

Optimal breeding strategies to enhance the sustainability and profitability of the European sheep and goat sector; recommendations and guidelines.

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Leading the way in Agriculture and Rural Research, Education and Consulting

## The iSAGE project







#### "Best" animals selected to breed next generation

- Farmers
- Industry
- Markets
- Consumers
- Traditions
- Regulation
- Environment
- "Best"

• .....



#### "Best" animals selected to breed next generation

**Productive** – milk, meat etc. product quality **Healthy** ۲ **Fertile** • **'Best**" Reproductive ۲ Well shaped ۲ Docile Good feed conversion Unlikely to cull involuntarily ۲



d to breed next generation

**Best**"

Long-term, permanents effects

- Productiy
  - milk, meat et
  - product quali
- Healthy
- Fertile
- Reproductive
- Well shaped
- Docile
- Good feed conversion
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Long-term, permanents effects

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Definitions of "Best" updated

d to breed next generation

"Bost

# New challenges

- Climate changes impacting on
  - Pastures
  - Animal production
- Increased weather volatility impacting on
  - Animal performance
- Need to define and quantify this
  - Stability in performance regardless of weather
  - Resilience to weather change







#### The research

- 1.3 mil sheep and goats
- 21 breeds
- 6 countries
- Diverse climates, environments and systems
- Derive novel animal traits
- Genetic analysis
- Breeding strategies







## Novel animal traits

- Joint analysis of animal records
  - live body weight
  - daily milk/protein yield
  - fertility (conception)
  - feed intake
- with weather variables
  - temperature, humidity, THI
  - before or at the time of performance record







#### **Novel animal traits**



- How do animals react to environmental (weather) challenge?
- Fit "reaction norm" functions into "random regression models"



 $Y_{ij} = X + f(\beta, X_j) + f_i(a_i, X_j) + f_i(p_i, X_j) + e_{ij}$ 

#### **Novel animal traits**



- Capture changes in performance as weather (e.g. temperature) fluctuates
  - Accounting for other factors affecting performance





Average reaction

Animal level



**Individual reaction** 

#### **Atlantic – average reaction**

- Temperate range
  - Not too extreme (temp. -3 19°C)
- Positive reaction to increasing temperature

   equally negative reaction to decreasing temperature



#### Milk yield (goats)

50

80 RH







Tava d10ava



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Sánchez-Molano et al. 2019. BMC Genetics

# Mediterranean – average reaction

- High temperature extreme (> 30°C hot!)
- Heat stress drives performance down











# **Individual variation**

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- Variation observed among individual animals
  - Different animals react differently to weather challenge
- "Flat" lines → unaffected performance (desirable)
- Otherwise 
   performance affected by weather volatility





### **Individual variation**

• Level of variation equal to that for other traits

 Useful to identify the "unaffected" animals (considered well-adapted, resilient) vis-à-vis the most affected ones



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#### **Novel animal traits - summary**



- Possible to derive
- No additional recording needed
  - Current performance records + meteorological data
    - Need to ensure proper animal recording in any case
  - Data analysis software available
- Atlantic (North)
  - Stability to weather change in "cold range" cold stress
- Mediterranean (South)
  - One trait <u>before</u> the heat stress threshold cold stress
  - Another <u>after</u> the heat stress threshold heat stress
- There is variation among individuals

   Genetic?

- Animal phenotypes, genotypes and pedigree
- Yes! part of the variation is genetic
- Heritability meat sheep (growth resilience)
  - 0.14 0.16 lamb trait
  - 0.05 0.10 ewe trait
- Heritability dairy sheep (production/fertility resilience)
  - 0.10 0.20 (cold stress)
  - 0.14 0.21 (heat stress)
- Heritability dairy goats (production resilience)
  - **0.10 0.12**







#### Largely polygenic traits but some genomic areas of interest



#### •Milk protein yield (sheep)











- Part of the variation is genetic
- May selectively breed to enhance resilience and adaptation
- What would the impact be on other traits of interest?



- Antagonistic correlation with some animal traits
- Meat sheep
  - Weaning weight
  - Carcass quality
- Dairy sheep
  - Milk, fat, protein yield
- Dairy goats
   Milk yield

Multi-trait breeding goals Selection index

• Need to enhance both level and stability of performance

#### **Selective breeding strategies**



- zero

- Simulate and assess breeding programmes •
- Varying levels of emphasis on "novel" traits vis-à-vis "traditional" traits
- 20 generations of selection
- **20 replicates**
- Assessment
  - Possible losses if resilience/adaptability traits do not feature in the breeding goal
  - Impact on individual traits
  - Stakeholder preference

#### Meat sheep Lambs **Ewes** - increase Weaning weight - increase - increase Litter size - increase to 1.8 - increase Longevity - increase **Resilience**

Weaning weight **Carcass weight** Muscle depth Fat depth Resilience

- stabilise

- zero

#### **Selective breeding strategies**



- Simulate and assess breeding programmes
- Varying levels of emphasis on "novel" traits vis-à-vis "traditional traits"
- 20 generations of selection
- 20 replicates •
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#### **Dairy sheep**

Milk protein yield **Fertility** 

- Heat stress

- - increase
  - increase
- Mastitis incidence avoid increase
  - zero

Milk yield Longevity Mastitis incidence Age at first kidding Resilience

#### **Dairy goats**

- increase
- increase
- avoid increase
- decrease to 12 mo
- zero

#### **Production losses**











### **Production losses**

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#### **Impact on individual traits**





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#### **Impact on individual traits**



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### **Stakeholder preferences**



- Participatory approach
- On-line survey
- Perceived benefits
- Relative importance
  - Rank of animal traits



#### **Stakeholder preferences**



♠ Projects > ■ Trait selection for sheep and goats > 목 Traits selection for meat sheep-SURVEY > Criteria

#### Criteria

COLLAPSE ALL EXPORT

Lamb live weight change due to temp. (g/°C):

#### Lowest ranked

lamb live weight variation (+/-) of 847 g/°C

no change

Highest ranked

Highest ranked

Lamb weaning weight (kg):

Lowest	ranked
	5 kg less
	as it is (27 Kg)
	5 kg more

#### www.1000minds.com

# Stakeholder preferences – relative importance



Meat sheep			
Ewe longevity	22%		
Ewe litter size	19%		
Lamb carcass weight	18%		
Lamb weaning weight	16%		
Lamb carcass muscle depth	12%		
Lamb resilience	5%		
Lamb carcass fat depth	4%		
Ewe resilience	4%		

Dairy sheep			
Mastitis	37%		
Conception rate	24%		
Vilk yield	24%		
Resilience	15%		

# Recommended emphasis on resilience



- Meat sheep: 5-10%
- Dairy sheep:
- Dairy goats: ~10%
- Minimise performance losses due to weather volatility

~15%

- Minimise adverse impact on individual traits
- Maximise value of selection index
- Consistent with stakeholder preferences
- Tailored to local breed characteristics

## Local breed studies



- More suitable than newly introduced breeds
- Differences in resilience among local breeds
- Targeted approach required at multiple levels
  - Government, famers, associations, scientists





#### **Concluding remarks**



- Selective breeding 

   one of the means to address current and future challenges
- Failing to consider animal resilience 

   suboptimal

Most suitable animals for each environment

- New tools, new knowledge from multi actor collaboration
- Industry/stakeholder uptake



#### **Support decision-making**

