# Designing sustainable production systems at the interface between agricultural systems and food systems

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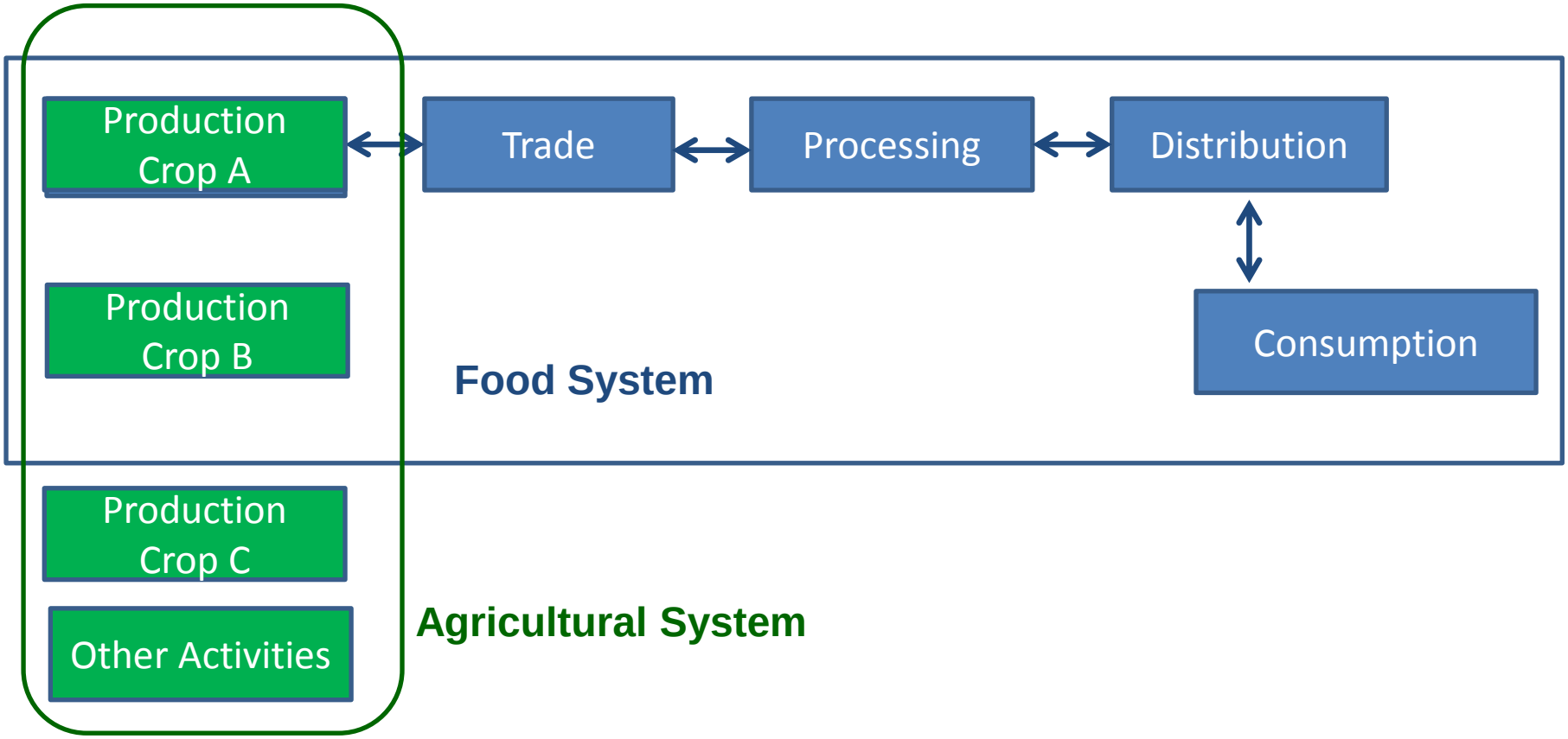
# Outline

1. Agricultural Systems are worth to consider to work on Food Systems.
2. Innovation in Food Systems can be a major driver of innovation in Agricultural Systems
3. Diversity as a driver of sustainability of Agri-Food Systems.
4. Conclusion: a plee for integrated analysis, assessment and design

# 1. Agricultural Systems are worth to consider to work on food systems

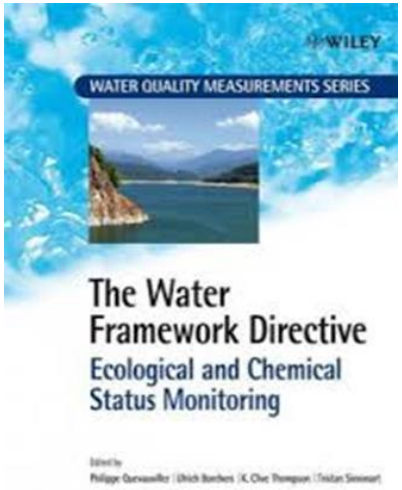



(adapted from Meynard et al., 2015. FSD5 )

# Food production is only one challenge for AS

Global Food Security

Sustainable, healthy food for all



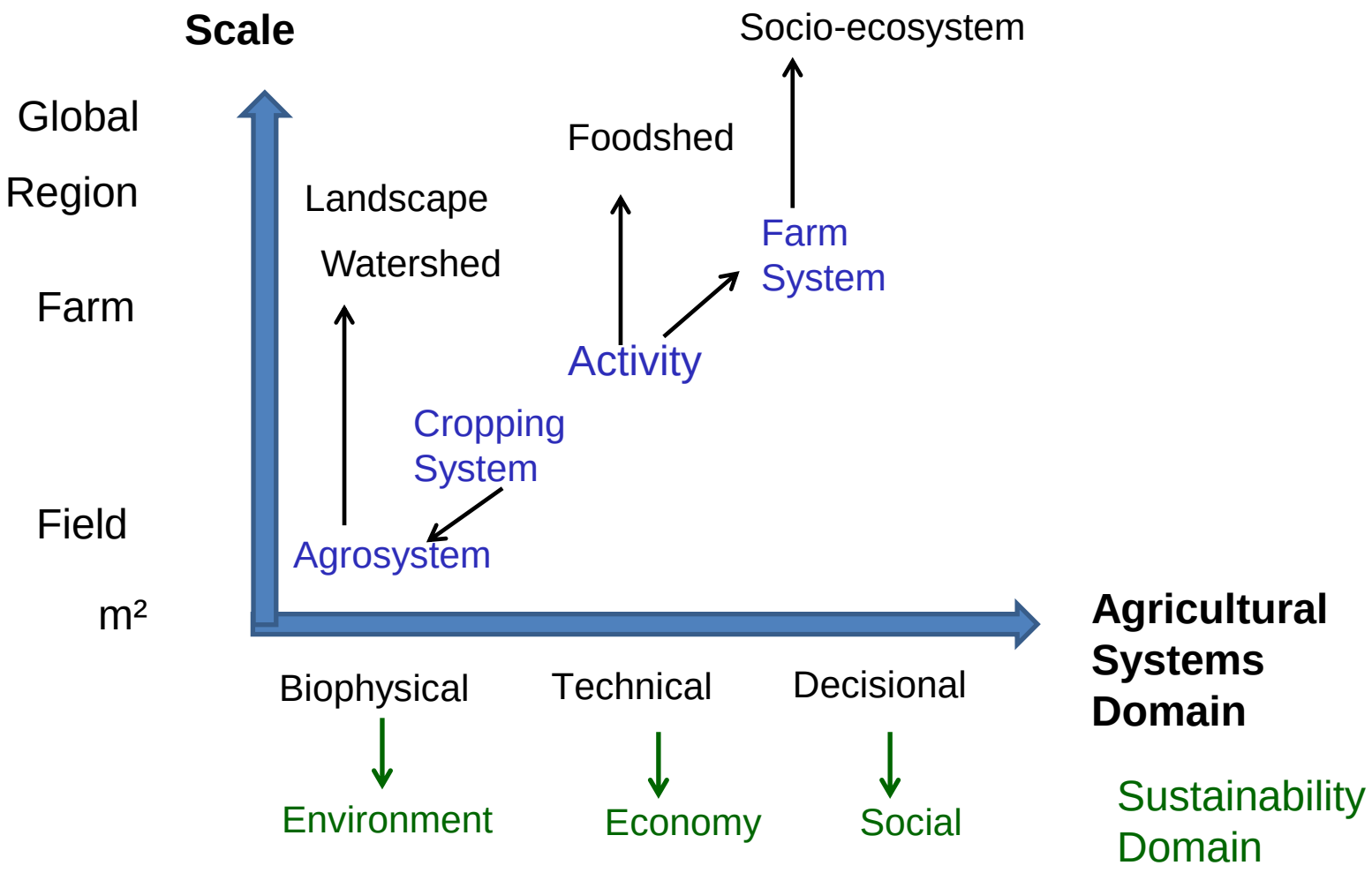

Rural Development

# Agricultural Systems (AS)

- **Complex systems** based on plant and/or animal **production**.
- Increasingly **Multifonctionals** (provision of ecosystems services in a trade-off with production)
- Intrinsically **controlled** systems (a pilot at farm level) → combine three sub-systems (Le gal et al., 2010)
  - **Biophysical** (process-based operating system)
  - **Technical** (technique-based managed system
  - **Decisional** (human-based decision system)
- **Sustainability** and **innovation** can only **emerge** from the combination of these three domains

(Wery et al., 2015. FSD5 ; http://fsd5.european-agronomy.org/video/FSD/index.html)

# Agricultural Systems can be analysed at various levels




(Wery et al., 2015. FSD5)

# The concept of Activity in a farm

- A technical sub-system or component using
  - farm resources (land, labour, money),
  - inputs (fertilizers, pesticides, energy….)
  - Natural resources (land, water, biodiversity…)
- To provision a service to the system
  - money from direct selling (eg. Wheat grain)
  - resource to an other activity (eg. Forage from cropping system provided to the animal sub-system)
  - Money from non productive services
    - On farm tourism
    - Environmental Services (C sequestration)
    - Off farm work
- To provision a service (or dis-service) to another system
    - Watertable
    - Landscape
    - Biodiversity

(Wery et al., 2015. FSD5)

# Input and Output of an Activity

Input → Activity → Output (in and off farm)


Pasta - Industry

Straw

Animals

Energy

Soil (fertility, C sequestration)

Nitrate Leached

# A dual-purpose activity (→supply chain and watershed)


Vignoble de la Voie d'Héraclès

# A multifunctionnal Farm Systems based on four activities

Triple M Ranch : http://www.albafarmers.org/farms.html

Activity

Service

Safe foods

Groundwater


Wildlife
Conservation

AGRICULTURE AND LAND-BASED TRAINING ASSOCIATION
ALBA

Social
cohesion



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# Food production may not be the major driver of the system

Valensole Plateau – South East France (mediterranean)

# 2. Innovation in Food System can be a major driver of innovation in Agricultural Systems

# Ex. 1: The food legumes paradox

- « marvelous » crops
- Good for our health
- Marginal in our meals and in our cropping systems
- Traditionnal countries (e.g. North Africa) import food legumes with a tendency to cereal monoculture

→ A lock-in
in the Agri-Food System

# Pasta with legumes could create a breakthrough in cropping systems

> 13% proteins



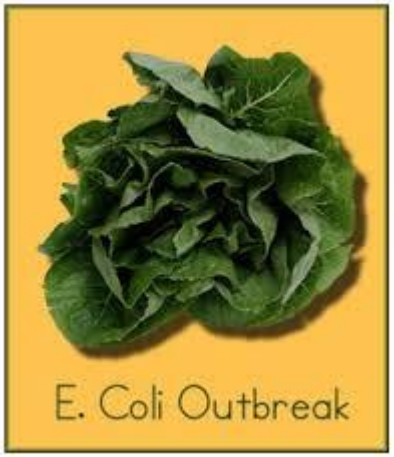

X


Three actions of chickpea to reduce N fertilizers

# Ex. 2: When food systems « lock in » the agroecological transition

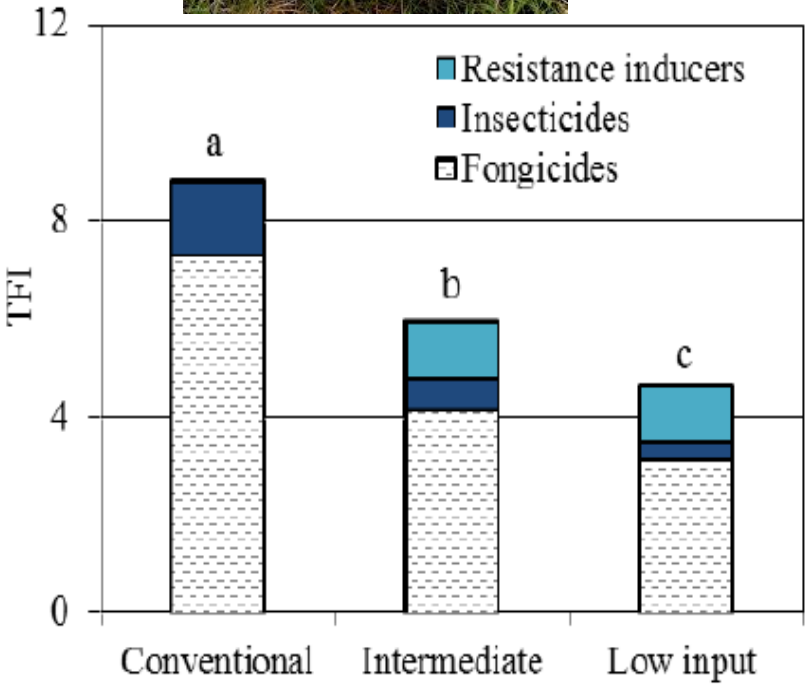

écophyto2018

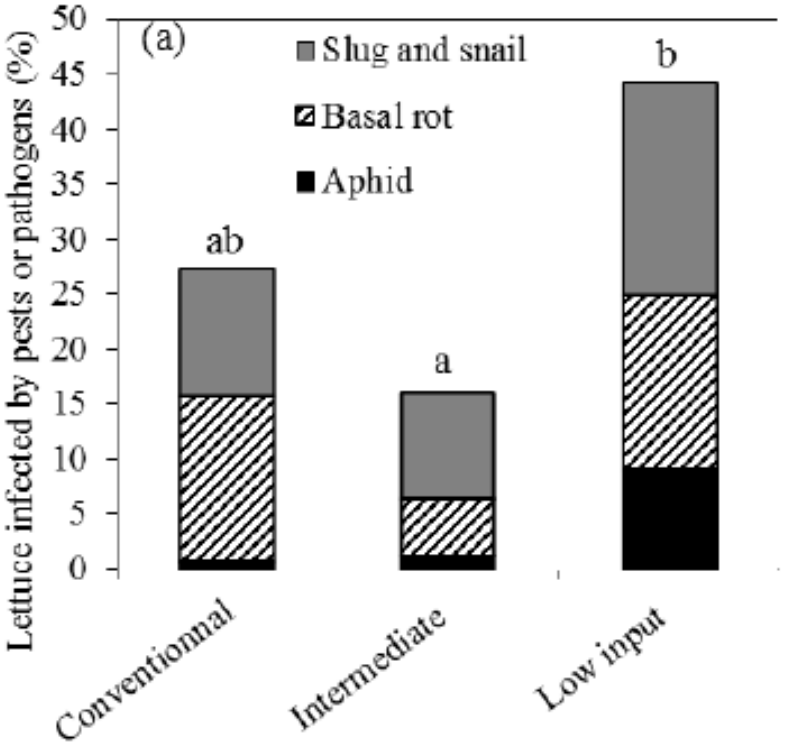
Réduire et améliorer l'utilisation des phytos dans l'agriculture :
moins, c'est mieux



# Pesticides can be reduced but not suppressed

One of the lock-in
is in your hand !

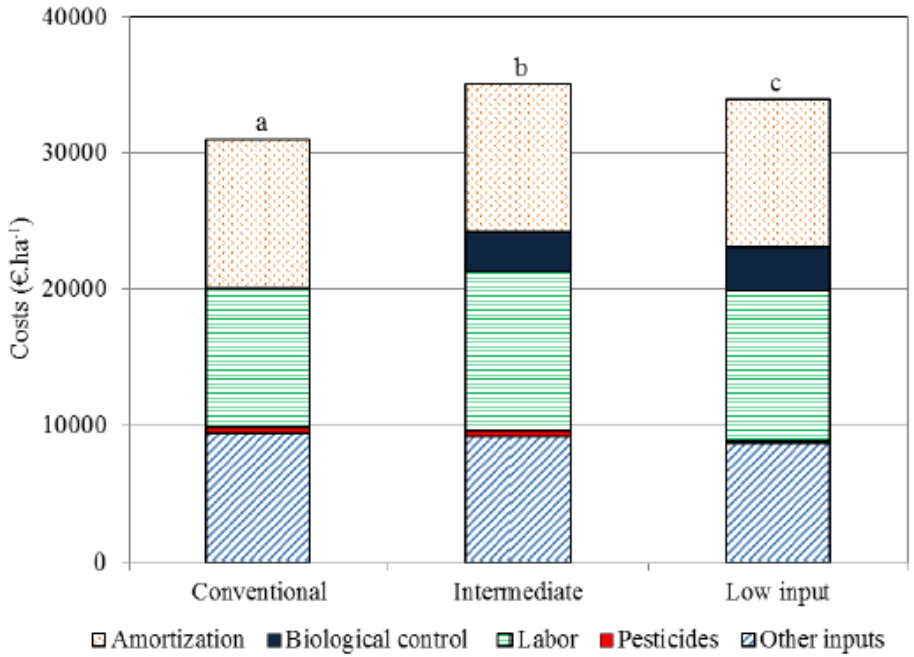



(Virginie Barrière, 2015. Thèse INRA PSH Avignon)

# The second is in your pocket

| CPS | Gross yield ($t.ha^{-1}$) | Marketable lettuces (%) | Marketable yield ($t.ha^{-1}$) | Residue Number |
|---|---|---|---|---|
| Conventional | 51.5 (±15.2) | 71.4 (±28.5) | 36.3 (±6.7) | 3.50 (±1.1) b |
| Intermediate | 47.9 (±13.7) | 82.9 (±24.2) | 39.9 (±6.3) | 4.83 (±0.8) a |
| Low-input | 45.8 (±11.0) | 78.3 (±10.1) | 36.0 (±10.7) | 2.50 (±1.4) b |
| P-value | 0.9599 | 0.3212 | 0.7378 | < 0.05 |




Same profit → + 13% for Intermediate and + 10% for low input.

Are you willing to pay for it ?

(Barrière et al., 2015)

# The innovation ?

# 3. Diversity as a driver of sustainability of Agri-Food Systems

- **Plant diversity** (including trees) in the field (in time and space), in the farm and in the landscape
- **Activity diversity** in farm and in a region (including plant and animal combinations)
- **Farm diversity** in a region

# The three pillars of sustainable agriculture

« Crop » the plant diversity

Soil and Organic Matter at the core of the Agrosystem


« Engineer » the trade-offs between Productivity and Input efficiency

# « Crop » plant diversity (the example of vineyard)

Limite/suppres pesticides

Compatibility ?

Intercropping « service plants »

Combination with crops and trees

Rotation with food crops

*Field Level*

*Farm Level*

# Economic and work efficiency has (an will) drive(n) simplification

A company producing and selling a 1000 ha of melon

60 family farms producing 50 ha of Durum Wheat for a cooperative

Monocropping ⟷ Economic Efficiency

# Farm diversification driven by local organic market

(Ferme en coton, Gers, France)

Chicken production

Pig production


Direct selling

Social activity

Crops for feed

# Can we feed our cities with permaculture ?

Sur une année, de septembre 2013 à août 2014, et sur 1000m² cultivés,
la valeur récoltée est de 50800 €,
pour une charge de travail sur les parcelles de 2000 heures.

- Risk of bias in the calculation ?
- Limits in the extrapolation to the whole country ?
- New circularities and solidarities ?

Fondation de France

Paris 21/11/16

Microfermes, macro effets: du projet de vie au vivre ensemble sur les territoires

# Design new systems combining international markets, specialized farms and plant diversity in the field ?

3000 ha

4000 ha of land

1000 ha

3 years

60 family farms

1 cooperative

1 year

1 company

AgroSYS
Ingénierie pour des AgroSystèmes Durables

# 8T/ha of rice without any fertilizer and pesticides !

Rizière bio, Mr. Philippin ; Variété Arelate//GAF du Cousse /Sept 2009./Photo J-C Mouret

# When sustainability upscale the problem

Conv.




Organic




Year 1 Year 2 Year 3 Year 4

Impacts at farm level ? At regional level ? Solutions to unlock the system ?

→ A need for Integrated Assessment of Agricultural Systems
(Delmotte et al., 2016 ; Agricultural Systems)

# Which priority in input reduction ?

# 4. Conclusion: a plee for integrated analysis, assessment and design of Agricultural Systems (IAAS)

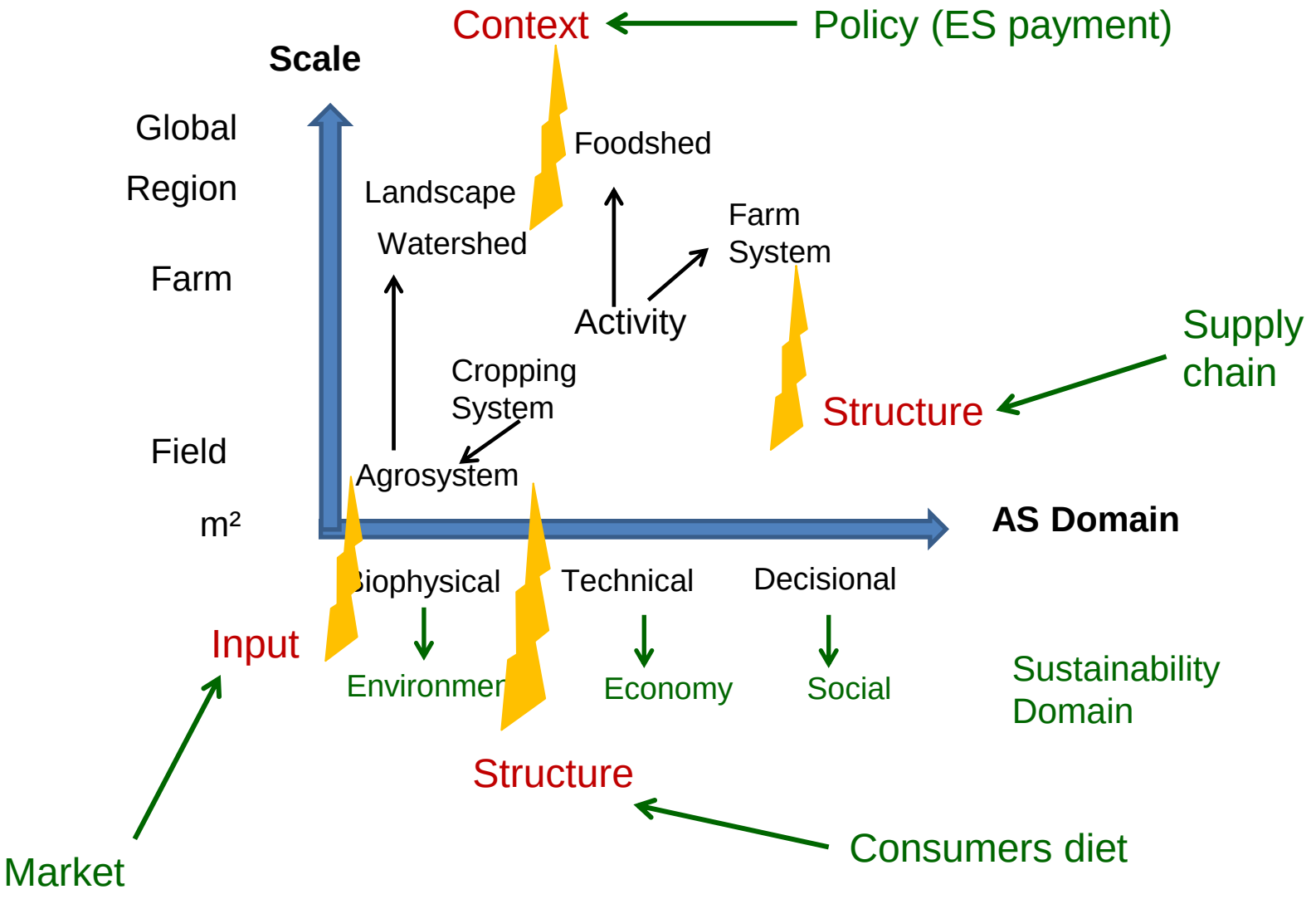
« Farm-centered » Multi-scale and multidomain system's analysis

(adapted from van Ittersum et al., 2008. Agricultural Systems)


Agricultural systems by design

http://fsd5.european-agronomy.org/

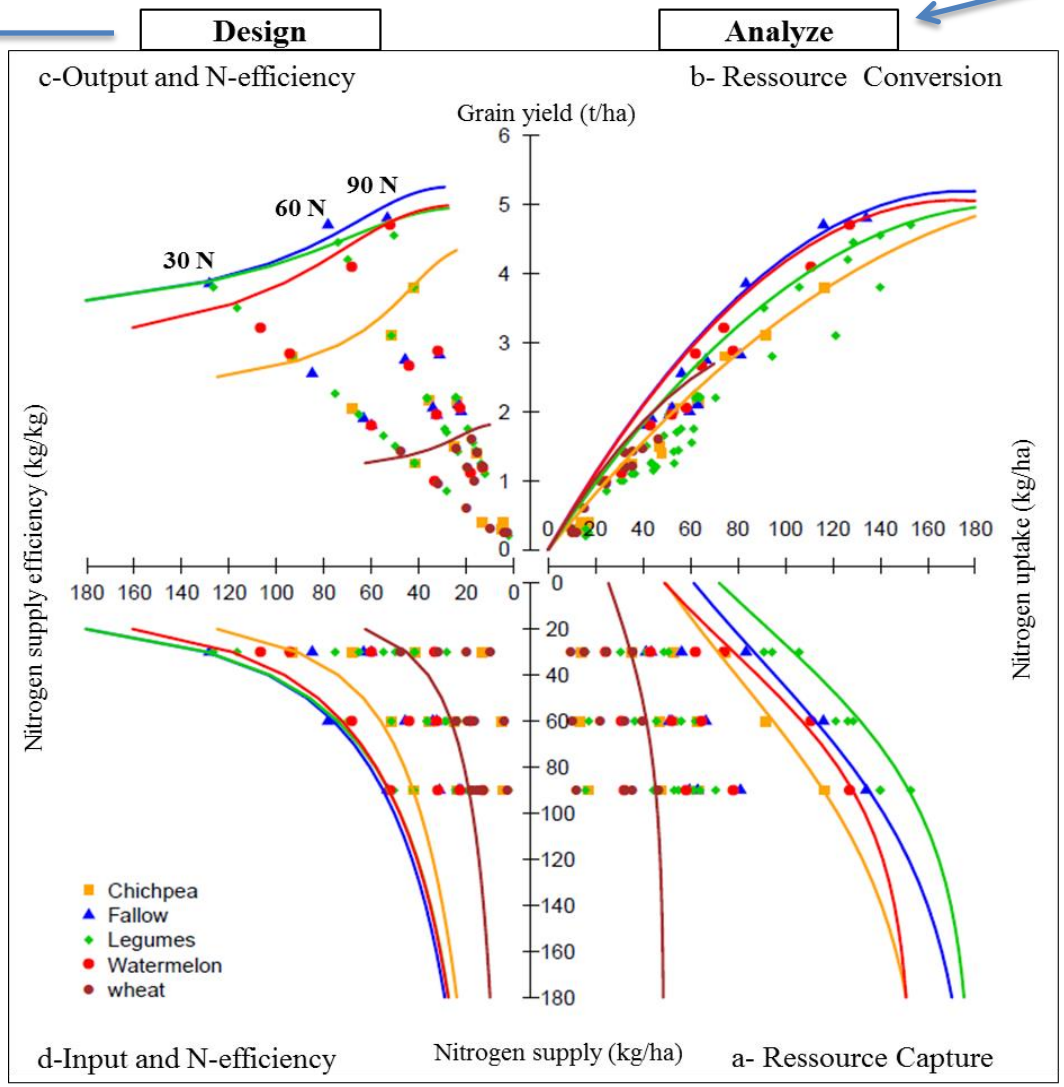
# Food Systems can drive innovation if Agricultural Systems are properly considered



# Combining field/farm data and modelling

Meta-models for scenario analysis

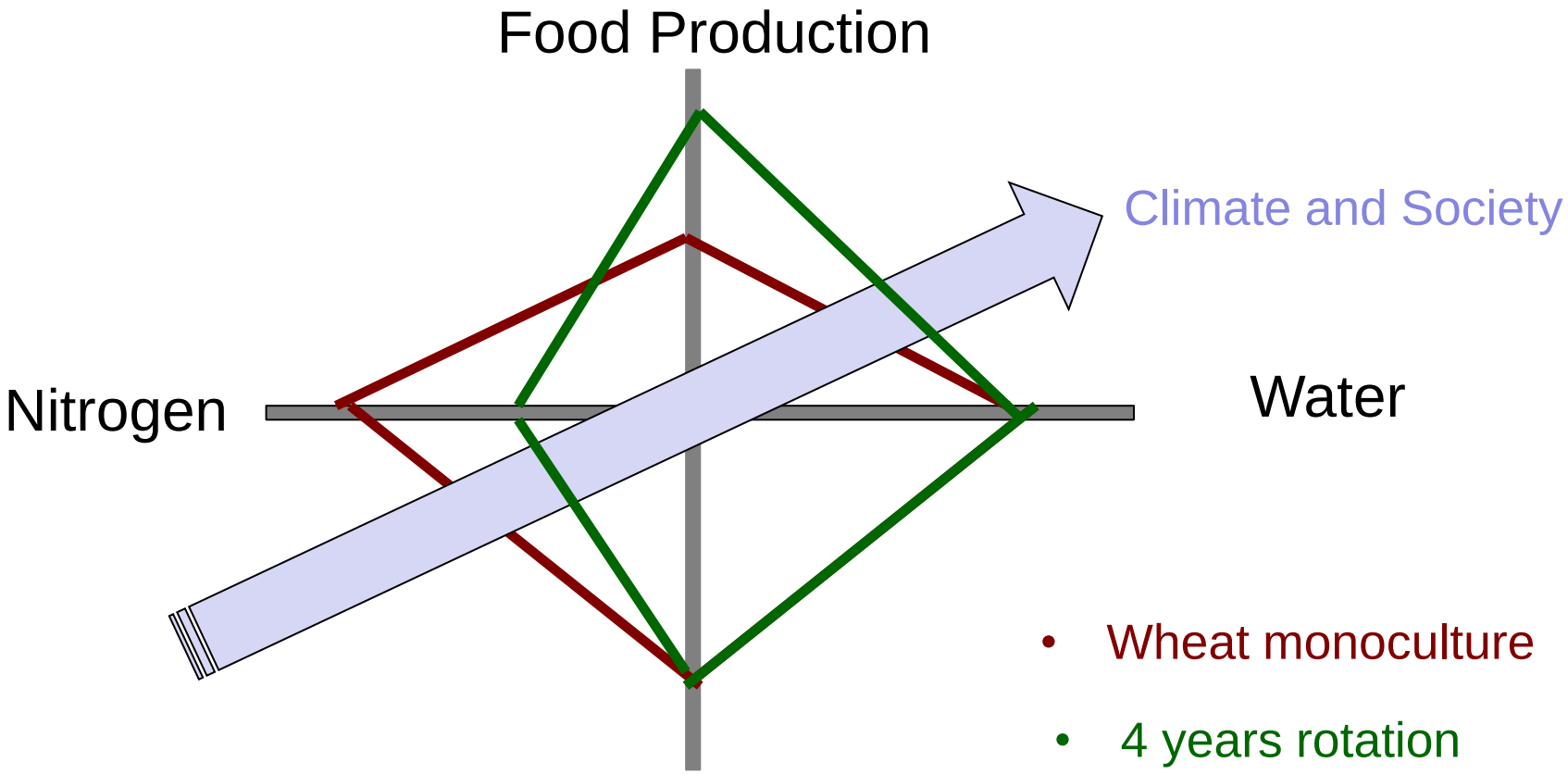
Knowledge on Processes




(Ben Zekri et al., submitted)

Durum Wheat in Syria

# To Design Agricultural Systems, Food Systems and Policies in a « contextualized » Nexus




- Wheat monoculture
- 4 years rotation with chickpea

(Ben Zekri et al., 2016)

# With Mediterranean students and institutions