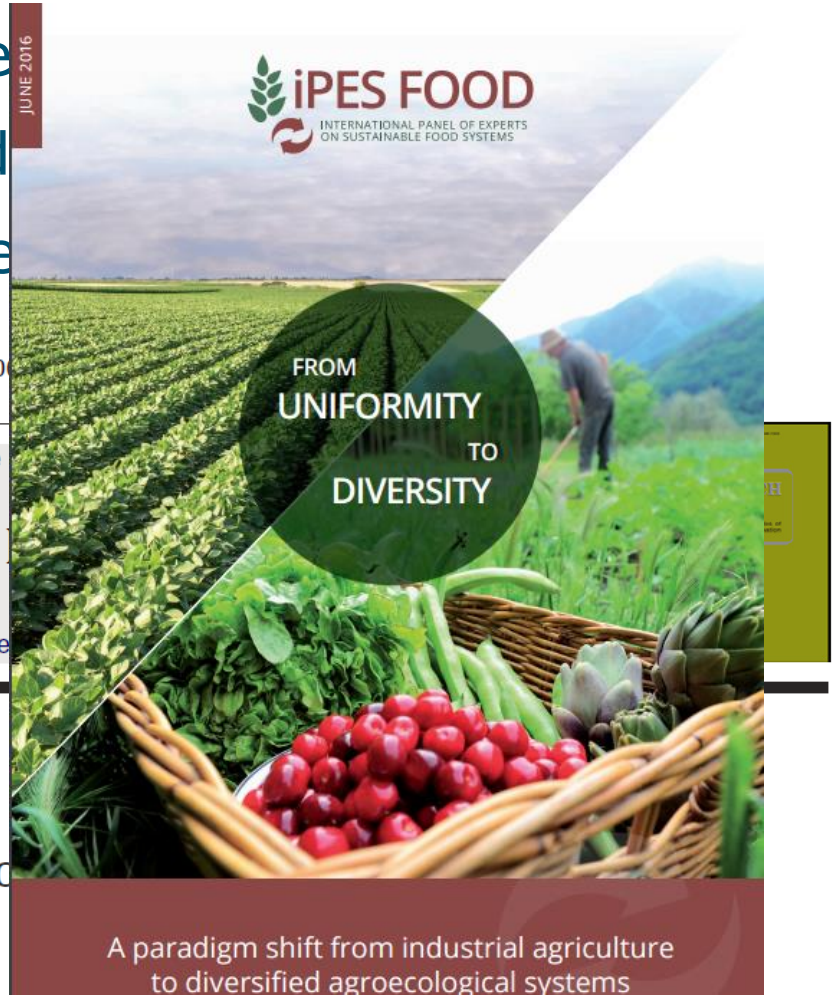
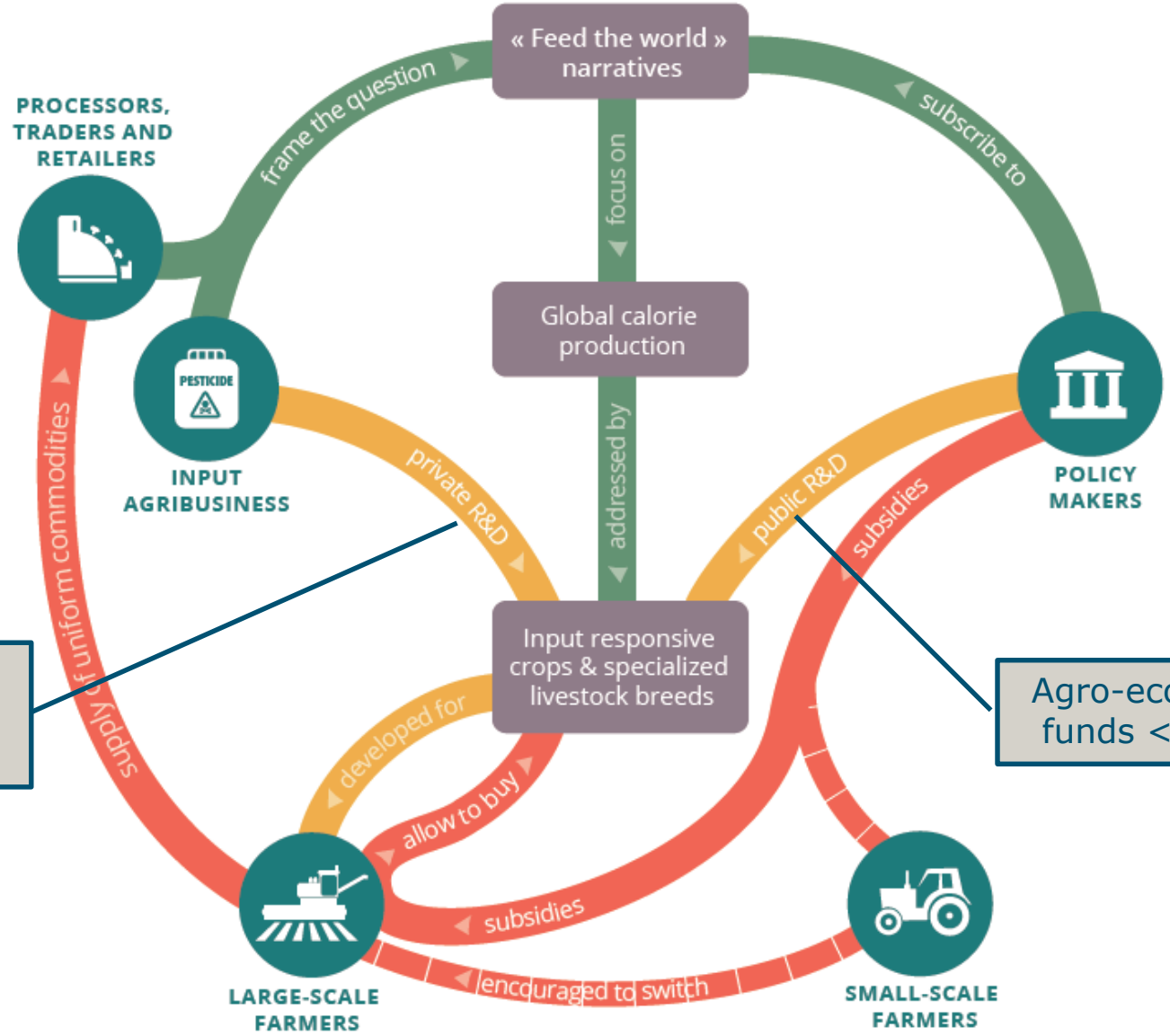


Lock-out of multi-resistant wheat varieties

Vanloqueren and Baret , 2008	
Farmers	Selection focused on gross yield with pesticides
	Resistance not 100%
	Limited choice
Market	Input suppliers sold seed and pesticides
	Breeding history and objectives
Public extension	Gross yield > gross margin
	Concentration on one type of management
	Perception of resistant varieties
Public regulations	Cultivar registration norms
	More attention for other issues
	Subsidies in past based on yield

Lock-out: power imbalances in framing

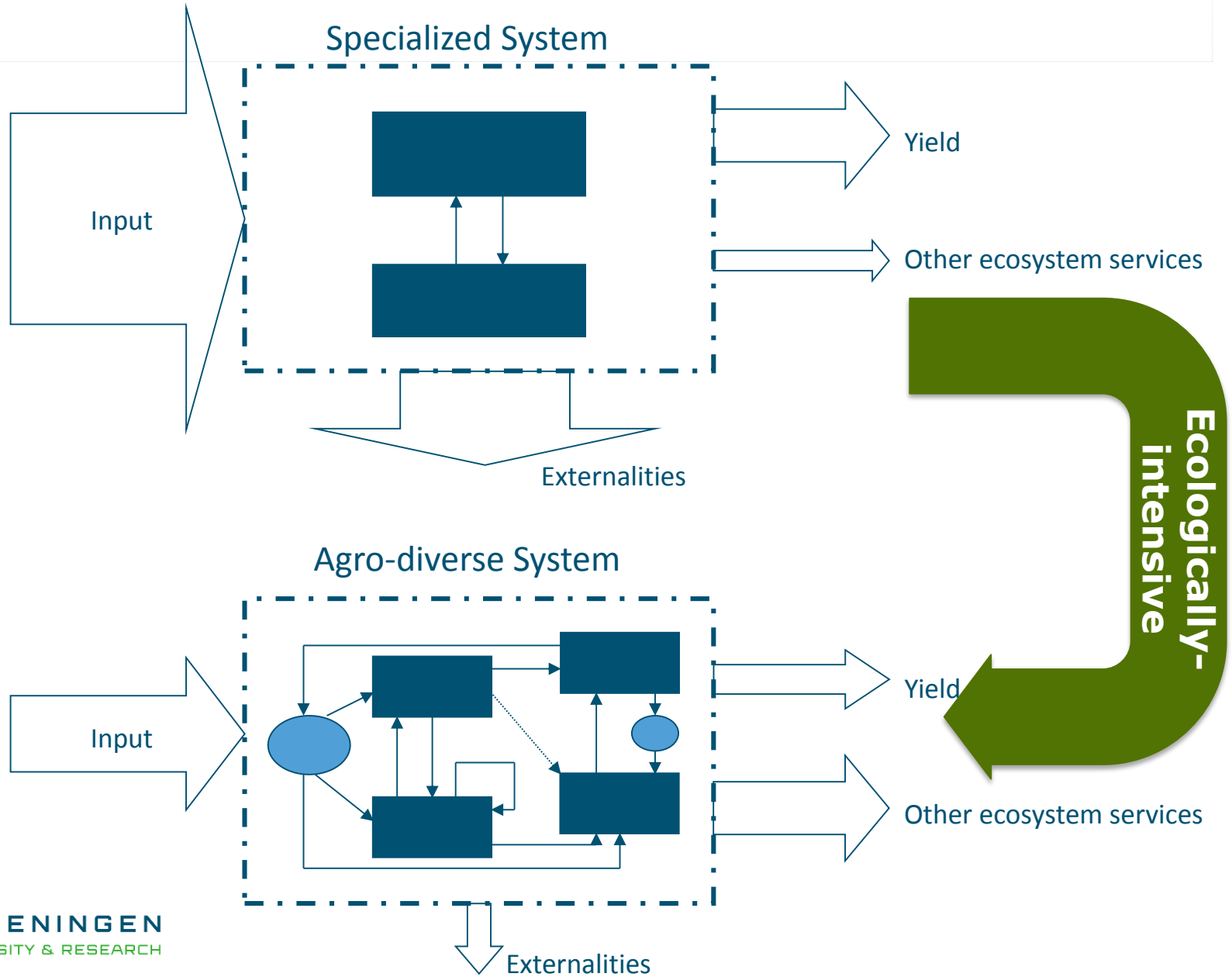


Dominates public spending

Agro-ecological funds <<10%

IPES, 2016

Transition to crop diversity



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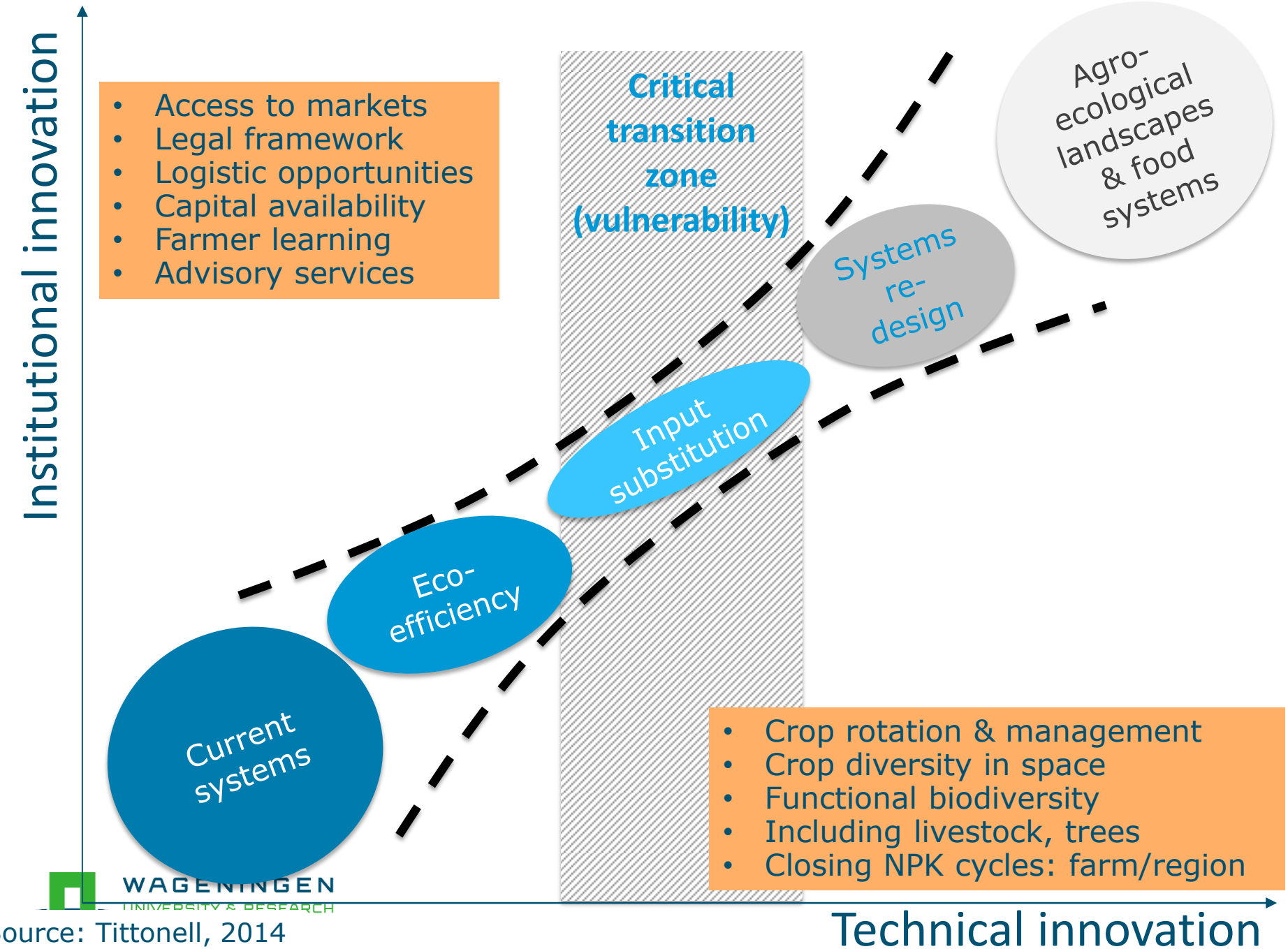
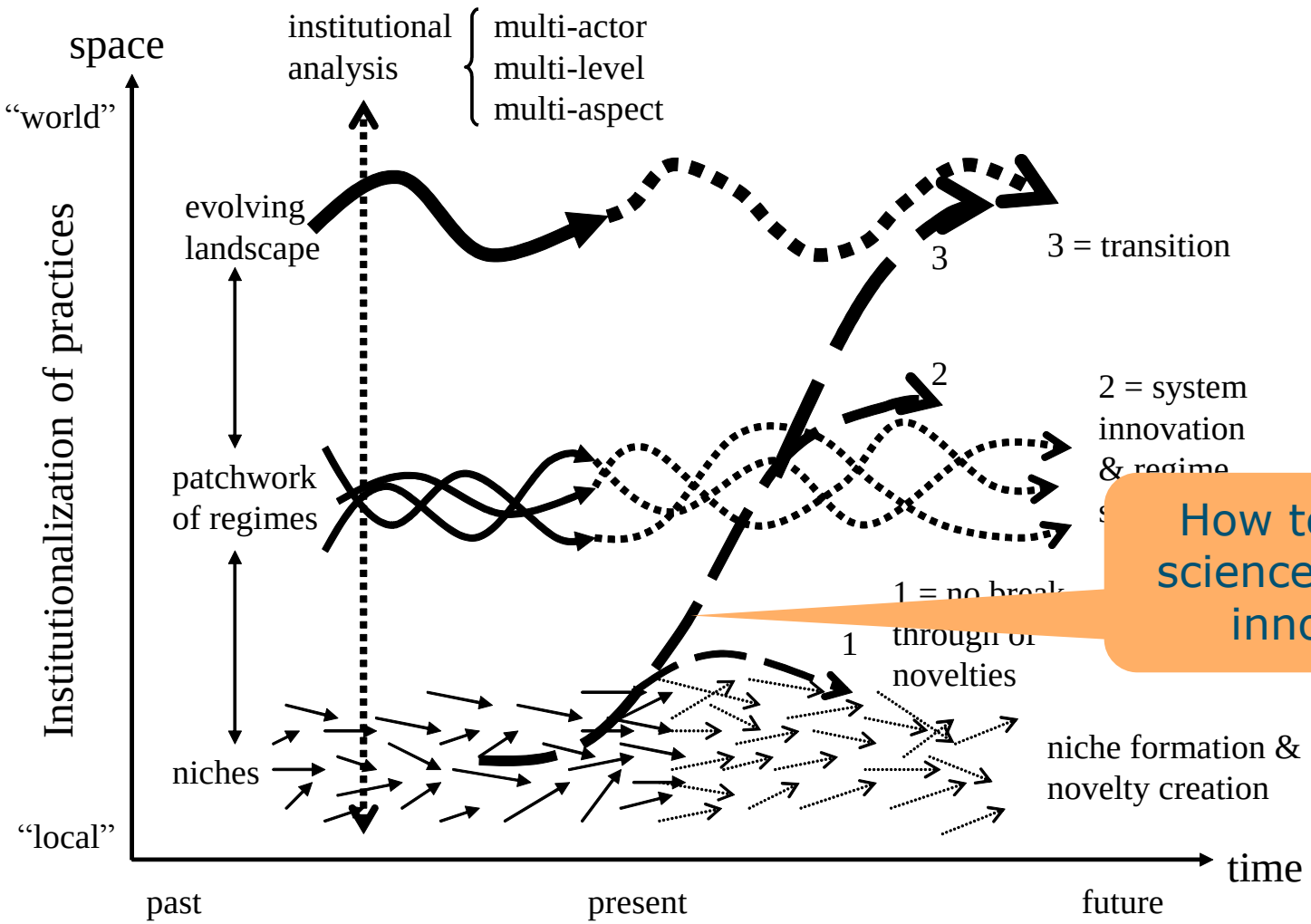


Source: Tittonell, 2014

The multi-level perspective to transition



How to organize science to support innovation?

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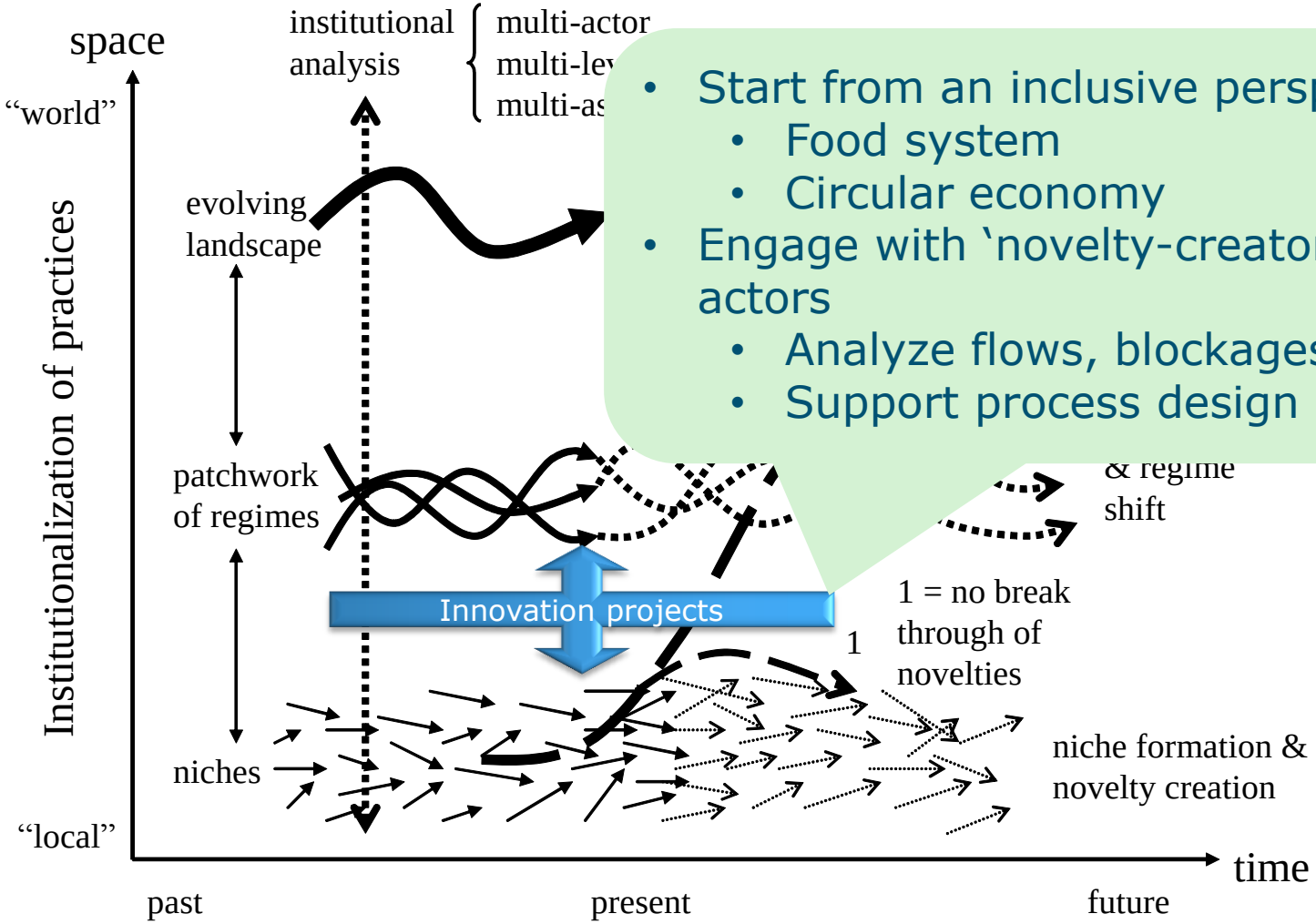
Geels, 2002

Roep et al., 2003

The multi-level perspective to change



- Start from an inclusive perspective
  - Food system
  - Circular economy
- Engage with 'novelty-creator' local actors
  - Analyze flows, blockages
  - Support process design

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Geels, 2002

Roep et al., 2003

Thank you for your attention

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Thanks to colleagues at

Farming Systems Ecology

for sharing slides

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