Breeding for resistance to parasites in French dairy sheep: towards an increase in resilience and sustainability of sheep dairying

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Why breed for resistance to gastrointestinal nematodes (GIN) in sheep? (1/2)

• GIN ingested only at **grazing** through grass intake

• Significant **economic losses** : mortality, milk production losses, direct costs of anthelmintics pharmaceuticals

• **Ecotoxicity** of some anthelmintics (e.g. macrocyclic lactones) : undesired effects on non-targeted fauna, coprophagous insects of the pastures mainly.
Why breed for resistance to gastrointestinal nematodes (GIN) in sheep? (2/2)

- The **important adaptation capacity** of the GIN has made them develop **anthelmintic resistances** (including multidrug resistance) => **RISK OF THERAPEUTIC IMPASSE**

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**Eprinomectin resistance in dairy sheep areas in southern France**

Source: P. Jacquiet

**Manech & Basco-Béarnaise breeds:**
- raised on pastures – mild & humid climate

2023
A standardized protocol of phenotyping: experimental infections with *Haemonchus contortus*

Objective: display differences between rams without hampering their fitness

**Naïf rams** (never exposed to parasites)

**Treatment (T)**

Infections (doses of L3 adapted to breed & age)

**FEC:** eggs / gram in faeces

**ΔPCV:** variation of PCV btw infection and 30 days after

**RESISTANCE**

**RESILIENCE**
Is the protocol relevant and justified?

- **FEC** is a commonly used criterion to measure the resistance to parasites. But time-consuming and costly => rams = targeted population

- Existence of **collective breeding programs in France** with breeding centres and AI centres where rams have a significant impact on the population (AI).

- **Haemonchus contortus** is a pathogenic and thermophile GIN. Most prevalent species in France. Species always concerned in case of resistance to drugs.

- Very high genetic **correlation** (≈ 1) between resistance to different species of GIN

- Very high genetic **correlation** (≈ 0.9) between natural infections and experimental infections.

➤ Feasibility of selection for resistance to parasites
Red-Faced Manech and Basco-Béarnaise breeds: 15 years of phenotyping

Number of rams at each cohort of infection
1826 Red-Faced Manech & 520 Basco-Béarnaise
FEC (resistance) has moderate heritabilities
ΔPCV (resilience) has lower heritabilities

Estimation of h2 in Red-Faced Manech (full bars) & Basco-Béarnaise (hatched bars) breeds
Genetic correlations between resistance and resilience traits

Genetic correlation between RESISTANCE and RESILIENCE traits in Red-Faced Manech

- High correlations across both infections
- High correlations between resistance & resilience

- FEC1 x FEC2: 0.83
- ΔPCV1 x ΔPCV2: 0.68
- FEC2 x ΔPCV2: 0.8
- FEC1 x ΔPCV1: 0.41
- FEC1 x ΔPCV2: 0.81
- FEC2 x ΔPCV1: 1
Genetic evaluation and composite indexes

- **Period 2017-2022**: polygenic evaluation (phenotypes and pedigree).
- **Since 2023**: genomic evaluation => possibility to include resistance to parasites in the genomic pre-selection step of young rams, simultaneously with other traits.

- **EBVs and index provided to breed organisations:**
  - FEC1 et FEC2
  - ΔPCV1 et ΔPCV2
  - **FEC index** = \( \frac{1}{4} \) FEC1 + \( \frac{3}{4} \) FEC2
  - **ΔPCV index** = \( \frac{1}{2} \) (ΔPCV1 + ΔPCV2)
  - **Parasitism index** = \( \frac{3}{4} \) FEC index OPG + \( \frac{1}{4} \) ΔPCV index

**Key question**: which criterion (weighing resistance and resilience)
Genetic correlations between resistance to GIN and traits in selection

The genetic correlations are low => selection for resistance to parasites will not jeopardise the selection on other traits.
Correlation between parasitism index and current TMI

663 rams RFM « 2023 »

Not significant correlation 0.04

\[ y = 0.0001x + 0.0231 \]
New Total Merit Index

- Resistance to parasites included for the first time in the Total Merit Index in 2024 for the selection of the rams (weight of traits = desired compromise by the breeding organisation).

- Towards a more balanced selection objective.

- Genetic gain expected on mid-long term => integrated control of GIN is even more important.
Integrated control of GIN: optimize the toolbox

Eliminate the GIN
- Rational use of anthelmintic drugs
  (Targeted selective treatments, new molecules)
- Tannin-rich plants

Increase the resistance/resilience of the host
- Vaccination, protein intake
  - Genetic resistance

Dry up sources of contamination
- Better manage pasture

Sustainable control of worms
ICAR guidelines?

- Different ways to phenotype resistance / resilience to parasites (experimental vs natural infection)
- Other phenotypes to assess resistance / resilience
- Deliverable of SMARTER project: recommendations to phenotype resilience (including resistance/resilience to parasites)
- Objective of Sheep-Goat-Camelid WG: include these recommendations into a new section of ICAR guidelines
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Thank you for your attention!

Work funded by:
Is the protocol relevant and justified? (2/2)

Ram resistance evaluated in breeding centre is transmitted to its offspring raised on farm, on pastures (Red-Faced Manech breed)

- Daughters born from resistant rams have FEC twice lower than daughters born from susceptible rams
- Proportion of daughters with low FEC excretion higher in daughters born from resistant rams than daughters born from susceptible rams

Source: Aguerre et al, 2018