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# Dealing with ecosystem services in the management of agroecological systems

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# Outline

- Agroecology and ecosystem services
- Motivation
- Challenging management aspects in agroecology
- Simulation-based constructivist approach
- Biophysical system modeling
- Decision-making system modeling
- Concluding remarks

# Agroecology and ecosystem services

Agroecology is the science and practice of applying ecological principles and knowledge to the design and management of sustainable agroecosystems

Basic principle = promote practices that:

- enhance regulation and provisioning ecosystem services
- drastically reduce external inputs (synthetic chemical pesticides and fertilizer, and fossil fuel)
- develop agroecosystem resilience



# Motivation

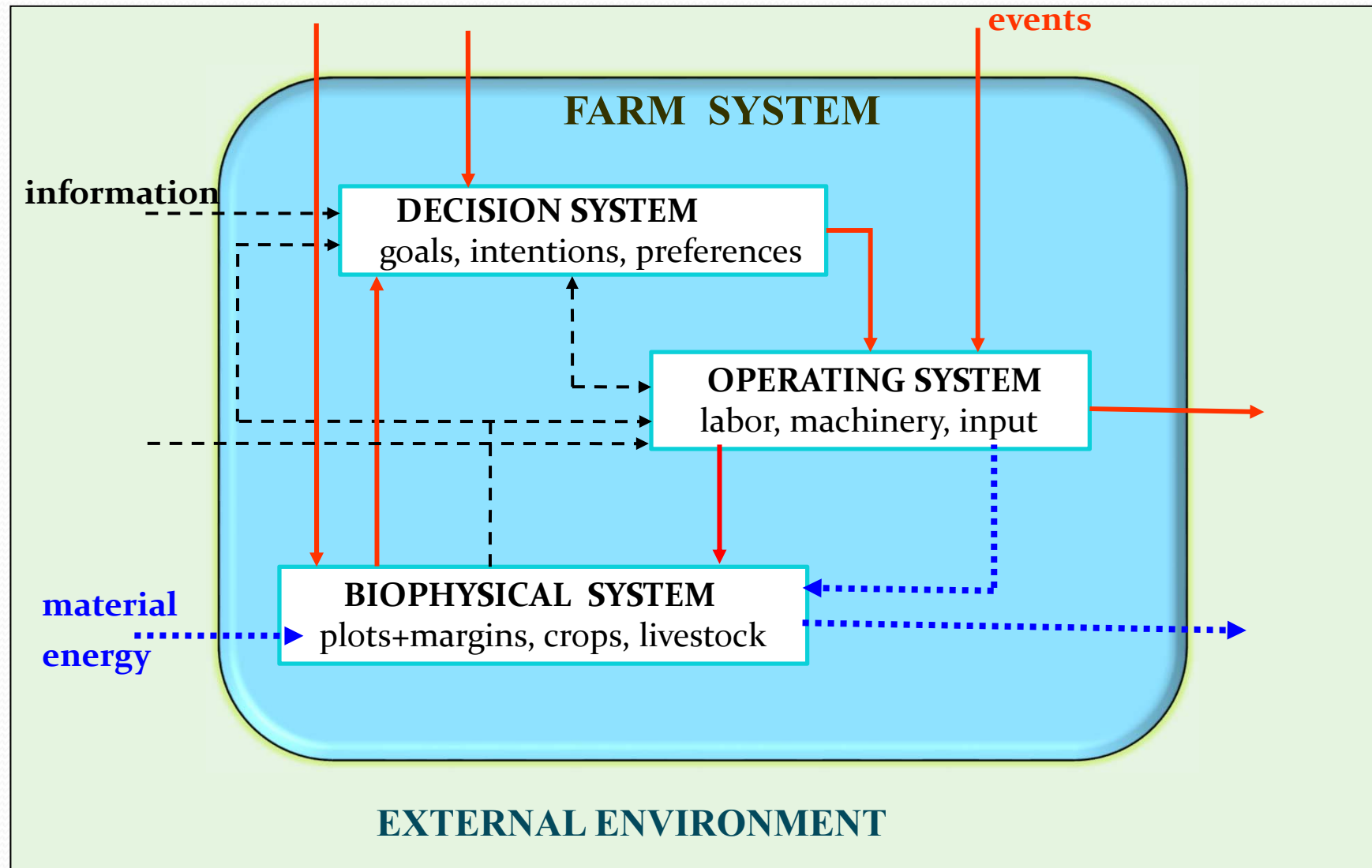
Agroecology is a very attractive approach, but the transition from conventional agriculture to agroecology is difficult: it requires knowledge-intensive active learning

The learning process can be boosted by modeling and simulation tools

Research needed because models are specific models to support understanding and design of agroecological systems:

=> Towards simulation-based experimentation as basis of participatory learning and design workshops

# Global view



# Challenging management aspects

A difficult problem of control of a dynamic complex system:

- Many highly connected variables, spatially structured
- Influenced by external factors (weather, pests)
- Knowledge intensive but many gaps
- Most actions are site-specific and have delayed effects
- Most variables are not directly observable
- Requires anticipatory (goal-based, plan based) behavior
- Some interventions require coordination between farmers (e.g. landscape matrix management)

# Simulation-based constructivist approach (1)

## Modeling/simulation framework:

- ❑ Incremental modeling of both scientific knowledge and farmers mental models of biophysical causality
- ❑ Virtual experimentation of interaction between biophysical, decision and operating systems
- ❑ To be used in a collective setting for critical discussions and cross fertilization of viewpoints and experience

Simulation as an intellectual partner to help exploration and support design

## Simulation-based constructivist approach (2)

To be used in a sequence of participatory workshops

- 3-6 farmers + scientist facilitator
- study of a concrete farm case with an initial management strategy
- 1- mental model + strategy (implementation),  
2- testing and analysis, 3- innovative strategies

Adequacy criterion = ability to effectively contribute to

- better understanding of local biophysical reality
- exploration of management variants in line with farmer's goals, values and constraints
- fruitful discussions and capitalization of knowledge

# Research issues: biophysical system

Develop representation framework of farmer's mental model of causality in the biophysical system:

- in terms of factors that enable to compare options
- responsive to events and actions
- rather simple: few parameters and driving variables
- rough representation (qualitative rate of change and landmarks)
- both fast and slow processes
- integrated with existing scientific knowledge

Enable frequent revision and fast development => modularity requirement

Enable participatory evaluation through comparison with typical cases => intelligibility requirement

Develop method to elicit knowledge (belief) from farmers

# Research issues: decision system

Develop cognitive structures and processes for representing farm management process:

- beliefs (informational state coming from mental state or observation)
- goals (state-based or abstract desire, achievement or maintenance)
- intentions (plans chosen to realise the goals, possibly collective)
- Preferences and values (internal criteria for evaluation of alternative goals, plans, actions)

## Affiliated processes

monitoring, prediction, goal formation, plan adjustment, action scheduling...=> **need of an integrative reasoning mechanism**

# Research issues: operating system

The link between decision and change made on the biophysical system

Essential role of resources (labor, equipment, inputs)

- Execution is resource-dependent (availability required, determine speed and quality of realization)
- Operation can be interrupted (resources no longer available, feasibility conditions no longer satisfied)
- Resource allocation and scheduling of operations

# Conclusion

- Model the link between farmer's biophysical knowledge, management strategy, actions
- Simulation to support collective learning and design

## Future works

- Develop framework for farmer's mental models of biophysical causality
- Develop model of cognitive structure and processes that handle reasoning about actions in agroecosystems
- Improve collective knowledge elicitation methodology
- Apply the approach as proof of concept for supporting the development and dissemination of agroecology