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ANIMAL FARMING FOR A HEALTHY WORLD
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Use of ecological network to analyse how interactions drive performance in mixed livestock farms

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Context - Mixed livestock farms

Diversification: at the heart of the implementation of agro-ecological principles

Better use of crop by-products, cover-crop…
Ruminants - monogastrics

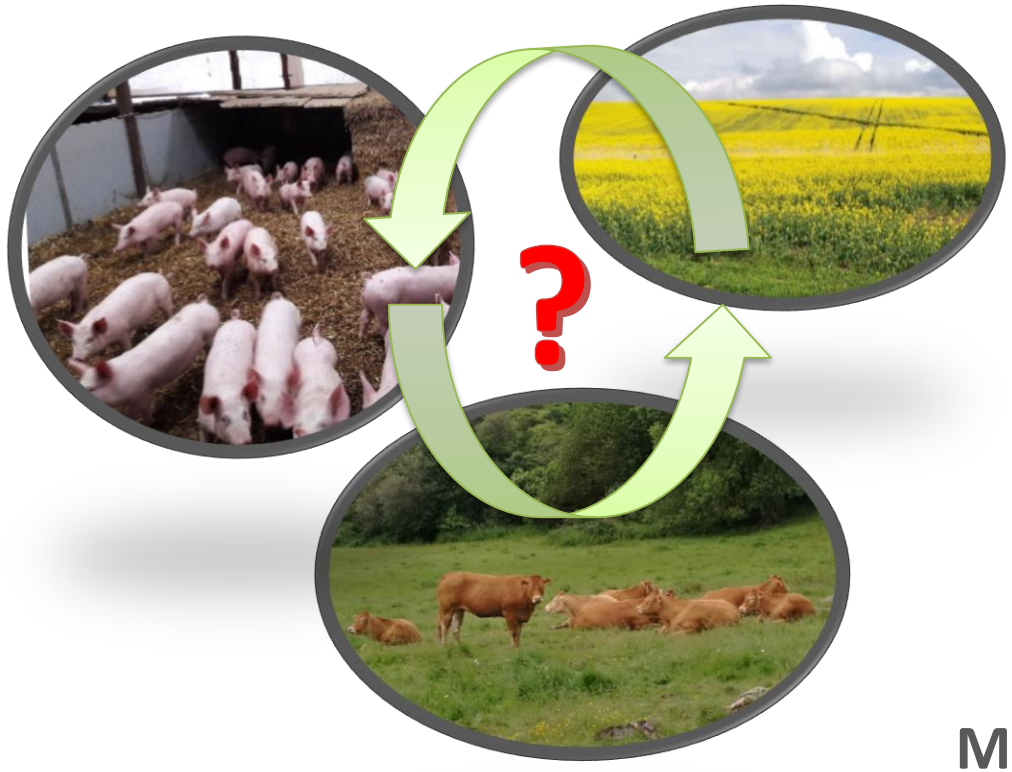
€ Income stability
diversification

Better use of pastures
co-grazing by ruminants

Reduce dependence on external inputs
Crop – livestock

→Few references on processes operating in mixed livestock farms and on their performances

Aim



- understand **how a mixed livestock system works**

How to represent ?

- From interactions among system components and between components and the environment

For a **large diversity of mixed livestock systems**

Propose a method to

- represent and analyse the functioning
- Assess the level of interaction

More complex interaction network will lead to higher multiperformances

Method – Ecological Network Analysis

- Input – Output analysis → study the relationships between the components of a system (Fath & Patten, 1999)

- Already applied on agrosystems

Nutr Cycl Agroecosyst (2009) 84:229–247
DOI 10.1007/s10705-008-9239-2

ORIGINAL ARTICLE

Analysing integration and diversity in agro-ecosystems by using indicators of network analysis

M. C. Rufino · H. Hengsdijk · A. Verhagen

Contents lists available at ScienceDirect

European Journal of Agronomy

journal homepage: www.elsevier.com/locate/eja

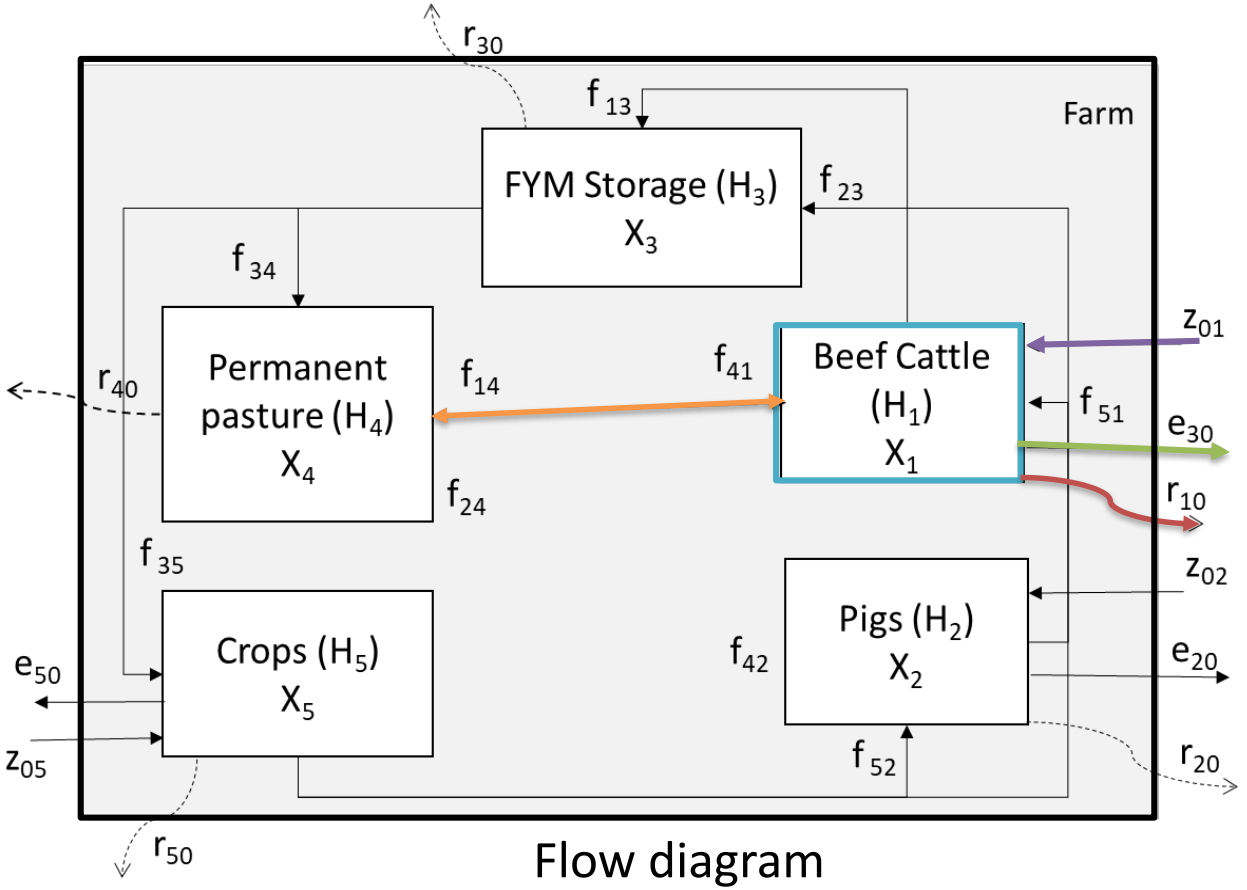
Crop-livestock integration, from single practice to global functioning in the tropics: Case studies in Guadeloupe

Fabien Stark[a,b,c,*], Audrey Fanchone[c], Ivan Semjen[d], Charles-Henri Moulin[e], Harry Archimède[c]

Method – Ecological Network Analysis

Step 1 : System conceptualization

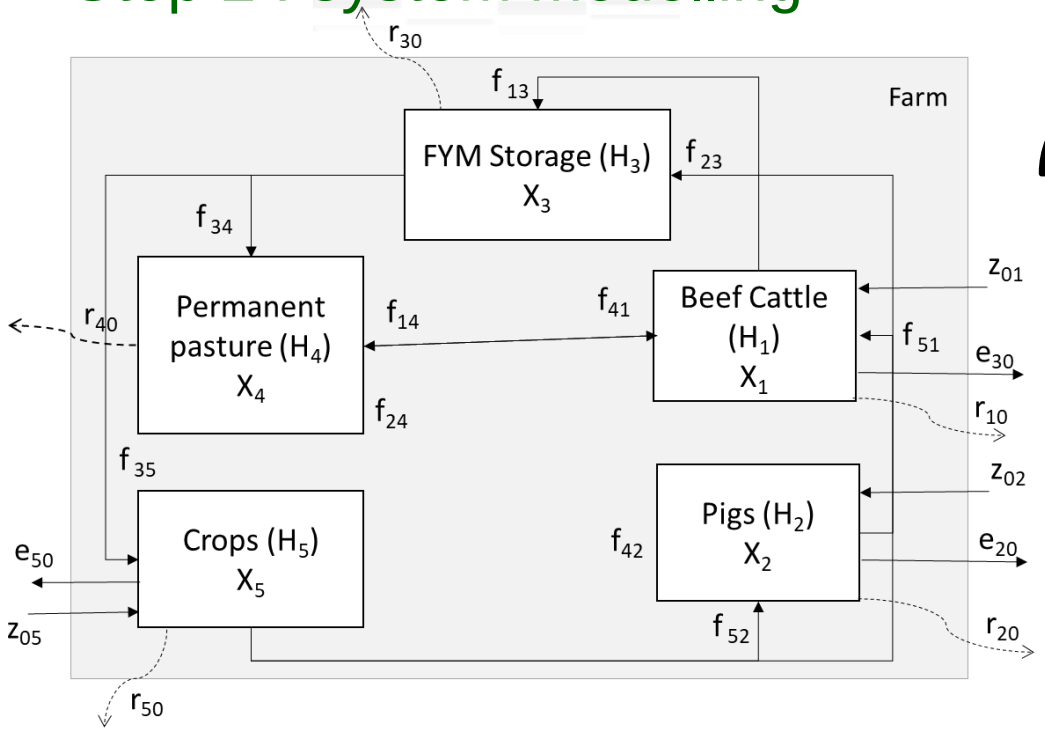
Step 1



Flow diagram

From the flow matrix to a set of indicators

Step 2 : system modelling



Step 2

	H_1	H_2	H_3	H_4	H_5	Export	Losses	Storage
Imports	z_{01}	z_{02}	z_{03}	z_{04}	z_{05}	0	0	0
H_1	0	f_{12}	f_{13}	f_{14}	f_{15}	e_{10}	r_{10}	X_1
H_2	f_{21}	0	f_{23}	f_{24}	f_{25}	e_{20}	r_{20}	X_2
H_3	f_{31}	f_{32}	0	f_{34}	f_{35}	e_{30}	r_{30}	X_3
H_4	f_{41}	f_{42}	f_{43}	0	f_{45}	e_{40}	r_{40}	X_4
H_5	f_{51}	f_{52}	f_{53}	f_{54}	0	e_{50}	r_{50}	X_5

i. Selecting a unit :
kg N / year

ii. Quantifiying flows and storage changes
- **farmer's interview**
- **estimates from scientific literature**

Method – Ecological Network Analysis

Indicators construction

Internal Link Density $= \frac{Fi}{n}$

Ratio between the number of internal flows (Fi), and the number of compartments (n).

→ **Flow diversity**

Method – Ecological Network Analysis

Indicators construction

Internal Link Density	$= \frac{Fi}{n}$	Ratio between the number of internal flows (Fi), and the number of compartments (n).	→ **Flow diversity**
Total System Throughflows	*TST*	Total quantity of flows circulating throughout the system (throughflows + inflows)	→ **Flow intensity**
Total Intern Throughflows	*TT*	Total quantity of flows circulating among compartments	→ **Flow intensity from interaction**

Method – Ecological Network Analysis

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Internal Circulation Rate	$= \frac{TT}{TST}$	share of the activity generated by integration among compartments	→ **Integration intensity**

Method – Ecological Network Analysis

Indicators construction

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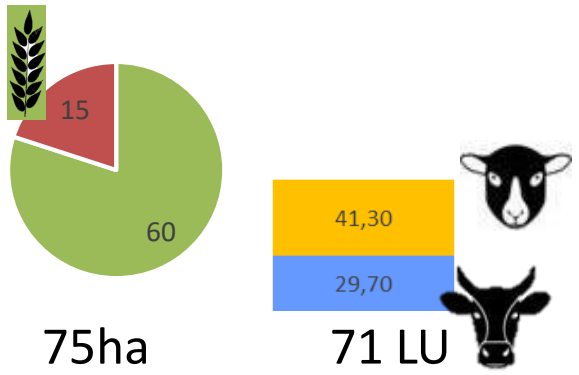
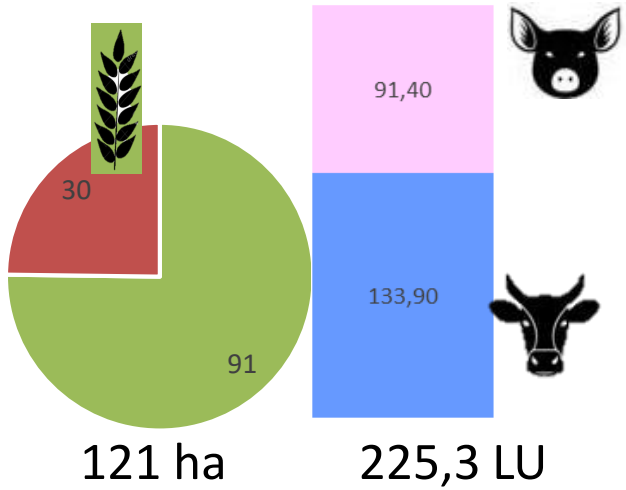
Total System Throughflows	TST	Total quantity of flows circulating throughout the system (throughflows + inflows)	→ **Flow intensity**
Total Intern Throughflows	TT	Total quantity of flows circulating among compartments	→ **Flow intensity from interaction**
Internal Circulation Rate	$= \frac{TT}{TST}$	share of througflows (TT) in the total system throughput (TST) flow circulating within the system	→ **Integration intensity**
Inputs	$= \frac{Inputs}{LU}$	Quantity of inputs (feed, animals, fertilizer, seeds) per livestock unit	→ **dependence**

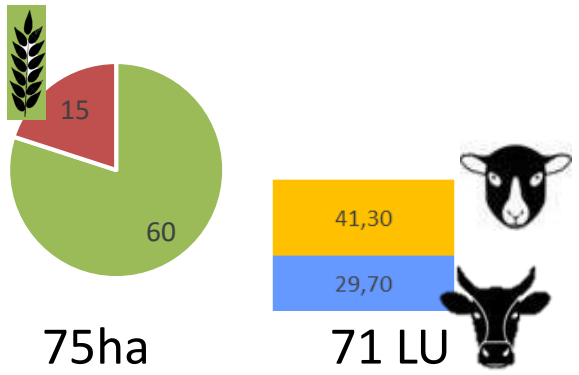
Results - Ruminants vs Monogastrics

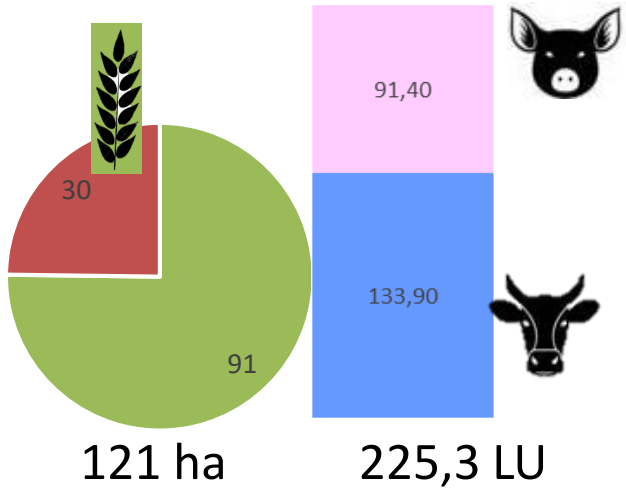




Number of comparments (n)	8	8
Flow diversity = Fi / n	3,38	2,13

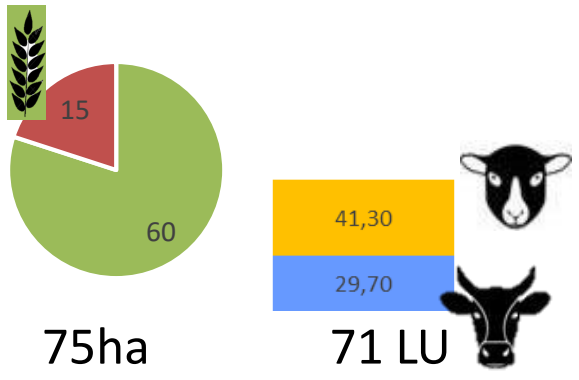
Results - Ruminants vs Monogastrics

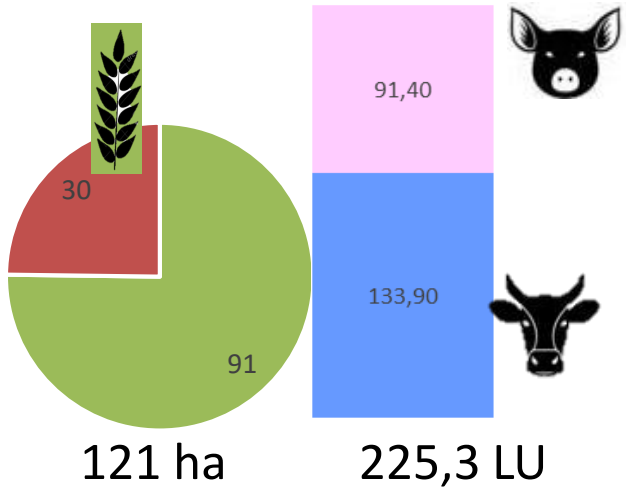




Number of comparments (n)	8	8
Flow diversity = Fi / n	3,38	2,13
Dependence = Inputs / LU	7,5	49,3
Internal Circulation Rate = TT / TST	0,98	0,80
	Less inputs → Feed autonomy	Buy of all the feed for monogastrics

Results - Ruminants vs Monogastrics





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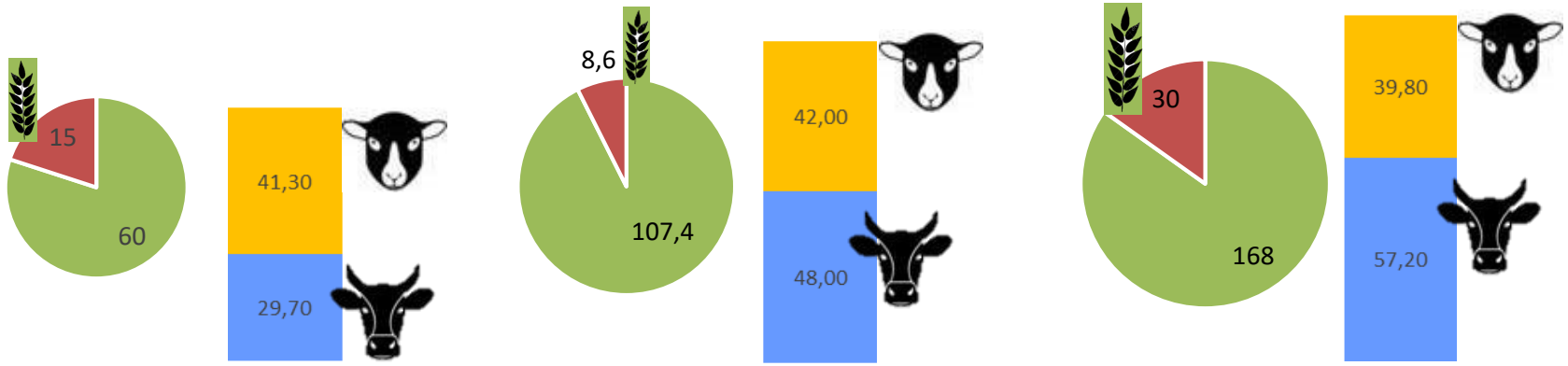
→More integrated

→More flows
→Less inputs
→More activity generated by interactions among components

Three beef cattle – sheep farms



75 ha | 71 LU | 116 ha | 90 LU | 198 ha | 97 LU

pratices

Mix – grazing	Yes	Yes	Yes
Crop residues and cover crop grazing	Yes	No	Yes

Most integrated

less integrated

Conclusion

- Ecological Network Analysis framework : interesting tool to **discriminate farms with different species combinations**; **sensitive to variations in practices**, thus allowing to represent the differences in the functioning of farms of the same combinations.

- Analysis will be conducted on other mixed livestock farms

4 farms (here) → 15 farms (Massif central) → 120 farms from EU project MixEnable

Conclusion

- Ecological Network Analysis framework: interesting tool to **discriminate farms with different species combinations**; **sensitive to variations in practices**, thus allowing to represent the differences in the functioning of farms of the same combinations.

- Analysis will be conducted on other mixed livestock farms

- Perspectives: Compare the level of integration with the economic and environmental performances of farms.

  → assess **multiperformances**

  → **link** among farm caracteristics, performances and level of integration ?

  → Test whether **more complex interaction network lead to ↗ multiperformances**

Thank you for your attention

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