Breeding strategies to enhance animal resilience

Prof Georgios Banos
Dr Enrique Sánchez-Molano
Vanessa Kapsona

Scotland’s Rural College (SRUC) and Roslin Institute, Edinburgh

Leading the way in Agriculture and Rural Research, Education and Consulting
The iSAGE project

- Challenges
  - Sustainability
  - Socio-demographics
  - Climate

- Solutions
  - Farm
  - System
  - Animal

iSAGE consortium consists of 34 partners from 7 countries.

https://www.isage.eu/
The challenge

• Climate changes impacting on
  – Pastures
  – Animal production

• Increased weather volatility impacting on
  – Animal performance

• Novel animal phenotypes
  – Stability in performance regardless of weather
  – Resilience to weather change
The research

- Work with Scottish Blackface meat sheep and Yorkshire dairy goats

- Parallel work by Mediterranean partners on dairy sheep
The research

• Joint analysis of performance records
  – live body weight records (4 measurements during growth)
  – daily milk yield records throughout lactation

• with weather variables
  – temperature, humidity, THI
  – before or at the time of performance record
The method

- Fitting reaction norm into random regression models
- Capture changes of the phenotype (performance) across an “environmental trajectory” (e.g. temperature values)
- Population level
- Individual animal

Sánchez-Molano et al. 2019. BMC Genetics
The outcomes - phenotypes

- Variation observed among individual animals
  - Different animals react differently to weather challenge

- "Flat" lines ➔ unaffected performance (desirable)

- Otherwise ➔ performance affected by weather volatility
The outcomes - phenotypes

- Novel phenotypes reflecting how animal performance is affected by weather volatility

- Useful to identify the “unaffected” animals (considered well-adapted, resilient) vis-à-vis the most affected ones
The outcomes - genetics

- Part of the variation is genetic

- Heritability sheep
  - 0.14 – 0.16 lamb trait
  - 0.05 – 0.10 ewe trait

- Heritability goats
  - 0.10 – 0.12

- May selectively breed to enhance resilience and adaptation

Sánchez-Molano et al. 2019. BMC Genetics
The outcomes - genetics

- **Significant correlation with**
  - Weaning weight (ca. 0.70) - antagonistic
  - Muscle depth (ca. 0.49) - antagonistic
  - Fat depth (ca. 0.43) - ?
  - Ewe litter size (ca. -0.50) - favourable ?
  - Milk yield (ca. 0.42) - antagonistic

- **No correlation with**
  - Carcass weight
  - Longevity (ewes, goats)
  - Mastitis (goats)
  - Fertility (goats)

- **Need to enhance both level and stability of performance**
The outcomes - breeding

- Simulate and assess breeding programmes
- 20 generations of selection
- 20 replicates

Starting values - Sheep
- WWT: 21 kg
- FWT: 41 kg
- ADG: 158 g
- CWT: 19 kg
- MD: 20 mm
- FD: 1.5 mm
- LS: 1.3
- LONG: 2.65 lambings

Starting values - Goats
- DMY: 3.6 kg
- LMY: 3,464 kg
- LONG: 962 d
- Kage: 14.8 mo
- Mast: 14%
- Res: 0.03 – 0.04

Res (lamb): 0.5 – 0.7
Res (ewe): 0.5 – 0.7
The outcomes - breeding

**Lambs**
- Weaning weight - increase
- Carcass weight - increase
- Muscle depth - increase
- Fat depth - stabilise

**Ewes**
- Weaning weight - increase
- Litter size - increase to 2
- Longevity - increase

**Dairy goats**
- Milk yield - increase
- Longevity - increase
- Mastitis incidence - avoid increase
- Age at first kidding - decrease to 12 mo
The outcomes - breeding

**Lambs**
- Weaning weight - increase
- Carcass weight - increase
- Muscle depth - increase
- Fat depth - stabilise
- Resilience - zero

**Ewes**
- Weaning weight - increase
- Litter size - increase to 2
- Longevity - increase
- Resilience - zero

**Dairy goats**
- Milk yield - increase
- Longevity - increase
- Mastitis incidence - avoid increase
- Age at first kidding - decrease to 12 mo
- Resilience - zero
The outcomes - lambs

Resilience: % losses in daily gain

% change from selection

Index = 85-90% carcass, 10-15% body weight
The outcomes - lambs
The outcomes - ewes

Resilience: % losses in daily gain

% change from selection

Emphasis on resilience

Index = 80%(LS+LONG), 20% body weight
The outcomes - ewes

Resilience: % losses in daily gain

Emphasis on resilience

% change from selection

Emphasis on resilience
The outcomes – goats

Resilience: % losses in milk yield

% change from selection

Index = 5-15% Milk, 85-95% fitness
The outcomes - goats

Resilience: % losses in milk yield

Emphasis on resilience

% change from selection

Emphasis on resilience
Ongoing

• Sensitivity analysis

• Estimate monetary value of resilience
  – Losses in growth/milk production due to lack of performance stability

• Literature - Milk yield
  • £<1 – 5 / dairy ewe
  • £10 – 90 / dairy cow

• Identify optimum strategy
  – Possibly 10-20% emphasis on resilience
Discussion points

• Is it worth considering these new traits?
  – No need to collect new animal data
  – Need for additional analyses (software available)

• Direction of selection
  – Breeding for performance stability
  – Breeding for positive reaction?
    • Increased temperature vs. temperature volatility

• Experience/thinking in other regions/countries
  – How do breeding goals evolve?

• Breeding for the future in view of other challenges

• Industry uptake