Mixed crop-livestock farming : an economical and environmental-friendly way to intensify production?

A case study in a european context

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ALIMENTATION
AGRICULTURE
ENVIRONNEMENT

Study rationales

❑ **A worldwide reconsideration of mixed crop-livestock systems (MCLS) in relation to sustainable development of agriculture.**

Definition of MCLS :
'Integration of livestock and crop production for sale at the farm level'
(Hendrickson et al., 2008 ; Wilkins, 2008 ; Russelle et al., 2007 ; Powell, 2004 ; Lhoste,2004)

❑ **MCLS appear as 'eco-efficient' over the world (Wilkins, 2008), i.e. as a possible way to intensify production while :**

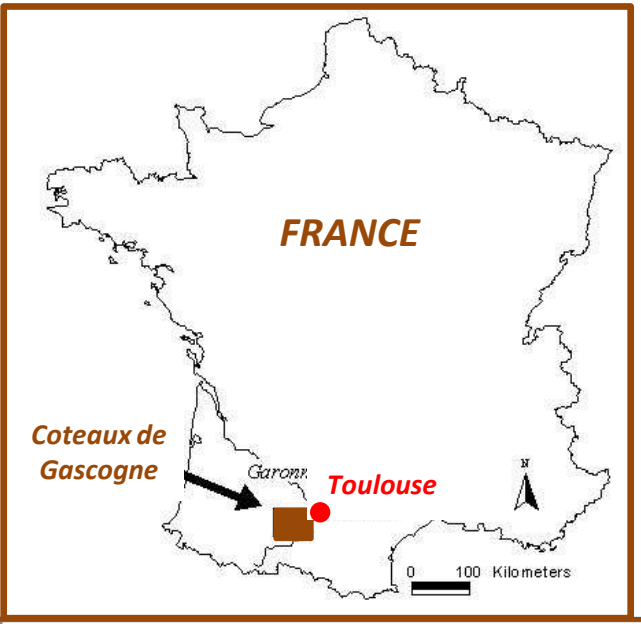
- Generating higher economic efficiency & economies of scope ➔ 1st
(Herrero et al., 2010; Vermersch, 2007; Lapierre, 2004 ; de Wit et al., 2001)

- Improving land management & maintaining biodiversity ➔ 2nd
(Hendrickson, 2008 ; Wilkins, 2008)

- Having environmental-friendly practices & improving nutrient cycling ➔ 3rd
(Hendrickson et al., 2008 ; Russelle et al. 2007 ; Powell et al., 2004;)

➔ **A comparative assessment of specialized farms vs MCLS according to the three dimensions in a case-study.**

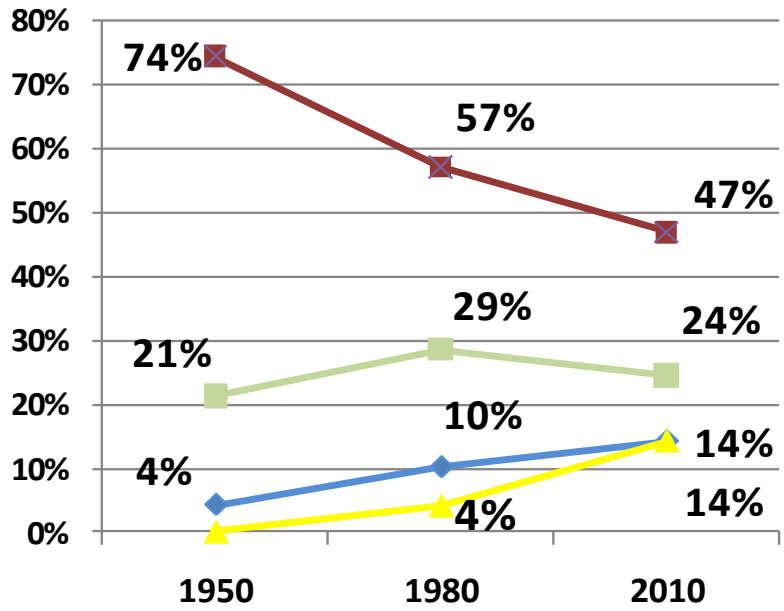
Study objectives and case study



Objectives: To assess & compare farm economics and farmers' management practices

A case-study : the 'Coteaux de Gascogne'

- Upland area with frequent summer draughts
- Part of the European LTER Network
- Participative working with actors
- Limited specialization of agriculture



Evolution of farms structures since 1950

(on 58 farms of the case-study)

➔ European region where MCLS maintained up to now.

(47% of local farms in 2006)

Study methodology

- **An account of every farm working land in a continuous reference area** *(4000 ha) ⇔ 93% of the UAA*
  (Choisis et al., 2010)

- **A 'spatially-explicit' survey method ➔ 2006**
  (Mottet et al., 2006; Choisis et al., 2010)
  - Information on farm structure and technical-economical dimension
  - Data on farmer's land-management practices
    ➔ from the parcel up to the farm level

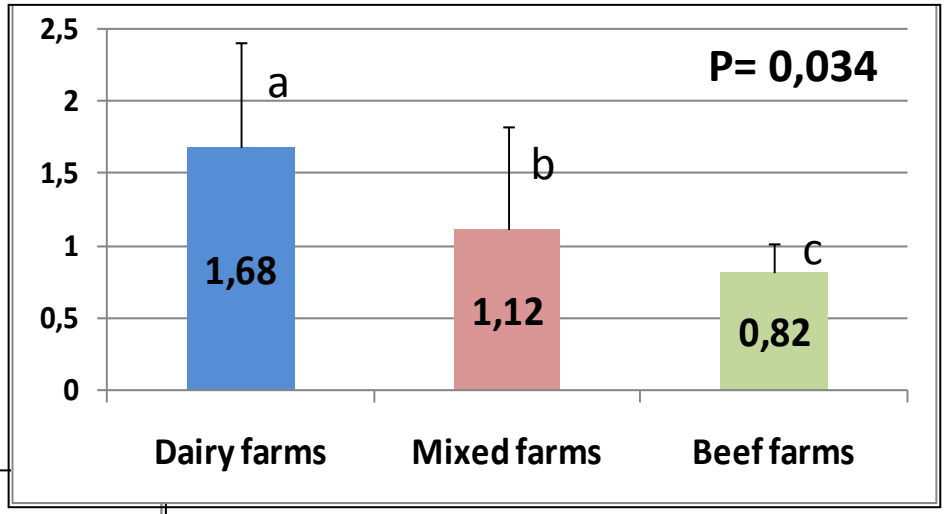
	Dairy farms	Beef farms	Crop farms	Mixed farms
UAA (ha)	93 ± 52	89 ± 58	66 ± 58	118 ± 23
Nb of cows (ha)	48 ± 20	54 ± 36	n.a.	48 ± 37

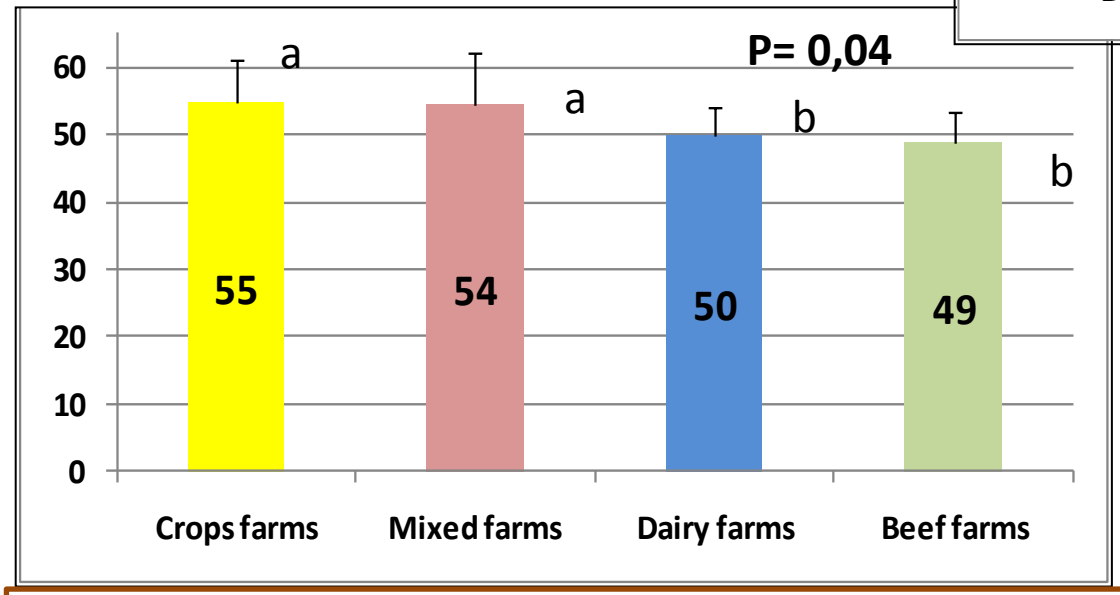
Intensity of production according to production systems

1. Animal production

Indicator used:
Stocking rate (LU/ha MFA)

➔ ***Relative intensity of cattle production in MCLS vs local LFS***





2. Crop production

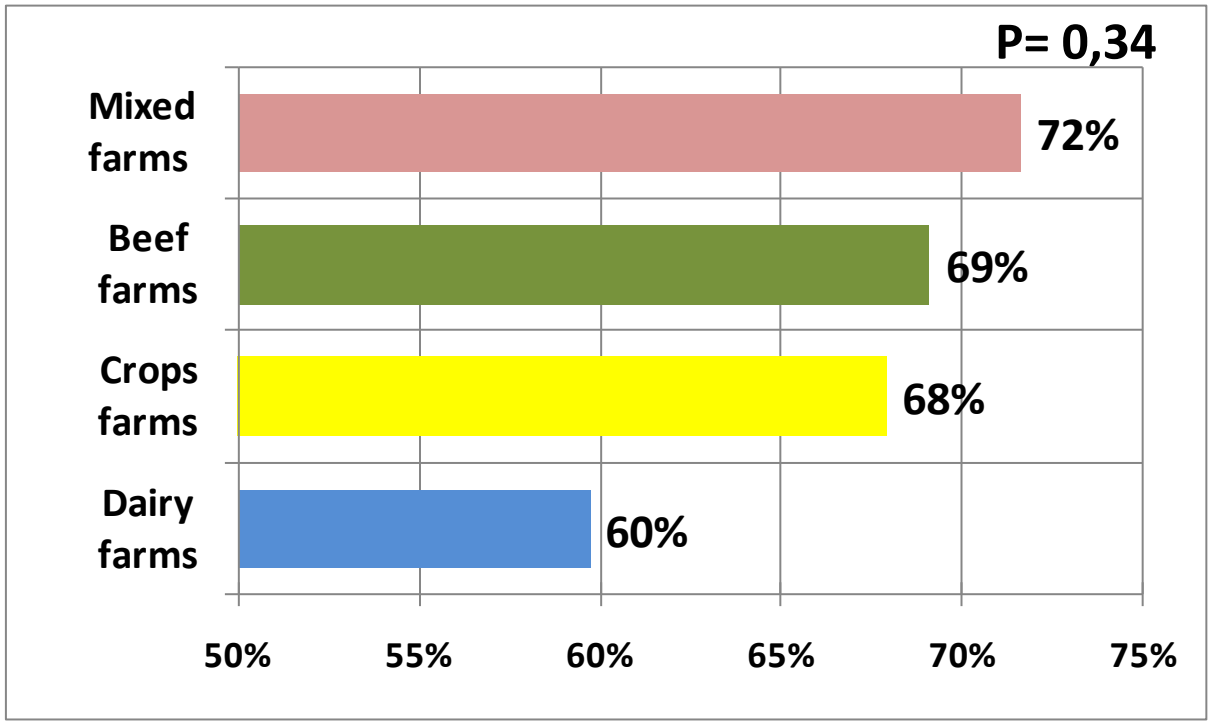
Indicator used:
Wheat yield (ql/ha)

➔ ***Relative intensity of crop production in MCLS***

➔ ***<u>Hypothesis</u> : MCLS are an economical and environmental-friendly way to intensify production.***

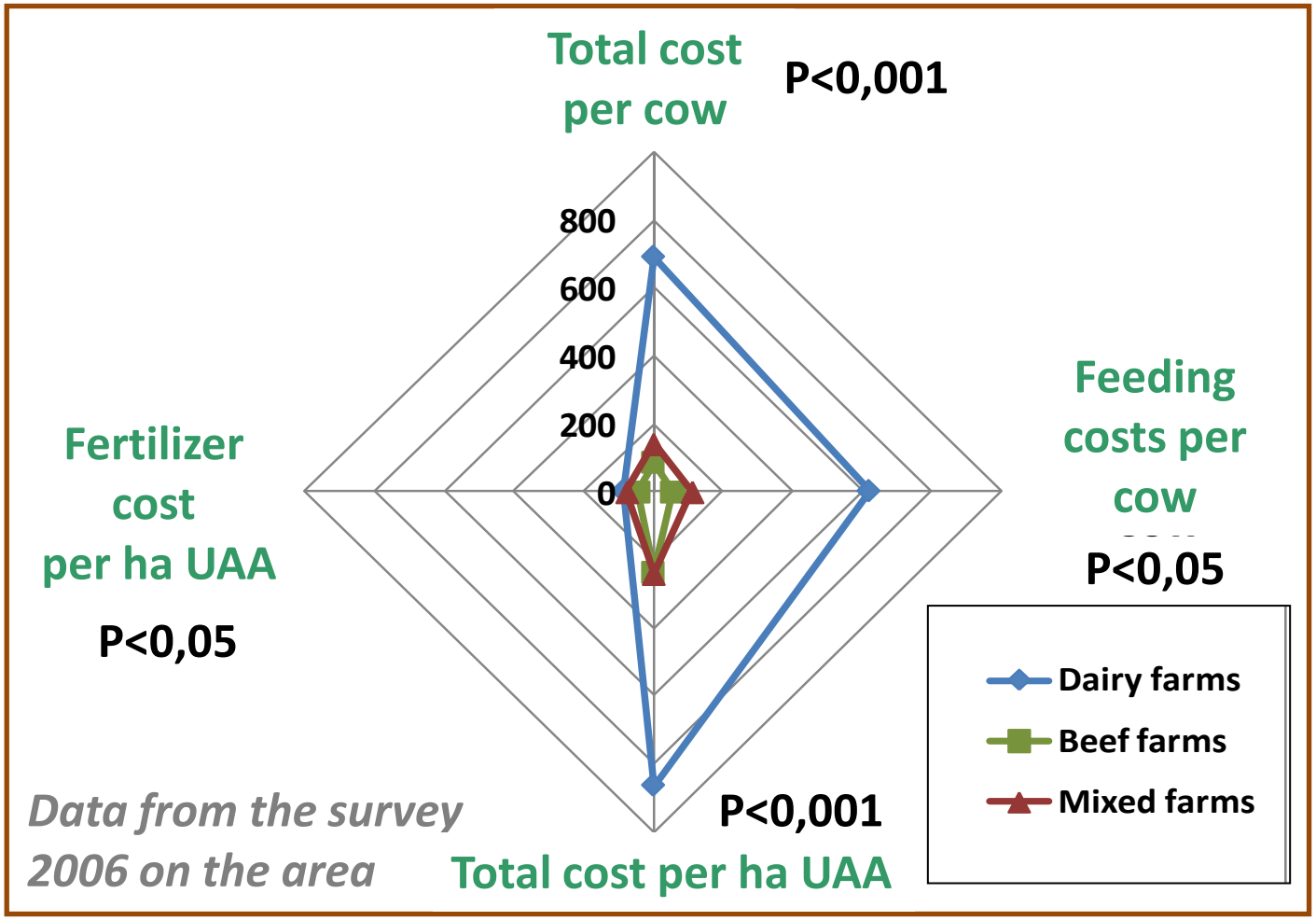
1st dimension : Economic performance of farms according to production systems (1/2)

❑ Indicator 1: Economic Efficiency at the farm level
= (Turnover - Operational Costs)/Turnover *100



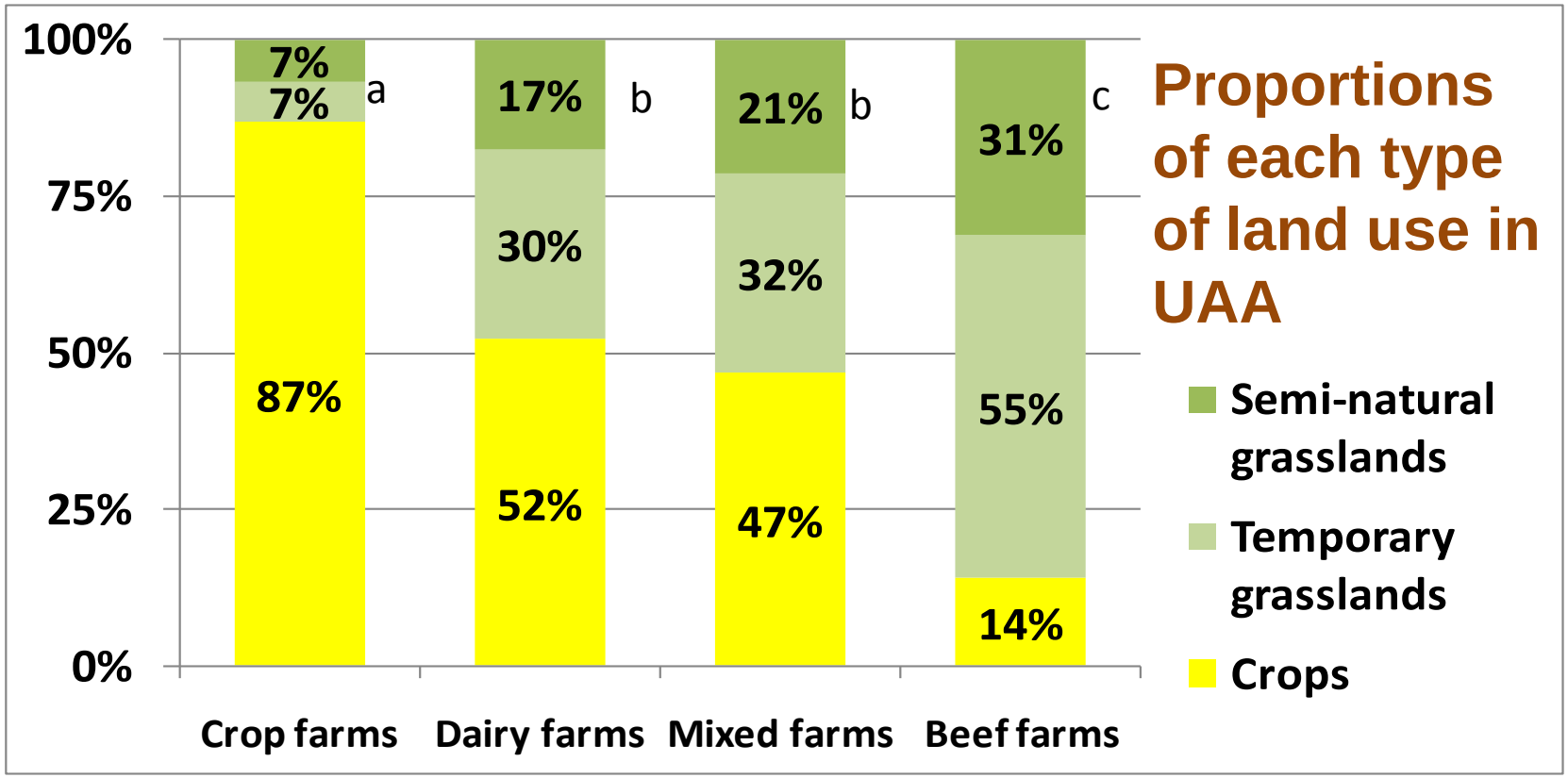
➔Local systems efficient➔ MCLS have the highest efficiency (NS)
(use fewer inputs and diversify sold productions)

1st dimension : Economic performance of farms according to production systems (2/2)



➔ Costs higher in dairy farms (P<0,05)/ MCLS close to beef farms

2nd dimension : Land use at farm level according to production systems



MCLS intermediate in comparison with other production systems

- ➔ In total UAA, less grasslands and more crops vs beef farms
- ➔ Comparable to Dairy farms
- ➔ Conservation SN grasslands in MCLS : Biodiversity

3rd dimension-1 : Characterization of farmers' crop management practices

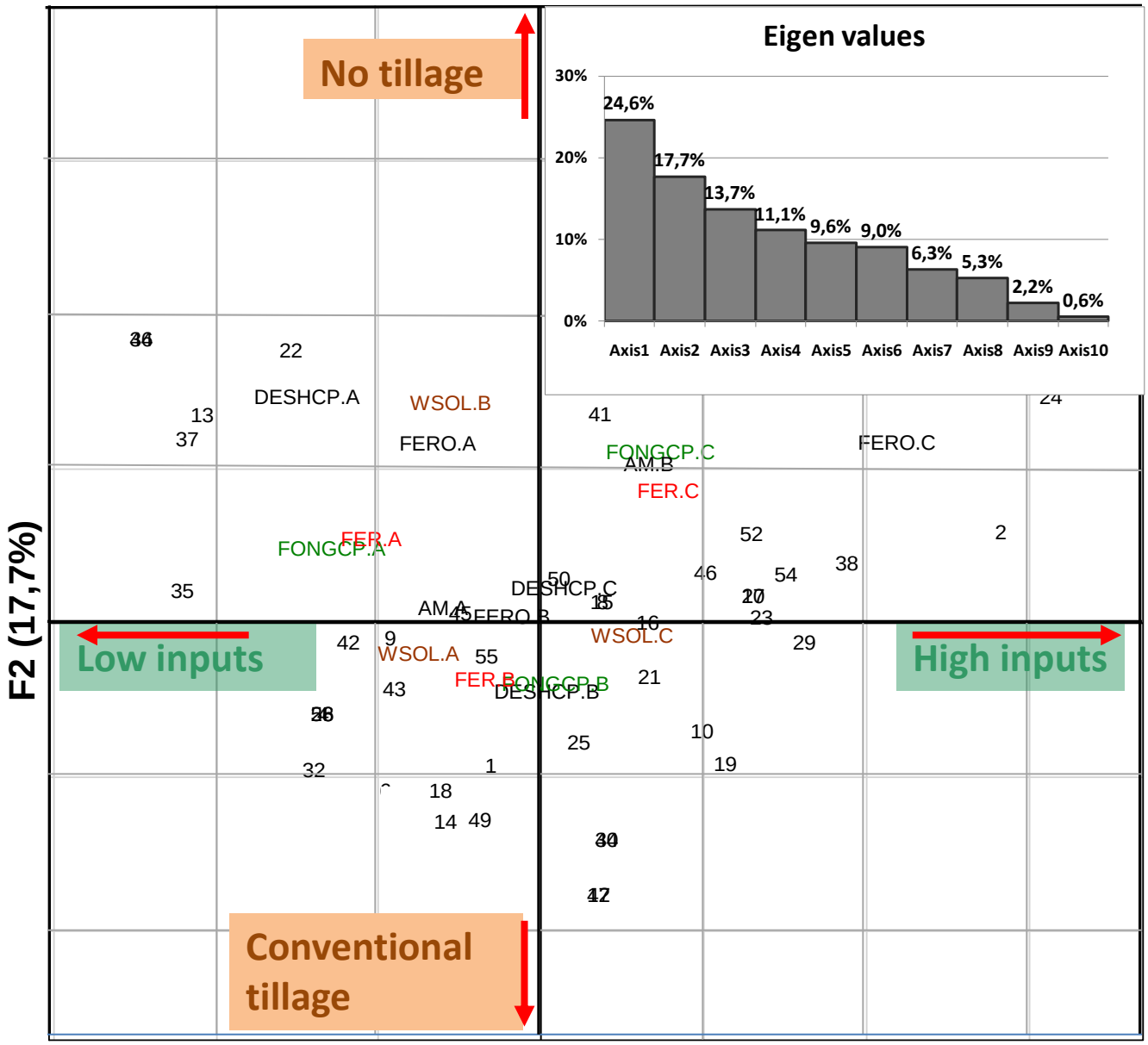
1. **Selection of qualitative indicators of crop management practices**

   - ❑ Type of ploughing
   - ❑ Type of organic fertilization
   - ❑ Presence of mineral fertilization
   - ❑ Level of mineral fertilization *(on wheat)*
   - ❑ Herbicides treatments
   - ❑ Fungicides treatments

2. **Definition of types of crop management practices**
   - An MCA
   - A K-means classification on the MCA *(on 51 out of the 58 farms)*

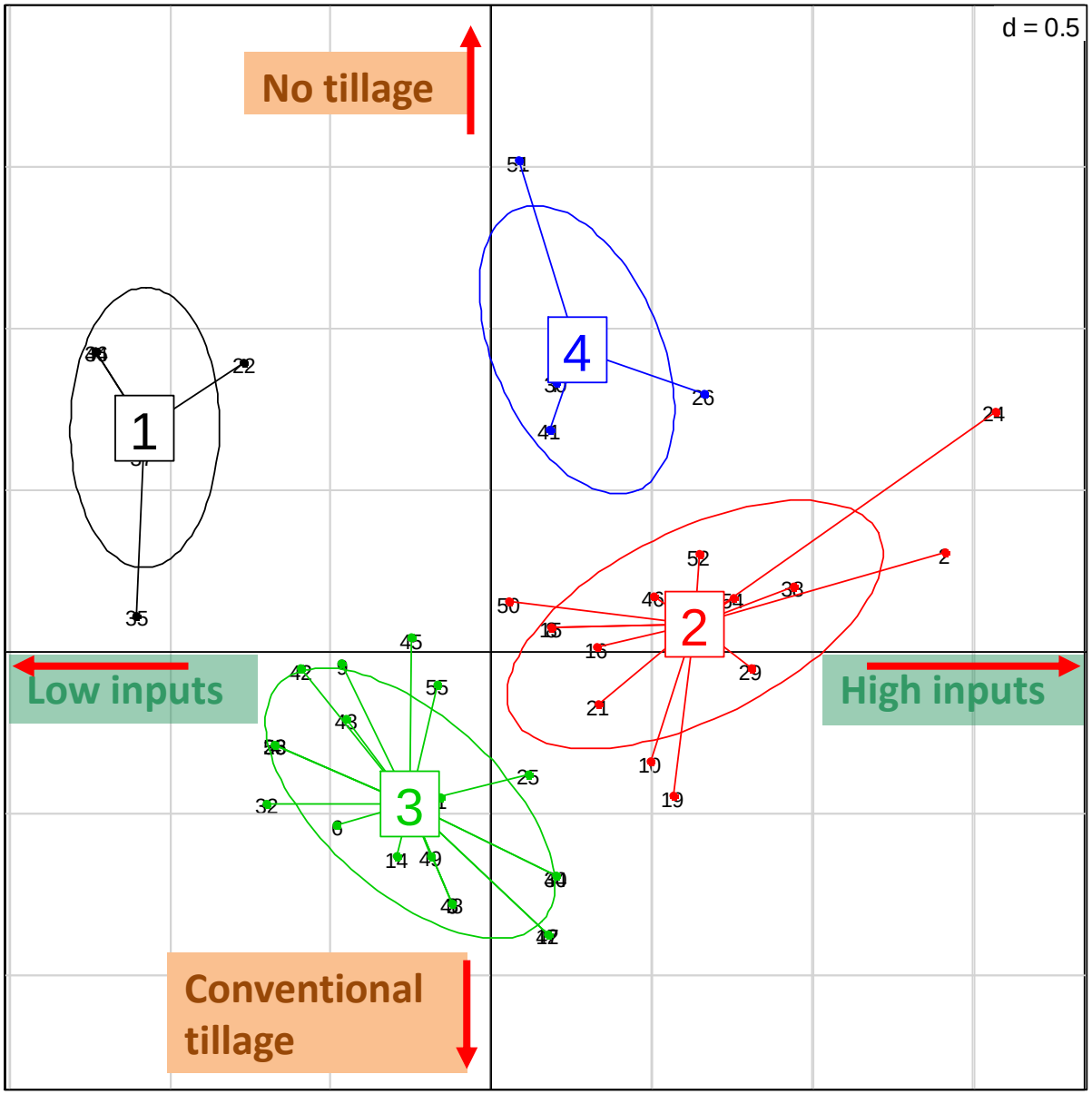
❑ **Projection of the 4 farms structures on the MCA factorial map to cross the information with the classification on practices**

Projection of variables on MCA factorial map



- Projection of variables on the MCA factorial map
- Variability explained by each axis
  ➔ F1-F2 = 42,3% of variability exp.
- Explanation of axis
- Projection of individuals on the MCA factorial map

4 Types of crop management practices



1. New conservation systems

- simplified tillage practices
- low use of inputs

(7 farms)

2. Conventional systems

- conventional tillage
- high use of inputs

(17 farms)

3. Traditional systems :

- conventional tillage
- intermediate use of inputs

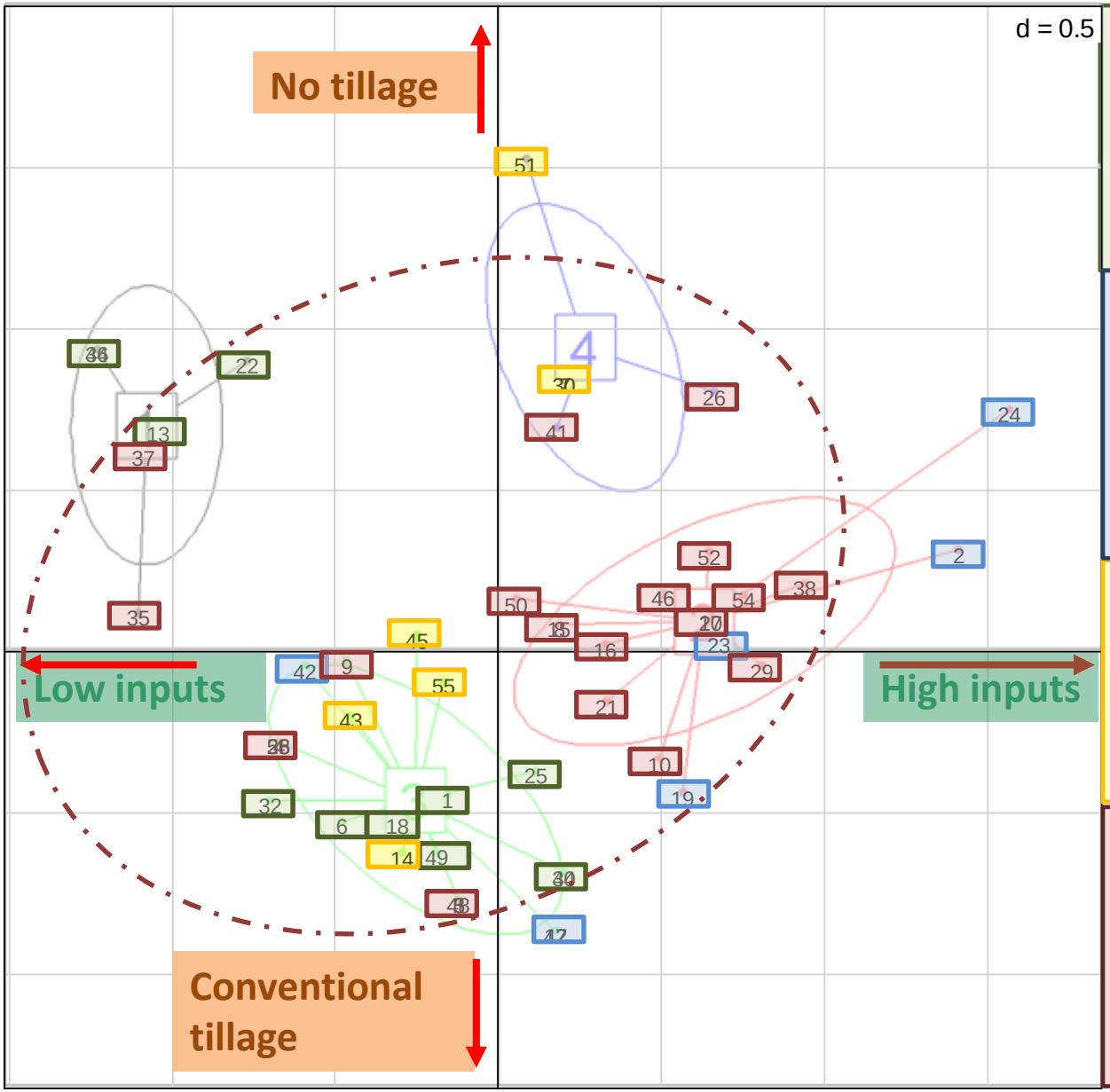
(22 farms)

4. New conservation systems :

- simplified tillage practices
- intermediate use of inputs

(5 farms)

Crossing the 4 types with farm structures



Beef farms :
Type 3 (and 1)
➔ Rather traditional practices

Dairy farms :
Type 2 (and 3)
➔ Rather conv. practices

Crop farms :
Type 3 and 4
➔Traditional or NCS

Mixed farms :
Large diversity of practices: 4 Types
➔ to study further

3rd dimension-2 : ANNUAL APPARENT N FARM GATE BALANCE

Hyp 2 : all straw and hay are reused for animals

N Fertilizers *for each type of crop*

N Fixation by Legumes

Straw, hay

Concentrates

AGRICULTURAL SYSTEM

Plant & soil activity

Animal activity

Straw, hay

Crops

Hyp 3 : a part of produced crops is used to feed the animals

Animal products *(meat, milk,…)*

Animal dejections

Hyp 1 : all dejections are used in the system

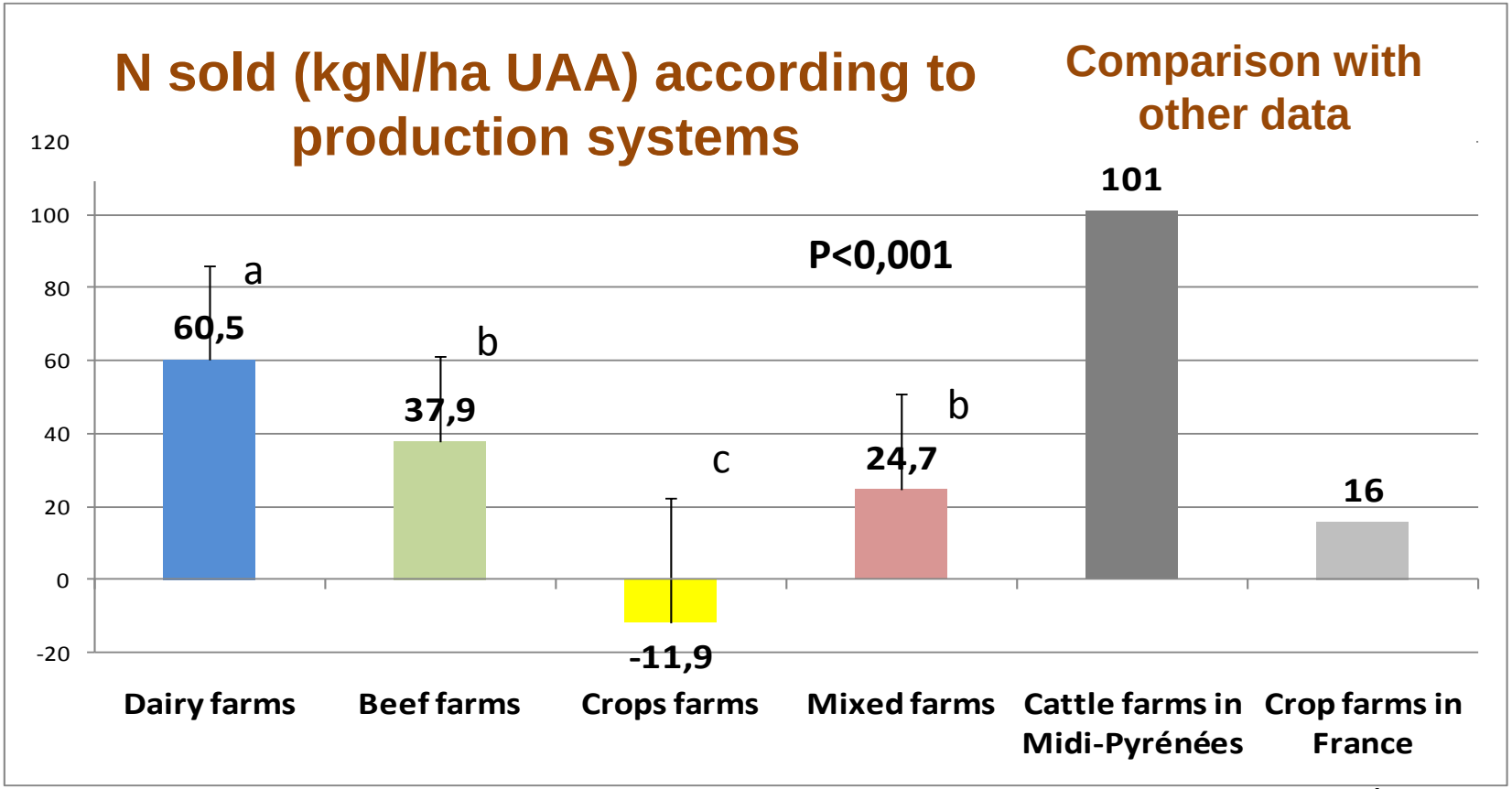
NS = (N inputs – N outputs)/ UAA

➔ *in kgN/ha of UAA on a year*

Methodology :

Simon J.-C. et Le Corre L., 1992

Apparent farm-gate N balances of local farms in 2006



MCLS has the best N balance :

- ➔ N better recycled in MCLS than in specialized systems
- ➔ Dairy farms have surplus
- ➔ Crop farms have lacks of Nitrogen

Discussion / Conclusion

- **In the study area, MCLS appear to have a better economical efficiency and less Nitrogen inputs than those with specialized LFS.**

➔ **A result in line with literature** (Herrero, 2010 ; Wilkins, 2008; Russelle et al., 2007; Vermerch, 2007; Lenné et al. 2006 ; Lapierre, 2004).

➔ **Point of vue of economy of scope** (Vermersch, 2007) **versus economy of scale**

➔ **Study should be strengthened on much years and other indicators like organic matter in the soils** (Russelle et al., 2007)

- **Farmers with MCLS appear however to have heterogeneous management practices but locally more environmental-friendly than others**

(Russelle et al., 2007; Schiere et al., 2002)

➔ **Differences between conventional and traditional farming systems / NCS**

➔ **Discussions between old (traditional knowledge) and new generations.**

- **Still working with local actors about those scientific issues ➔ using those reliable and originals methods of surveys and participative working**

THANK YOU FOR YOUR ATTENTION !

Some questions ?

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Apparent N farm-gate balances

- **Our Aim :** ➔ **Identify management deficiency as regards N fertilization**
- **Assessment of the method selected : Farm-gate apparent N balance**
  - **A method coined for the assessment of potential pollution risk due to surplus of Nitrogen inputs at the farm level**
    ➔ **Simon J.-C. and Le Corre L., 1992. Le bilan apparent de l'azote à l'échelle de l'exploitation agricole : méthodologie, exemple de résultats. Fourrages, 129, 79-94.**
    ➔ **Cited by Vayssières J., 2009 for evaluation of aspects of N dynamics.**
  - **Assets : Reliable method with a fast calculation based on a basic principle**
    (Chambaut H. and Le Gall A., 1998).
  - **Limits :**
    ➔ **Balance only "apparent" on a year**
    ➔ **Processes like leaching are ignored.**
  - **Principle of the method :**
    ➔ **Annual apparent N farm Gate balances calculated at the whole-farm scale.**
    ➔ **Farm is considered as closed black box**
    ➔ **N surplus (in kgN/ha/year) calculated as follows:**

$$\rightarrow NS = N_{in} - N_{out}/UAA$$

Description of each type of farm structure with means of characteristics

	Dairy farms	Beef farms	Crops farms	Mixed farms
Nb farms	6	12	7	23
UAA (ha)	93 ± 52	89 ± 58	66 ± 58	118 ± 82
MFA (ha)	48 ± 32	77 ± 53	13 ± 12	64 ± 56
WU	2.3 ± 1.1	1.3 ± 0.6	0.5 ± 0.4	1.8 ± 1.0
Nb of cows	48 ± 20	54 ±36	N.A.	48 ±37

Description of indicators choosen for the MCA

Indicators	Level of indicators		
Type of ploughing	Conventional	None	Both
Organic fertilization	None	Manure	Slurry
Mineral fertilization	Yes	No	
Level of Mineral fertilization (on wheat)	Low *<90 UN/ha*	Intermediate *90-130 UN/ha*	High *> 130 UN/ha*
Herbicides treatments	None	Broadleaf killer	Broadleaf and grass killer
Fungicides treatments	None	1	2

Characterisation of mineral fertilization for each types of crop management practice

Indicators	Levels	1	2	3	4
Number of individuals		7	17	22	5
UAA	*Has*	*47*	*134*	*74*	*135*
Crop area	*Has*	*39*	*61*	*36*	*53*
Corn mineral fertilization	UN/ha	0	104	60	68
Wheat mineral fertilization	UN/ha	10	122	90	148
Artificial grasslands mineral fertilization	UN/ha	30	57	47	14
SN grasslands mineral fertilization	UN/ha	16	20	14	0

Indicators	Levels	1	2	3	4
Number of individuals		*7*	*17*	*22*	*5*
UAA		*47*	*134*	*74*	*135*
Crop area		*39*	*61*	*36*	*53*
Type of tillage	No tillage (%)	71	18	9	100
	Both (%)		70	36	
	Conventional (%)	29	12	55	
Organic fertilisation	Manure (%)	57	82	82	40
	Slurry (%)		12		
	0 (%)	43	6	18	60
Mineral fertilisation	No (%)	86	41	90	40
	Yes (%)	14	47	5	60
	n.a. (%)		12	5	
Level of Mineral fertilization (on wheat)	Low	8	6	16	0
	Intermediate	6	6	20	2
	High	0	22	8	8
Herbicides treatment	Broadleaf killer (%)		18	27	
	Broadleaf and grass killer (%)		82	69	80
	None (%)	100		4	20
Fungicides	1 treatment (%)		41	60	
	2 treatments (%)		59		100
	None (%)	100		40	