Designing integrated crop-livestock systems across scales:
toward new agroecological models?

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EAAP Session 6 - Mixed Farming systems - does diversity bring any benefits and at what scale?

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Environmental problems linked to specialisation of farming
A renewed interest on ICLS

- Integrated Crop-Livestock Systems (ICLS) as a theoretical agroecological ideal

ICLS should provide multiple ecosystem services

ICLS have economic and environmental advantages

Bonaudo et al. (2014)
Toward agroecological ICLS?

- ILCS as a theoretical (!) agroecological ideal
  - Which level of integration to have economic and environmental benefits?

- Large decline of ICL farms in Europe
  - Tendencial specialisation of farms (market, policies, …)
  - Labour organization constraints

⇒ A need to design agroecological ICLS
How to describe integration between crops and livestock?

- 3 spheres to describe integration between crops and livestock at different level of organisation (farm, region, ...)
- Considering spatial and temporal interfaces
- Describing practices at the interfaces

⇒ Grazed grasslands integrated in crop rotations as an example to integrate the three spheres

Moraine et al. (2014)

Grazing

Use of grains and fodder for animal feeding

Integrating grasslands in crop rotations
Designing agroecological ICLS

• Two options to design ICLS:
  • Improving existing ICLS
  • Reintroducing new ICLS

→ ICLS at the local level: goes beyond farm-level workforce constraints

Two levels to consider:

Farm level:
farm integrating crops and livestock

Local level:
specialised crop farms and livestock farms exchanging in a local area

How to design agroecological ICLS?

Focus on three complementary case-studies at different scales:
- farm level considering temporal changes - case-study 1
- beyond farm level considering:
  i) a group of 24 farmers - case-study 2
  ii) a subgroup of 6 farmers - case-study 3
A methodological framework to design ICLS

Step 1: Problem definition

Step 2: Individual farm surveys

Step 3: Participative design of scenarios

Step 4: Simulation and multicriteria evaluation

Step 5: Collective evaluation of scenarios

Process combining collective and individual steps

Researchers: Martin et al. (2013)
Case-study 1: Participative design of ICLS at the farm level

The Coteaux de Gascogne
A French less-favoured area
⇒ Low specialization of agriculture (50% of farms ICLS)

Local actors: Which future for their ICLS farms?

Mutual objective: Designing scenarios including technical innovations to develop agroecological ICL farms.

Research: ICLS as agroecological models

Ryschawy et al. (2014)
Participatory design of scenarios with farmers

A. Studying farmers’ long-term strategies as a baseline for future scenarios

B. Collective brainstorming on future scenarios

C. Vote to select two scenarios of technical innovation (and two real-farms)

Type Autonomy-led farmers

⇒ **Scenario**: sowing legumes intercrops to achieve feed autonomy for herd

Type Diversified family-farmers

⇒ **Scenario**: adding a finishing unit of heifers to achieve direct sales
Major barriers to maintain ICL farms

- **Workforce limitations:**
  - Higher requirement on labour and management
  - Skills to manage crops and livestock

- **Farm economics results:**
  - Higher investments required
  - Lower opportunity for economies of scale
  - Few politic incentives favouring ICLS

- **Juxtaposition of livestock and crops without real integration**
  - Not the economic and environmental benefits expected

- **ICLS at the local level as an alternative option:**
  - Goes beyond farm-scale workforce constraints
  - While providing comparable environmental benefits.
ICLS beyond farm level
Considering exchanges between specialized farmers

**Bio 82**: a group of organic farmers interested in exchanges between specialised farms

**Case-study 2**: Analysis considering 24 specialised farmers interested in exchanges of crop and manure

**Case-study 3**: A subgroup of 6 neighbouring farmers among them
Case-study 2:
ICL between 24 specialised farmers

- 14 livestock farmers (beef/dairy/ovine/poultry)
- 10 crop farmers

→ UAA considered: 1655 ha

→ 3 groups identified according to farming systems and localisation

Exchanges between crop farms (yellow) and livestock farms (green)

- 341 tons alfalfa
- 125 tons mixed cereal-legume crop
- 88 tons straw
- 1059 tons manure

Moraine et al. (2016)
Scenarios designed with local actors

3 organisational options

- Centralized
- Multicentralized
- Multirelated

... crossed with 3 technical options of exchanges

- Inserting Alfalfa
- Mixed crops
- Manure/Straw
Case-study 3:
A focus on 6 neighbouring farmers

6 farmers in close relationship:
- 2 crop farms
- 4 diversified livestock farms
\[ \Rightarrow \text{UAA considered: 180 ha} \]

- 40 tons barley-pea
- 18 tons maize
- 8 tons alfalfa
- 4 tons sunflower

105 tons manure

Ryschawy et al. (2016)
Scénario 4 : Parcel exchanges associated to the introduction of legumes, mixed crops and manure exchanges

Territorial synergy

Scénario 3 : Introducing mixed crops & manure exchanges - Complementarity

Scénario 2 : Introducing cereals and legumes by crop farmers for feeding animals

Complementarity

Scénario 1 : Exchanges with no modification in the crop rotations

Local coexistence

Scenario 0 : Initial situation

Global and local coexistence

Temporary coordinations

Trade-offs between individual and collective performances

Spatial coordinations
Major barriers to regional ICL

• Technical
  • Need to get/share **new practical skills** to combine crops and livestock
  • **Risk aversion** of farmers ➔ Feed quality, level of production,…

• Social
  • How to build trust between farmers (contracts?)
  • ? Collective organisation?

• Logistic
  • Storage availability and transport
  • Sharing equipment
  • Time dedicated to manage exchanges

Adaptation of research advisory & education system needed… … and specific policies?

More complex than farm level barriers
Trade-offs between individual and collective performances…
Lessons and challenges

- Decision Support Systems needed to design ICLS
  - Combine participative studies and simulations
  - Design locally-adapted ICLS considering local history of agroecosystems
  - Lack of expertise and data on ICLS

⇒ How to combine simulation and case-study methods?
   A serious game in perspective!

Considering the appropriate level implies specific skills:
- Designing ICL at farm level to favour ILCS maintaining
- Designing ICL at local level to go beyond farm level barriers
- Complex collective organization implies interdisciplinarity

⇒ How to develop multi-level approaches to manage trade-offs? What about outscaling / upscaling?

Thank you!