Dealing with ecosystem services in the management of agro-ecological systems

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SCIENCE & IMPACT

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

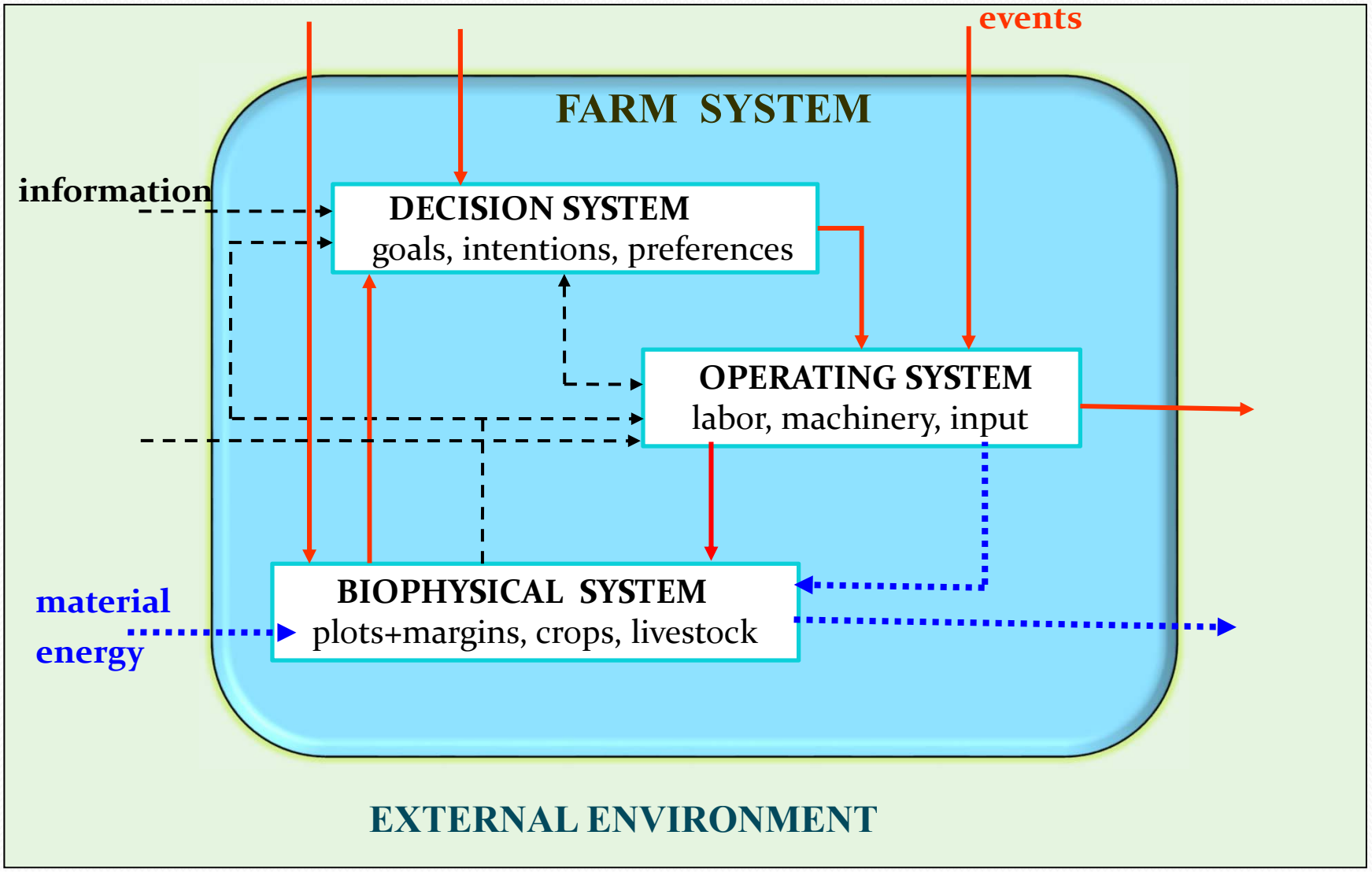
Agroecology is a very attractive approach, but the transition from conventional agriculture to agroecology is difficult: it requires knowledge-intensive active learning

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


events
FARM SYSTEM
information
DECISION SYSTEM
goals, intentions, preferences
OPERATING SYSTEM
labor, machinery, input
material
energy
BIOPHYSICAL SYSTEM
plots+margins, crops, livestock
EXTERNAL ENVIRONMENT

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