Smarter
SMAll RuminanTs breeding for Efficiency and Resilience

Farmers' breeding management practices: *which pattern for different countries?*

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with collaboration of Julien Quénon and al.

INRAE

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Introduction

- Small ruminant livestock are of socio-economic and environmental importance to many rural communities around the world (FAO, 2009)

  their sustainability is a crucial issue (Joy et al., 2020; Leite et al., 2021)

- Choosing breeding goals adapted to such issue (Phocas et al., 2016), by selecting traits that enhance:
  - **Resilience/robustness** = buffer, adaptive and transformative capacity in a changing/uncertain context (Dumont et al., 2020)
    - Resistance to heat stress (Sejian et al., 2019; Sánchez-Molano et al., 2020)
    - Resistance to parasitism and diseases (Hine et al., 2022; Doeschl-Wilson et al., 2022)
  - **Efficiency** = production related to the use of the necessary resources
    - Feed intake (Amarilho-Silveira et al., 2022)
    - Land use (Hennessy et al., 2021)

Introduction

- SMARTER (SMAll RuminanTs breeding for Efficiency and Resilience) H2020 project aims to **redefine genetic selection criteria to increase the sustainability of the small ruminants sectors**
- Adjusting breeding objectives to small ruminants farmers' expectations, actual breeding practices and views on sustainability (Perucho et al., 2019; Kosgey et al., 2006)

What criteria (genetic or not) do farmers/breeders use?

Which traits do they think are relevant to increase the sustainability of their farm?

Which diversity in SMARTER project?

Milk
Meat
Wool

Sampling

15
Breed × System

N = 83 | N = 60 | N = 50 | N = 63 | N= 16

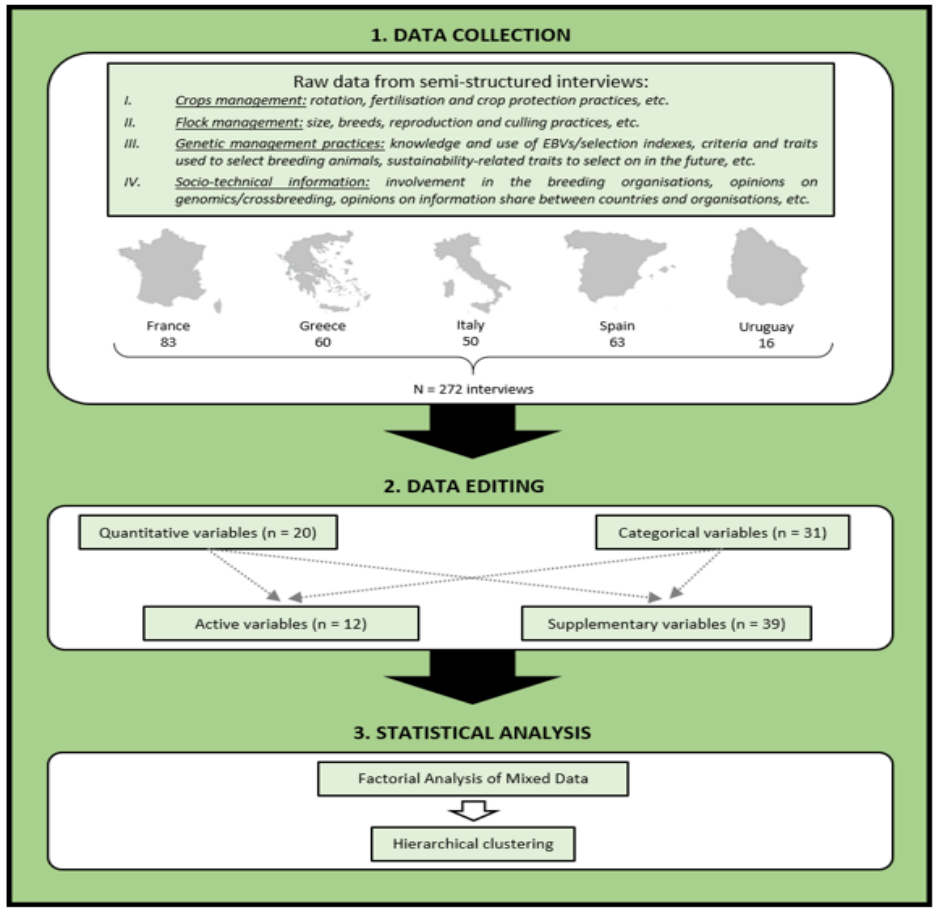
N = 272 farms

Material and methods

To collect information on farmers' practices, we decided to conduct interviews with farmers and breeders.

Interviews about the farmers' practices

- to identify livestock selection management
- to understand farmers' choice



Material and methods

1. DATA COLLECTION

- 15 breeds sheep & goat
- Different types of system: milk production, meat production, wool production, dual-purpose
- Different local conditions: Extensive, semi-intensive, intensive management

Material and methods

1. DATA COLLECTION → 2. DATA EDITING

- Final dataset: 272 individuals described by 12 active (+ 29 supplementary) variables

I. Crops management: Ø

II. Flock management:
   - **V1 – Replacement rate** (%)
   - **V2 – Percentage of artificial insemination used in the flock** (%)
   - **V3 – Use of AI:** *Only natural mating / Only artificial insemination / Both AI and NM*

Material and methods

1. DATA COLLECTION **2. DATA EDITING**

- Final dataset: 272 individuals described by 12 active (+ 29 supplementary) variables

III. Genetic management practices:

- **V4 – No. of culling criteria**: *0 to 1 / 2 to 3 / 4 and more*
- **V5 – Culling criteria**: *No culling criteria / Production only / Functional traits only / Production & Reproduction / Production, Health & Age*
- **V6 – Type of criteria used to select animals**: *No genetic criteria / Genetic only / Genetic & Phenotypic / Genetic, Phenotypic & Socio-economic*
- **V7 – No. of selection traits used**: *0 to 2 / 3 to 5 / 6 and more*
- **V8 – No. of traits to ↗ sustainability**: *0 / 1 to 3 / 4 and more*
- **V9 – New traits to ↗ sustainability**: *No answer / No need / Production / Robustness / Robustness & Health*

Material and methods

1. DATA COLLECTION | 2. DATA EDITING

- Final dataset: 272 individuals described by 12 active (+ 29 supplementary) variables

IV. Socio-technical information

- **V10 – Change to make in selection indexes**: *No change / More traits / New indexes with different weighting*
- **V11 – Breeder status:** *Farmer using genetic progress / Breeder*
- **V12 – Enrollment in performance recording organisations:** *Enrolled / Not enrolled*

Material and methods

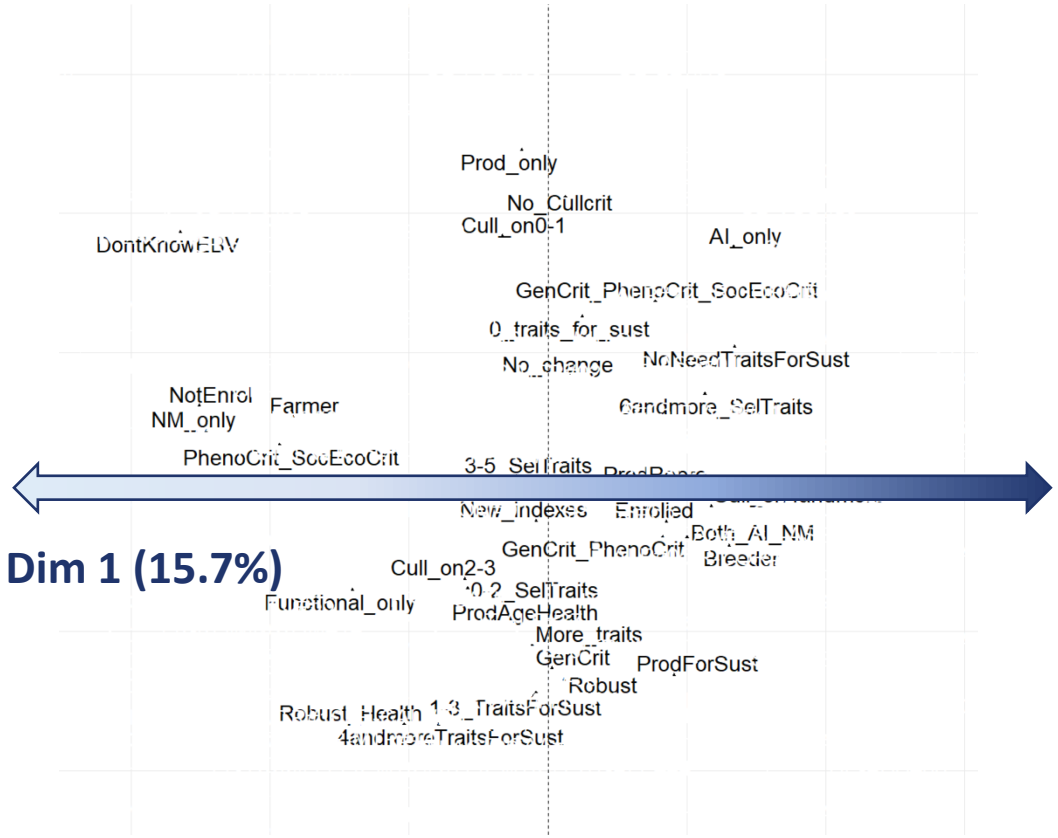
1. DATA COLLECTION → 2. DATA EDITING → 3. MULTIVARIATE ANALYSIS

- **Factorial analysis of mixed data (FAMD)**: analysing pattern of relationships described by both quantitative and categorical data

- **Hierarchical clustering**: discriminating and characterising groups of small ruminants' farmers with contrasted breeding practices

Practices analysis

Axis 1 determined by the **level of integration of small ruminants' farmers in the sociotechnical system of breed selection and performance recording**

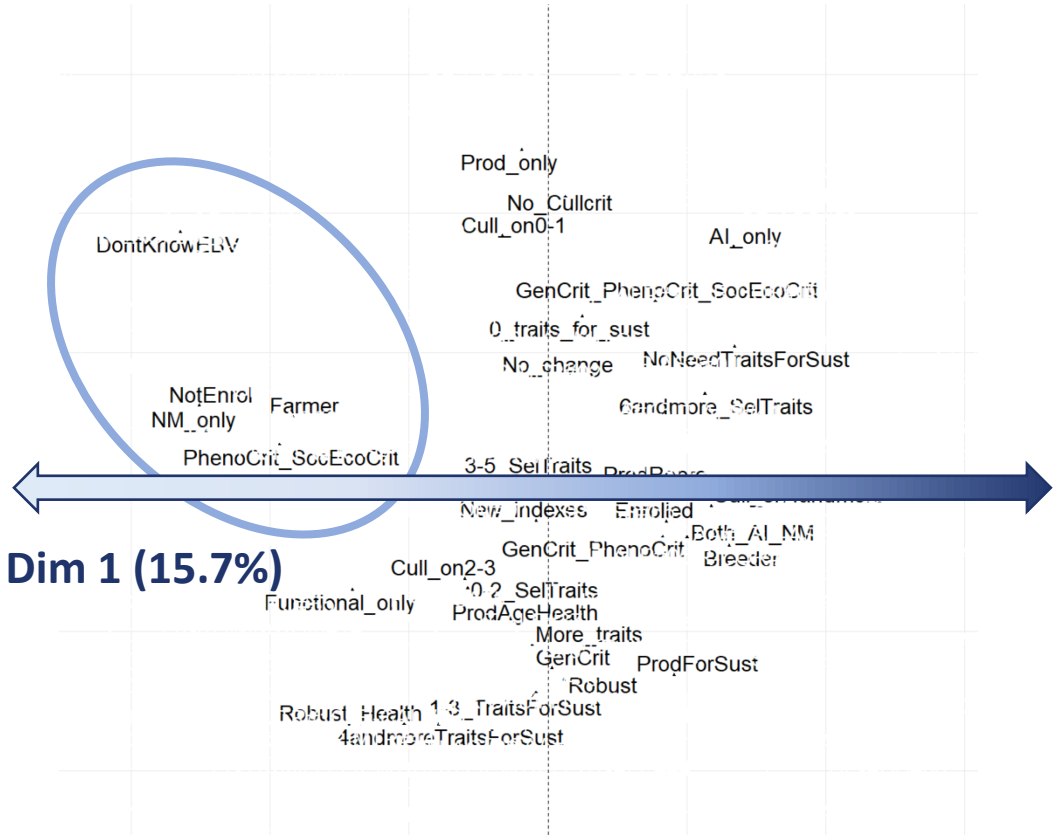


Practices analysis

Axis 1 determined by the **level of integration of small ruminants' farmers in the sociotechnical system of breed selection and performance recording**

- Farmers
- Don't know EBVs
- Not enrolled in performance controlling organisations
- Using natural mating only
- Don't use genetic criteria to buy breeding animals

Low level of integration in the sociotechnical system of breed selection and performance recording organisations



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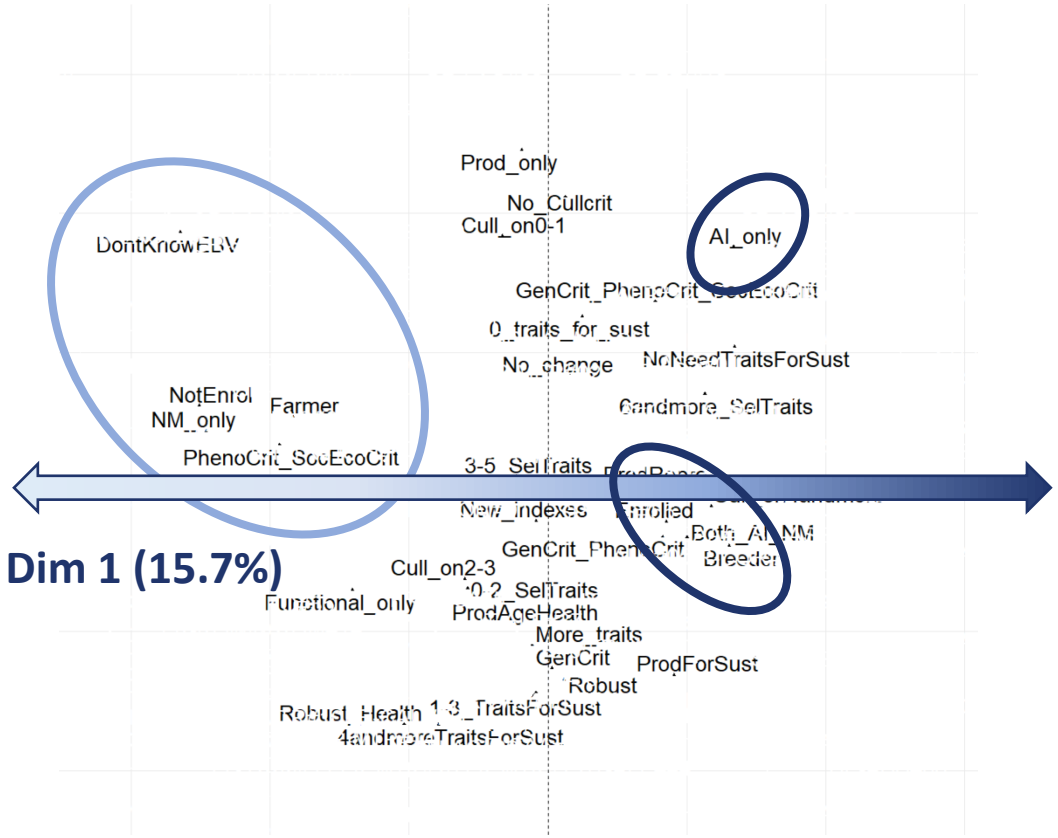
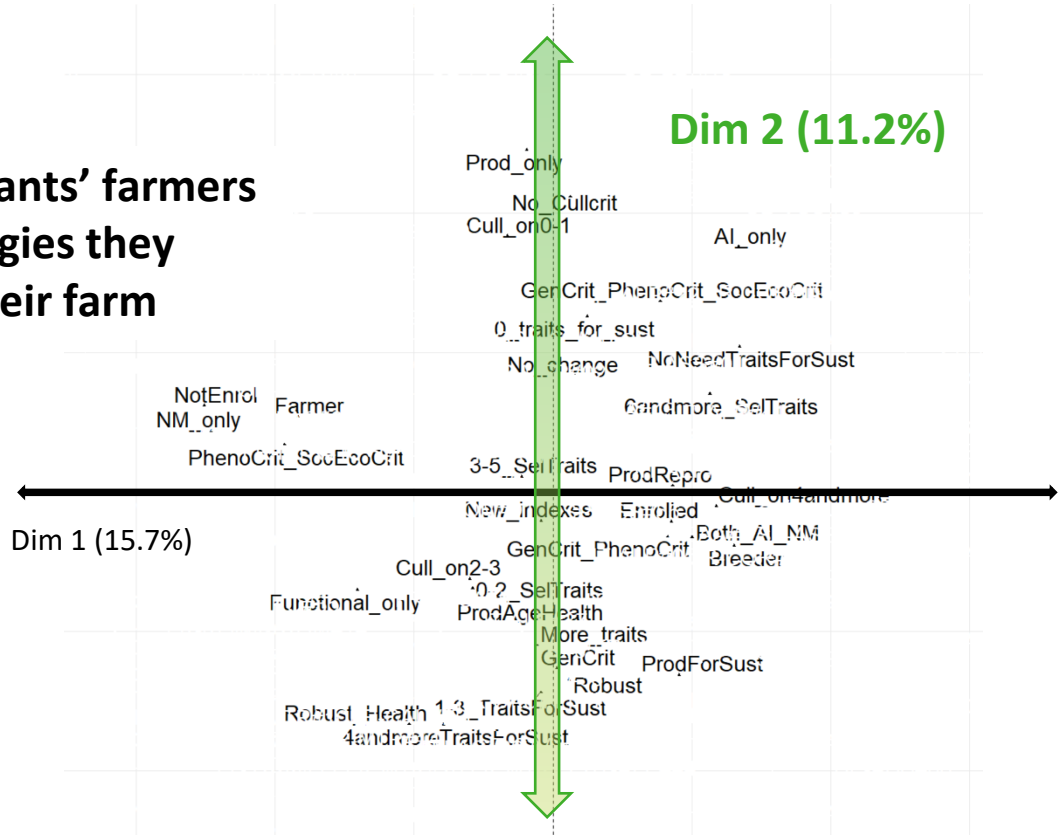


- Breeders
- Enrolled in performance controlling organisations
- Using artificial insemination only

High level of integration in the sociotechnical system of breed selection and performance recording organisations

Practices analysis

Axis 2 determined by the **small ruminants' farmers views on sustainability and the strategies they intended to adopt to increase it on their farm**



Practices analysis

- No need new traits for sustainability
- Sustainability is no relevant objective
- Satisfied with the current indexes
- Production-driven management for culling

Little interest in adding new traits in the selection indexes nor in increasing the sustainability of their farming system

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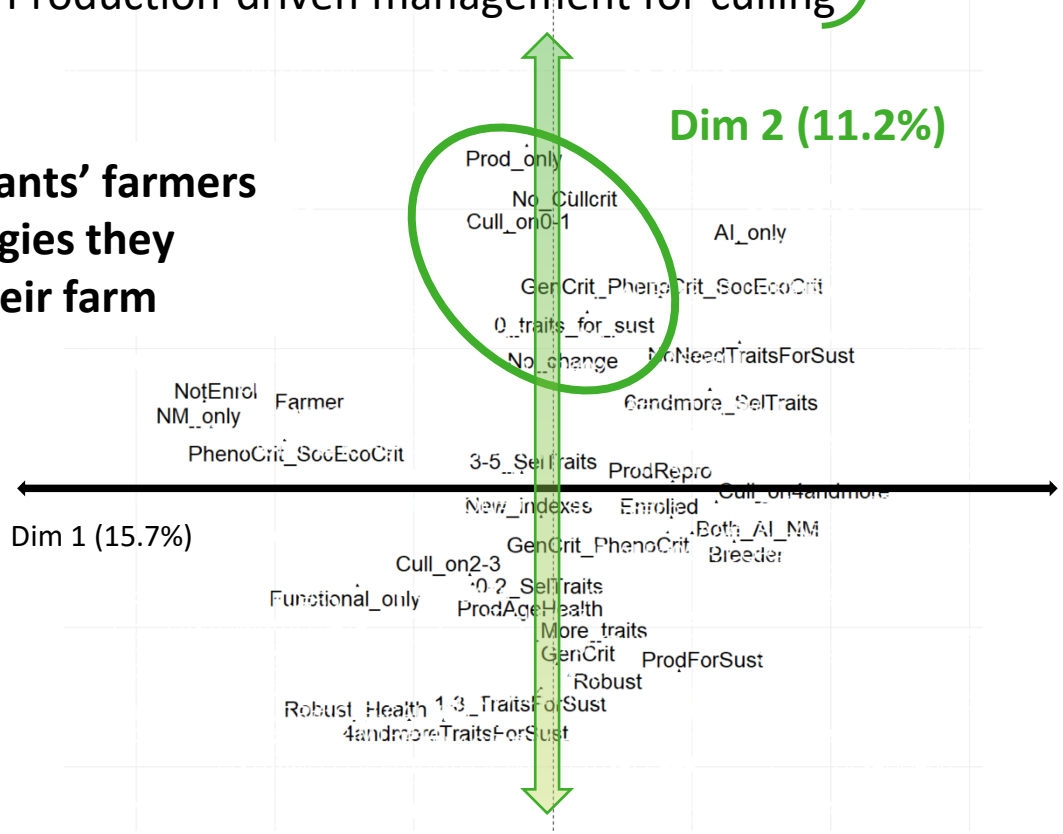

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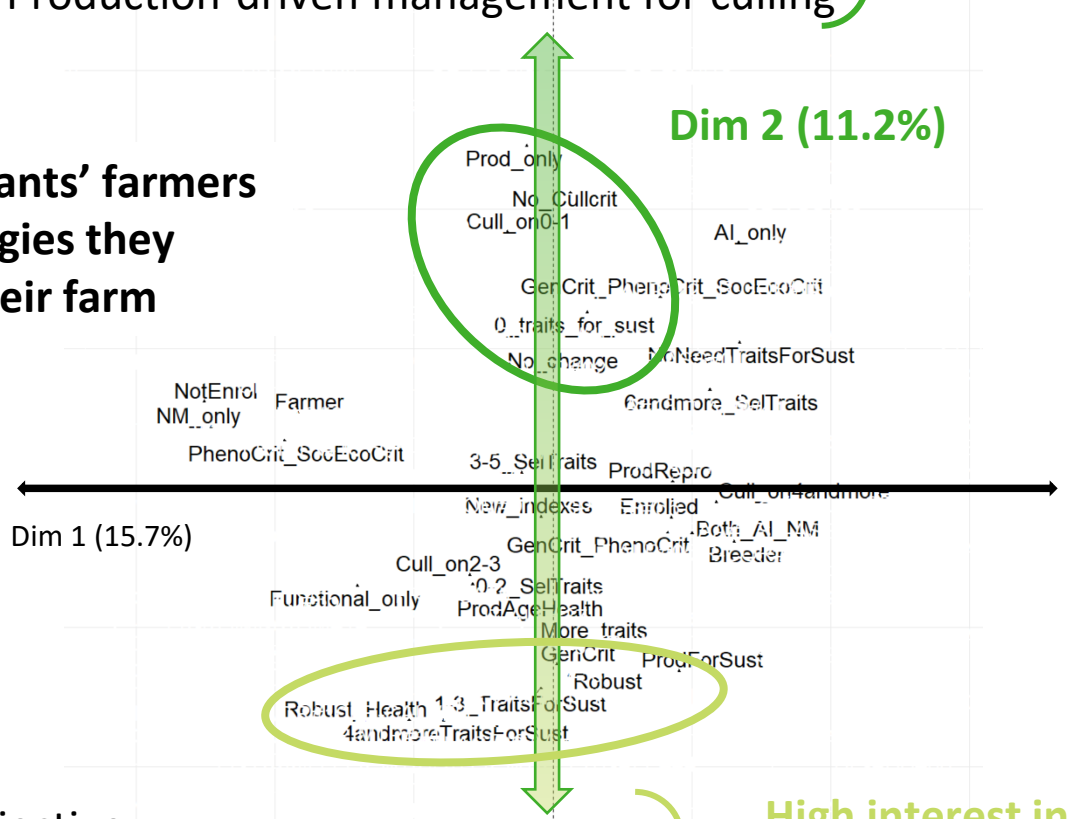


- Sustainability is a crucial objective
- Unsatisfied with the current indexes
- Ask for robustness- and health-related traits in the indexes

High interest in adding robustness-related traits in the current selection indexes to increase sustainability of their farming system

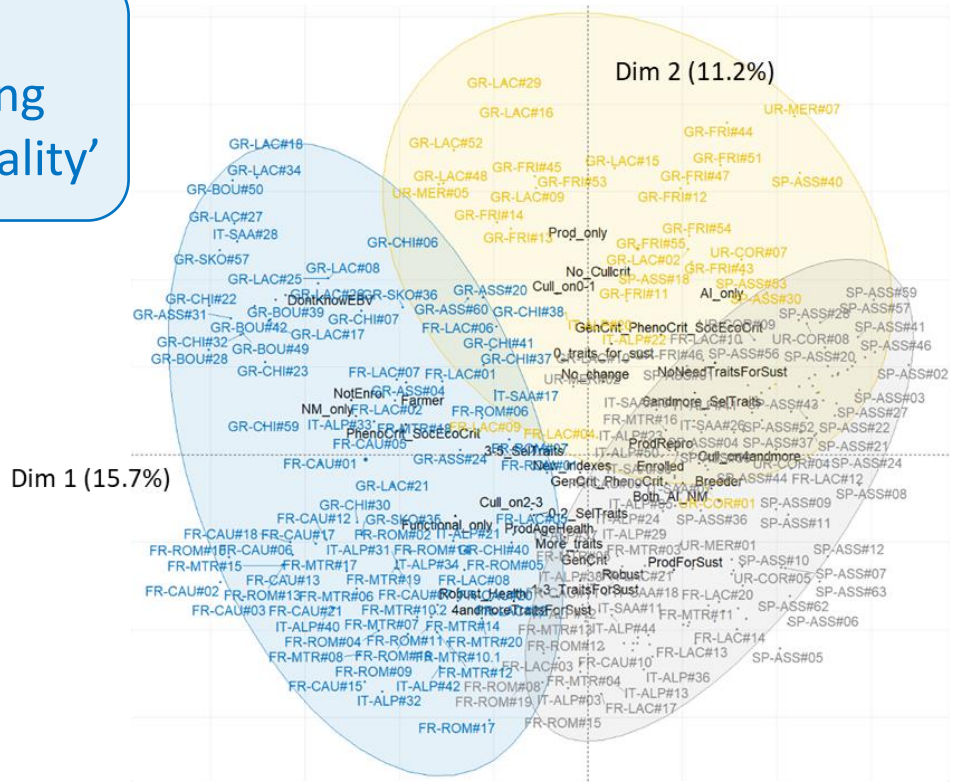
Three breeding managements

Little interest in adding robustness traits in the indexes to increase sustainability

Group 1 (n = 93)
'Non genetic farmers seeking robustness and multifunctionality'

Group 2 (n = 34)
'Genetic farmers seeking production efficiency'

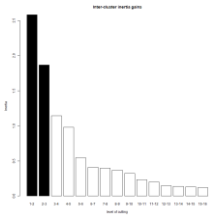
Low level of integration in the sociotechnical system



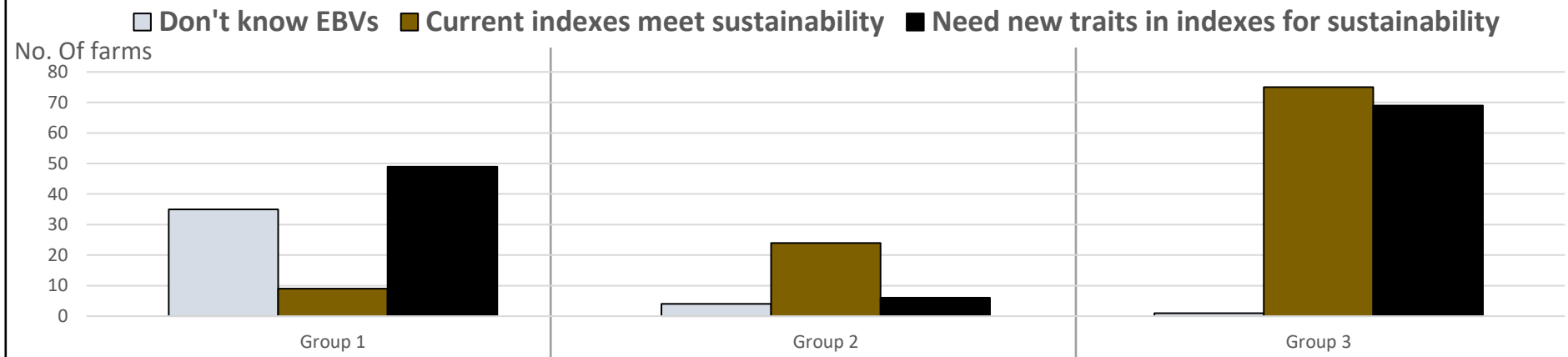
High level of integration in the sociotechnical system

Group 3 (n = 145)
'Breeders seeking production efficiency and sustainability'

High interest in adding robustness traits in the indexes to increase sustainability



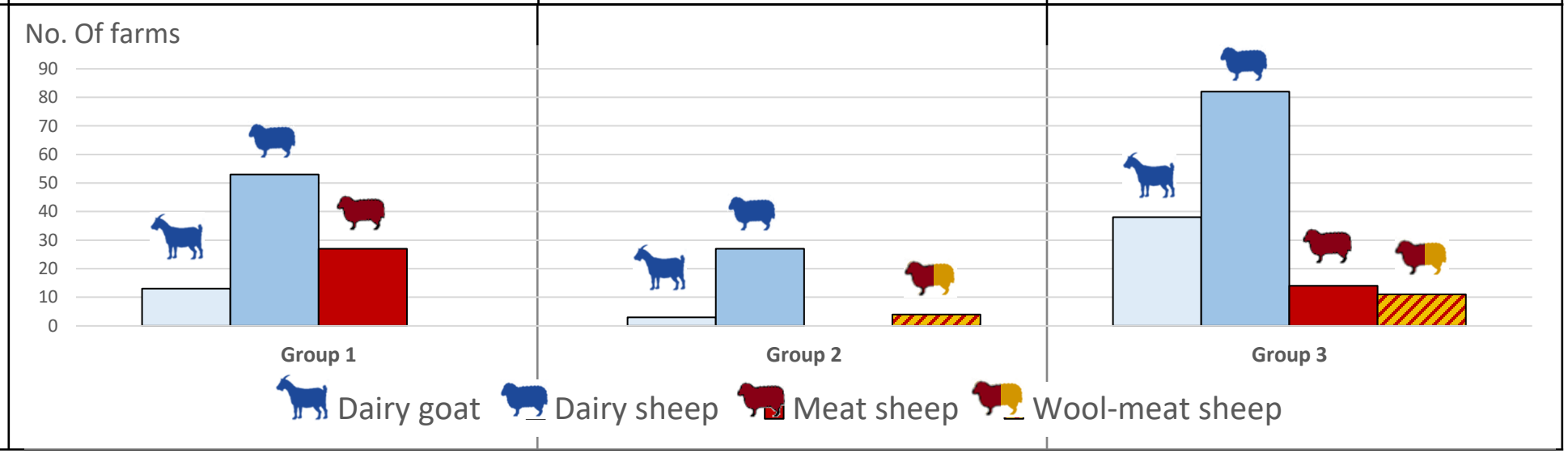
What about genetics?

	Group 1 (n = 93) 'Non genetic farmers seeking robustness and multifunctionality'	Group 2 (n = 34) 'Genetic farmers seeking production efficiency'	Group 3 (n = 145) 'Breeders seeking production efficiency and sustainability'
Views on sustainability			

- **Interest in the issue of sustainability** varied among farmers
- **Confidence in genetic tools and their relevance** to increasing resilience varied among farmers

➡ to what extent SMARTER objectives fit farmers' expectations (vs. breeders')?

What about Livestock systems?

	Group 1 (n = 93) 'Non genetic farmers seeking robustness and multifunctionality'	Group 2 (n = 34) 'Genetic farmers seeking production efficiency'	Group 3 (n = 145) 'Breeders seeking production efficiency and sustainability'
Livestock farming system			

➡ No overlap between groups and livestock systems: **breeding management strategies** and **views on sustainability do not seem to depend on livestock species/farming system**

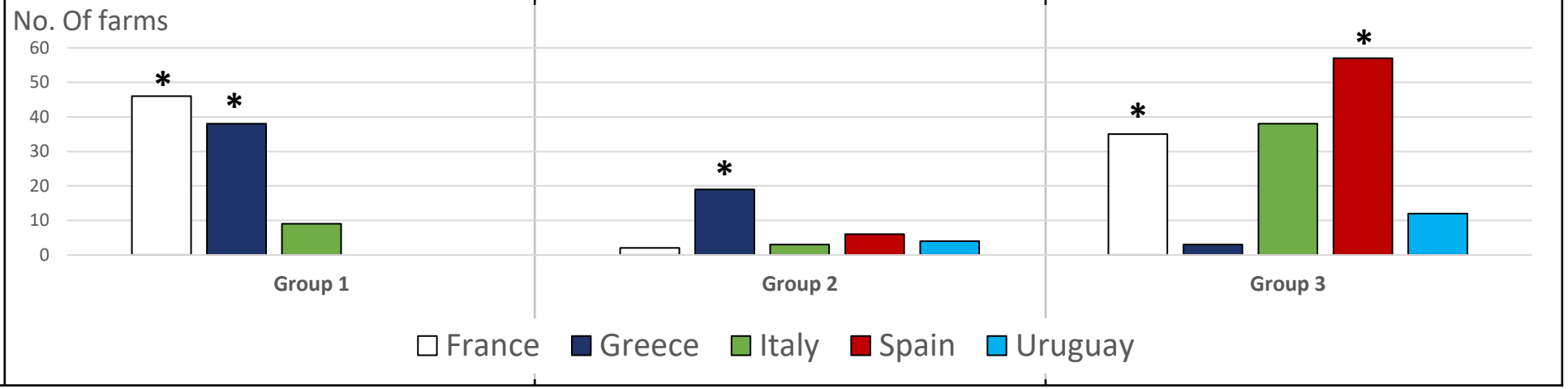
What about countries?

Group 1 (n = 93)
'Non genetic farmers seeking robustness and multifunctionality'

Group 2 (n = 34)
'Genetic farmers seeking production efficiency'

Group 3 (n = 145)
'Breeders seeking production efficiency and sustainability'

Country



➡ Overlap between groups and countries: **socio-technical elements could explain the differences between the groups**

- **Level of structuring** of the breeding selection system
- **Level of dissemination** of technologies and knowledge on genetics (e.g. AI, indexes, genomics)
- **Shared knowledge among farmers** on specific topics (e.g. sustainability/robustness/resilience)

Discussion

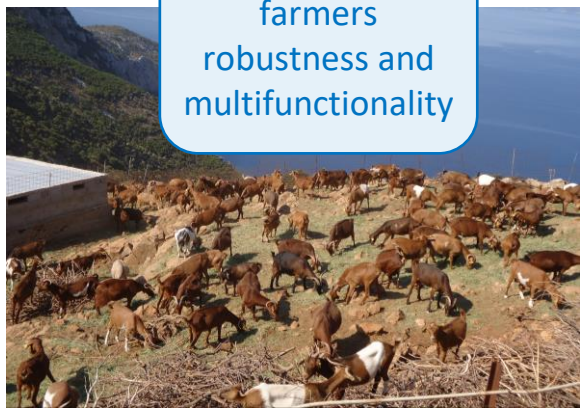
Goat production:

Greece → **Italy**

Intensification in ressource use

SKOPELOS:
Extensive system

Non genetic farmers robustness and multifunctionality



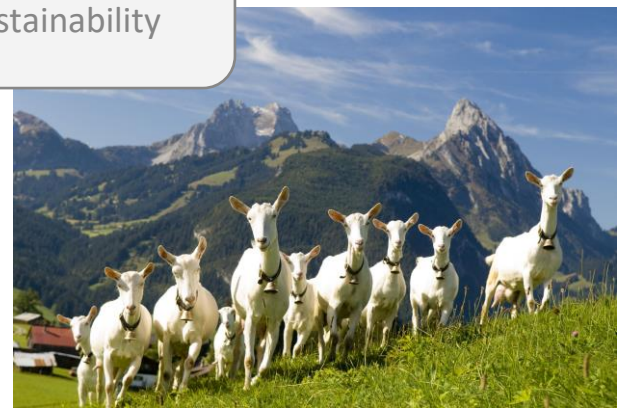
231.7 ha (*27-256*)
38.2 UGB goat

ALPIN or SAADEN:
Semi-intensive system

Genetic farmers production efficiency

Breeders production efficiency and sustainability

16 ha (*3-90*)
12 UGB goat



10.1 ha (*1-46*)
13.3 UGB goat

Discussion

Milk sheep production

France **Greece** **Spain**

Intensification in ressource use

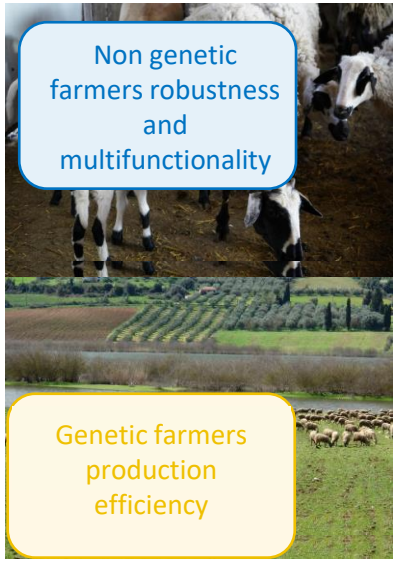
LACAUNE;
MANECH TETE ROUSSE:
Extensive & Semi-intensive system

Non genetic farmers robustness and multifunctionality

Breeders production efficiency and sustainability

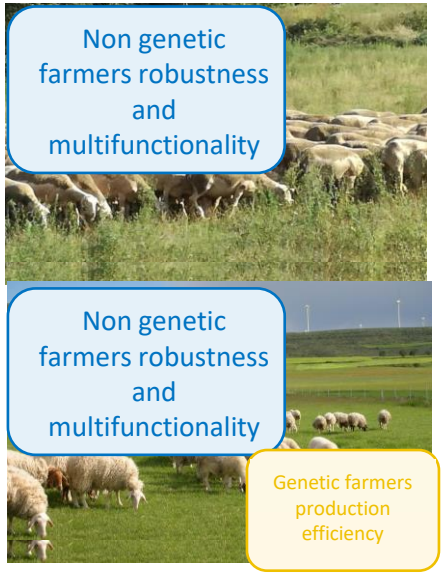
111 ha (*20-714*)
69 UGB sheep

FRIZERTA; ASSAF;
LACAUNE; CHIOS:
Semi-intensive system



Non genetic farmers robustness and multifunctionality

Genetic farmers production efficiency



Non genetic farmers robustness and multifunctionality

Non genetic farmers robustness and multifunctionality

Genetic farmers production efficiency

33 ha (*1-155*) - 27 UGB sheep

ASSAF:
Intensive system

Breeders production efficiency and sustainability

111 ha (*3-900*)
109 UGB sheep

Discussion

Meat sheep production with milk or wool

Urugay **Greece** **France**

Intensification in ressource use

MERINOS; CORRIEDALE:
Wool, Meat extensive system

1753 ha (*88-7300*) - 313 UGB sheep

BOUTSKO:
Milk &Meat
extensive system

135 ha (*70-200*) – 60 UGB sheep

CAUSSE du LOT; ROMANE;
Extensive & Semi-intensive system

272 ha (*25-1000*) - 101 UGB sheep

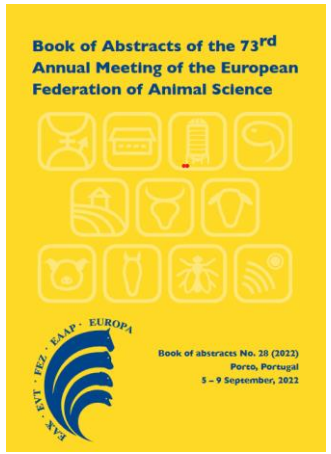
Take-home messages

- **Not all farmers have the same level of genetic knowledge** and use of genetic tools
- There is **no significant overlap between breeding management and breeds/farming systems/countries.**
- **The sustainability is a major concern, but the levers are different:** health and robustness, productivity, multifunctionality.
- **The Sociotechnical system are fundamental** to understand farmers preferences
- How to assess if **the goals of the SMARTER project really correspond to the farmers' expectations** and their need to adapt their breeding system: breeder/farmer *iatus*
- ***"Genetic progress will be difficult to maintain as it is because climate change will force farmers to adapt rather than relying solely on animal adaptation or selection"***

First results

Resilience and efficiency traits impact system performances and modify farmers' breeding choices

1. How farmers can increase resilience of small ruminants farming systems: three management strategies across countries?
2. How social acceptance and economic, social and environmental benefits of breeding strategies that use R&E traits and genomic tools to achieve balanced breeding objectives?



Increasing resilience of small ruminants farming systems: three management strategies across countries

J. Quénon [1], G. Arsenos [2], G. Bailo [3], R. Baptista [4], I. De Barbieri [4], G. Bruni [3], F. Freire [5], A. Theodoridis [2], S. Vouraki [2] and V. Thénard [1]

73rd EAAP Annual Meeting – Porto (POR)

Acknowledgments

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Thank you for your attention

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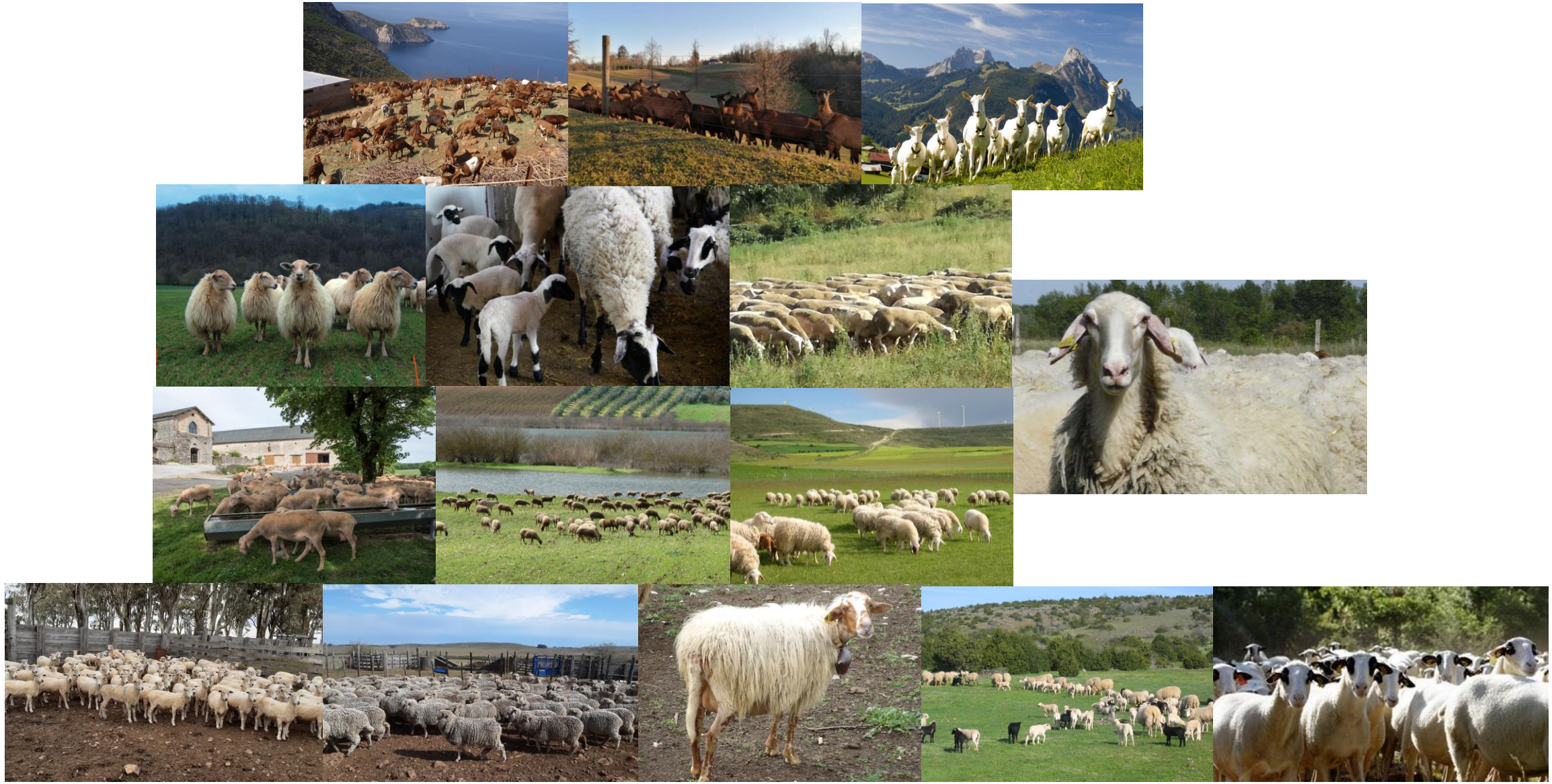

Material and methods

1. DATA COLLECTION → 2. DATA EDITING → 3. MULTIVARIATE ANALYSIS

Itw section	Name of the variable	Definition	Type of variable	Use of the variable in the FAMD	Details
2.LIVESTOCK	Replacement	Replacement rate	Quantitative	Active	
2.LIVESTOCK	PercOfAI	% of the flock on which AI is used	Quantitative	Active	
2.LIVESTOCK	UseOfAI	Use of AI or natural mating	Categorical	Active	AI only / NM only / Both
2.LIVESTOCK	BreederStatus	Status of the farmer	Categorical	Active	Breeder/Farmer
2.LIVESTOCK	PerfControl	Enrollment in performance recording organisation	Categorical	Active	Enrolled/ NotEnrol
2.LIVESTOCK	NbCullCrit	No. Of culling criteria used	Quantitative	Active	

Material and methods

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Itw section	Name of the variable	Definition	Type of variable	Use of the variable in the FAMD	Details
3.TRAITS & INDEXES	CritForSelec	Criteria to select reproductive animals	Categorical	Active	Genetical/Phenotype/Other
3.TRAITS & INDEXES	NbSelTraits	Number of traits used to select	Quantitative	Active	**Med = 4**; Min = 0; Max = 10
3.TRAITS & INDEXES	NbTraitsForSust	Number of traits cited as potentially increasing the resilience of the farm	Quantitative	Active	**Med = 0**; Min = 0; Max = 8
3.TRAITS & INDEXES	TraitsForSust	Traits cited as increasing the resilience of the farm	Categorical	Active	Ø / Production / Robustness / Don't know EBV
3.TRAITS & INDEXES	ChangeIndex	Would the farmer like a new index?	Categorical	Active	More traits / New indexes / No change
3.TRAITS & INDEXES	BuyMales	Does the farmer buy males?	Categorical	Active	No / Yes with/without EBV

Material and methods

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Itw section	Name of the variable	Definition	Type of variable	Use of the variable in the FAMD	Details
1.CROPS	UAA	Utilized Agricultural Area (ha)	Quantitative	Supplementary	
1.CROPS	PercMeadGrass	% of meadows + grassland in UAA	Quantitative	Supplementary	
1.CROPS	FertiPractices	Fertilization practices	Categorical	Supplementary	Mineral/Organic/Both/None
1.CROPS	PercSurfPesti	% of UAA on which pesticides are used	Quantitative	Supplementary	
2.LIVESTOCK	UGBSmallRum	Flock size (UGB)	Quantitative	Supplementary	
4. BREEDING ORGANISATION	LimGenProgress	What limits genetical progress?	Categorical	Supplementary	Nothing / Organisation / Data / Indivdual /
4. BREEDING ORGANISATION	GenomicsDev	How do you consider genomics development?	Categorical	Supplementary	Want to be in / Not a priority
4. BREEDING ORGANISATION	Crossbreeding	Do you use crossbreeding?	Categorical	Supplementary	Yes / No

Results

Group 1 (n = 93): 'Non-genetic farmers seeking robustness and multifunctionality'

- Not enrolled in performance recording org.
- Less knowledge of genetics
- Less use of the tools of genetic progress (e.g. indexes, AI).
- Selection of animals on non-genetic traits and culled on functional traits.
- Mostly French and Greek meat sheep farmers
- Smaller flocks
- Multiple-breeds flocks
- Lower replacement rate
- Higher % of meadows and grassland in UAA.

Results

Group 2 (n = 34): 'Genetic farmers seeking production efficiency'

- Production-driven flock management
- Mostly Greek dairy sheep farmers
- Low % of meadows/grassland in the UAA
- Low use of pesticides
- Selecting on production traits to increase sustainability of their farming system.

Results

Group 3 (n = 145): 'Breeders seeking production efficiency and sustainability'

- Mostly Spain and Italian breeders + Uruguayan farmers
- Large flocks
- Low % of meadows/grassland
- High use of pesticides
- Demanding flock configuration practices:
  - higher use of artificial insemination
  - higher replacement rate
- Strong knowledge in genetics
- Enrolled in performance control recording organisations
- Satisfied with the current indexes to ensure the sustainability of their system

Results

	Group 1 (n = 93) 'Non genetic farmers seeking robustness and multifunctionality'	**Group 2 (n = 34)** 'Genetic farmers seeking production efficiency'	**Group 3 (n = 145)** 'Breeders seeking production efficiency and sustainability'
Flock size *(LSU)*	47[a]	51[a]	96[b]
Grassland in UAA *(%)*	0.59[a]	0.28[b]	0.36[b]
Use of pesticides *(% of UAA)*	0.59[a]	0.09[b]	0.30[c]
% of AI used *(%)*	0.06[a]	0.62[b]	0.58[b]
Replacement rate *(%)*	0.23[a]	0.09[b]	0.36[c]
No. of breeds in the flock	1.4[a]	1.1[b]	1.1[b]