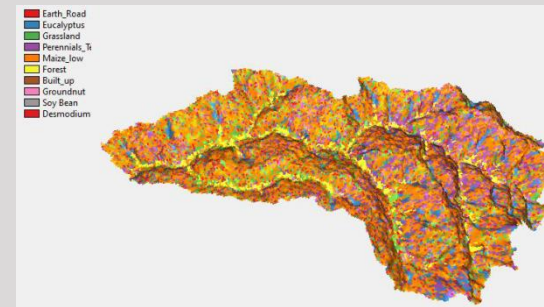# A Framework of Biophysical Measurements, Innovation Platforms and Modelling

for Agricultural Stakeholders' Landscape-Scale Decisions

Carsten Marohn[1], Rainer Weisshaidinger[2], Gian Nicolay[3], Abigael Otinga[4], Alex Pohl[1], Roel Merckx[5], Ruth Njoroge[5], Eric Koomson[1], Francis Kerre[6], Jane Wangaruro[6], Samuel Njogo[4], Bernice Munini[4], Georg Cadisch[1]

[1]University of Hohenheim, Hans Ruthenberg-Institute of Agricultural Sciences, Germany
[2]Research Institute of Organic Agriculture (FiBL), Austria
[3]Research Institute of Organic Agriculture (FiBL), Switzerland
[4]University of Eldoret, Soil Science, Kenya
[5]KU Leuven, Dept. of Earth and Environmental Sciences, Belgium
[6]Kenyatta University, Kenya

The CONNESSA project

CONNESSA – CONNEcting knowledge, scales and actors;
An integrated framework for adaptive organic resource management, targeting soil aggradation and agroecosystems' resilience in SSA

Aims & approach: Build up a knowledge network for rehabilitation of degraded soils through organic amendments at various spatio-temporal scales.

ERAfrica call:
Strengthen intercontinental research collaboration in the field of science and technology research, model for future cooperative ventures between the two continents
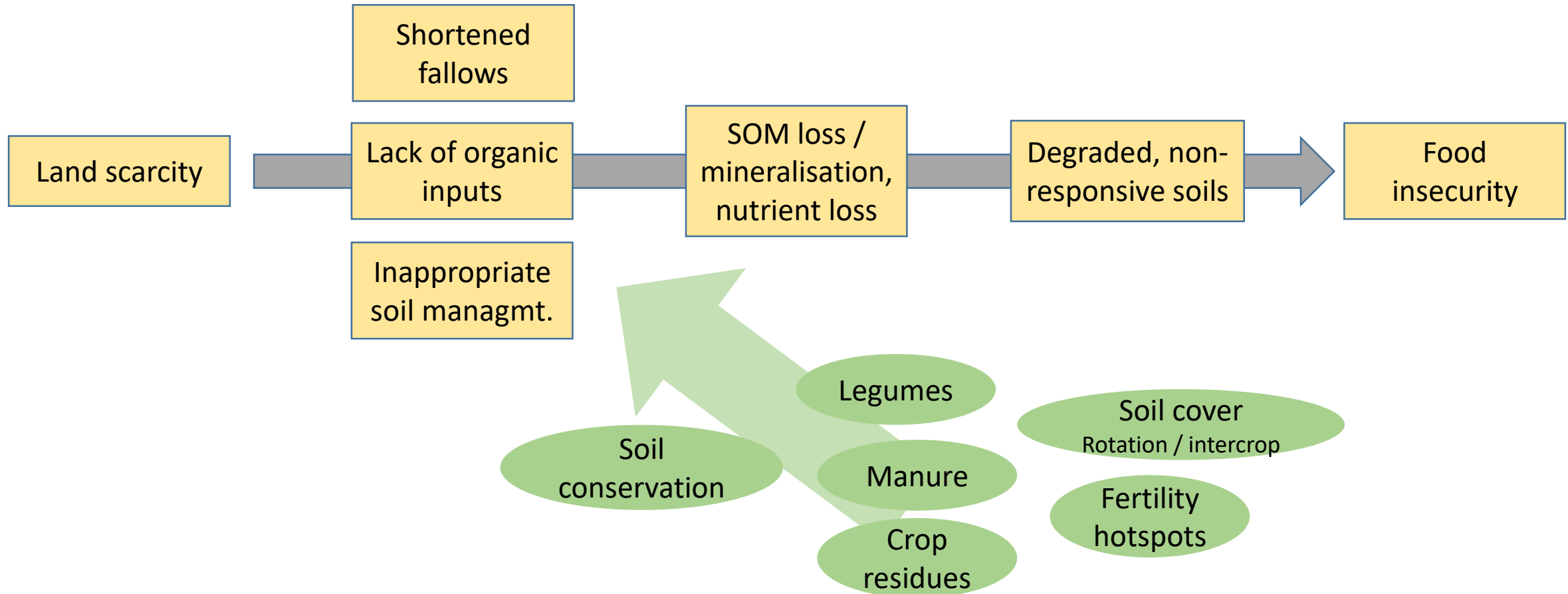
Partners:
Kenya: University of Eldoret, Kenyatta University, Katholieke Universiteit Leuven, FibL. Burkina Faso: University of Ouagadougou, IRD, CIRAD.
Cote d'Ivoire: Nangui Abrogoua University.

https://connessa.uni-hohenheim.de/en
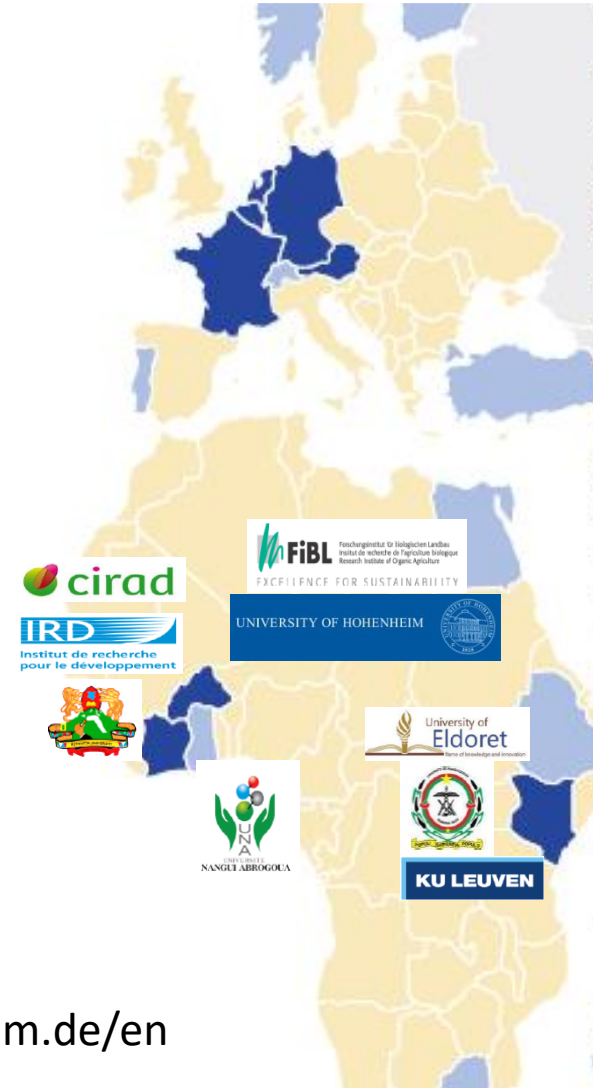
Soil degradation and rehabilitation

Local approaches to soil degradation

Afforestation / tree plantations

Crop-livestock integration

Legume rotations / intercropping (Desmodium intortum)

Mulch of *Piliostigma reticulatum* (source: Some 2014)

Improved manure management (?)

Urban waste composting for horticulture

Exchange / adoption of diverse local approaches – generic framework for identification of locally adapted ideas, evaluation of strategies and trade-offs
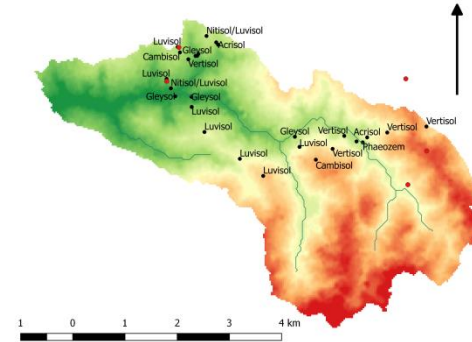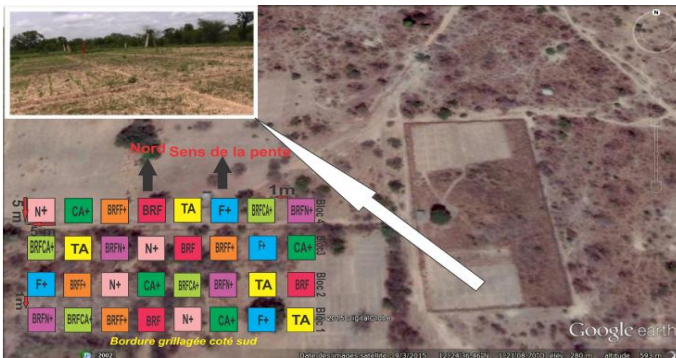
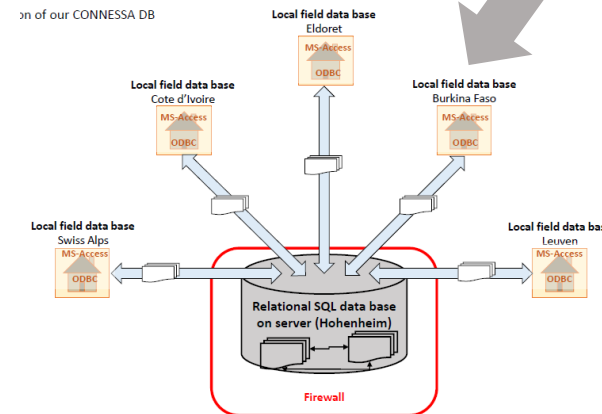On farm field trials LRS 2015, W Kenya

Student-farmer coop's

Watershed level

Partner projects:
LegumeChoice, SOM trials, VLIR, RUFORUM, WASSA, ...
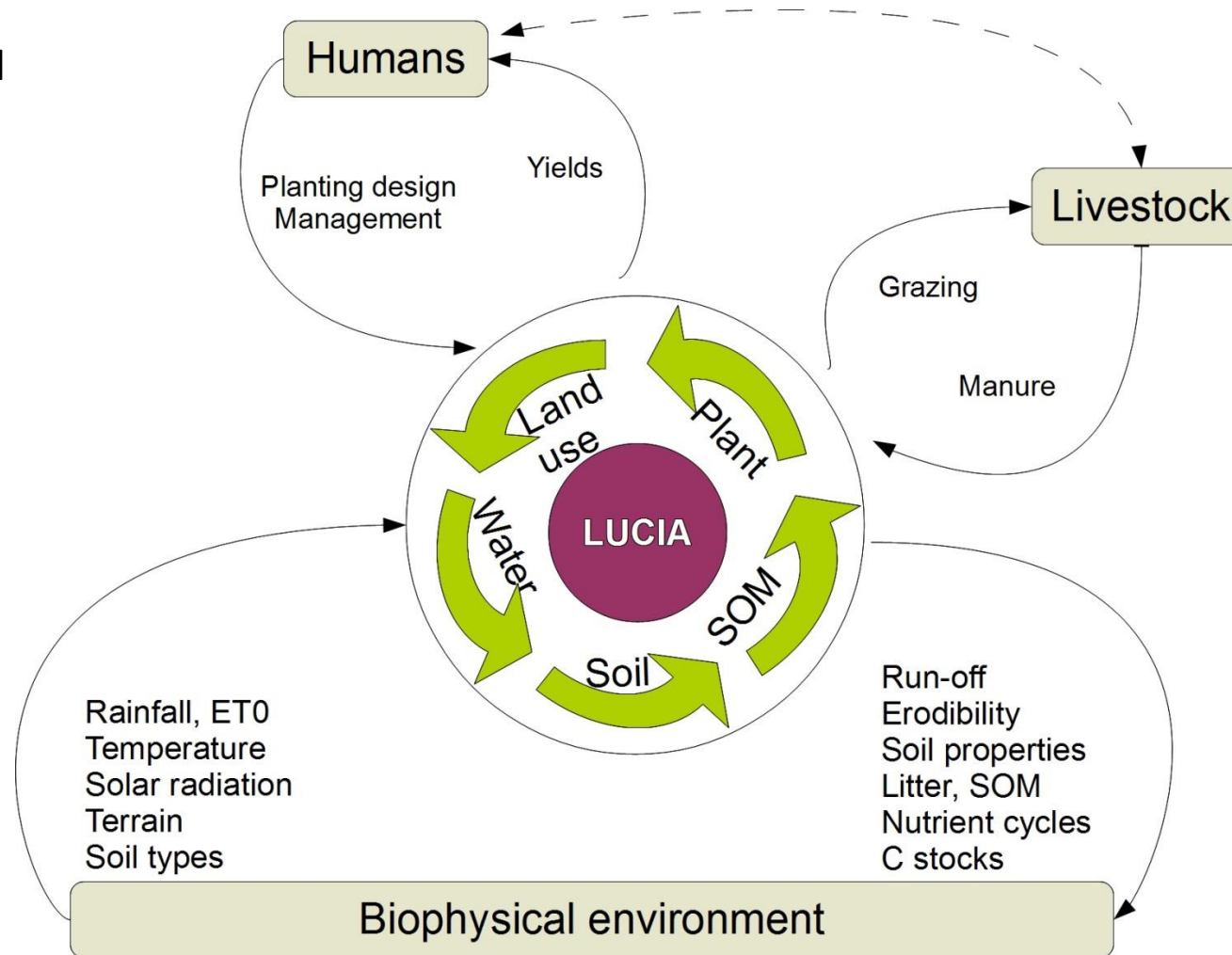
Source: Sanou 2015

Field trials Burkina Faso

Joint DB

SOM long-term trial Machanga, Kenya

Land Use Change Impact Assessment (LUCIA)

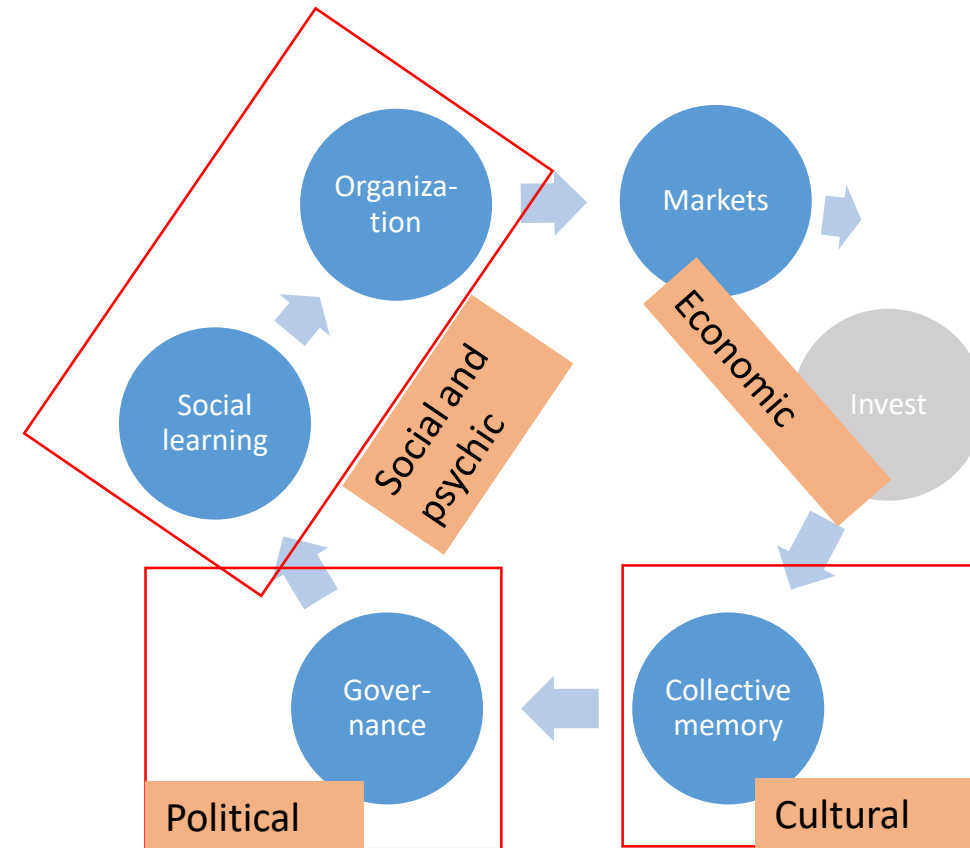Distributed raster-based
Dynamic, 1-day step
Small catchments

https://lucia.uni-hohenheim.de/en

Farm- and society level information, numerical characterisation of indicators

Object: Farm		A	B	C	D	E	F	G	
	Parameter			variables					n var
1	land and soil quality	arable (ha)	meadows	agroforest/forest	org matter balan	other			4
2	other assets	animals	seed, trees	machinery/tools	buildings	water	other		6
3	labour	family	off-family	labor costs	other				3
4	farm income	monetary	value in kind	production	other				2
5	off-farm income	monetary	net	other					2
6	knowledge	education level	extension	access media	training receivd	oher			4
7	markets	output	input	distance	other				3
8	yearly investment	land	machinery	knowledge	other				4
9	savings	monetary	other						1
10	farm resilience	CC adaptation (Ecl)	HR availab, (Soc)	Input access (ecn)	other				3
	: farm type								32

Object: Society (local/district; including national characteristics)								
1	demography	pop density	structure						2
2	human capital	age	health	knowledge	dignity	food security			5
3	economic capital	legal property	agr. markets	investments	farm type	techn.dev	poverty		6
4	financial capital	% HH with cred. Acce	incomes (HH, oth)						2
5	social capital	customs	trust	education status	networks	cities	clans	organizations	7
6	cultural capital	languages	values	norms	innovations	myths	ritual	collect. memory	7
7	symbolic capital	influence	rigths	territoriality	governance				4
8	Economy	Ag sector	Industry	Services	land market	production	consumption		6
9	Politics	coherent ag pol	coh. rural dev pol.	security	leadership				4
10	Law	property rights	land laws	human rights	labor rights				4
11	Civil Society	local communities	tribes	age groups	CBO	NGO	movements		6
12	Culture	initiation	education	art	collect. stories				4
13	Mass media	radio access	TV access	mobile phones acc	internet/ soc.m	press access			5
14	Research/Science	ag sciences	ag research	universities	higher edu.				4
	: society tpe								66

Innovation platforms: Stakeholder discussions, participants = cross-section of society

Represent the entire system

Kenya and (red) Vihiga
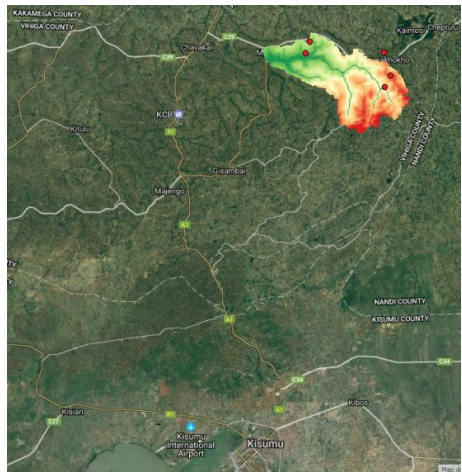
Field data collection

↓

IP: Scenario development

↓

Modelling, 1st round

↓

IP: Stakeholder feedback

↓

Modelling, 2nd round

↓

Policy rec's

N stress   P stress

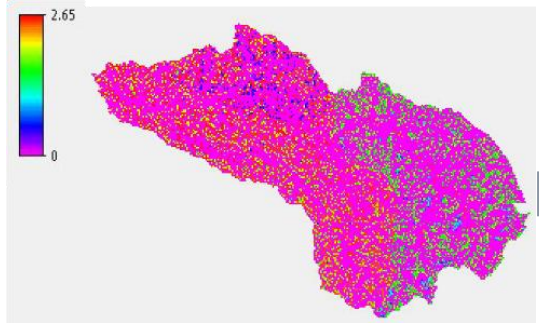Foto: Univ. of Eldoret
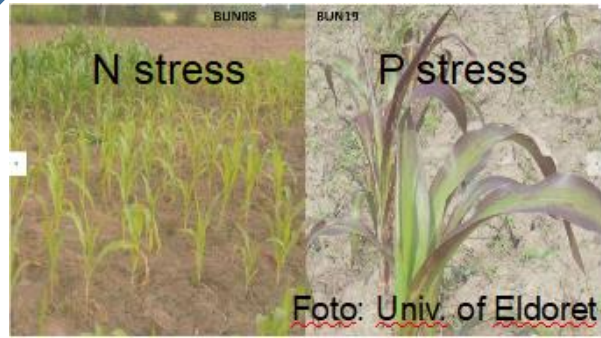
S1: Increase in legume-based cropping systems
S2: Intensified manure management
S3: Afforestation

Earth_Road
Eucalyptus
Grassland
Perennials_Tea
Maize_low
Forest
Built_up
Groundnut
Soy Bean
Desmodium

LU Sabatia

Long Rainy Season

Short Rainy Season
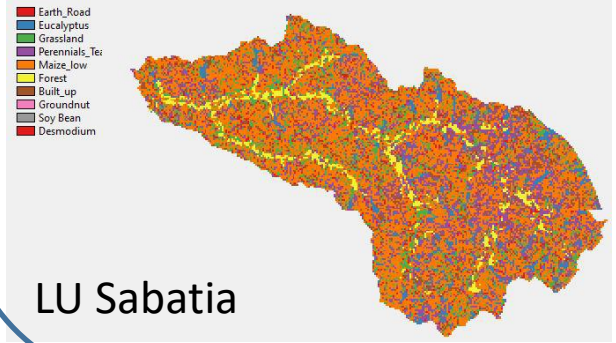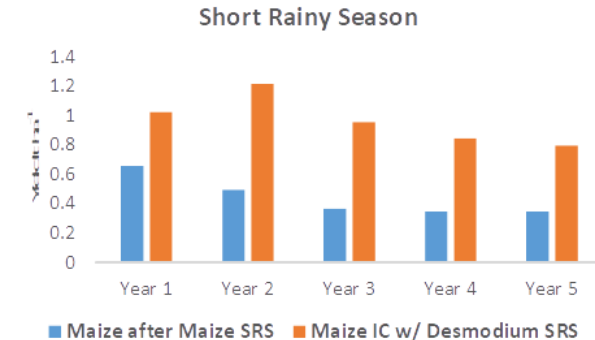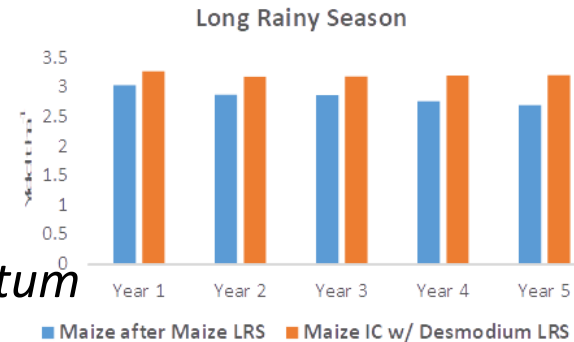

Model output:

- Decreasing monocropped maize yields,
- stabilised by intercropping with *D. intortum*

Discussion:

- Modelled yield levels and trends are realistic
- Detailed characterisation of soils in the landscape –suitability

Model output: Amounts of manure needed to increase maize yields → heads of cattle → fodder quantity → land for fodder

Discussion:

- Land size not sufficient to increase number of cattle
- Fodder can be bought
- Improve manure management

Scenarios
A) Current land use
B) Plant tree along rivers (forest sites)
C) Plant trees on steep marginal sites (erosion hotspots, but slower tree growth)

For scenario (a), we considered all grasslands within 40 m distance to the river

For scenario (b), all grasslands > 15.2% slope amounted to 23 ha

Questions
- Suitability and performance
- Soil conservation (erosion hotspots)

Discussion
- Modelled lower biomass along river confirmed
- Joint action to combat erosion along hotspots (e.g. roads), but difficult on private land
- Low incentive to invest in soil fertility if land tenure insecure
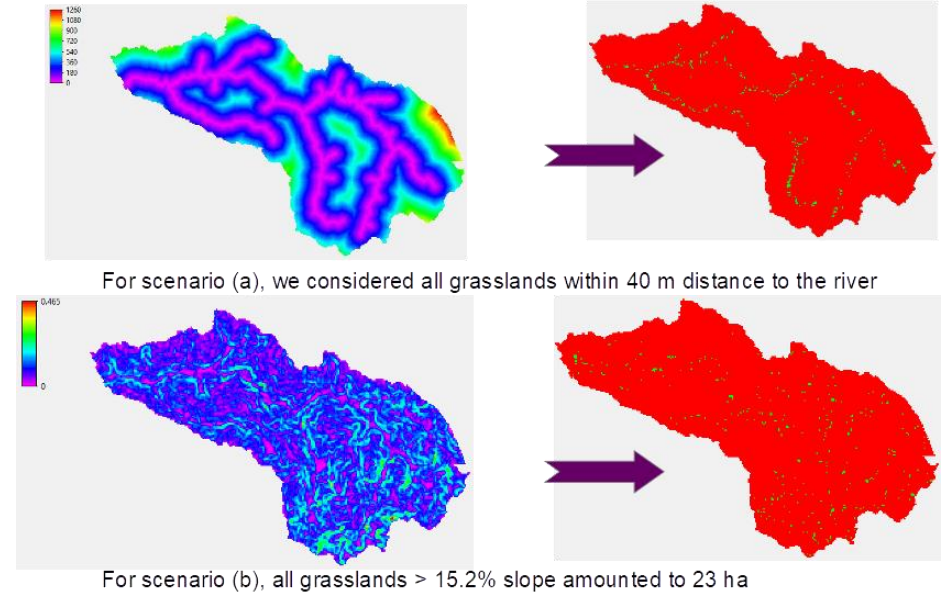
Evaluation by IP participants
- Recognition of "a rare opportunity where farmers got feedback from research"
- Model trustworthy at the targeted level of accuracy
- Potential of increased livestock numbers as well as afforestation limited by land area
- Additional scenario on liming requested

Remarks from the modelling perspective:
- Modelling – IP – combination as promising tool to spark discussions on collective issues (requires trust and local knowledge)
- Closer [formalised?] linkage between biophysical and sociological methods / findings

Aims
- Participatory modelling accepted to develop scenarios and explore trade-offs
- Stimulate discussions, support ownership and local joint initiatives

Conditions:
- Knowledge of area and topics of interest
- Field data base
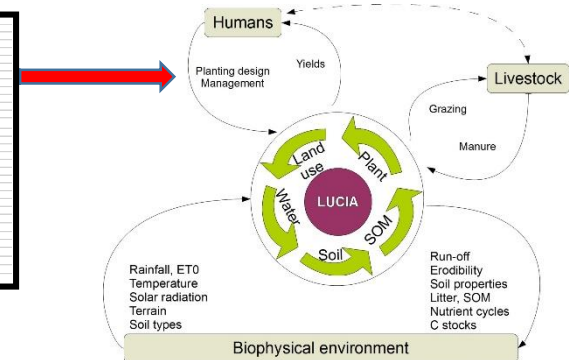- Human resources

Open tasks & questions:

Second model round ongoing

Model workshop conducted in Burkina Faso

Generic approach?

Policy recommendations - work in progress (at which level? To what detail?)

Acknowledgments

Farmers & stakeholders on site

Partners working in Burkina Faso:
- IRD
- CIRAD
- WUR (Farm ecology group; M Pulleman)

Cooperating projects in Kenya & Burkina Faso

https://connessa.uni-hohenheim.de/en