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# 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**

Eprinomectin resistance in dairy sheep areas in southern France

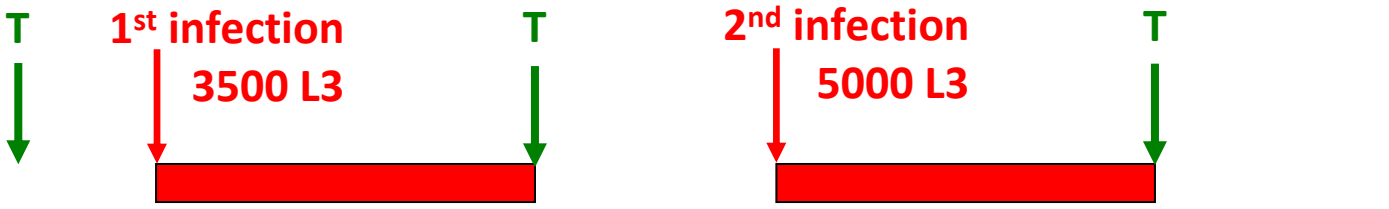

Source: P. Jacquiet

**=> a relevant selection objective**

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

# A standardized protocol of phenotyping:

## experimental infections with *Haemonchus contortus*




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

**D-15** **D0** **D30** **D45** **D75**

**FEC1** **FEC2**

$PCV1_{init}$ **ΔPCV1** $PCV1_{end}$ $PCV2_{init}$ **ΔPCV2** $PCV2_{end}$

Objective : **display differences** between rams without hampering their fitness

**Treatment (T)**

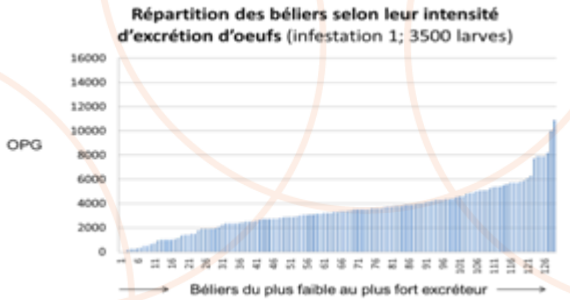
**Infections (doses of L3 adapted to breed & age)**

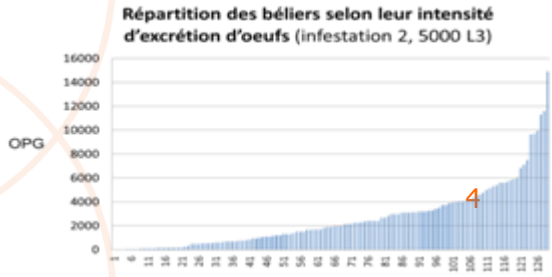
**FEC: eggs / gram in faeces**

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

**RESISTANCE**

**RESILIENCE**



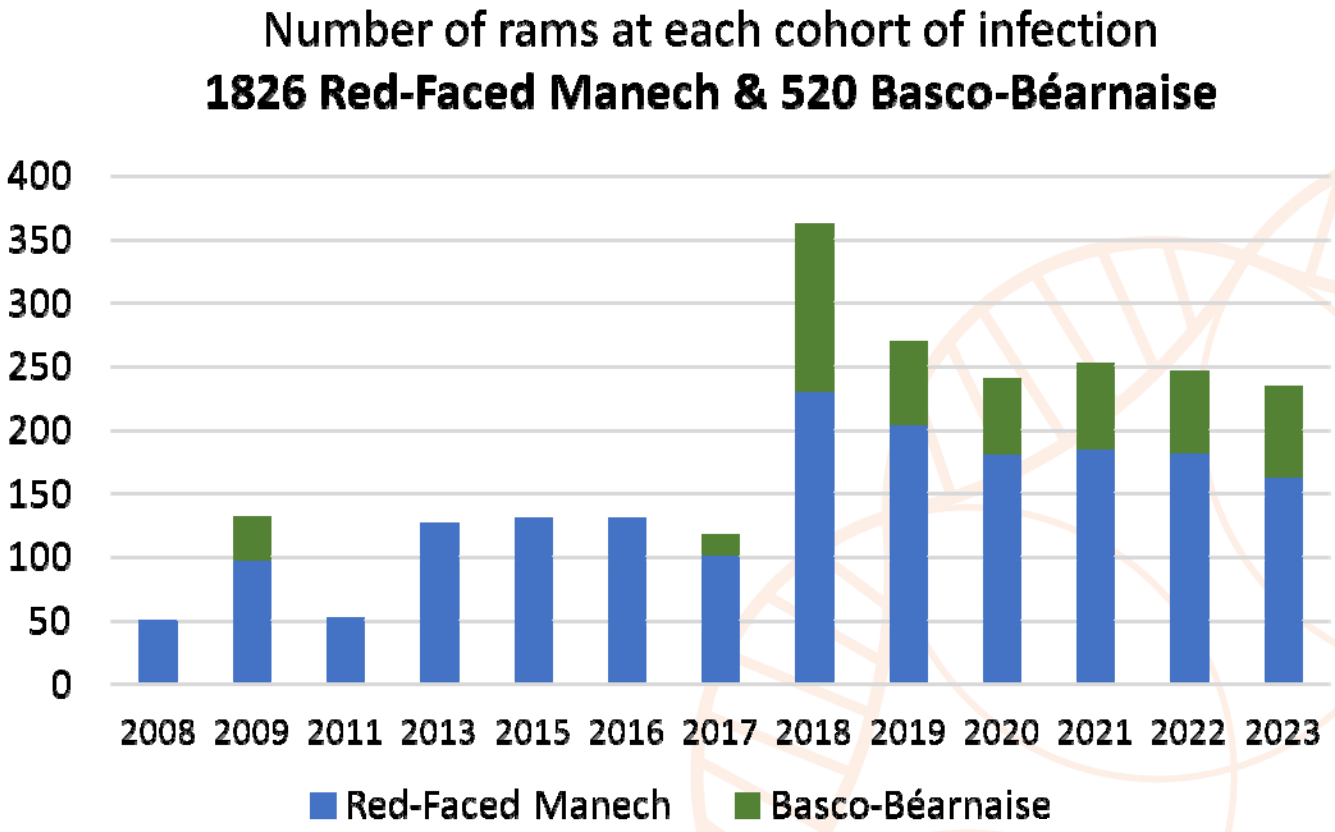
# Is the protocol relevant and justified?

- **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).

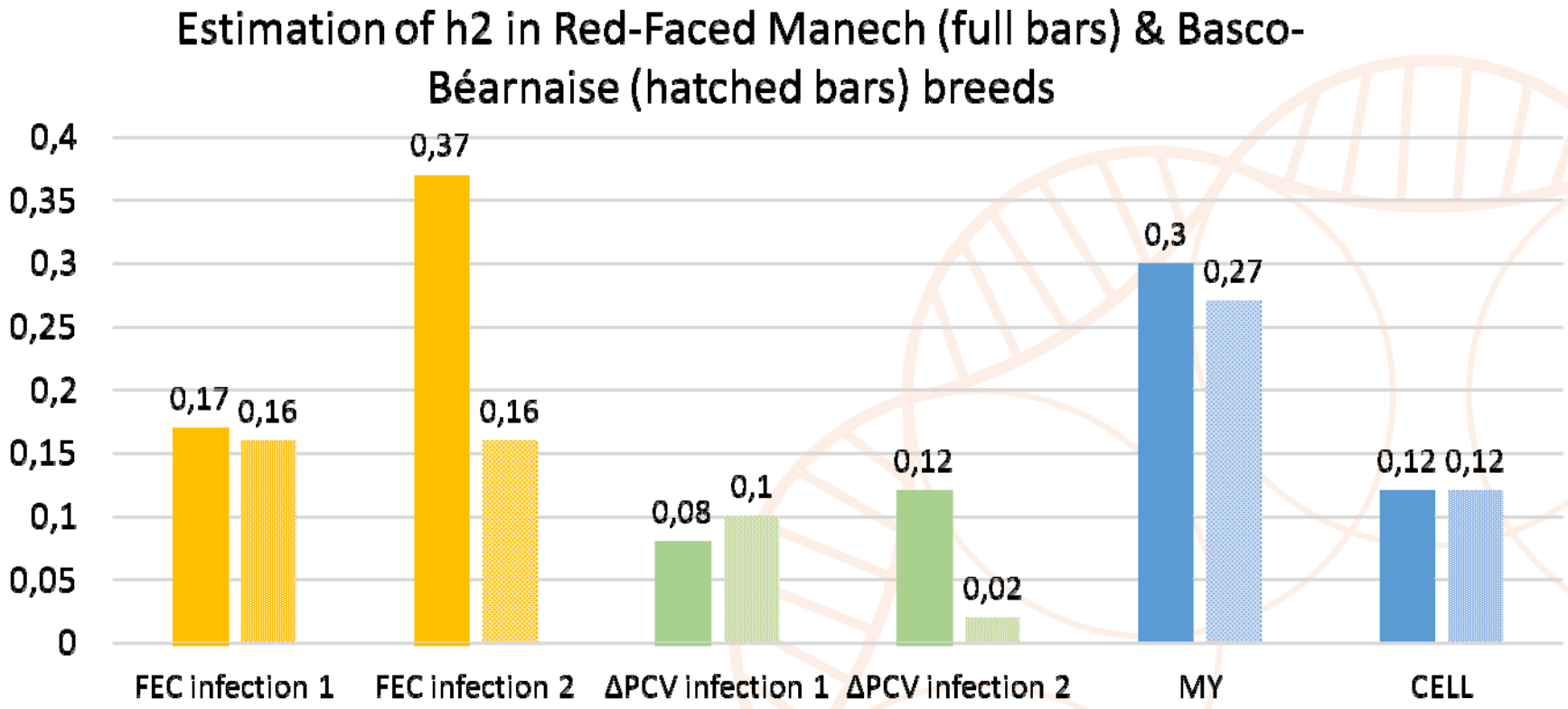
- *Haemonchus contortus* is a pathogenic and thermophile GIN. Most prevalent species in France. Species always concerned in case of resistance to drugs.
- Very high genetic **correlation** (≈ 1) between resistance to **different species of GIN**
- Very high genetic **correlation** (≈ 0,9) between **natural** infections and **experimental** infections.

➢ Feasibility of selection for resistance to parasites

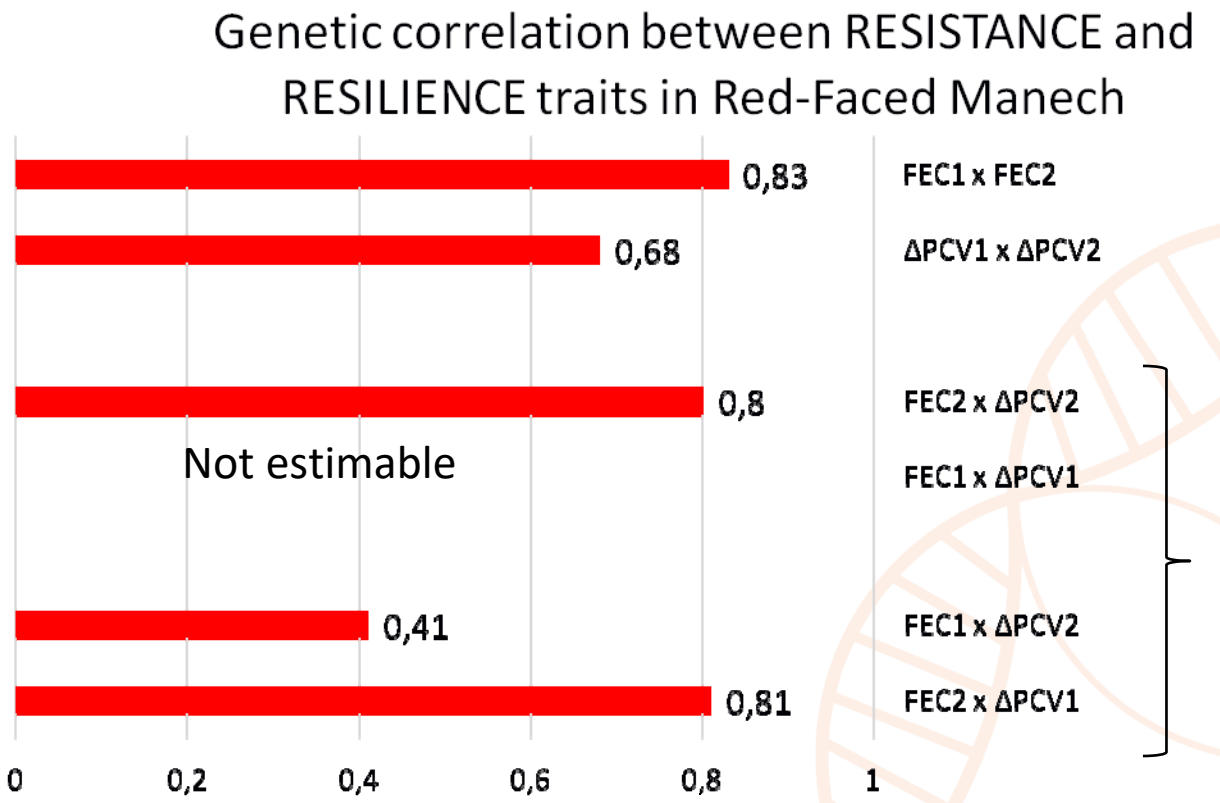
# Red-Faced Manech and Basco-Béarnaise breeds: 15 years of phenotyping



# FEC (resistance) has moderate heritabilities ΔPCV (resilience) has lower heritabilities



# Genetic correlations between resistance and resilience traits




High correlations across both infections

High correlations between resistance & resilience

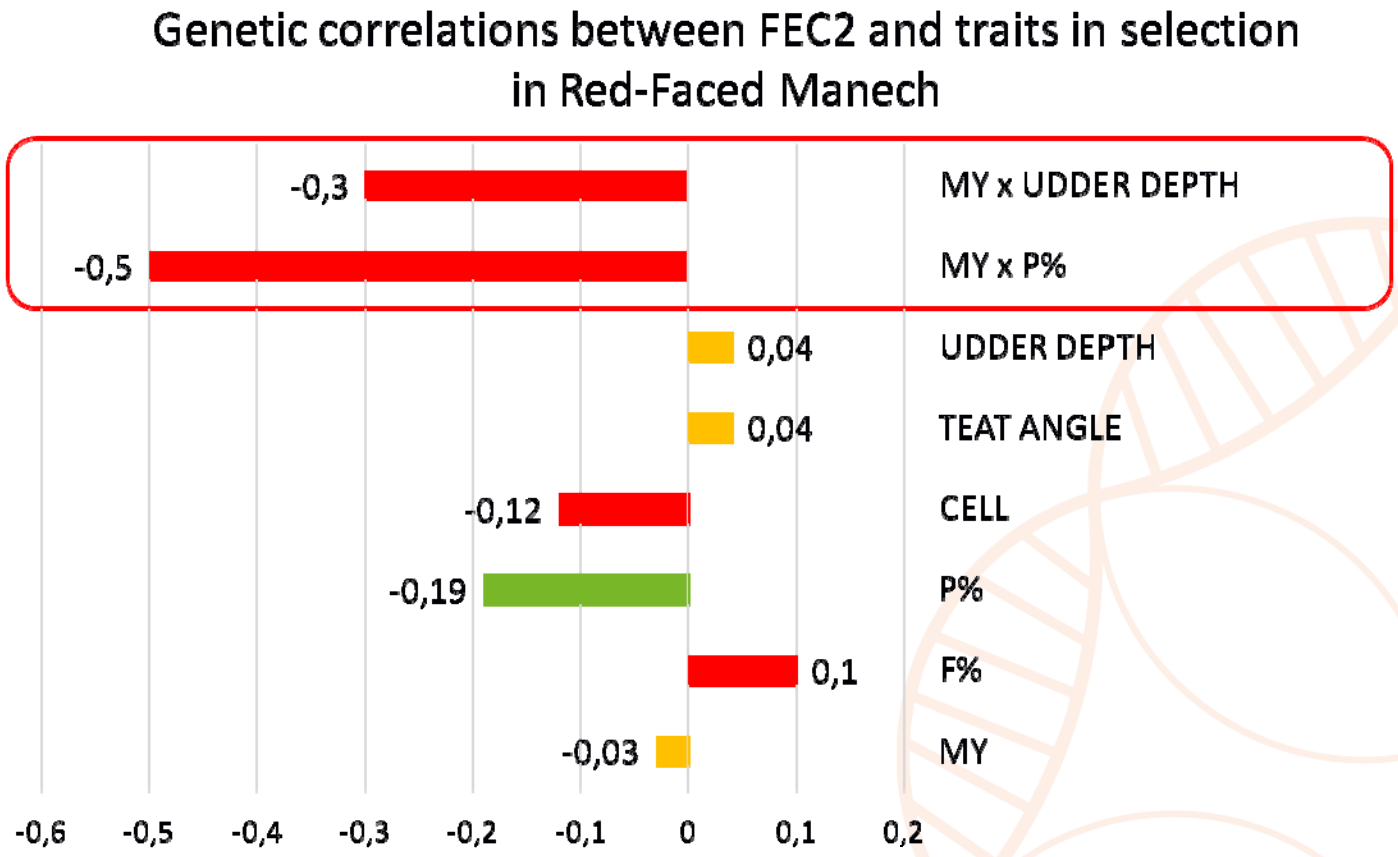
# Genetic evaluation and composite indexes

- **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** = ¼ FEC1 + ¾ FEC2
  - **ΔPCV index** = ½ (ΔPCV1 + ΔPCV2)
  - **Parasitism index** = ¾ FEC index OPG + ¼ ΔPCV index

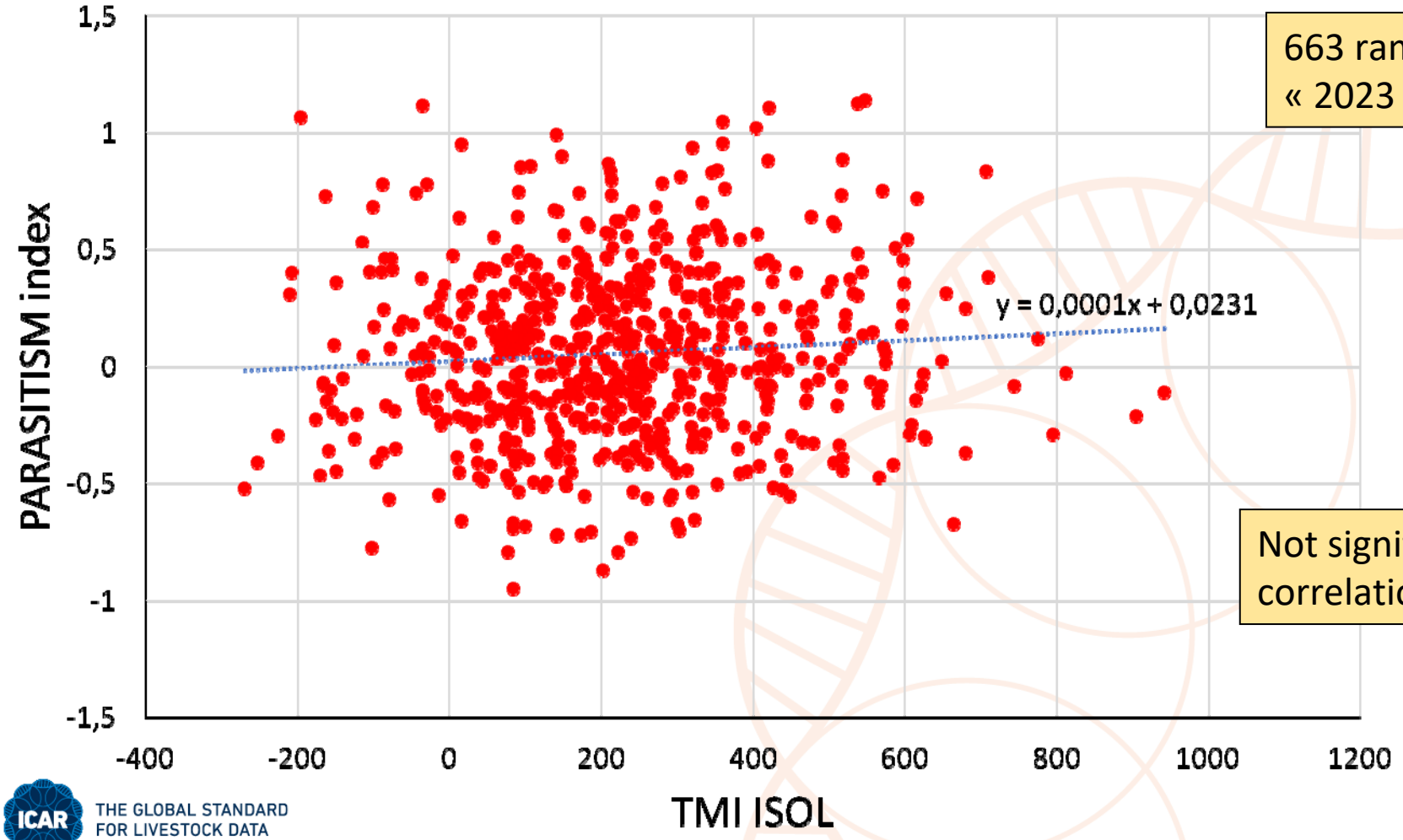
**Key question**: which criterion (**weighing** resistance and resilience)

# 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



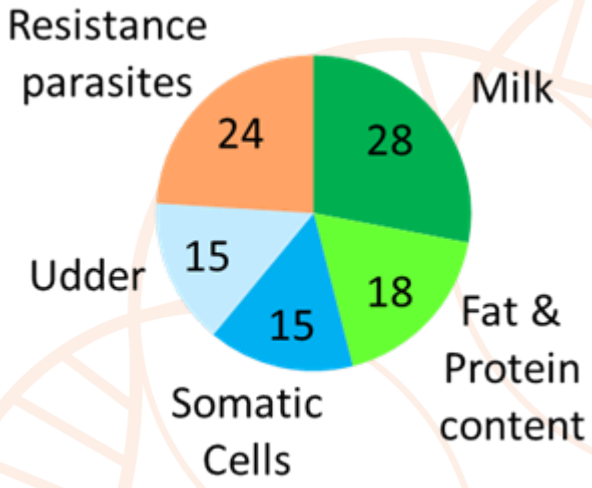

663 rams RFM « 2023 »

Not significant correlation 0.04

# 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.




*Selection criterion in Red-Faced Manech*

- 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

Sustainable control of worms

**Dry up sources of contamination**

•Better manage **pasture**

**Increase the resistance /resilience of the host**

•Vaccination, protein intake

**•Genetic resistance**

# 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!

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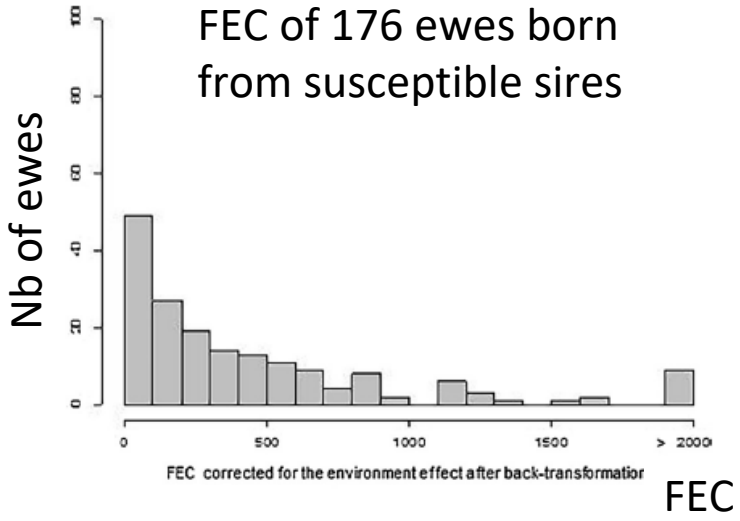
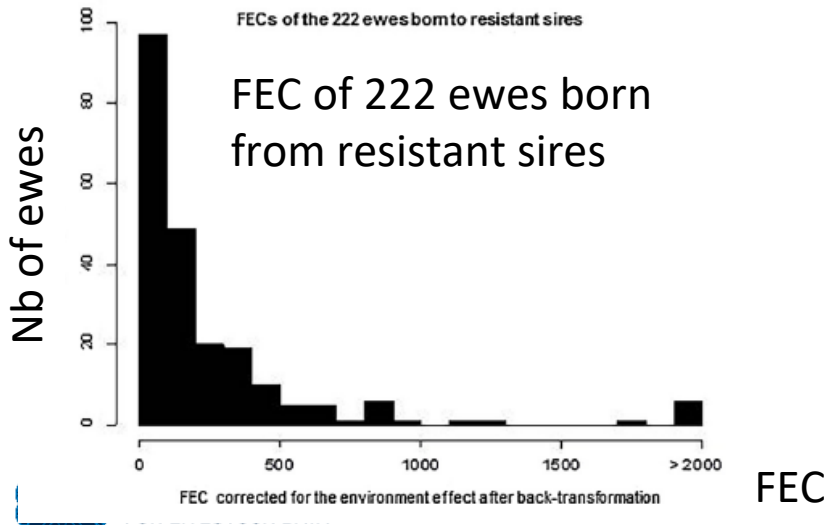
# Is the protocol relevant and justified? (2/2)




- **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