Ten years of genomic selection in French dairy sheep breeds: assessment and perspectives

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Jean-Michel ASTRUC
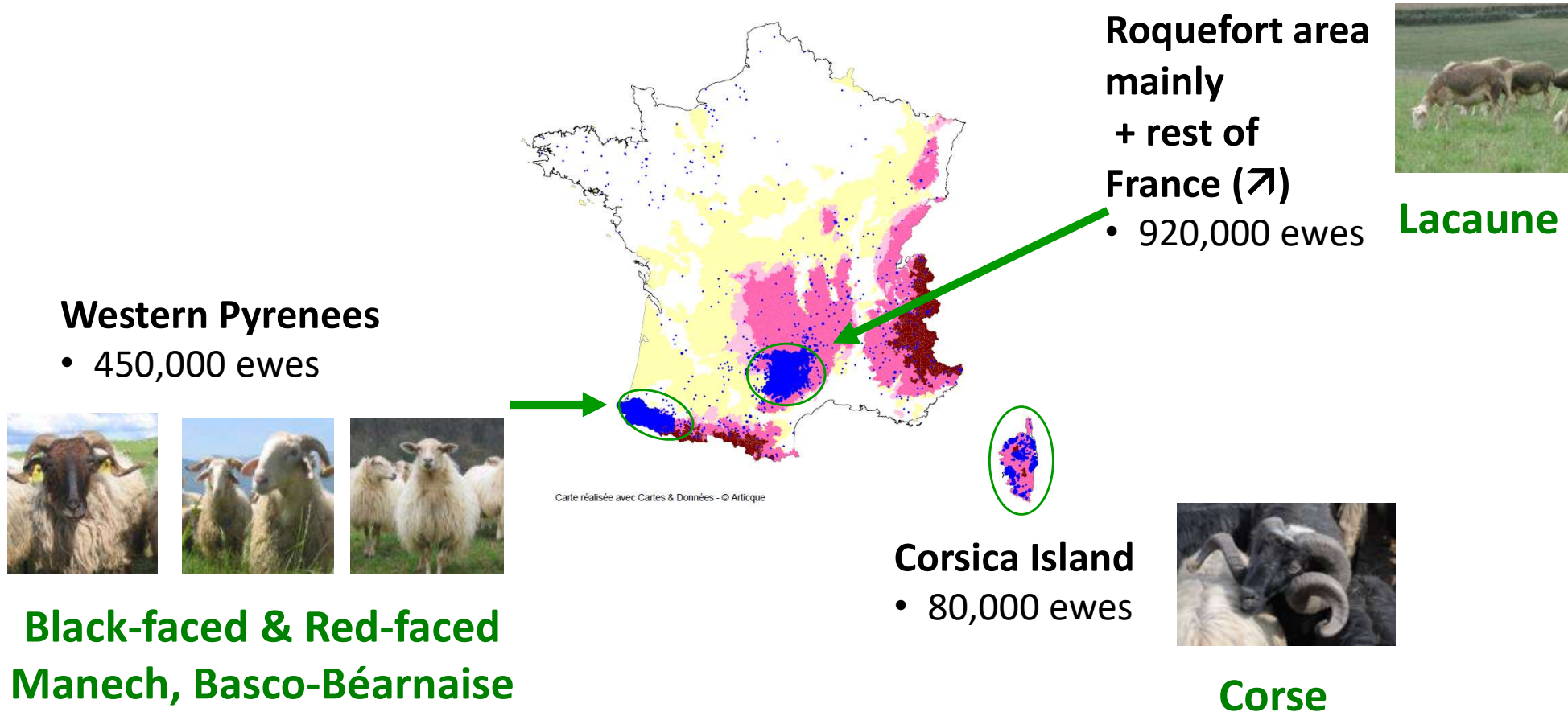
Dairy sheep populations in France
1,450 M dairy sheep in France
(30% of sheep population)

- Local breeds raised in their own areas (mostly harsh & mountainous) & production systems.

Roquefort area mainly
+ rest of France (↗)
- 920,000 ewes

Lacaune

Western Pyrenees
- 450,000 ewes

Black-faced & Red-faced Manech, Basco-Béarnaise

Corsica Island
- 80,000 ewes

Corse

Carte réalisée avec Cartes & Données - © Articque

The selection programs in French dairy sheep breeds: main features and current situation

- ***Pyramidal organization*** within each breed for benefit to the whole population (organize both creation and diffusion).

	Lacaune	Basco-Béarn.	BF Manech	RF Manech	Corsica
# flocks in selection program	205 k	29 k	9 k	79 k	16 k

- ***Major role of AI***

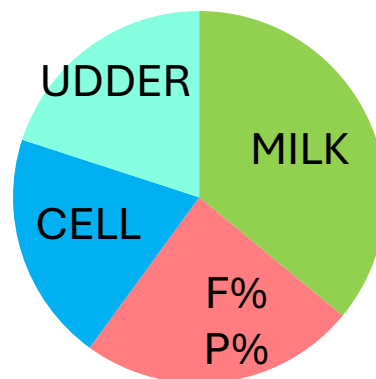|	Lacaune	Basco-Béarn.	BF Manech	RF Manech	Corsica
% AI in selection flocks	84%	47%	43%	47%	46%
# new AI rams each year	320	70	25	160	20
# total AI rams in AI centre	1100	180	75	420	45
# young rams genotyped	3700	300	85	800	350

Balanced breeding goals

- The selection objectives are more and more balanced

=> Selection criteria include a growing variety of abilities / traits.
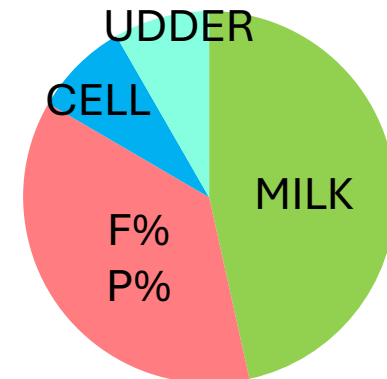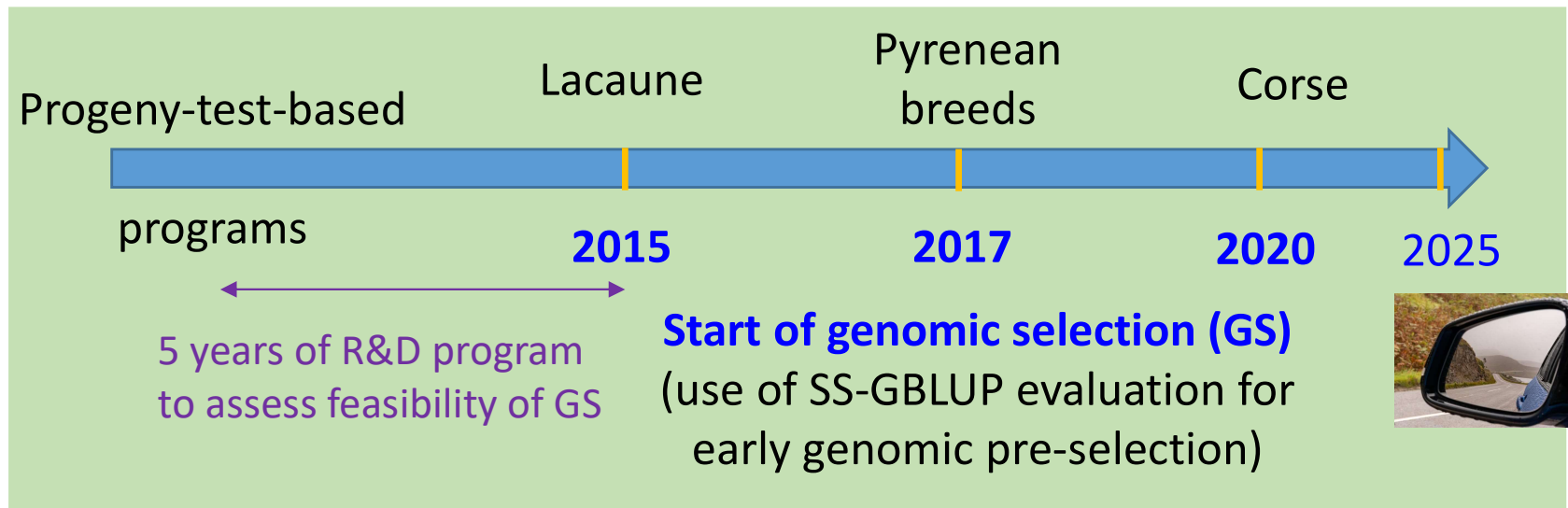
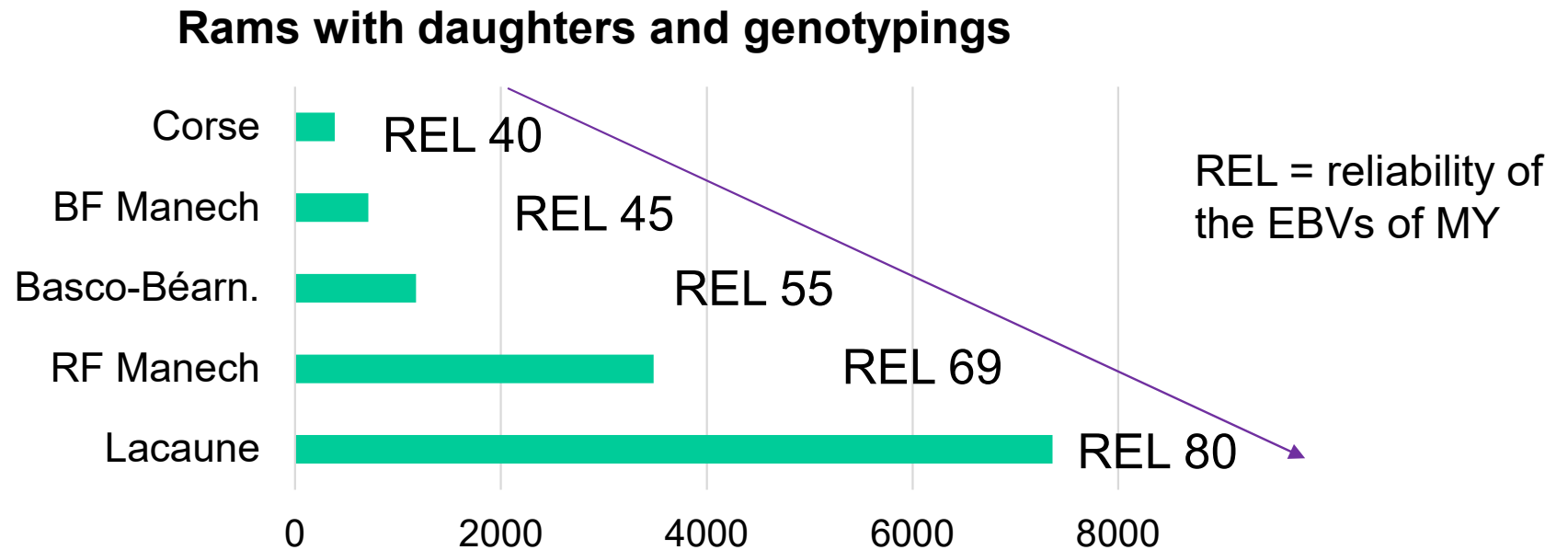- Weights adapted to each breed

Lacaune
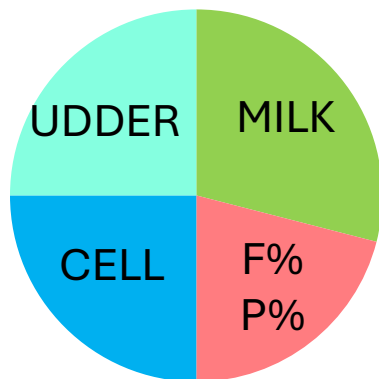
Red-faced Manech

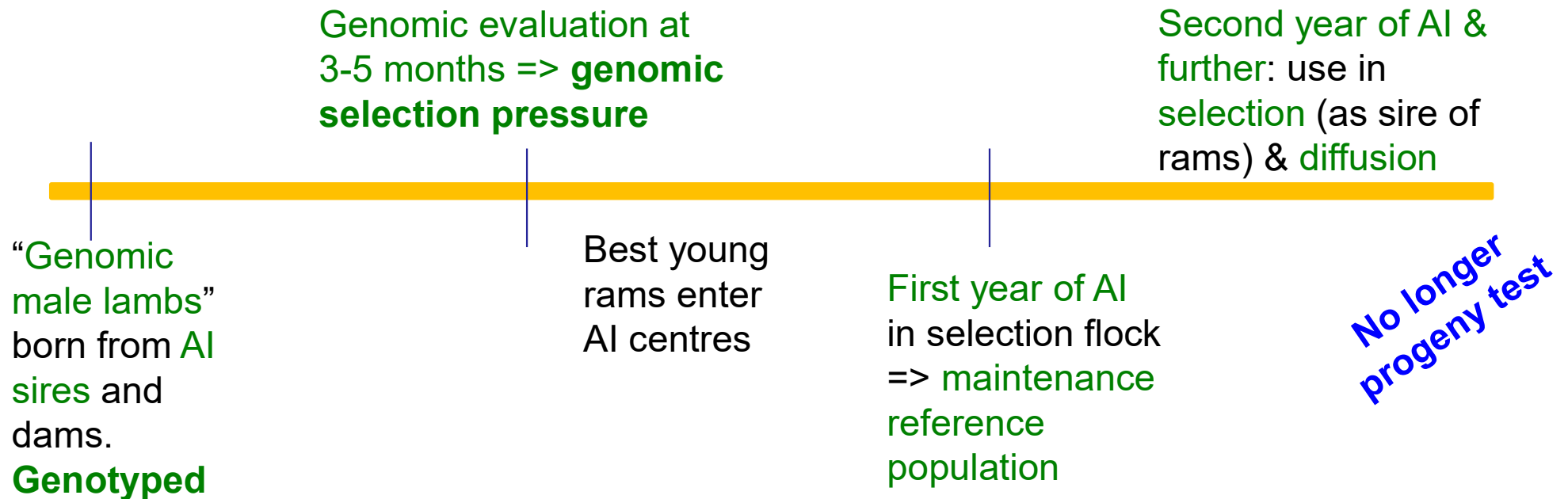Corse

Timeline of genomic selection in French dairy sheep

Progeny-test-based programs

Lacaune

Pyrenean breeds

Corse

2015 **2017** **2020** 2025

5 years of R&D program to assess feasibility of GS

Start of genomic selection (GS)
(use of SS-GBLUP evaluation for early genomic pre-selection)

Size of the reference populations / consequences on reliability

Rams with daughters and genotypings

Corse — REL 40
BF Manech — REL 45
Basco-Béarn. — REL 55
RF Manech — REL 69
Lacaune — REL 80

0 2000 4000 6000 8000

REL = reliability of the EBVs of MY

Reliability significantly increases with size of reference population

How does genomic programs work?

Genomic evaluation at 3-5 months => **genomic selection pressure**

Second year of AI & further: use in selection (as sire of rams) & diffusion

"Genomic male lambs" born from AI sires and dams. **Genotyped**

Best young rams enter AI centres

First year of AI in selection flock => maintenance reference population

No longer progeny test

Actual genomic selection pressure
<< apparent (# rams selected / # candidates)
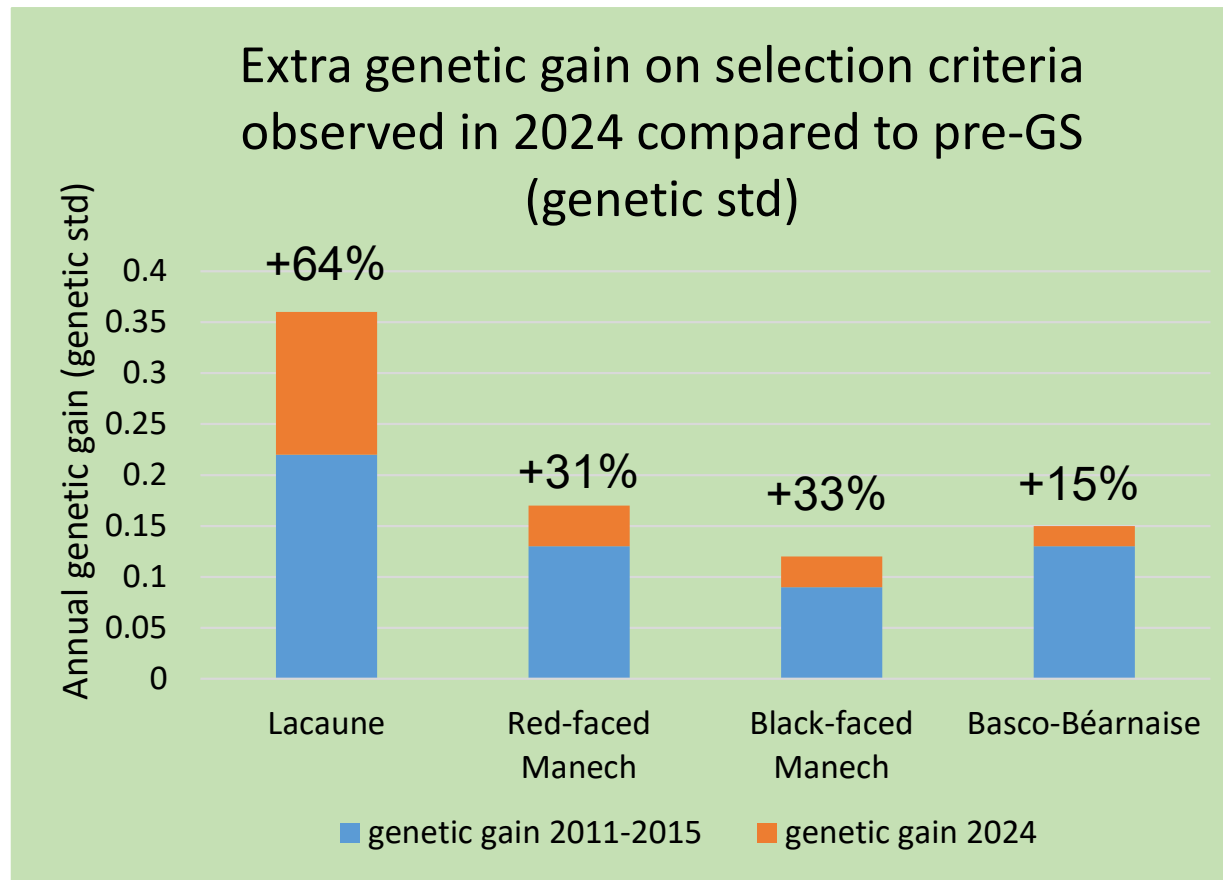Lacaune ~ 20%
BB ~ 58%
BFM ~ 48%
RFM ~ 53%
Corse ~ 52%

Benefits of genomic selection

- Generating an annual genetic gain for economical index ranging from 0.12 to 0.36 genetic standard deviation

- Increase in genetic gain from 15 to 64%

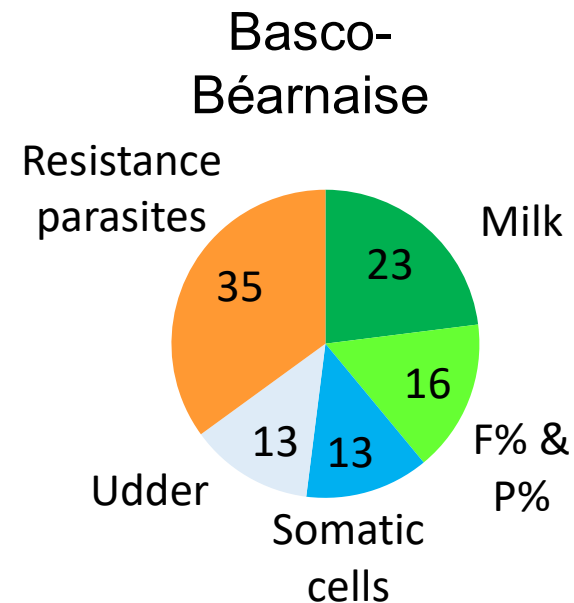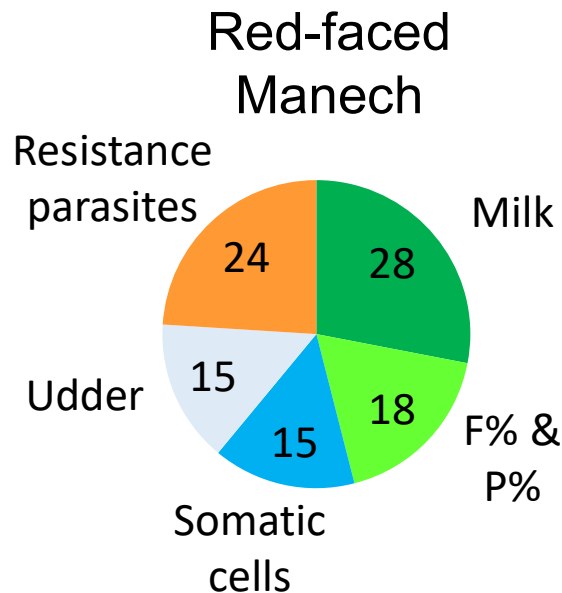Extra genetic gain on selection criteria observed in 2024 compared to pre-GS (genetic std)

How to valorise a most efficient genomic selection?

Extra genetic gains permitted by GS is / will be oriented toward **inclusion of new traits** related to adaptation / resilience / efficiency

Since 2024, resistance to parasites included in the selection objective of Basco-Béarnaise and Red-faced Manech

Red-faced Manech

Resistance parasites 24 · Milk 28 · F% & P% 18 · Somatic cells 15 · Udder 15

Basco-Béarnaise

Resistance parasites 35 · Milk 23 · F% & P% 16 · Somatic cells 13 · Udder 13

- Other actual selected criteria: horn, functional morphology (including feet and legs), PrP, semen production
- On-going criteria: longevity
- R&D criteria: feed efficiency, GHG emissions, fine milk components (caseins)

# Multi-purpose valorisation of genotypings

Besides GS:

- **Parentage verification** followed by parentage discovery applied on males chosen for genomic selection (before genomic pre-selection)
  - ✓ 4-5% of wrong sires => ~90% of sire discovery

- **Sire discovery** on ewes in flocks that does not do AI (including organic farms where synchronisation by hormone is forbidden)
  - ✓ 3,500 ewes in 2023 => ~95% of sire assignation

- **Major genes**
  - ✓ PRP – scrapie resistance
  - ✓ SOCS2 - susceptibility to somatic cells
  - ✓ Horn - management of horn in Red-Faced Manech (& Corse breed)
  - ✓ New genes in the next years - lethal mutations, cryptorchidism

- **Better management of inbreeding**
  - ✓ Not yet in routine in France

Genotypings of females: complement the reference population

Case of Corsica breed

- Corsica breed: few rams in the reference population – 385 rams, +20 each year

- Decision to switch toward a balanced selection objective => Phenotyping of milk quality / cells / udder started in 2017

- Very low reference population on new traits

➢ Genotypings of dams of rams allow an increase in precision of EBVs

Evolution of reliabilities with dams of rams's genotypings

■ extra REL with female genotypings
■ REL without female genotypings
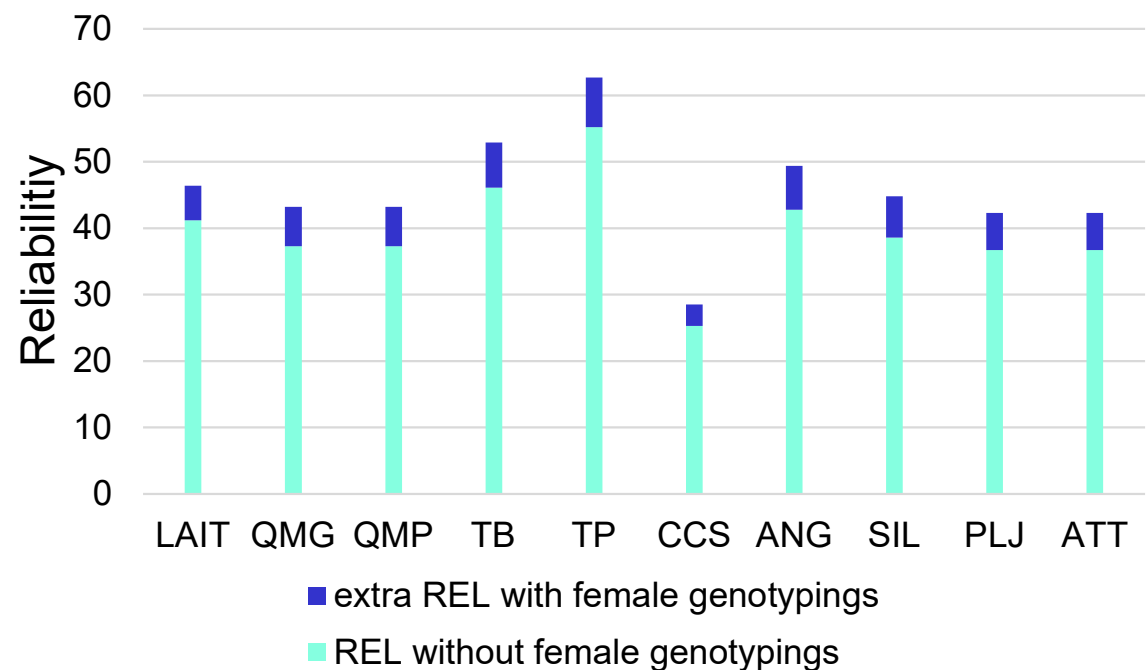
~2,100 dams of rams genotyped
Reliability : gain of 5-7 points

Toward a genomic selection at a multi-country level

**Collaboration Basque Country
Spain / France**

MTN = Manech Tête Noire

LCN = Latxa Cara Negra

MTR = Manech Tête Rousse

LCR = Latxa Cara Rubia
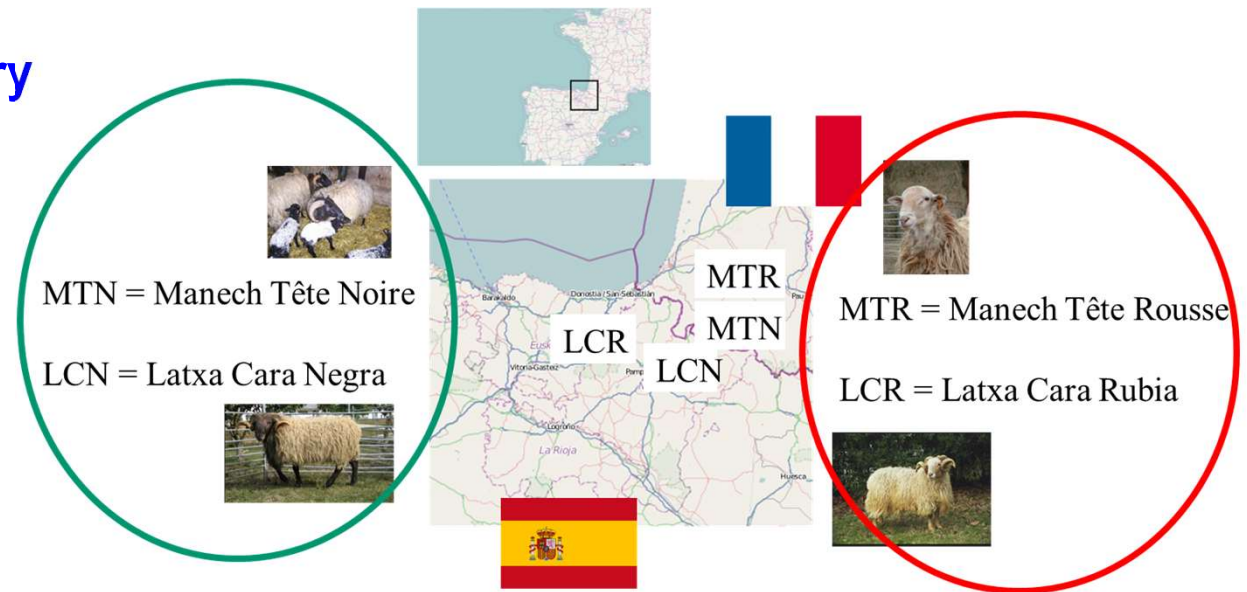
A series of projects since 2010 : Genomia, ARDI, SMARTER, ARDI2

- Creation of ARTALDEAN ~ across country breed society
- **Across-country genomic evaluation**
- Genotypings merged/processed in **GenoEx in Interbull**

Sheep GenoEx (ARDI2 specifically financed the project in Interbull for its needs)
might be expanded to other situations in small ruminants.

Take home messages

✓ **Genomic selection started in France in 2015** in Lacaune and spread quickly to the other breeds.

✓ After 10 years, an **extra genetic gain is observed** in mostly all breeds. Highly fostered by organised and collective breeding programs.

✓ **Genomic selection cost-effective**: higher genetic gain, decreasing cost of genotypings compared to 10 years ago, existing market for "genomic" rams destined to natural mating, multi-purpose valorisation of genotypings.

✓ Higher efficiency used to include **new traits in the selection program** (e.g. resistance to parasites, functional morphology)

Pending questions and perspectives

✓ Use of genomic selection at an **across-country level**: increase reference population, compensate smaller populations in selection than in cattle, increase accuracy and selection intensity

✓ **Local** breeds vs "**international**" breeds

✓ Various issues: **technical, legal** (sharing of data)

✓ **Existing initiatives** to promote and facilitate networking and "actions" across countries

✓ ICAR sheep, goat, camelid WG proposed an **EU Reference Centre in small ruminants** (with outcomes beyond EU) to produce harmonisation, services and incentives in the field of performance testing and genetic evaluation in sheep and goats, **with focus on genomics**

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