




Multi-level nutrient cycle model in agro-sylvo-pastoral systems of West Africa

Case of the Groundnut Basin in Senegal

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AGIR AGroécologie - Innovations - TeRritoires

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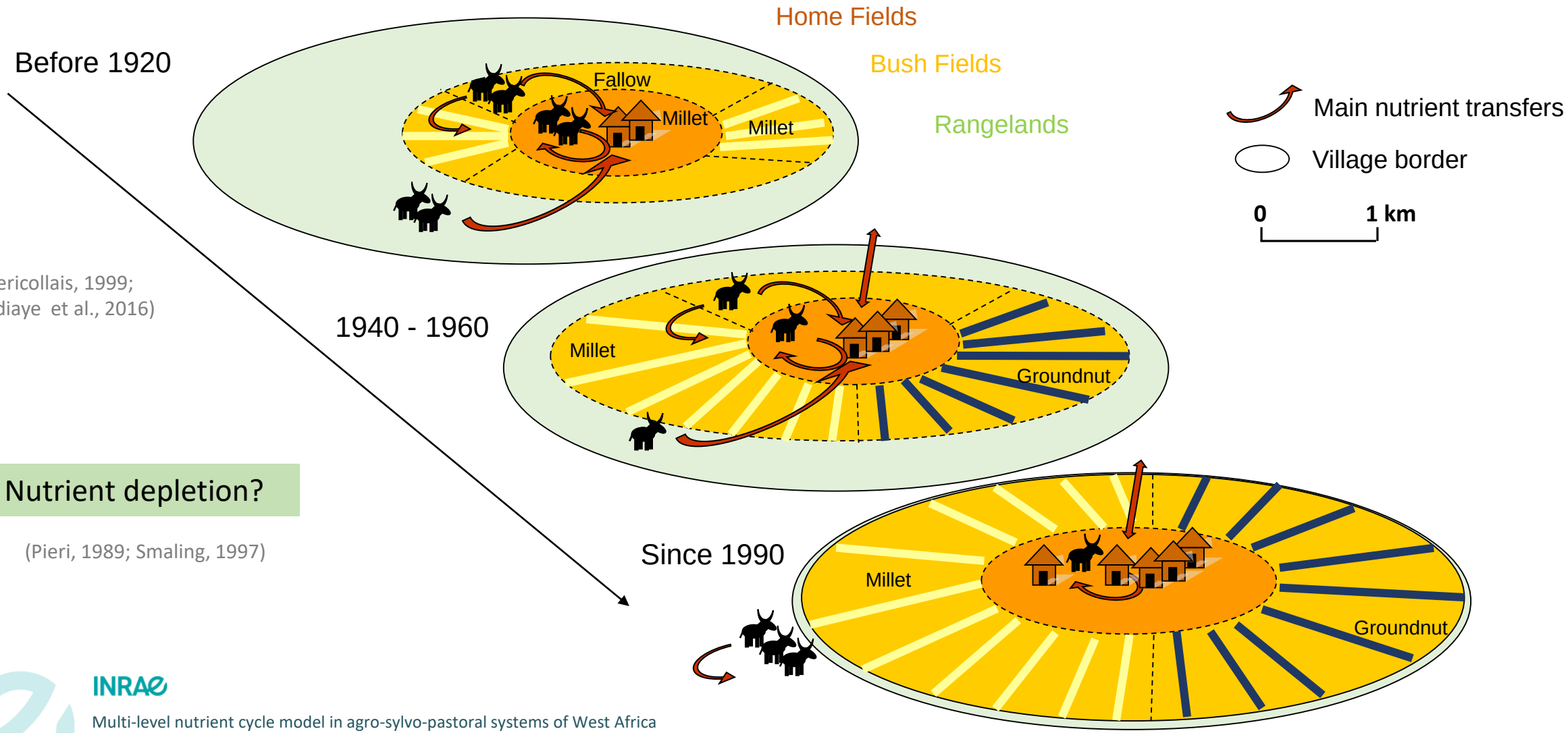
Landscape evolution in West Africa and nutrient cycling

Example in the Senegalese groundnut basin



(Lericollais, 1999; Ndiaye et al., 2016)

(Pieri, 1989; Smaling, 1997)

Nutrient depletion?

Vayssières et al., 2015

Research question

How simultaneous evolutions of
livestock systems and **landscapes**
impact **nutrient** cycles and
the functioning of agro-sylvo-pastoral systems?

Objective 1: represent ASPS functioning

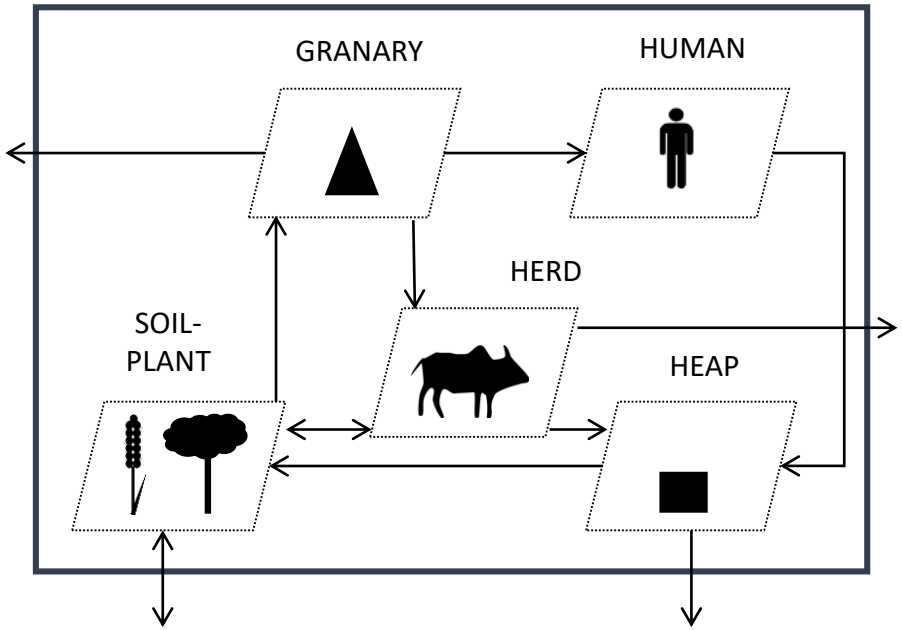
Objective 2: analyze the impacts of an agrarian transition

Focus on Nitrogen flows

TERROIR model

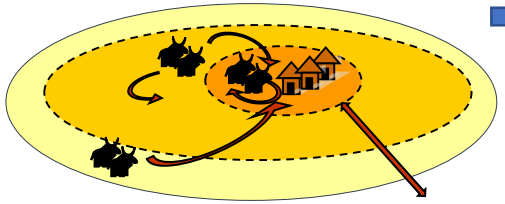
2 stock-flow models to describe the functioning of an ASPS

- Activities



(Rufino et al. 2009, Stark et al. 2016 and Bénagabou et al. 2017)

- Spatialization



(based on Vayssières et al. 2015)

Homestead

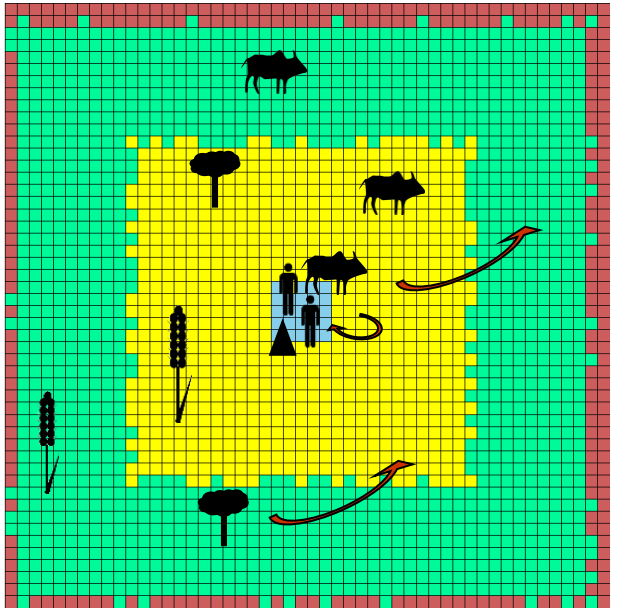
Home fields

Bush fields

Rangelands

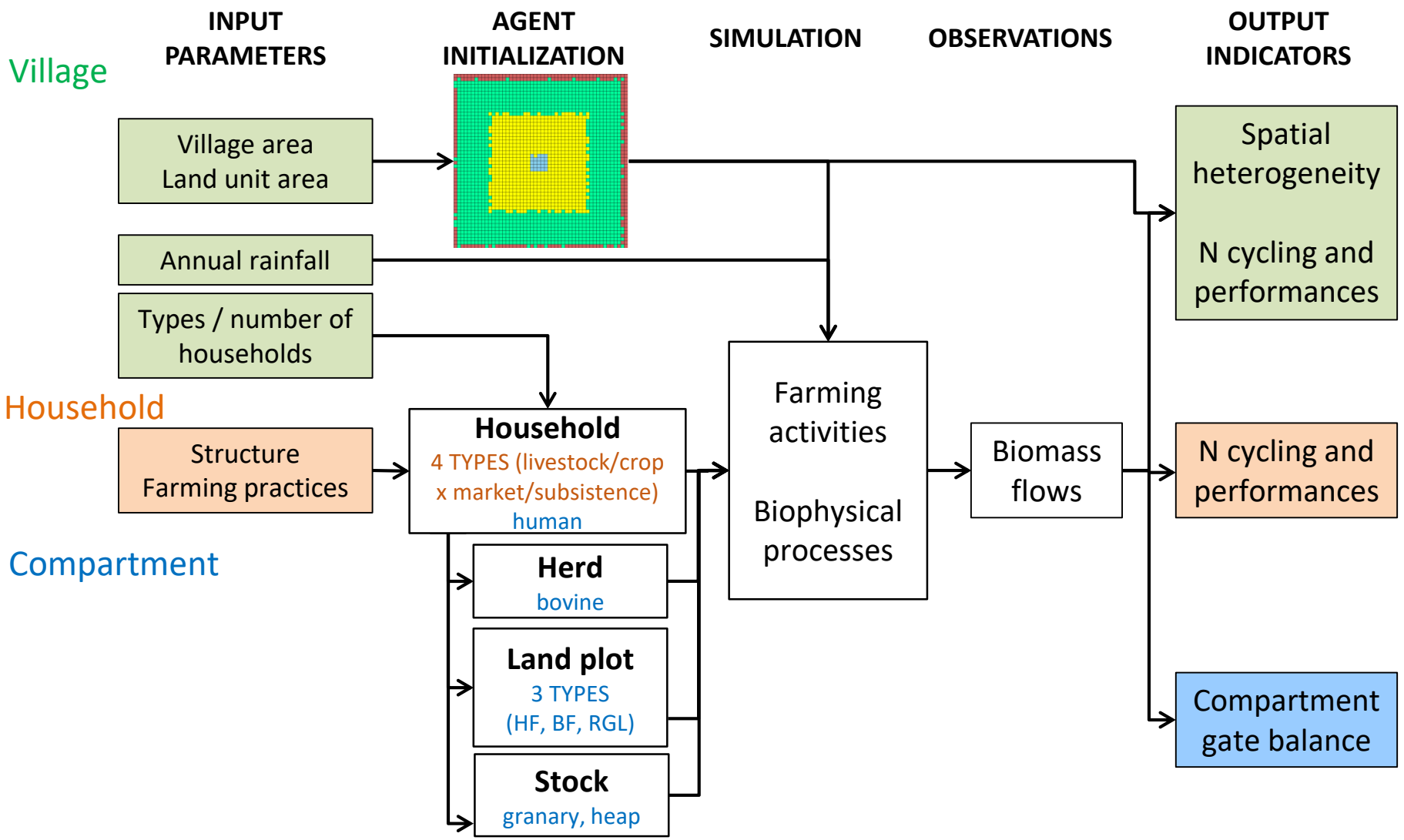
Grid (625ha)

0.25 ha



(Manlay et al. 2004)

Structure of the TERROIR model



Activities time scale over a year of simulation

Focus on exchanges between households

Decisional

Compartment	Daily (1 d)	Weekly (7 d)	Annually (360 d)
Livestock	**Graze** Feed	Choose corral **Buy / sell**	
Soil-plant		Spread manure Sow Harvest	Mineral fertilization Sell crops
Human		Human consumption **Buy / sell food**	

Biophysical

Compartment	Daily (1 j)	Weekly (7 d)	Annually (360 d)
Livestock	**Excrete**		
Soil-plant		Crop growth	Compute yield Atmospheric fixation
Human		Waste production	

1 simulation = 5 years => outputs = the 5th year ; 8 replications

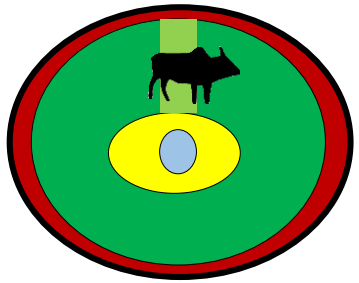
Model evaluation

Simulations vs surveys from 2 contrasted villages

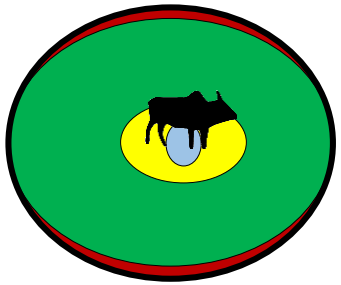
117 households ; 1 040 plots ; 5 455 livestock units

(Odru, 2013, Audouin, 2014)

- Traditional village

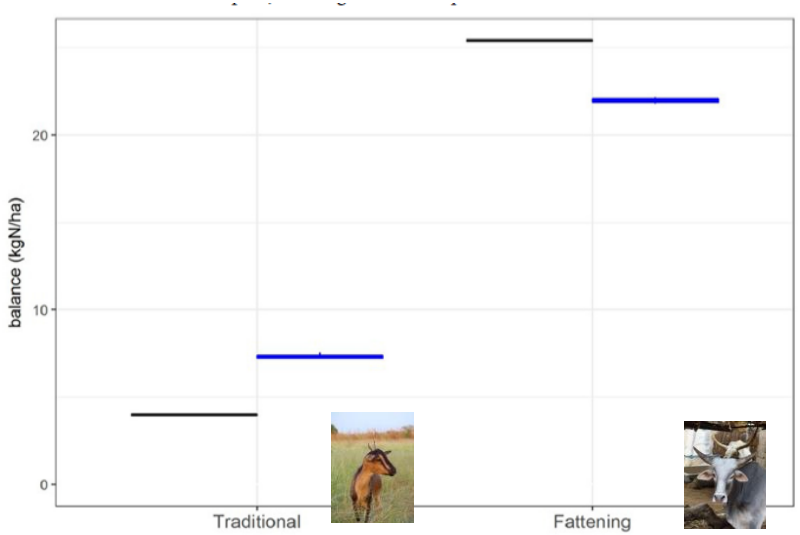


- Livestock fattening



observation simulation

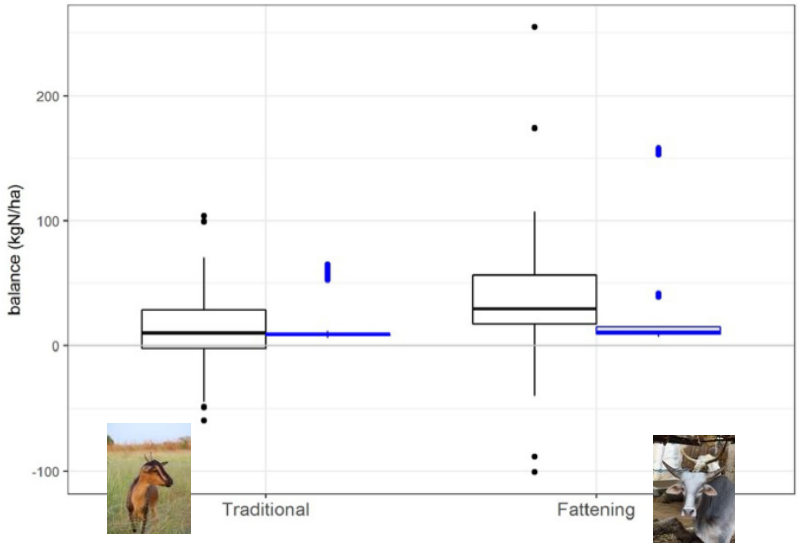
N balance at Village level



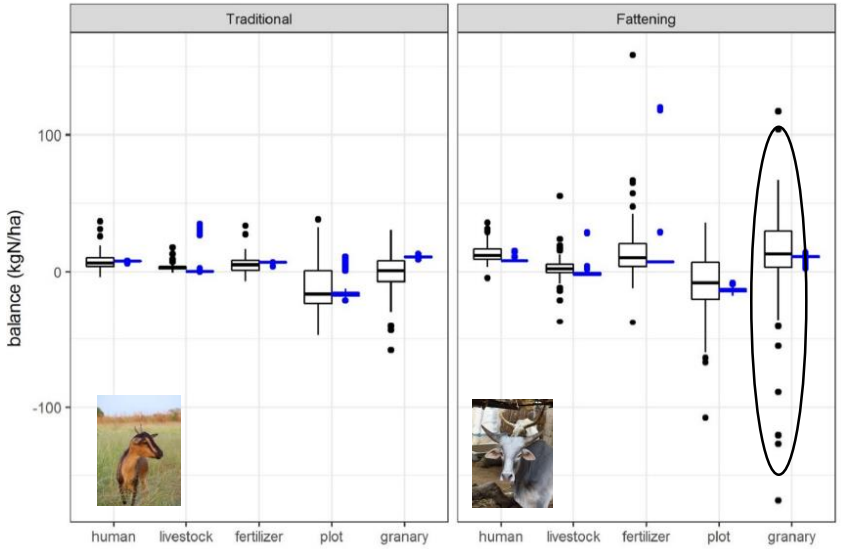
- 3 kgN/ha

+3 kgN/ha

N balance at Household level

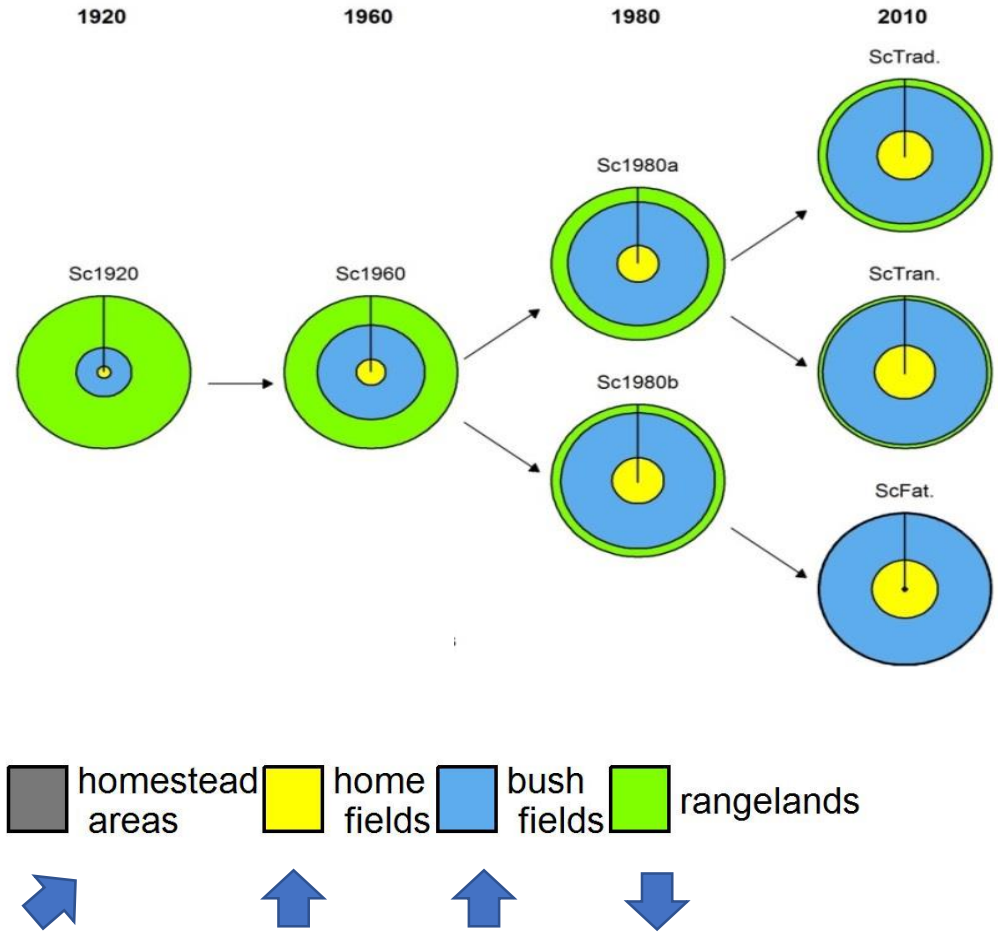


N balance at Compartments level

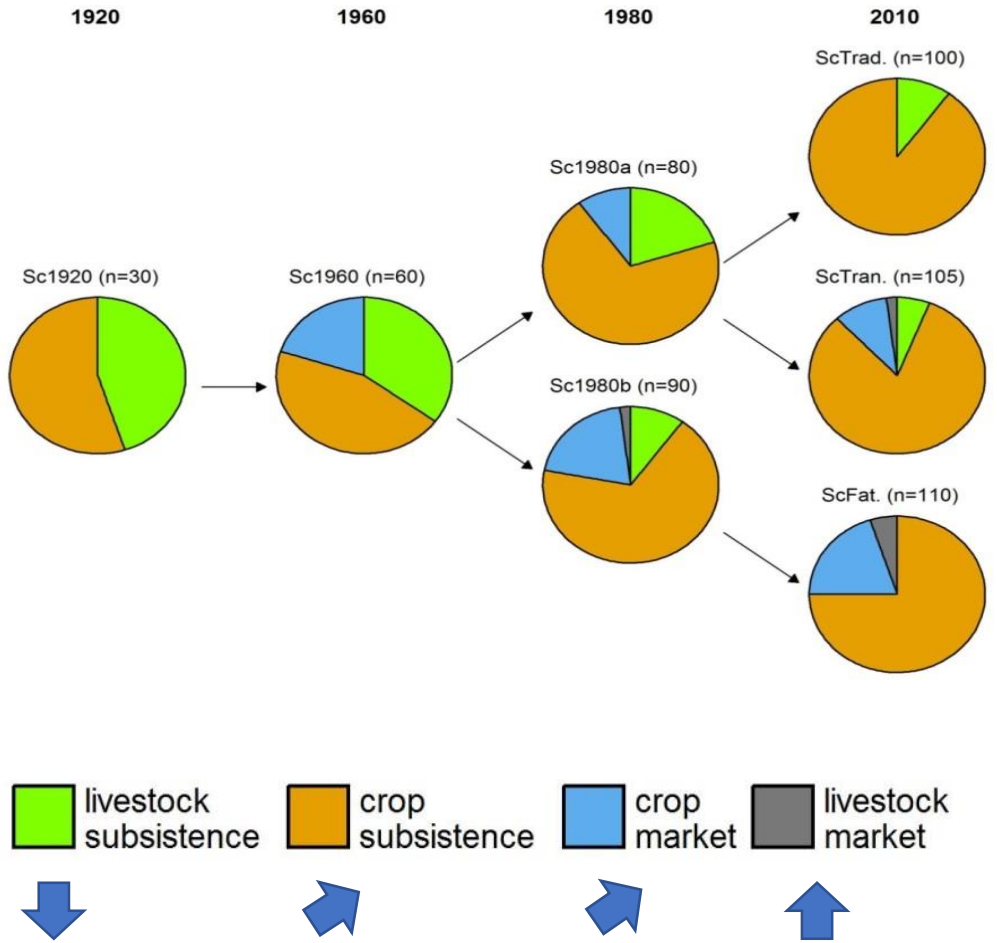


7 scenarios for the agrarian transition

- Landscape structure

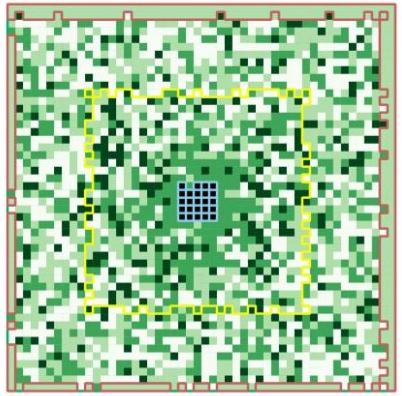


- Household types



Main results

- Nitrogen flow intensification
- Internal cycling rate (Σ inputs/ Σ flows) > 0,6
- Crop-livestock integration maintained
  - in-field grass => stored forage
  - direct deposit of excreta => manure spreading
- Decrease of N balance at plot level but accumulation in manure heap
- Spatial heterogeneity maintained



Conclusion

- 2 conceptual stock-flow models
- Multi-level analysis
- Outlook
  - Integration of other indicators?
  - Test innovating system / change constraints?
  - Simulate other areas in West Africa?

THANK YOU

Code: https://github.com/MyriamGrillot/TerroirModel

Full model description: **Grillot M., Guerrin F., Gaudou B., Masse D., Vayssières J.**, 2018. Multi-level analysis of nutrient cycling within agro-sylvo-pastoral landscapes in West Africa using an agent-based model. *Environmental Modelling & Software* 107, 267-280. https://doi.org/10.1016/j.envsoft.2018.05.003

Simulation of the transition: **Grillot M., Vayssières J., Masse D.**, 2018. Agent-based modelling as a time machine to assess nutrient cycling reorganization during past agrarian transitions in West Africa. *Agricultural Systems* 164, 133-151. https://doi.org/10.1016/j.agsy.2018.04.008