Smarter
SMAll RuminanTs breeding for Efficiency and Resilience

Farmers' practices to identify livestock selection management and to understand farmers' choice

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with collaboration of Julien Quénon

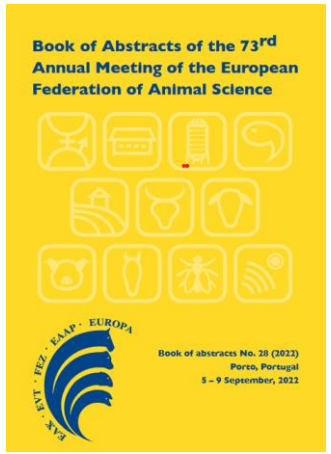
INRAE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°772787

Background

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)

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)

SMAll RuminanTs breeding for Efficiency and Resilience

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

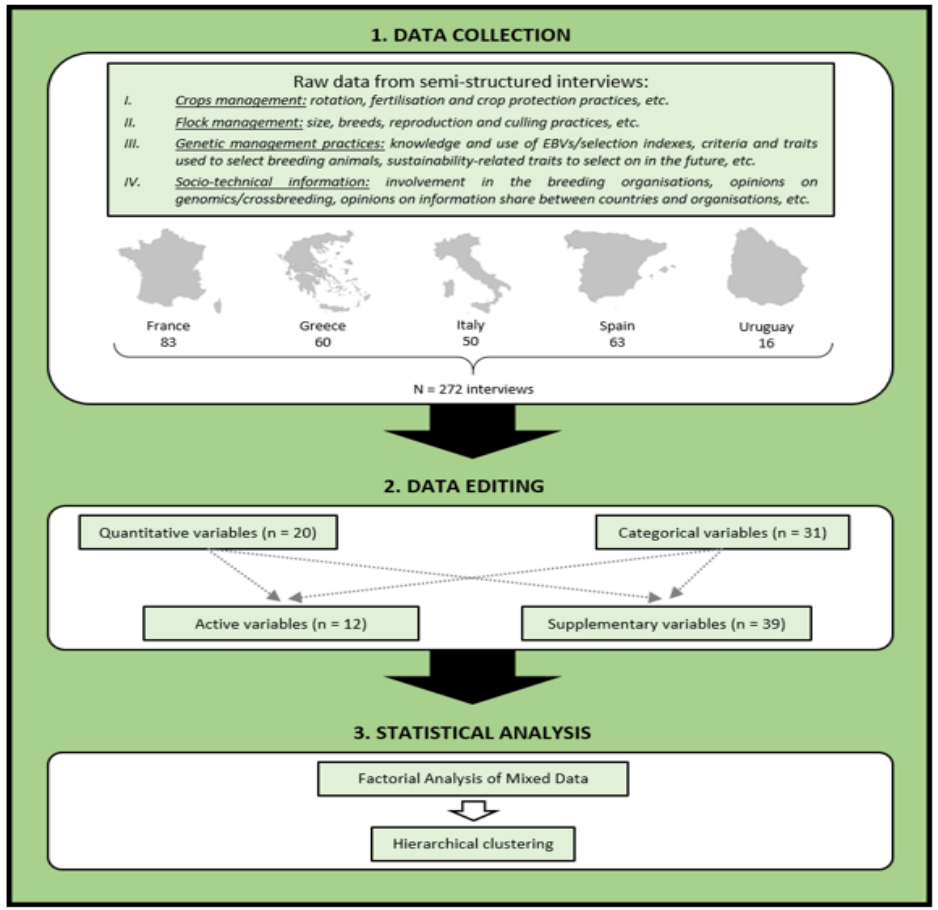
Which traits do they think are relevant to increase the sustainability of their farm?

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

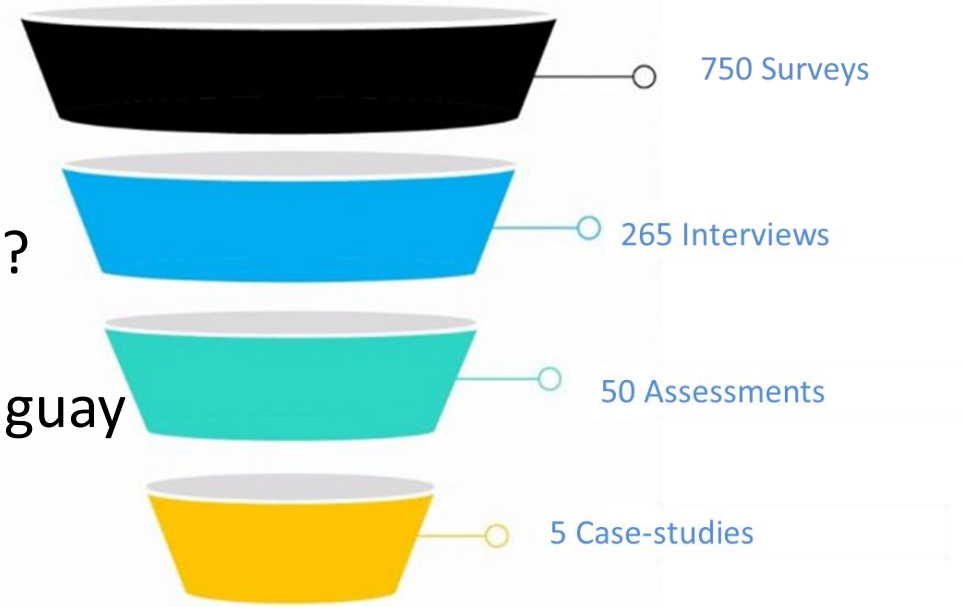
1. DATA COLLECTION

- 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

How analyze the diversity of framing system in the WP7?



- 5 different countries: Greece, France, Italy, Spain, Uruguay
- 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

Milk
Meat
Wool

1. DATA COLLECTION

Sampling

France

Lacaune
Manech tête rousse

Causse du Lot
Romane

Greece

Assaf
Chios
Frizarta
Lacaune

Boutsko

Skopelos

Italy

Alpine
Saanen

Spain

Assaf

Uruguay

Corriedale
Merino

15
Breed × System

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

N = 272 farms

Material and methods

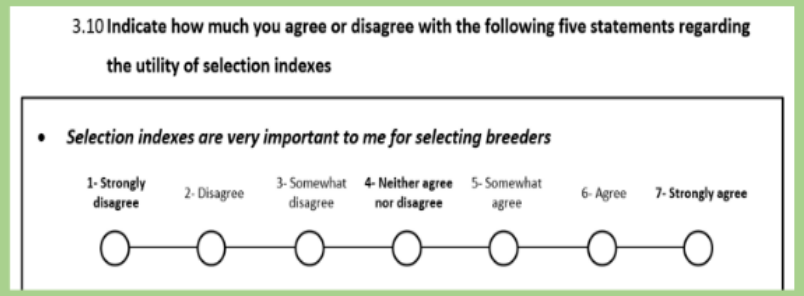
1. DATA COLLECTION

Sampling	Semi-structured interviews

N = 272

Exemple of questions

(a)



3.10 Indicate how much you agree or disagree with the following five statements regarding the utility of selection indexes

- *Selection indexes are very important to me for selecting breeders*

1- Strongly disagree | 2- Disagree | 3- Somewhat disagree | 4- Neither agree nor disagree | 5- Somewhat agree | 6- Agree | 7- Strongly agree

(b)

3.8 **How relevant/important for you are the following traits, which have EBVs available, for selecting animals?** *Please fill in the table below thinking in terms of what you take into account when buying a breeding ram/buck or selecting the rams that you are going to keep in the flock.*

Trait importance	From 0 (totally irrelevant) to 10 (extremely important)	Not available for my breed	Not available for my system
• *Milk quantity*	----	O	O
• Protein content	----	O	O
• Fat Content	----	O	O
• Udder morphology	----	O	O

Material and methods

1. DATA COLLECTION

Sampling | Semi-structured interviews

I. **Crops management:** rotation, fertilisation and crop protection practices, etc.

N = 272

Material and methods

1. DATA COLLECTION

Sampling	Semi-structured interviews

I. **Crops management:** rotation, fertilisation and crop protection practices, etc.

II. **Flock management:** size, breeds, reproduction and culling practices, etc.

N = 272

Material and methods

1. DATA COLLECTION

Sampling | Semi-structured interviews

N = 272

I. **Crops management:** rotation, fertilisation and crop protection practices, etc.

II. **Flock management:** size, breeds, reproduction and culling practices, etc.

III. **Genetic management practices:**

- Knowledge and use of EBVs/selection indexes
- Criteria and traits used to select breeding animals
- Sustainability-related traits to select on in the future

Material and methods

1. DATA COLLECTION

Sampling	Semi-structured interviews

N = 272

I. **Crops management:** rotation, fertilisation and crop protection practices, etc.

II. **Flock management:** size, breeds, reproduction and culling practices, etc.

III. **Genetic management practices:**
- Knowledge and use of EBVs/selection indexes
- Criteria and traits used to select breeding animals
- Sustainability-related traits to select on in the future

IV. Socio-technical information:
- Involvement in the breeding/performance recording organisations
- Opinions on genomics/crossbreeding
- Opinions on information share between countries and organisations

1. DATA COLLECTION | 2. DATA EDITING

- Qualitative data:

  Building categorical variables = data abstraction (Girard et al., 2008) :

  "*From a abundant diversity of responses to an acceptable one*"

- Quantitative data:

  Calculation of relative indicators e.g. % of artificial insemination used

Material and methods

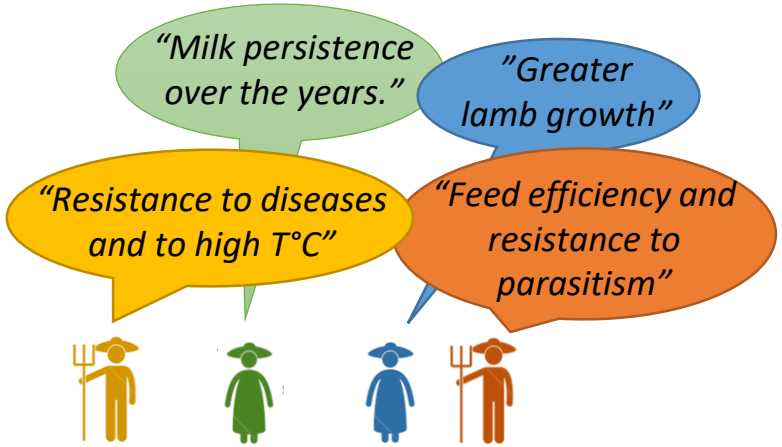
1. DATA COLLECTION **2. DATA EDITING**

- Qualitative data:

  Building categorical variables = data abstraction (Girard et al., 2008) :

  "From a abundant diversity of responses to an acceptable one"

On which traits do you think animals should be selected to increase sustainability of your farming system?



#	Livestock system	Production trait	Robustness trait	Health trait
	Meat-wool sheep	No	Yes	Yes
	Dairy goat	Yes	No	No
	Meat sheep	Yes	No	No
	Dairy sheep	No	Yes	Yes

Traits needed for sustainability
Robust_Health
Production
Production
Robust_Health

Material and methods

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

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#	Livestock system	Production trait	Robustness trait	Health trait
	Meat-wool sheep	No	Yes	Yes
	Dairy goat	Yes	No	No
	Meat sheep	Yes	No	No
	Dairy sheep	No	Yes	Yes

From **4 initial unique responses** to **2 classes**

Traits needed for sustainability
Robust_Health
Production
Production
Robust_Health

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

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

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
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

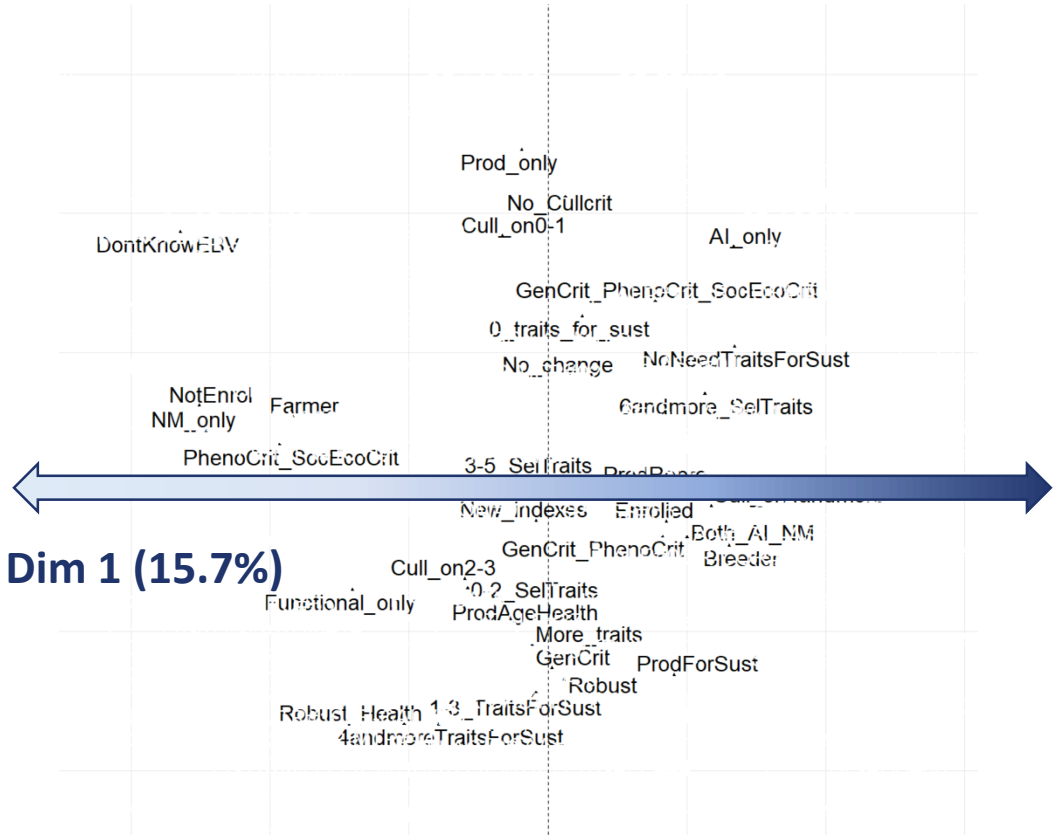
Material and methods

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
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

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



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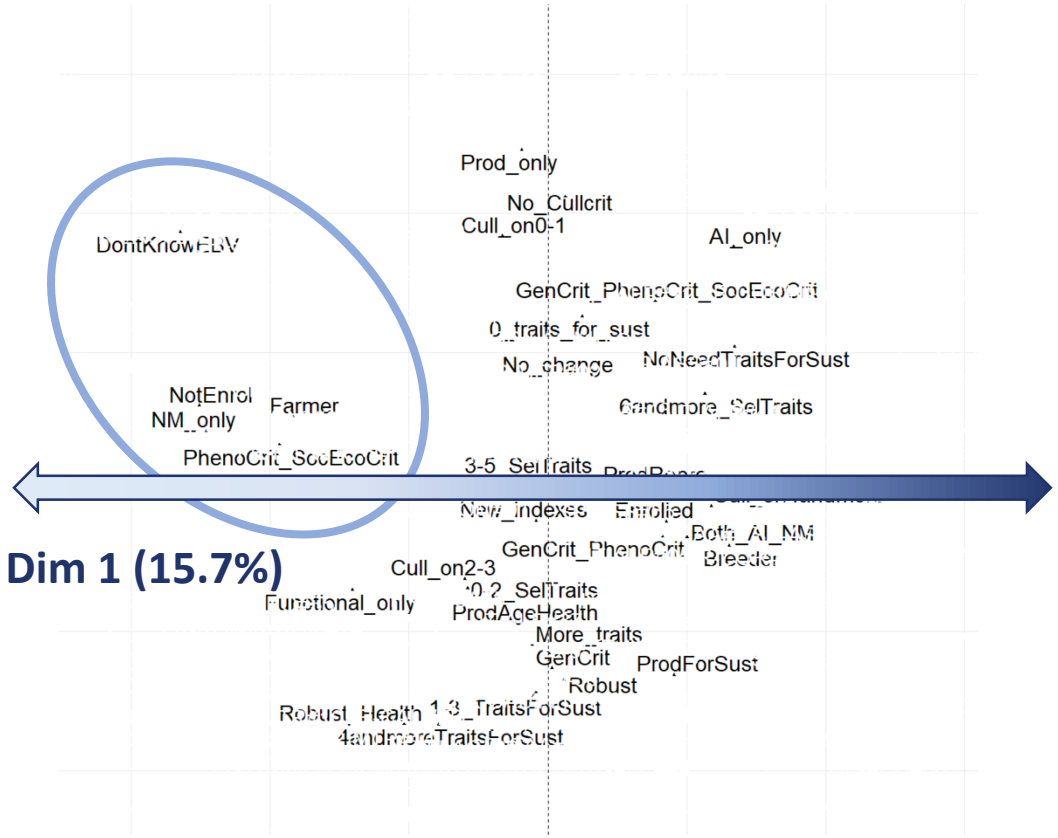

- Farmers
- Don't know EBVs
- Not enrolled in performance controlling organisations
- Using natural mating only
- Don't use genetic criteria to buy breeding animals

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

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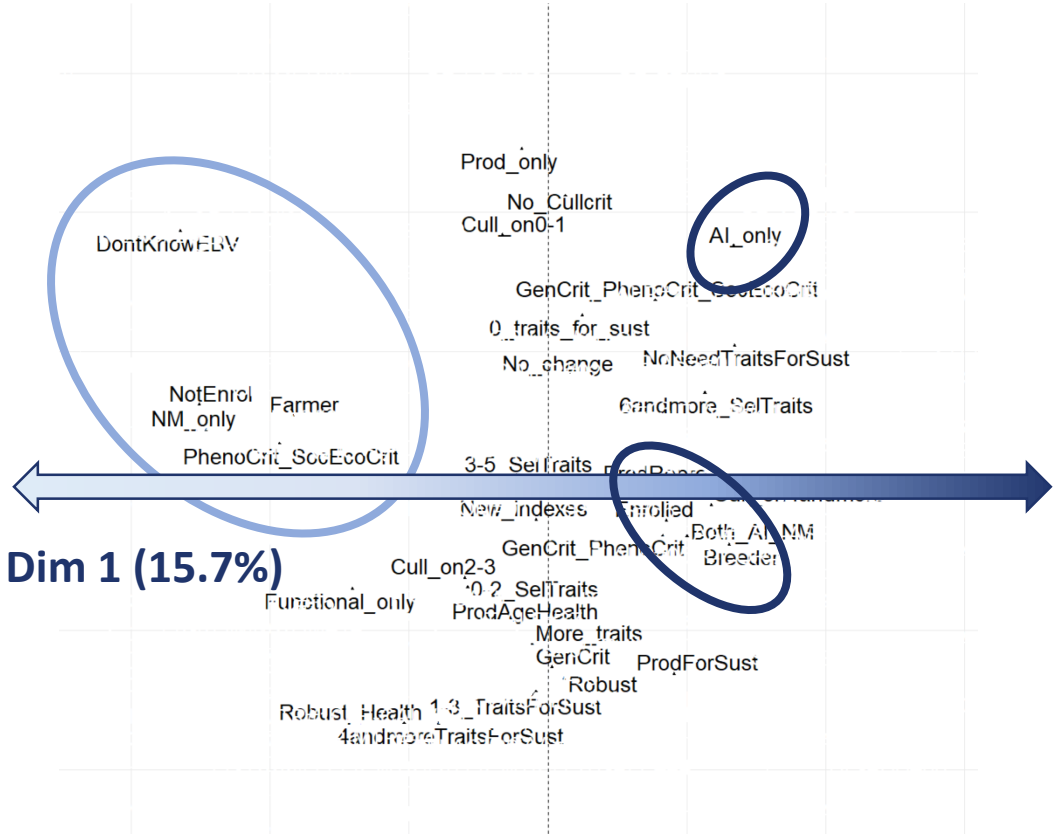
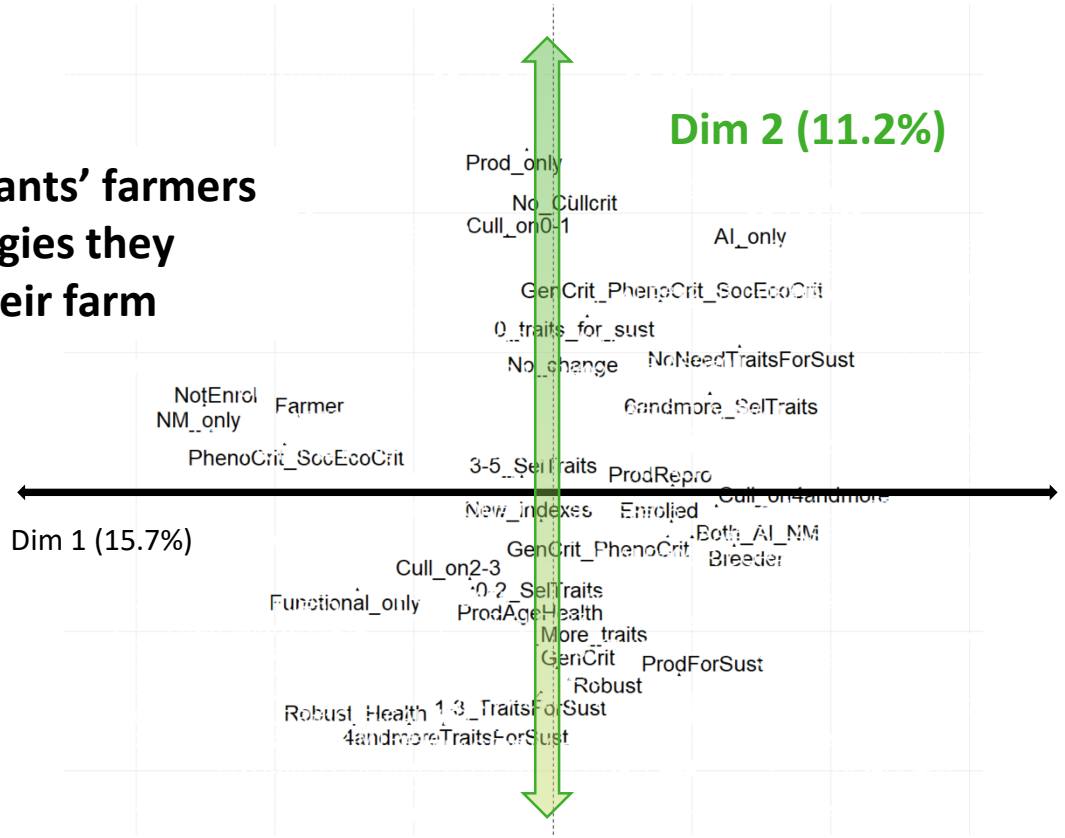


- Breeders
- Enrolled in performance controlling organisations
- Using artificial insemination only

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

Results

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



Results

- 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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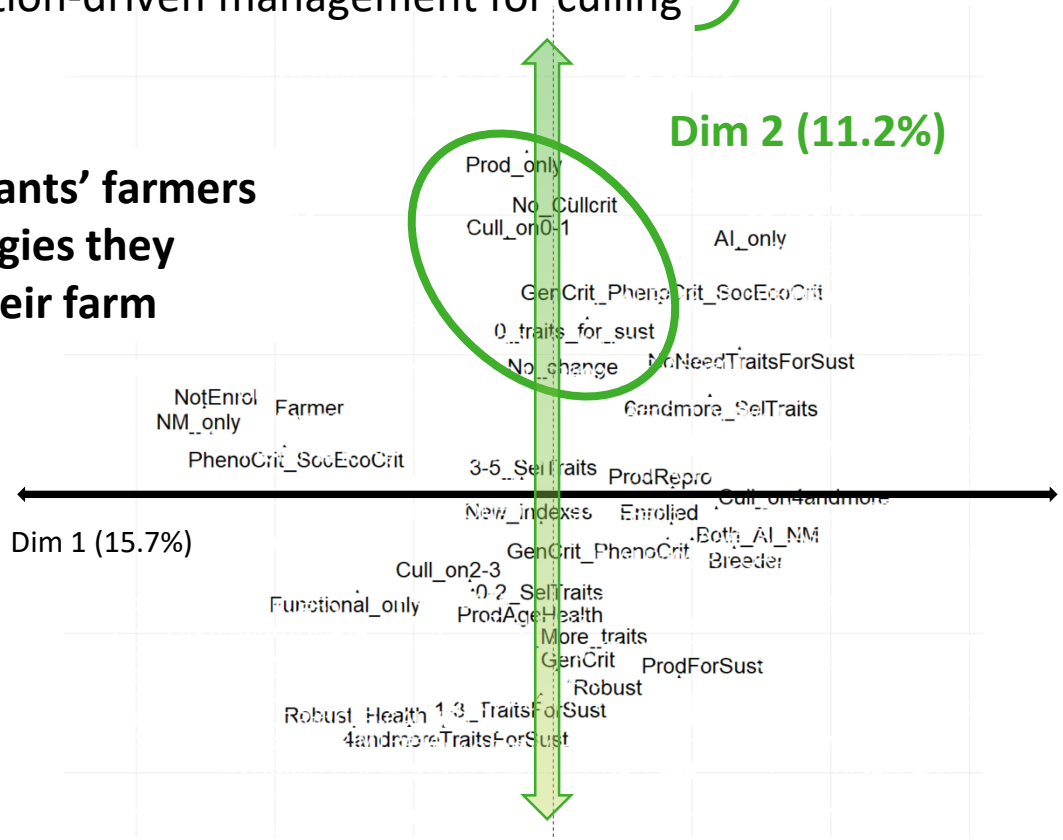

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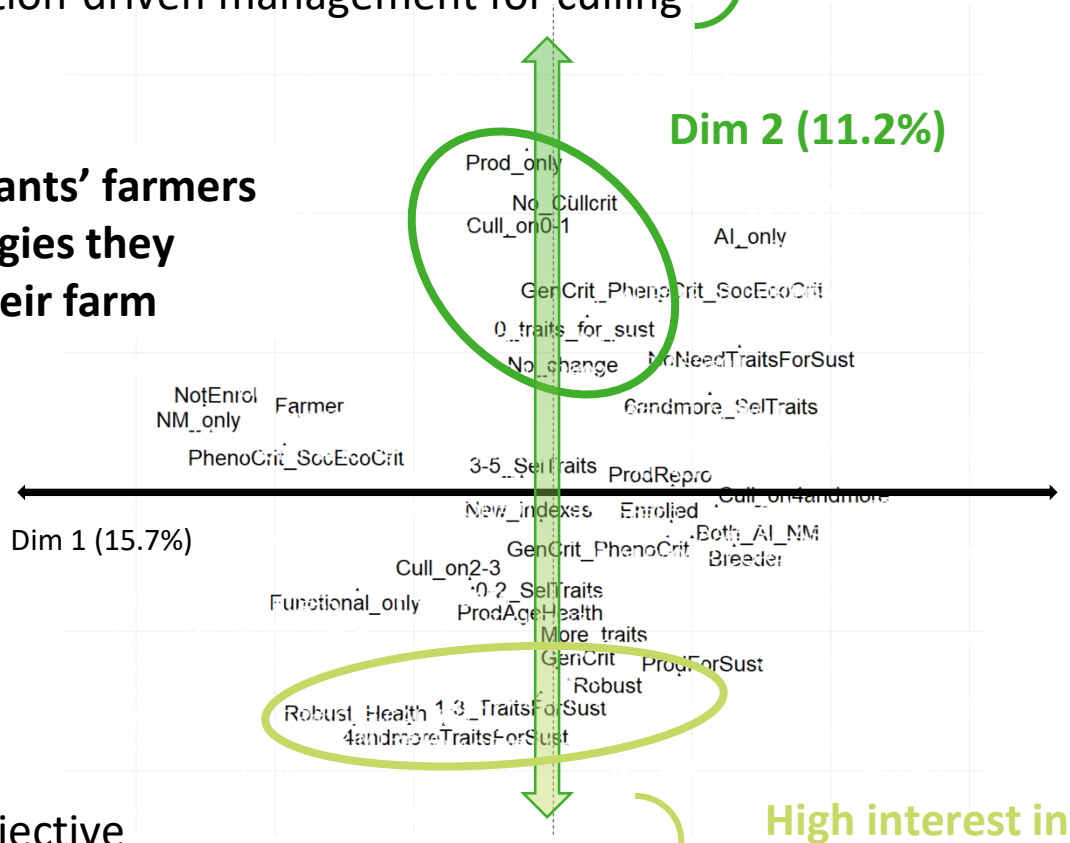


- Sustainability is a crucial objective
- Unsatisfied with the current indexes
- Ask for robustness- and health-related traits in the indexes

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

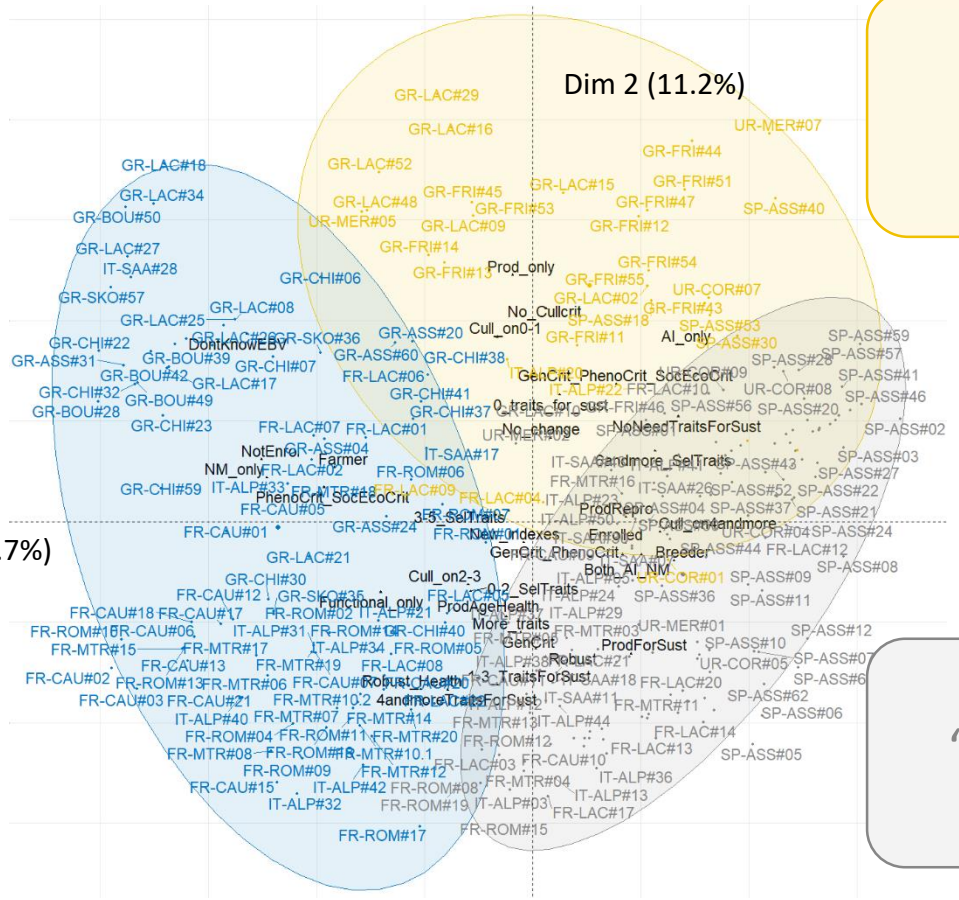
Results

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'

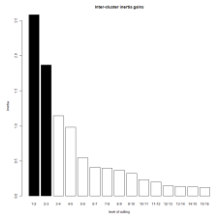
Low level of integration in the sociotechnical system



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



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

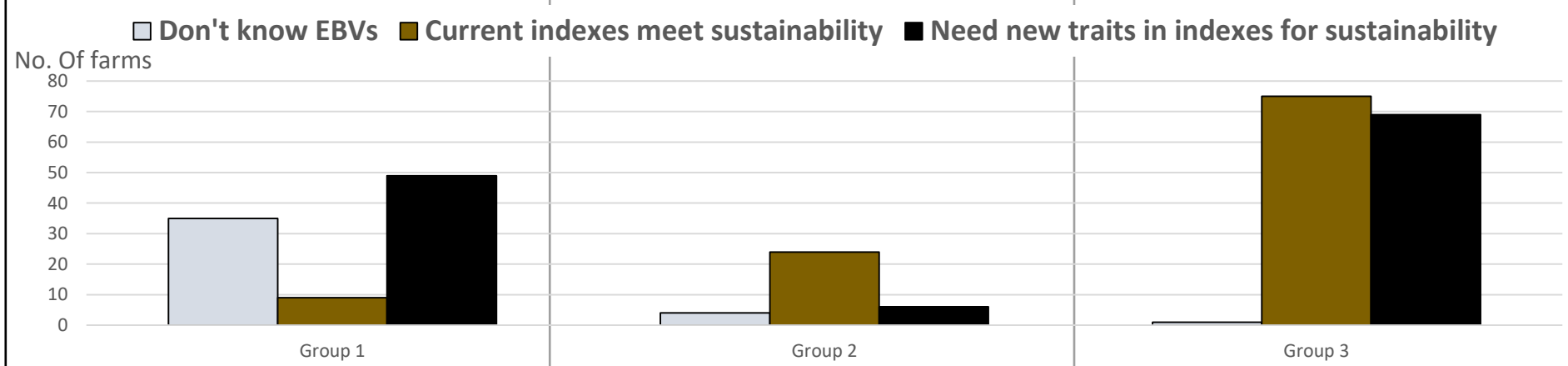
Group 3 (n = 145): 'Breeders seeking production efficiency and sustainability'

- 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]

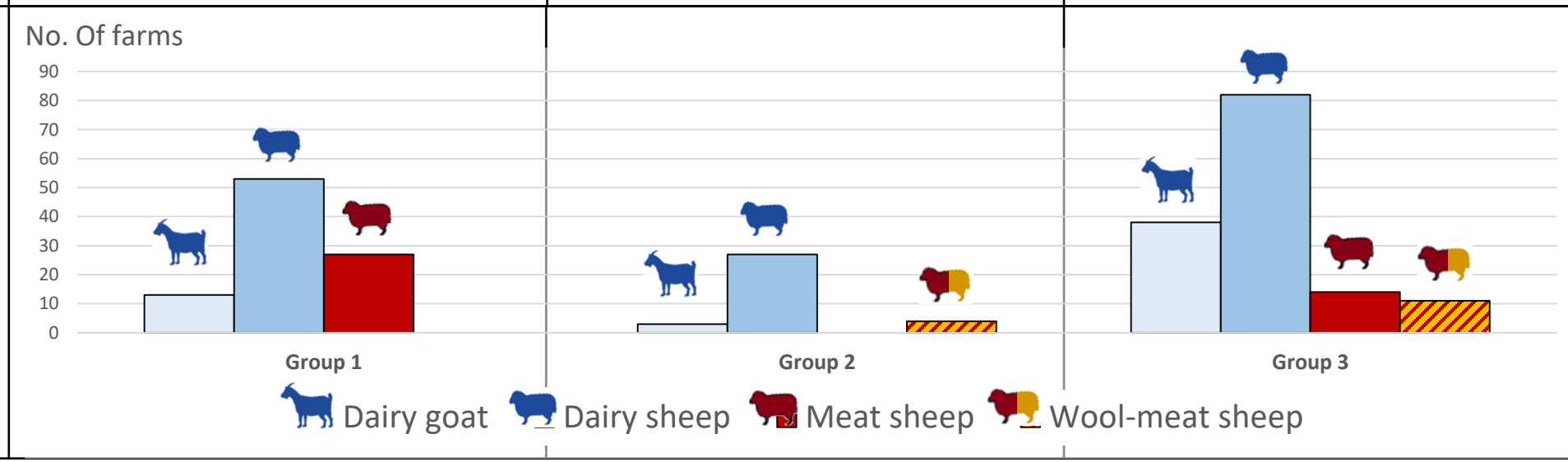
Discussion

	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

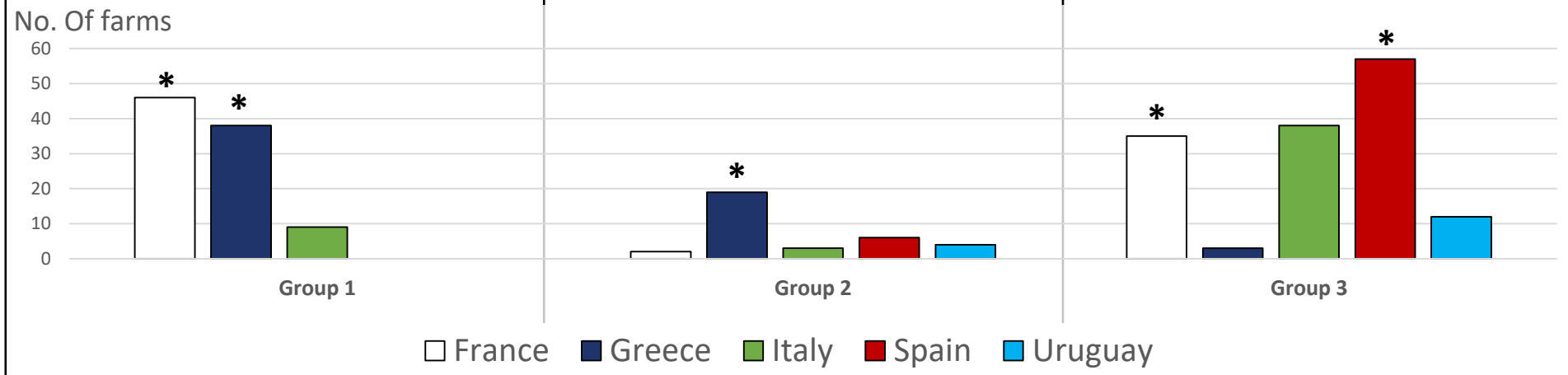
➡ to what extent SMARTER objectives fit farmers' expectations (vs. breeders')?

Discussion

	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**

Discussion

	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

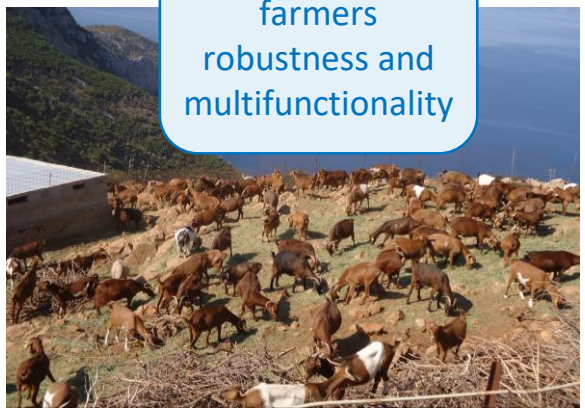
Goat production:

Greece → **Italy**

Intensification in ressource use

SKOPELOS:
Extensive system

Non genetic farmers robustness and multifunctionality



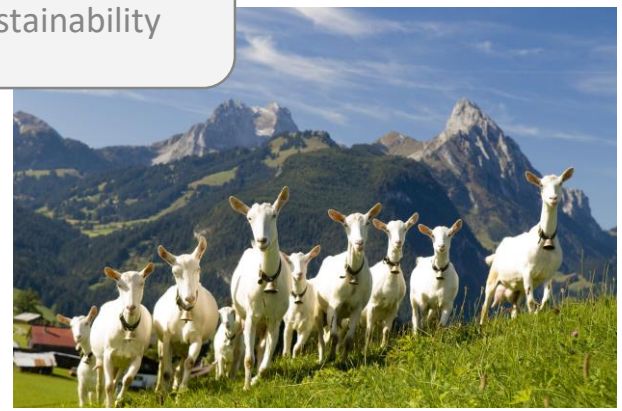
231.7 ha (*27-256*)
38.2 UGB goat

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

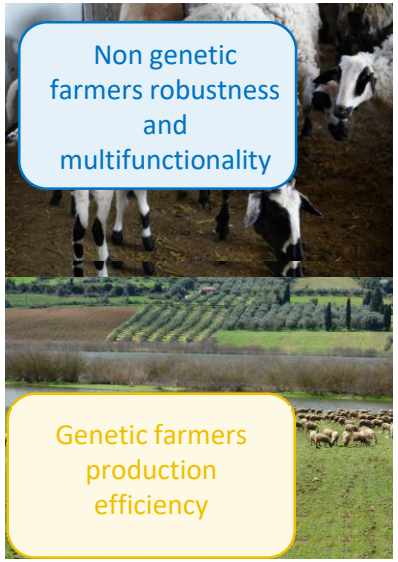
LACAUNE;
MANECH TETE ROUSSE:
Extensive & Semi-intensive system

Non genetic farmers robustness and multifunctionality

Breeders production efficiency and sustainability

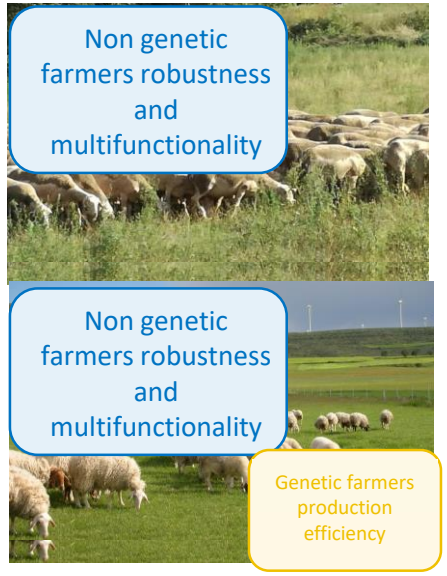
111 ha (*20-714*)
69 UGB sheep

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

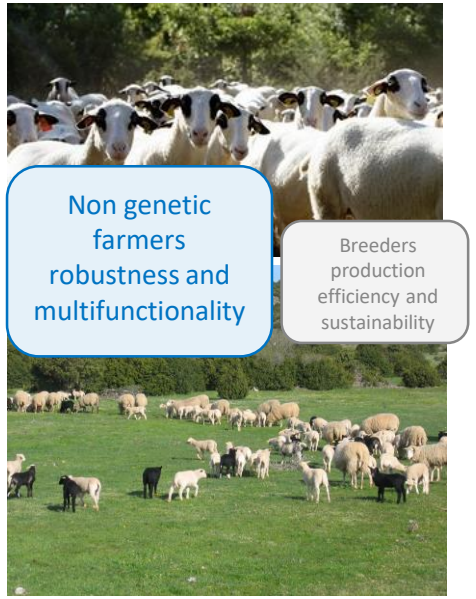
MERINOS; CORRIEDALE:
Wool, Meat extensive system

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

New envolvement

Performance data of the farms (e.g. milk/meat production, economical results) are missing in order to objectivize and develop differences across groups.

However, such information were hard to access because of:

- the diversity in sociotechnical environments: variable access to milk record database
- the diversity of production in sampled farms: milk, meat, wool
- the length of the interviews: already quite long, we did not include a section on farm performance, which would have had the disadvantage of collecting only declarative information

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"***

Acknowledgments

ARISTOTLE UNIVERSITY OF THESSALONIKI


Sotiria Vouraki


Alexandros Theodoridis


Georgios Arsenos

INIA URUGUAY


Rebeca Baptista


Ignacio de Barbieri


Guido Bruni


Giovanni Bailo

Ovigén


Fernando Freire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INRAE


Julien Quénon


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SMARTER PARTNERS

Thank you for your attention

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°772787