Integrated systems research for farms and livelihoods in Africa RISING phase II

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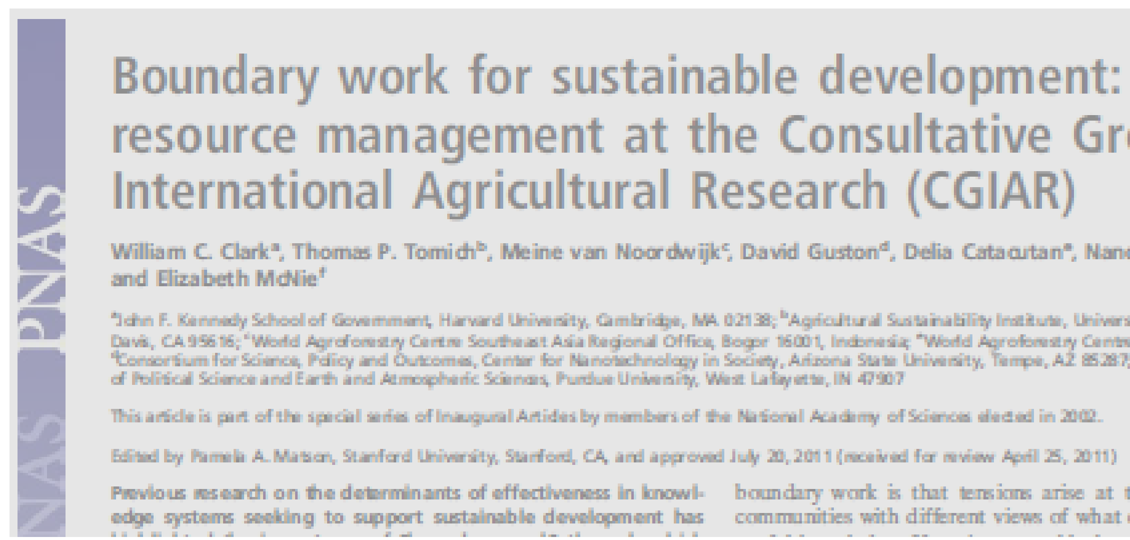
Systems approach

- Larger-whole implications
- Interactions among components
- Multifunctionality of components and system



PNAS

Boundary work for sustainable development: resource management at the Consultative Gr International Agricultural Research (CGIAR)

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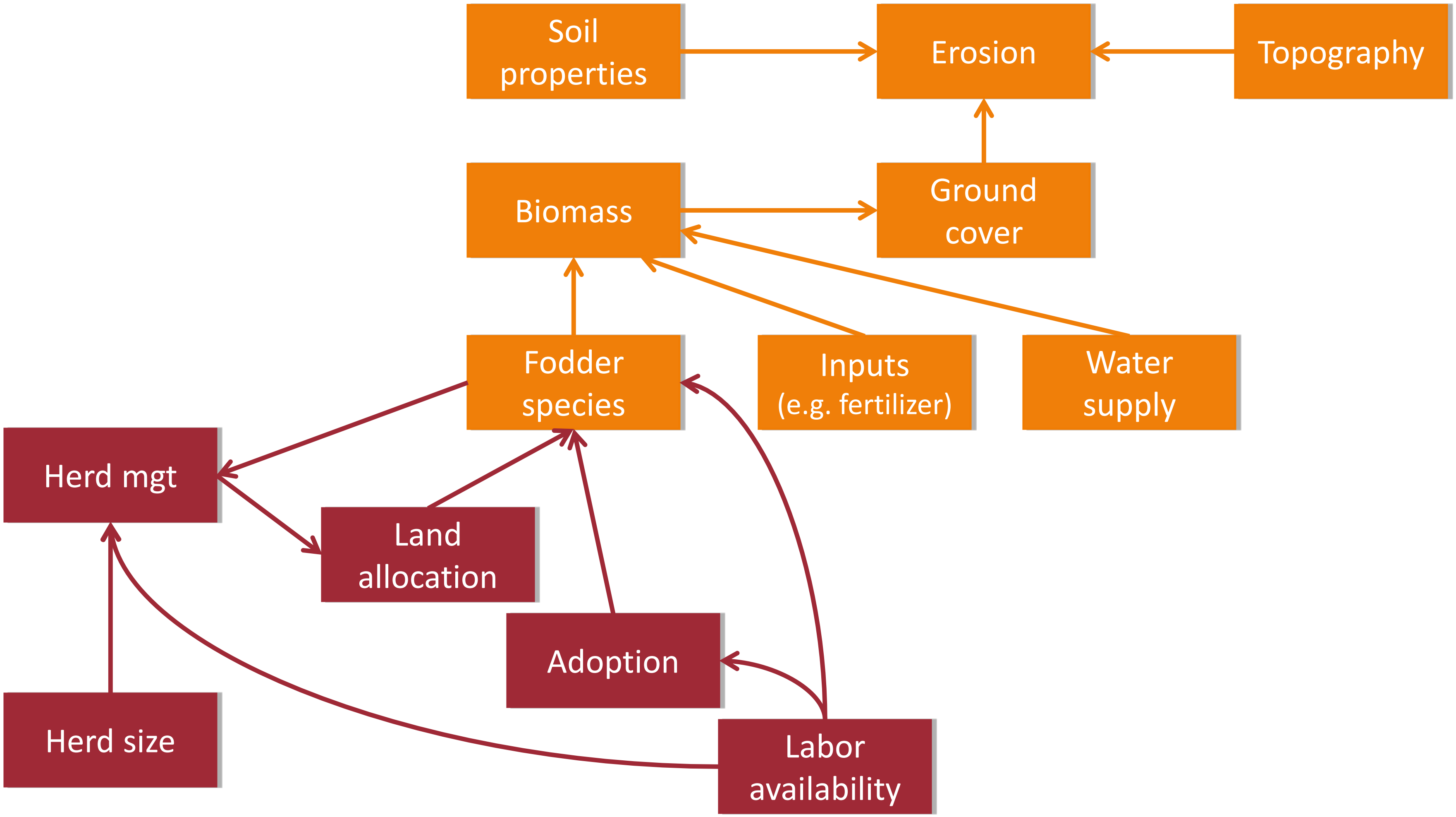
Previous research on the determinants of effectiveness in knowledge systems seeking to support sustainable development has

boundary work is that tensions arise at communities with different views of what

- Portfolio of methods
- Multidisciplinary
- **Boundary objects**
  - **Experiments, models**
  - **Research products**
  - **Design tools: SI framework, impact pathways, influence diagrams**

Influence diagram (example boundary object)

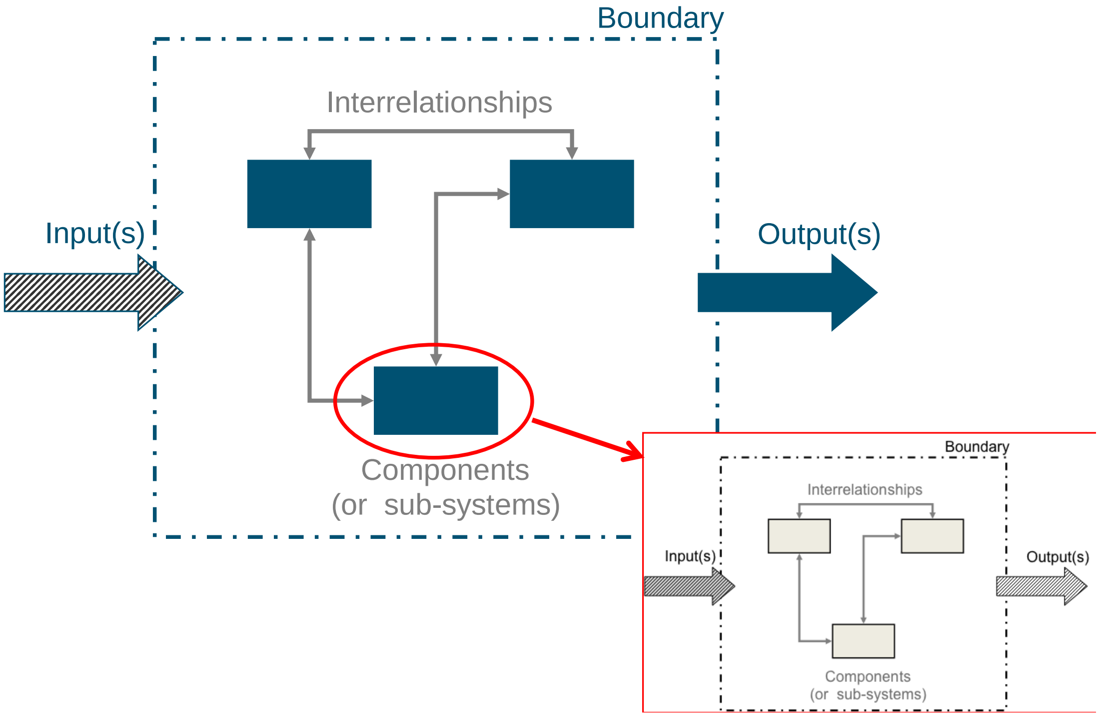


Portfolio of methods (examples)

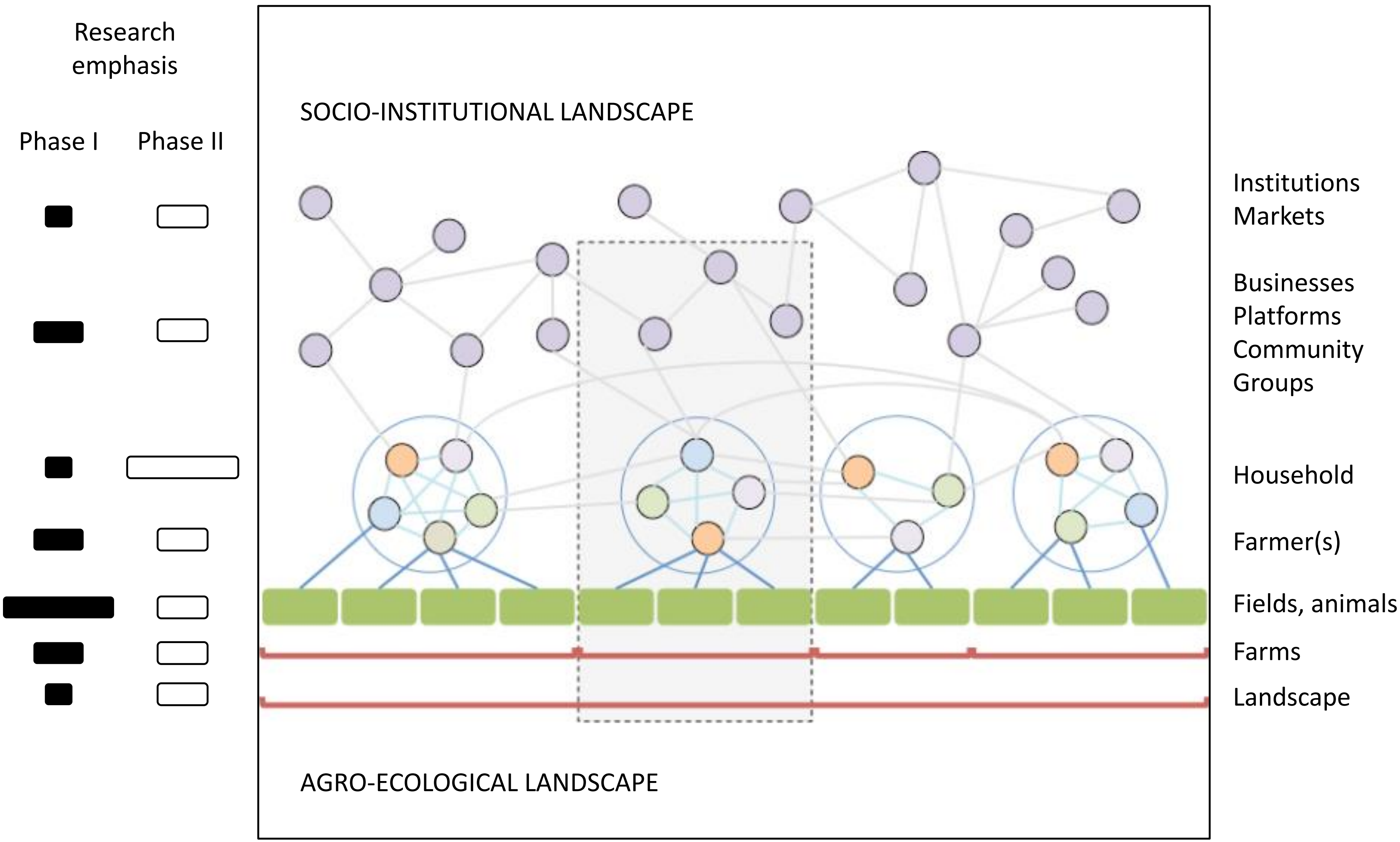
- On-station and on-farm experiments
- Participatory
  - Focus Group Discussions; interviews; livelihood analysis
  - Participatory mapping; resource flow maps; transect walks
  - Problem trees; Appreciative Inquiry; Most significant change
  - Co-innovation, project management
- Farm analysis and redesign
  - Farm surveys, typologies
  - Crop, animal and environmental simulation
  - Farm and landscape modeling
- Scaling approaches

Systems and integration

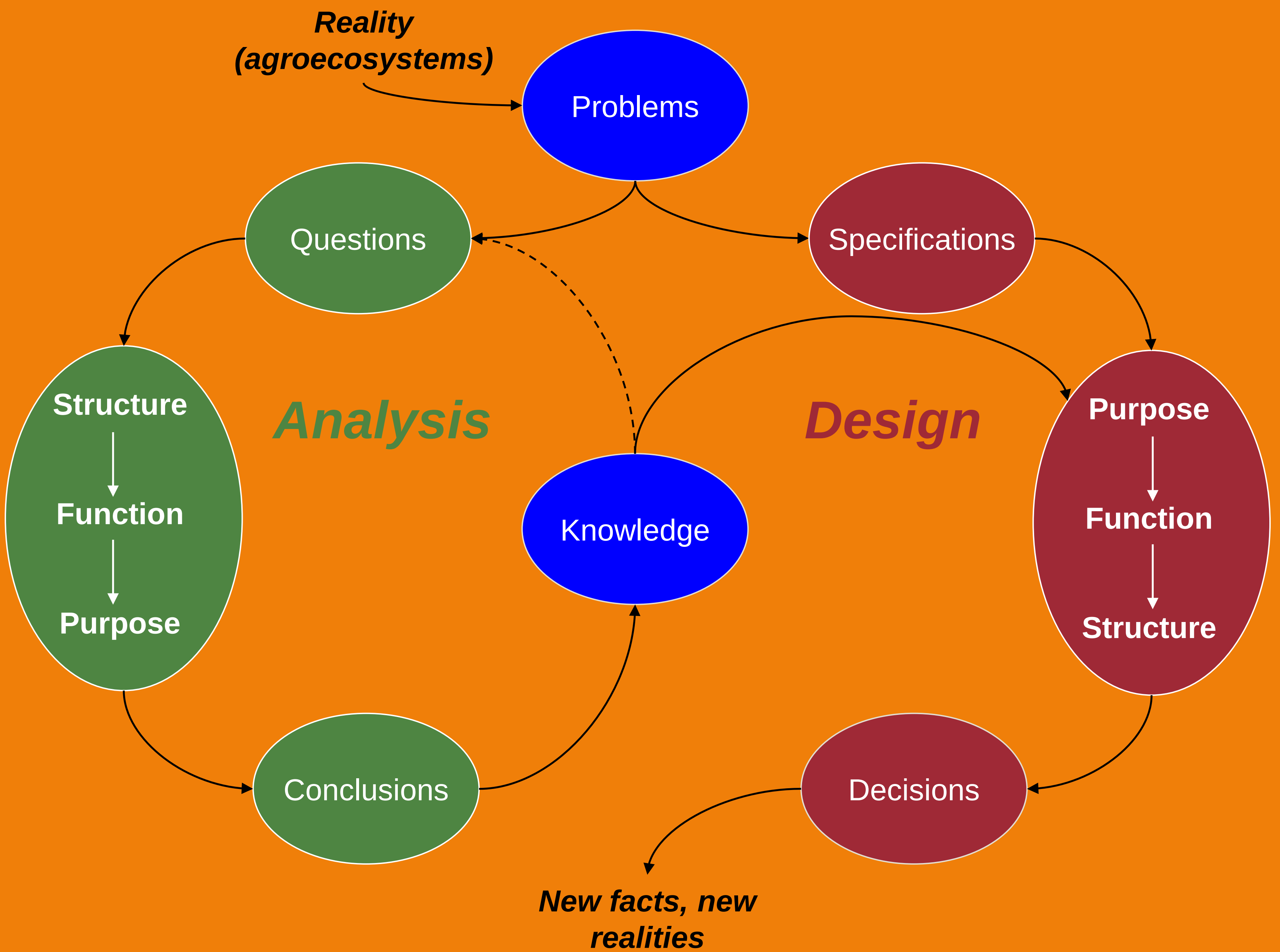
- System:
  - Limited part of reality
  - Interacting components
  - Delineation



- Integration:
  - What does the research result mean at the **target** system level?
  - What is the pertinent management unit? → farm / household



Research emphasis
Phase I
Phase II
SOCIO-INSTITUTIONAL LANDSCAPE
Institutions
Markets
Businesses
Platforms
Community
Groups
Household
Farmer(s)
Fields, animals
Farms
Landscape
AGRO-ECOLOGICAL LANDSCAPE



After Goewie (1993) and
Tittonell et al (2015)

Means- vs. goal-oriented

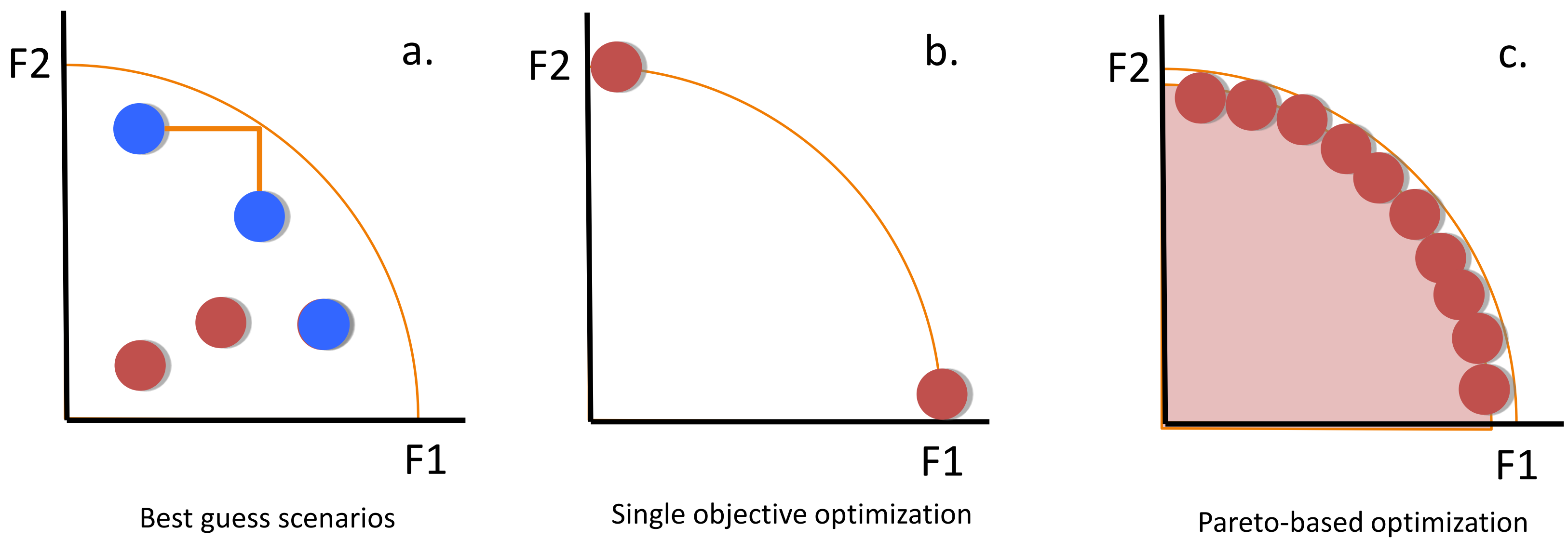
- Means-oriented:
  - Evaluation of quality of measures and techniques at field and farm level
  - Often labeled “sustainable” a-priori

- Goal-oriented:
  - Comparison of the productive, environmental and social performance
  - Using a set of explicit goals, made operational through indicators (MF)
  - Different spatial and temporal scales and organization levels

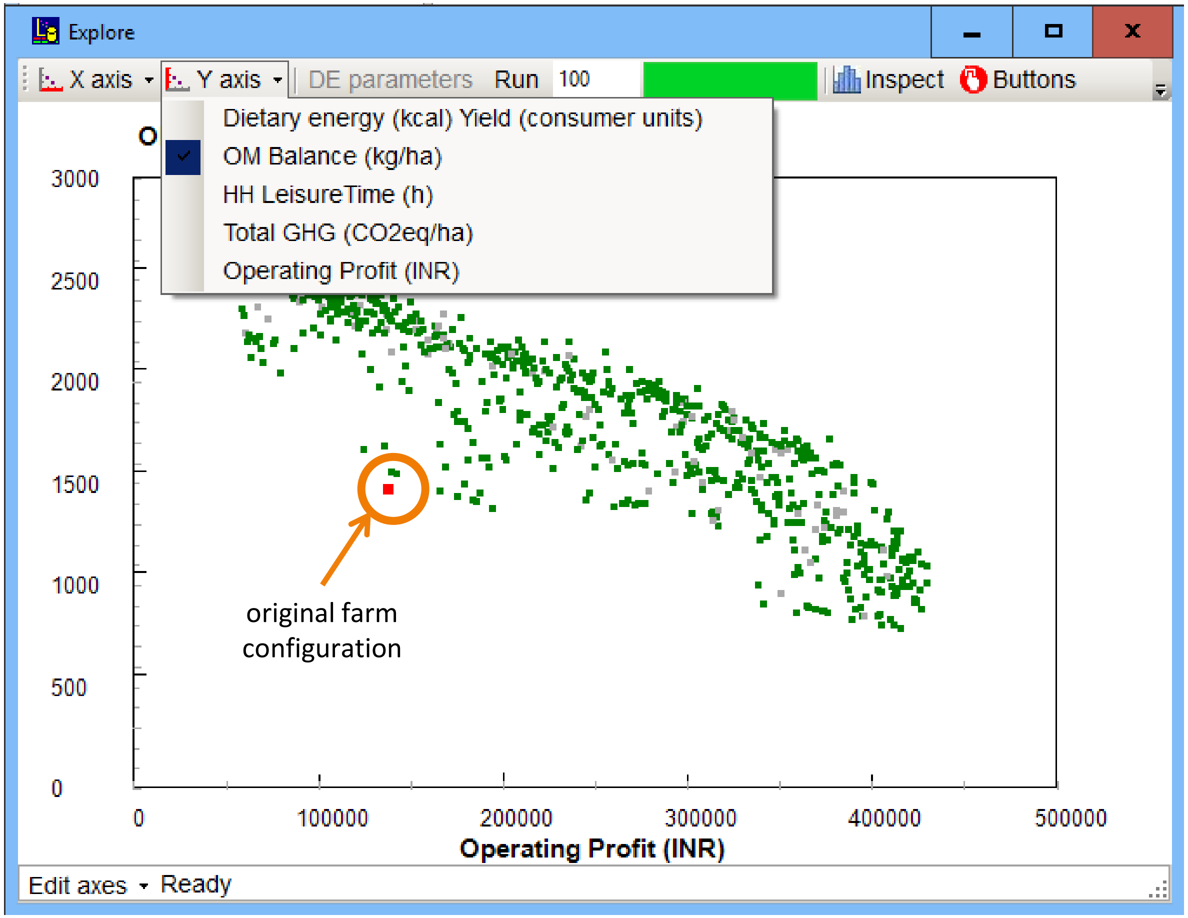
- Focus on the outcomes (goals), that can be reached by **different system configurations** and implemented measures and techniques

Trade-offs at system level

- When improving the system for one goal, an other goal can be compromised (ex. F1 = profit, F2 = soil quality – i.r.t. livestock)
- Evaluate trade-offs in terms of goals at the target system level
- Often there are multiple ways to reconfigure to reach goals



Ex. Trade-offs between multiple goals



Ex. Goals for HHs (1): Labor/leisure time

Explain

To file

Crop areas | Destination | Feed balance | OM balance | Manure | Pesticide | Energy | Nutrients | C cycle | N cycle | P cycle | K cycle | Water | Labor | Profit | Budget | GHG | Nutrition | Flow metrics

Labor balance

		Regular	Casual
Required			
	Farm management	800	0
	Crop management	36	0
	Herd management	730	0
Available			
	Hired labor	0	0
	Own labor	3200	0
Balance			
	Surplus	1634	0

← **Farm labor balance**

Labor input per gender and age class

	Total	≤19	20–34	35–49	50–64	≥65
Female	1000	0	0	1000	0	0
Male	2200	0	0	2200	0	0

Fraction of labor per gender and age class

	Total	≤19	20–34	35–49	50–64	≥65
Female	0.31	0.00	0.00	0.31	0.00	0.00
Male	0.69	0.00	0.00	0.69	0.00	0.00

← **Gendered labor distribution**

Family labor

Available time	3200
Farm labor	1566
Off-farm labor	1600
Leisure time	34

← **Household labor allocation**

Ex. Goals for HHs (2): Budget

Explain

To file

Crop areas | Destination | Feed balance | OM balance | Manure | Pesticide | Energy | Nutrients | C cycle | N cycle | P c

Household budget

Household size

Number of household	5

Income

Farm income	42201
Off-farm income	73980
Total income	116181

← On and off-farm income

Costs

Costs for food	35672
Other expenditures	60000
Total expenditures	95672
Proportion food costs	0.37

← Expenditures, food and other

Financial result

Free budget	20509

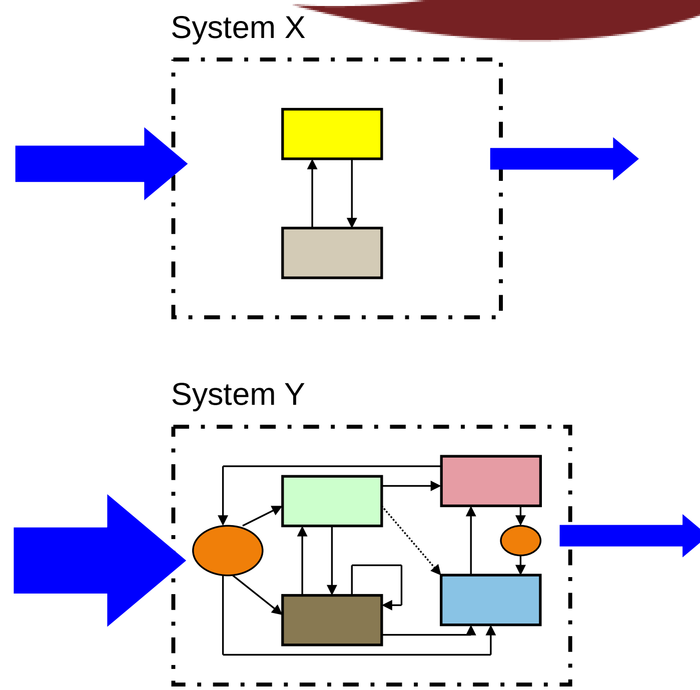
← Available free HH budget

Beyond trade-offs: integrative solutions

- Try to identify solutions to problems that overcome trade-offs and avoid compromise
- Integrative solutions require insight into whole-system responses to different forms of use and an overview of services provided

- Example crop residue use:
  - Allocations: as mulch, feed, firewood, building material
  - Goals: improve soil fertility, feed animals, cooking, heating, building
  - Solutions…

Dealing with diversity



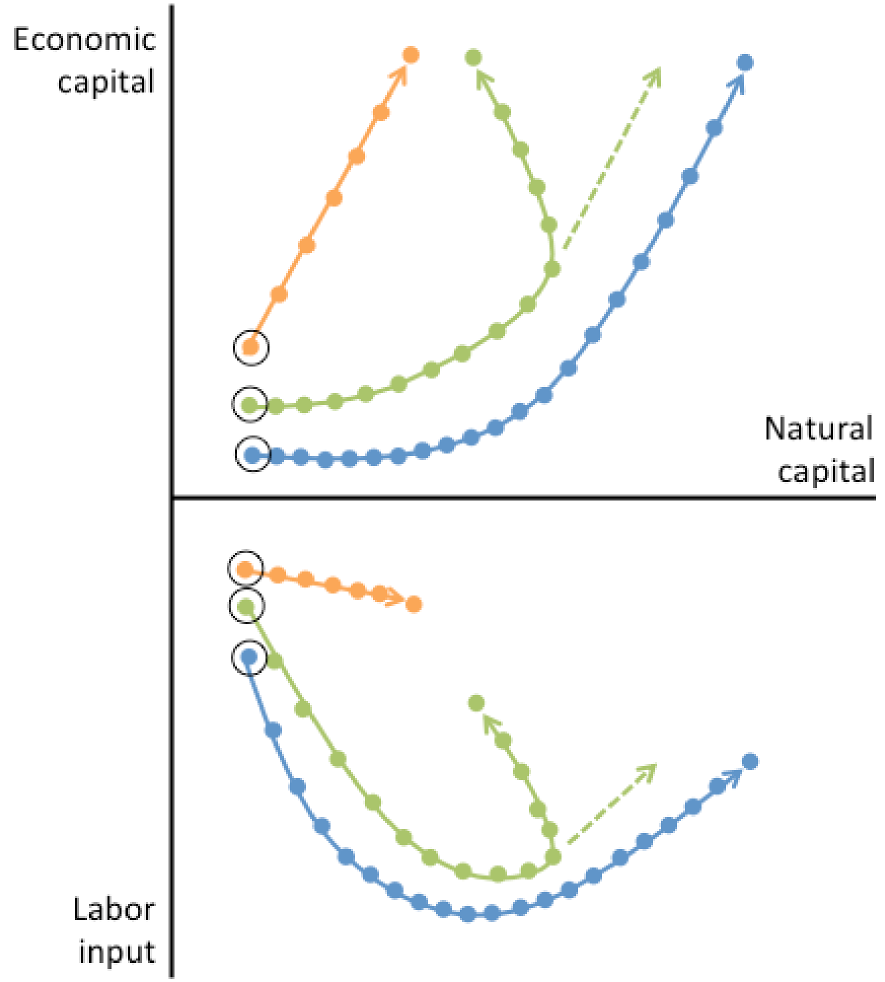
- Farms and households differ in:
  - Size and structure (farm, HH)
  - Development stage (HH)
  - Goals and constraints (HH)

- Distributions: overview of the ranges and variation
- Typologies: grouping of diverse population into similar types

- Farms/HHs with different characteristics need different solutions

Trajectories of change

- How to attain goals in a sequence of changes?
- Different pathways (sequences of solutions) for different farm/HH types



Conclusions

- Evaluate research outcomes in the context of the target system
- Focus on the goals of farms and households, how to attain these
- Explore the system-level trade-offs, look for integrative solutions
- Identify the trajectory (-ies) to follow to reach the ultimate goals
- Accommodate diversity in farm and household structure and goals
- Embrace a portfolio-approach combining multiple methods

Thank You

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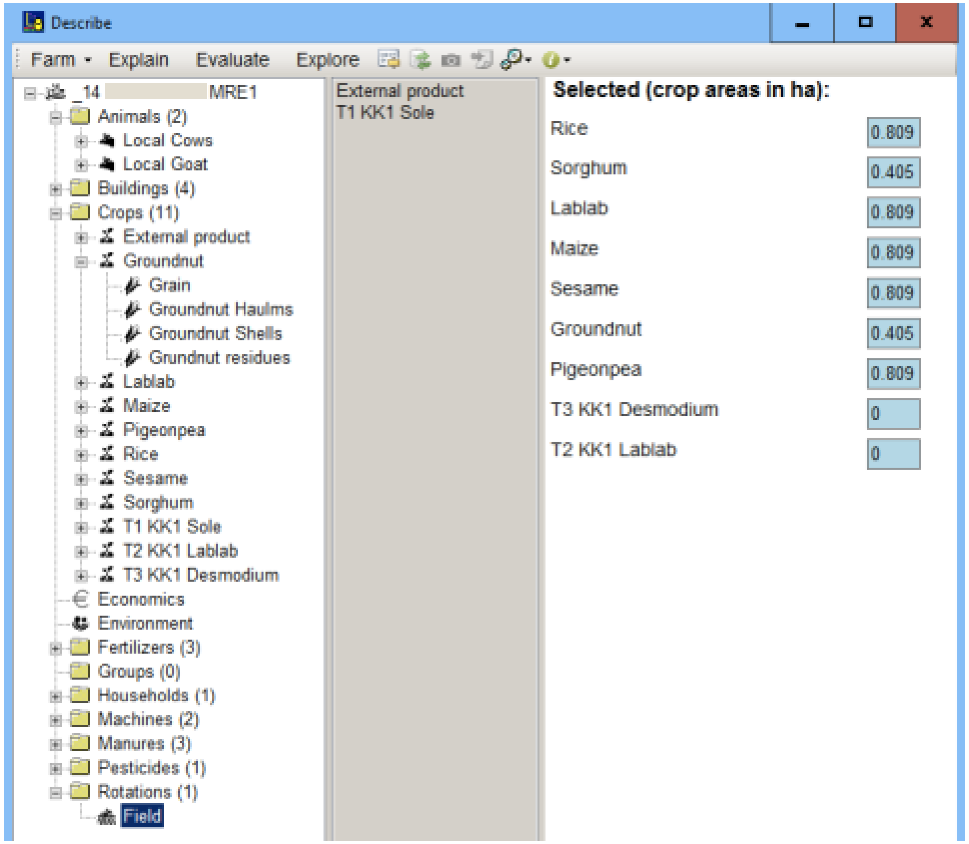
Ex. Farm configuration



Ex. Goals for farms (1): Nutrient yield

Explain

To file

Crop areas | Destination | Feed balance | OM balance | Manure | Pesticide | Energy | Nutrients | C cycle | N cycle | P cycle | K cycle | Water | Labor | Profit | Budget | GHG | Nutrition | Flow metrics

Nutrient yield

Nutrient	Produced	Yield	Per hectare
Dietary energy (kcal)	12450756	13	19
Carbohydrates (g)	2320465	49	70
Dietary fiber (g)	317459	23	33
Fat (lipid; g)	204863	0	0
Protein (g)	436360	21	30
Phosphorus (P; mg)	11256013	44	63
Potassium (K; g)	21987	13	18
Magnesium (Mg; mg)	3401989	23	33
Manganese (Mn; mg)	0	0	0
Calcium (Ca; mg)	5110728	14	20
Sodium (Na; mg)	1323388	2	3
Iron (Fe; mg)	153887	53	75
Zinc (Zn; mg)	85711	21	30
Sulfur (S; mg)	0	0	0
Vitamin A (µg)	3397999	10	15
Vitamin C (mg)	391478	12	17
Tiamin (mg)	15319	35	50
Riboflavin (mg)	7619	16	23
Folate (µg)	5445313	37	53
Niacin (mg)	118358	20	29
Vitamin B-6 (mg)	13056	28	39
Vitamin B-12 (µg)	6570	8	11
Copper (µg)	228	0	0
Vitamin D (µg)	0	0	0
Vitamin E (mg)	25703	5	7

Yield is expressed as the number of people (consumer units) that can be sufficiently nourished for a given nutrient

Ex. Goals for farms (2): Operating profit

Explain

To file

Crop areas | Destination | Feed balance | OM balance | Manure | Pesticide | Energy | Nutrients | C cycle | N cycle | P cycle | K cycle | Water | Labor | Profit | Budget | GHG | Nutrition | Flow metrics

Margins, costs and profit

Returns

Gross margin crops	113615
Risk crop margin	0
Gross margin animals	17166

Costs

Manure costs	0
Crop protection costs	0
Green manure costs	2880
Land costs	700
Equipment costs	0
Building costs	75000
General costs	10000
Hired cas. labor costs	0
Hired reg. labor costs	0

Totals

Operating profit (+return	42201
Own labor costs	39159
Return to family labor	27
Home consumption	35672
Interest costs	15000
Depreciation costs	30000

Returns from animal production

Name	Price	Production	Amount used	Purch-sale bal.	Returns
Milking cows Milk	30.00	1825	200	-1625	54750

Margin for animal production

Feed costs	Bedding costs	Interest costs	Other costs	Returns	Margin	Margin p.ha
29981	2103	0	5500	54750	17166	24523

Returns from crop production

Name	Amount used	Production	Purch-sale bal.	Self supply	Returns	Returns p.ha

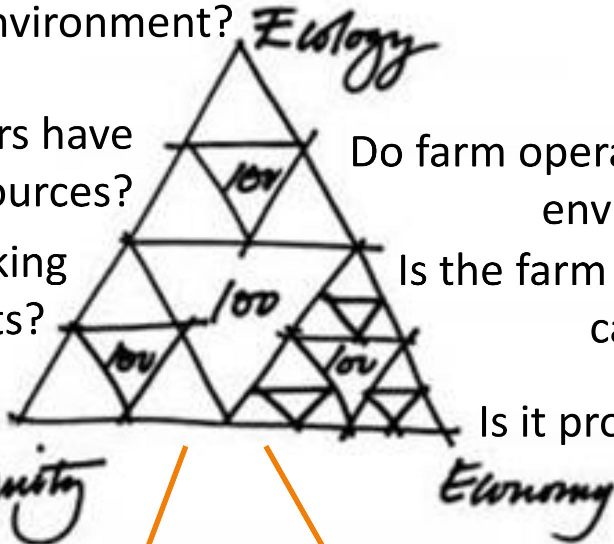
Sustainable by design (example boundary object)

Is it good for the environment?

Do all HH members have access to resources?

Are farmers safe in making and using their products?

Are people treated the same?



Do farm operations contribute to environmental quality?

Is the farm productive without causing degradation?

Is it profitable?

Do men and women paid the same for the same job?

Do farmers and workers get a living wage?

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Boundary work for sustainable development: Natural resource management at the Consultative Group on International Agricultural Research (CGIAR)

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Previous research on the determinants of effectiveness in knowledge systems seeking to support sustainable development has boundary work is that tensions arise at the interface between communities with different views of what constitutes reliable or

Scholarship on boundary work is rapidly expanding (6, 7, 11, 12). In general, it hypothesizes that boundary work is more likely to be effective in promoting used and useful research to the extent that it exhibits at least three key attributes: (*i*) meaningful participation in agenda setting and knowledge production by stakeholders from all sides of the boundary; (*ii*) governance arrangements that assure accountability of the resulting boundary work to relevant stakeholders; and (*iii*) the production of "boundary objects," defined as collaborative products such as reports, models, maps, or standards that "are both adaptable to different viewpoints and robust enough to maintain identity across them" (13).

Boundary objects. ASB created a variety of boundary objects that were jointly "owned" by natural and social scientists. One of the first of these was the development of shared protocols for data collection developed to guide and coordinate work across the ASB benchmark sites (27, 28). There was little truly interdisciplinary scholarship involved in this work. However, the commitment of natural and social scientists to contribute their respective parts to a common whole clearly advanced mutual understanding and respect. Real interdisciplinary integration eventually followed, perhaps most clearly illustrated by the bioeconomic models developed by ASB and its partners from Brazil's Embrapa (29). These models