

New breeding goals and role of genomics on adaptation and resilience traits: the case study of French dairy sheep



Jean-Michel ASTRUC,

Diane BUISSON, Hélène LARROQUE, Gilles LAGRIFFOUL

EAAP Annual Meeting 2018 Dubrovnik (Croatia)

**Session 65: Practices and prospects for adapting to a challenging
Mediterranean environment**

30 Aug. 2018

Outline

Dairy sheep in France and overview on breeding programs

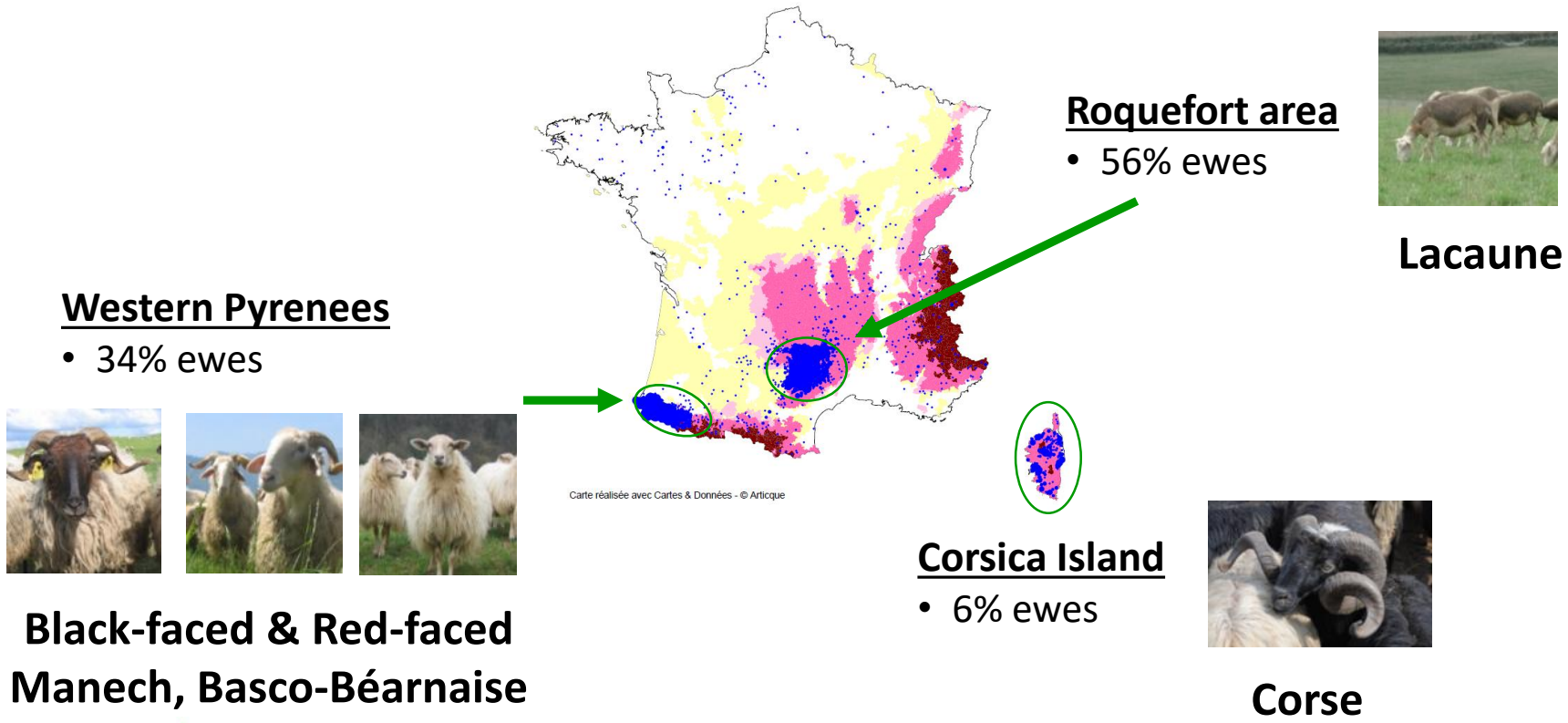
Development of genomic selection in French dairy sheep

Novel traits recently taken into account or under study

In which way the situation is favorable for adaptation and resilience?

1.4 M dairy sheep in France (27% of sheep population)

- Local breeds raised in their own areas (mostly harsh & mountainous) & production systems.
- Production of PDO cheese only with milk from local breed.

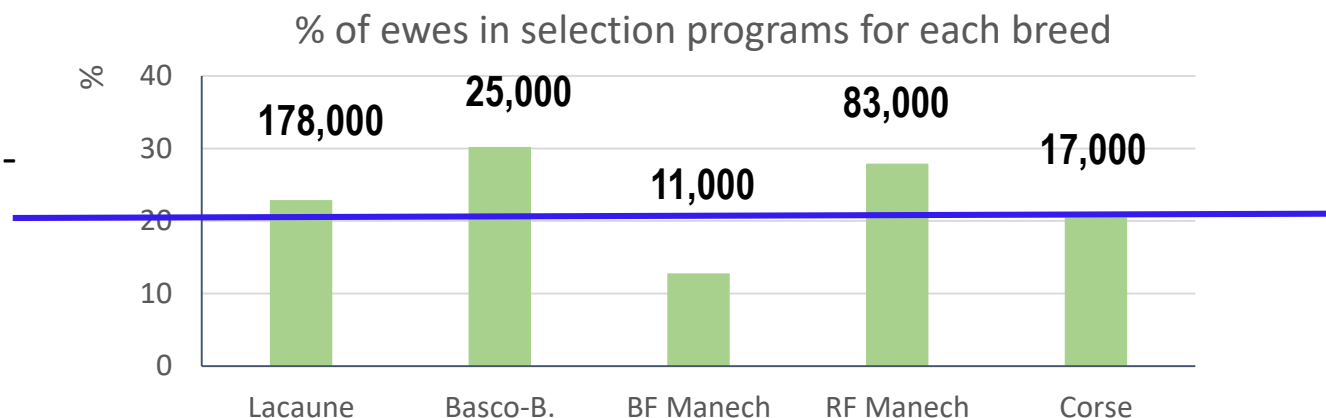


Breeding programs: main features and current situation

○ Based on:

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

20% = technical-economic optimum



% AI in selection flocks	85%	50%	45%	50%	36%
# Progeny-tested rams	445	44	26	146	25
Annual Genetic gain (σ_g)	0.23	0.16	0.11	0.17	0.10

Breeding programs: different ways to valorize the genetic gain

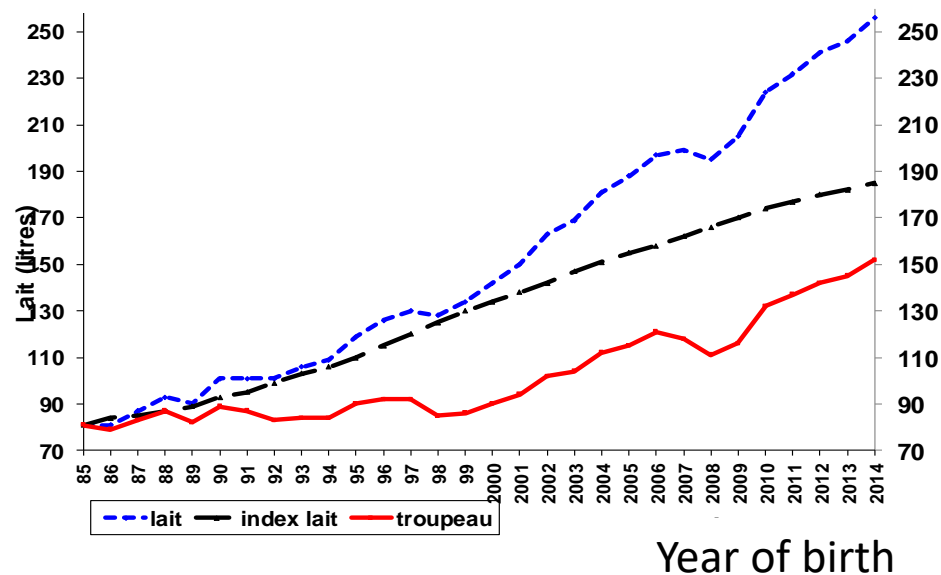
Different ways according to the industry situation in each production areas

RED-FACED MANECH

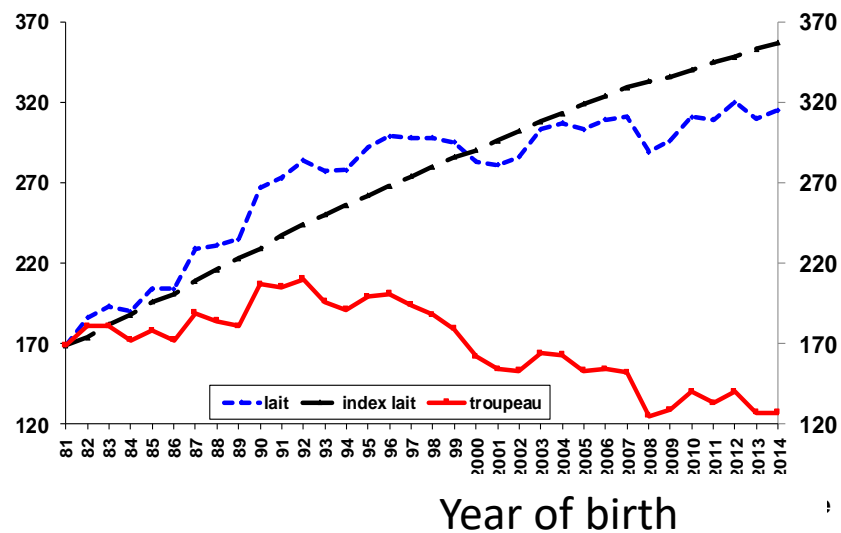
≠

LACAUNE

Milk yield (liters)



Milk yield (liters)



Year of birth

Year of birth

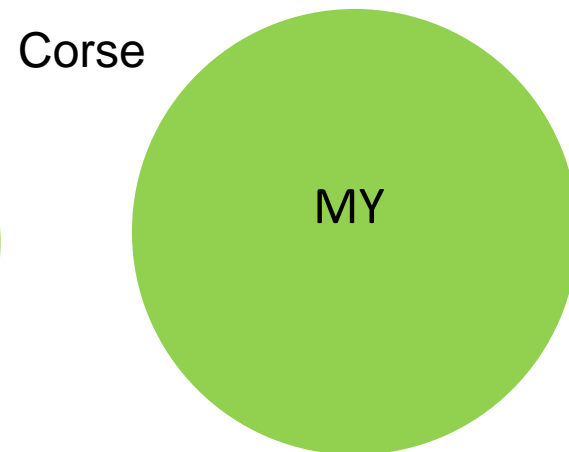
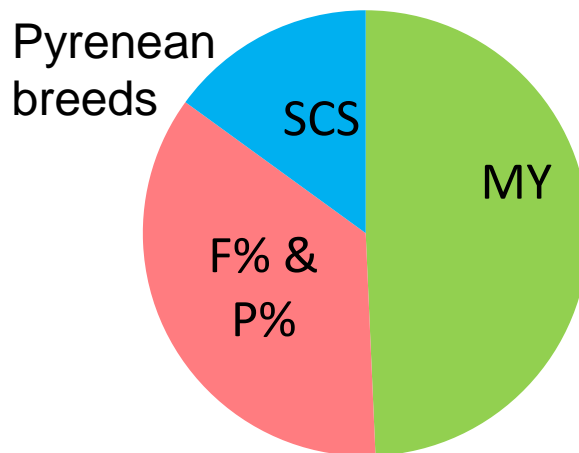
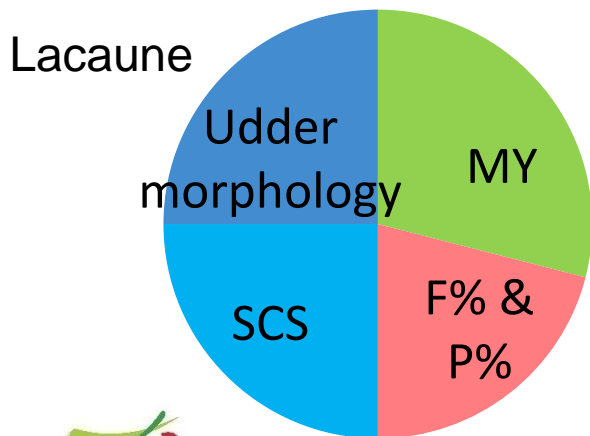
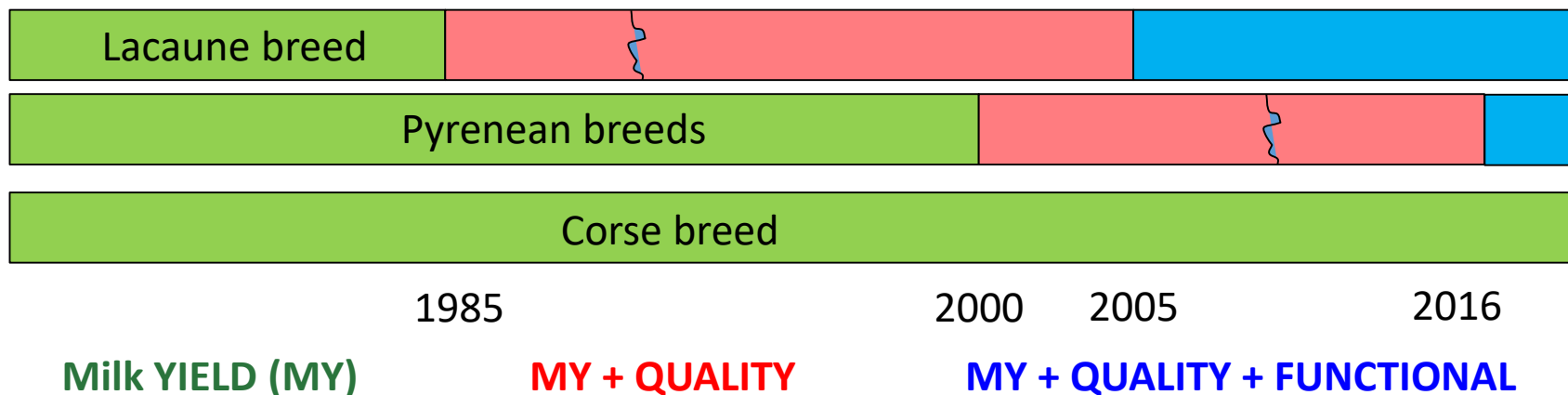


MY

EBVs

Flock x yr effect

Breeding programs in France: breeding goals from start to 2018



The strengths of the classical breeding programs regarding adaptation and resilience traits

- **On-farm selection** => phenotypes expressed within the constraints of the local system & environment
- **Local breeds**
 - Well adapted to local production systems / pedoclimatic conditions
 - Maintain local breeds = **maintain genetic diversity**
- **Maintain genetic variability within breed** (through balanced selection objectives + management of genetic variability + high number of reproducers) => allows adaptation to upcoming changes
- **GxE?** Might be limited as rams used (by AI) in wide range of systems

Genomic selection: new opportunities?

2009: availability of OvineSNP50 BeadChip + start of GS in dairy cattle
=> A raising interest in French dairy sheep

Sheep vs dairy cattle: less favorable situation

- Lesser reference population + less precise phenotypes + lesser LD
 - Lesser accuracy
- cost of genotypes / gross margin higher
 - Lesser selection intensity
- rams progeny-tested at 3 yr-old
 - Fewer gain on generation interval

=> Lesser expected increase of genetic gain

2009-2016 in France: **7 years of R&D programs**
to **assess genomic selection** in dairy sheep

GENOVICAP
GOLD
GENOMIA
GENOPYR
SHEEPSNPQTL
COSEGOV
DEGERAM
ROQUEFORT'IN

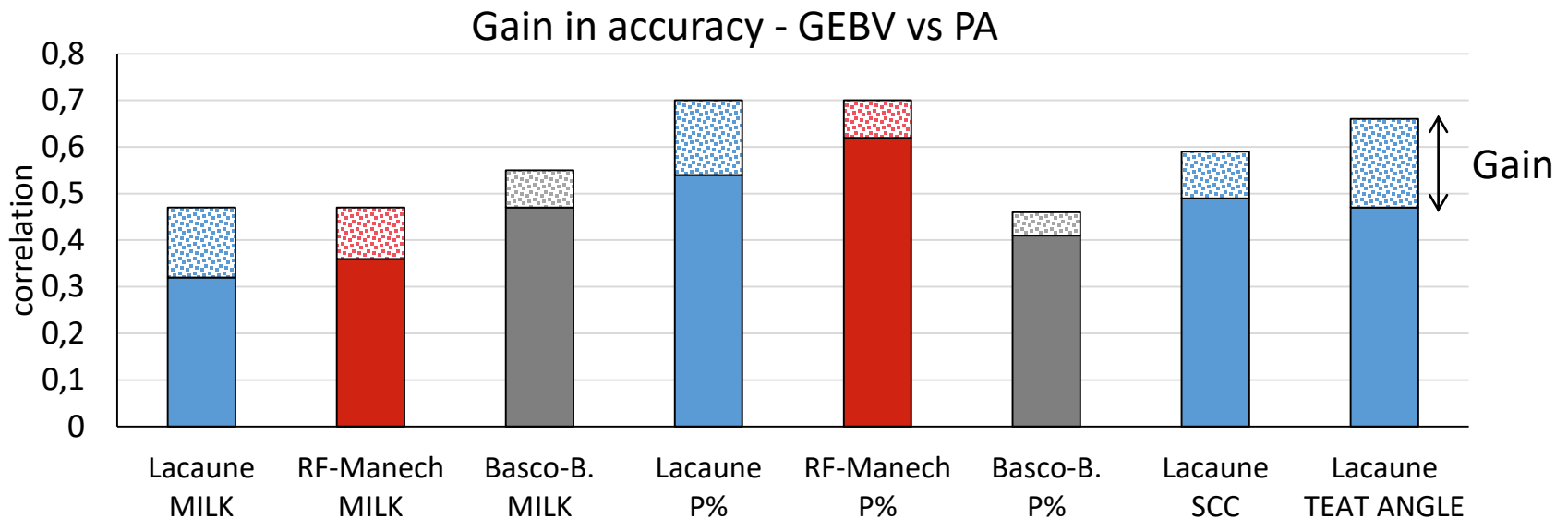
Genomic selection: reference populations

Situation in 2018	Genotyped rams	With daughters	Reference population depth	1 ^{er} complete year of birth
Lacaune	13212	5368	1996-2017	2003
RF Manech	3007	2238	1998-2017	2000
Basco-Béarnaise	945	667	1999-2017	1999
BF Manech	643	510	1996-2017	1996
Corse	746	243	2001-2017	2005



Genomic selection: genomic evaluation

Single-Step GBLUP



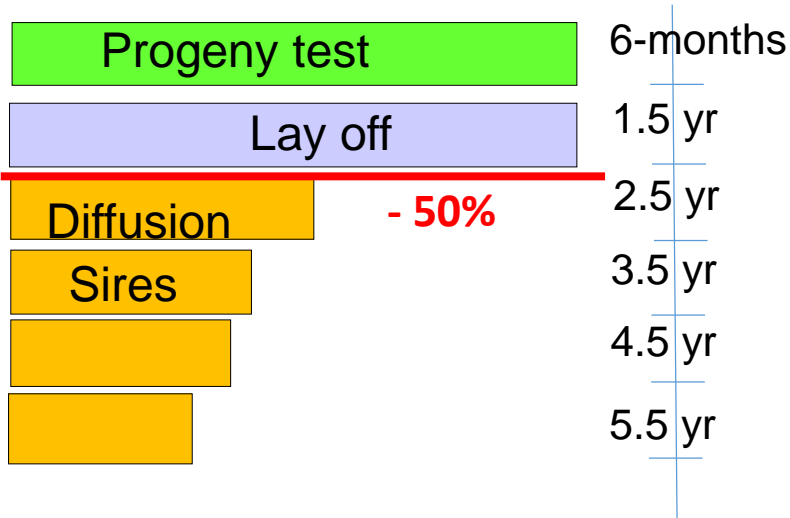
Sources:

Baloche et al, 2014 ;

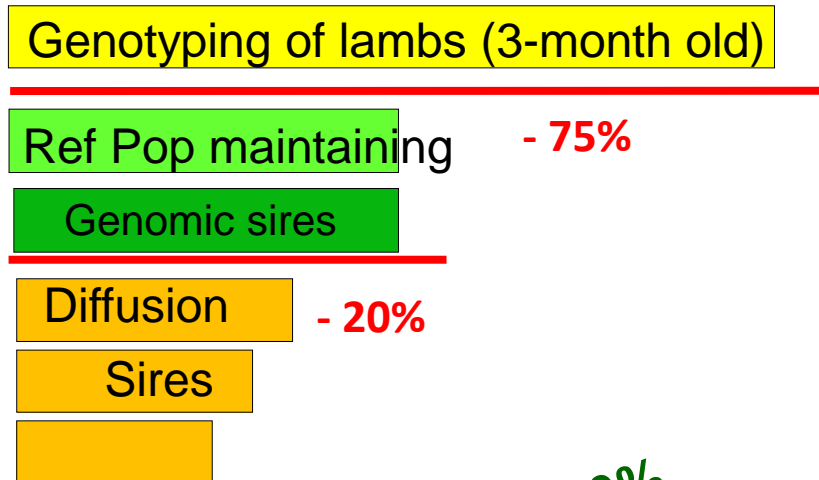
Astruc et al, 2016

Genomic selection: genomic breeding programs

Selection on PA + PrP genotypes of lambs before progeny-test



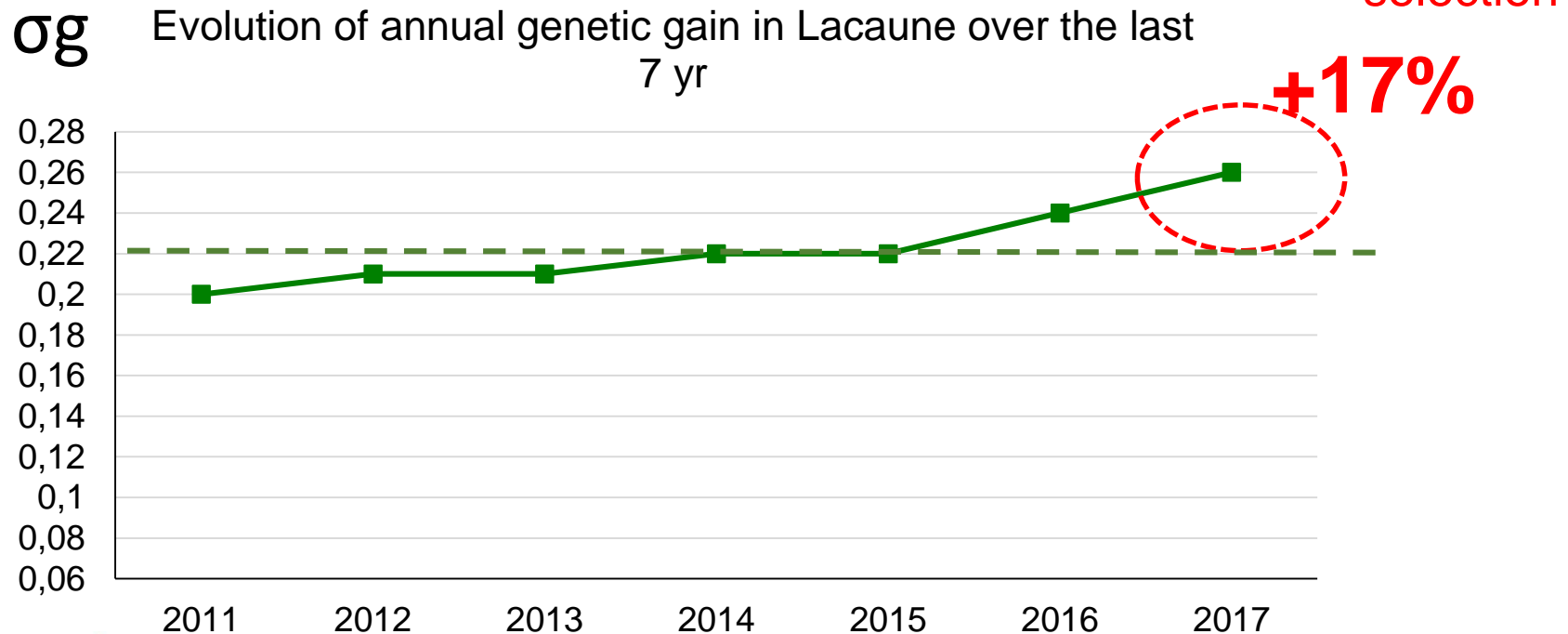
Selection on PA + PrP genotypes of lambs before genotyping



Expected ΔG : + 10-20%
 (if pre-GS 1/3)
 Low extra cost for breeding organizations

Genomic selection: first results observed in Lacaune breed

Shift to GS in Lacaune breed in 2015
Shift to GS in Pyrenean breeds in 2017
Shift to pseudo-GS in Corse breed in 2016



Genomic selection: how to benefit from the extra genetic gain

- Apply a higher selection pressure on current selected traits
- **Select for new traits => more balanced selection objectives (eg. adaptation & resilience)**
 - challenge = phenotype new traits
 - ⇒ WARNING: extra cost for the program
 - ⇒ Best if covered by the entire value chain of the industry
- ❖ Better manage genetic variability with genomic tools

New traits under study or already accounted for

Main goal	Traits	Situation
Rusticity/robustness/ health/resilience	Functional longevity	R&D programs
	Milk persistency	Experimental EBVs
	Resistance to internal parasites	EBVs available \geq 2015 in Pyr. breeds
	Udder health	SCC in breeding goals R&D on genetic x milking routine x machine x drying-off treatment
Milk quality/cheese-making traits	Fine milk composition	Mid InfraRed Spectrometry
Reproduction/Rams (efficiency of GS)	Semen production	EBVs available \geq 2013 in all breeds
	Functional morphology of rams	EBVs available \geq 2017 in Lacaune
	Form of the horns	EBVs available \geq 2016 in Corse

New traits under study: functional longevity

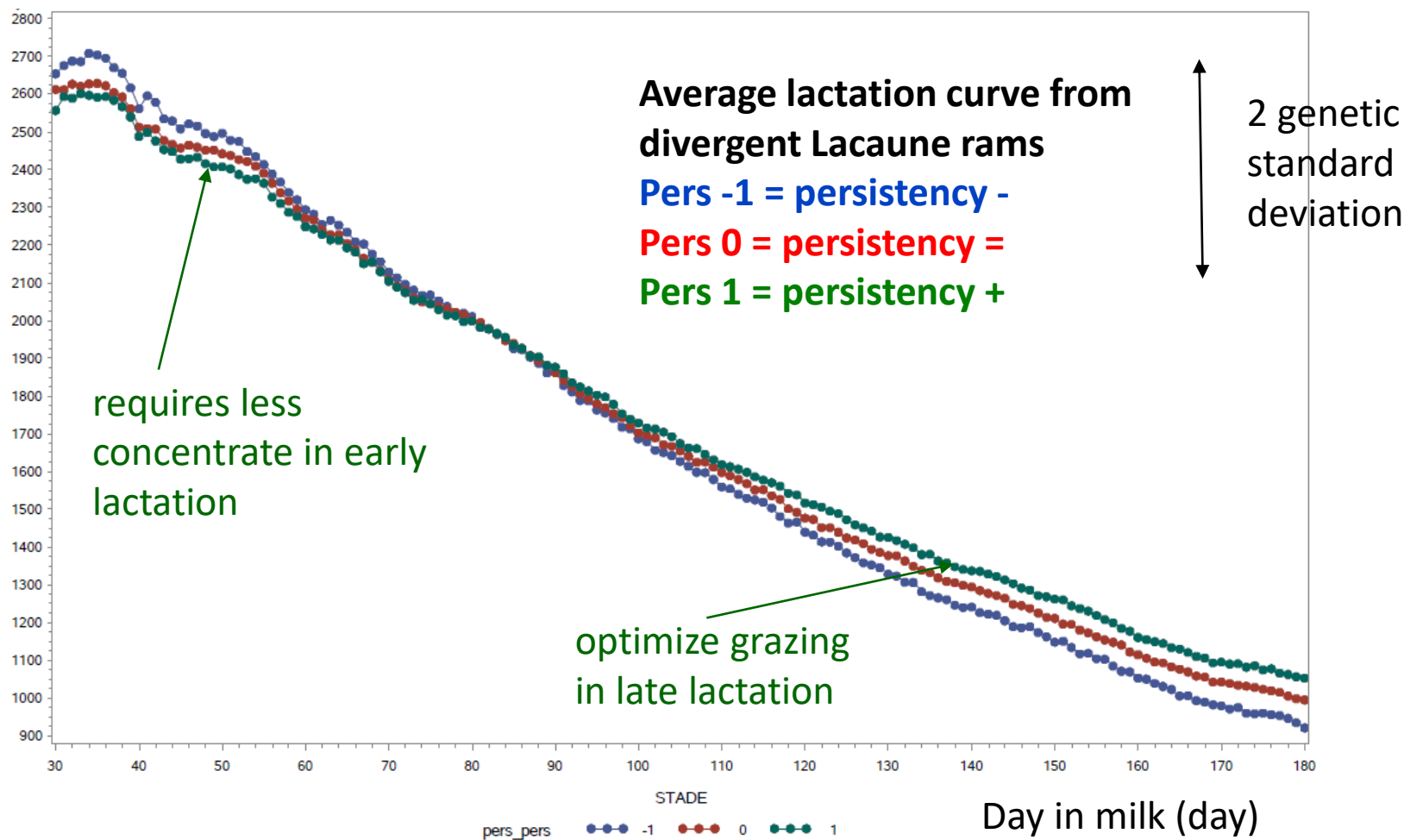
- ❖ **Ability to delay culling for reasons not linked to the level of production**
 - ✓ Synthetic trait
 - ✓ But
 - Quite low heritability (survival analysis => $h^2 \sim 10\%$)
 - Rams are known lately (GS maybe useful)

- ❖ **How to benefit from a higher genetic level on functional longevity**
 - ✓ Lower replacement rate
 - ✓ Higher selection pressure on traits of interest (because decrease of culling for udder, feet and legs, reproduction)

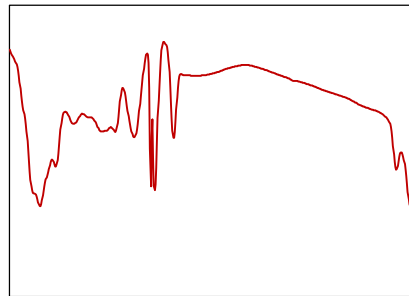
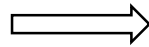
New traits under study: lactation persistence

EBVs on rams: criteria = **coefficient of variation of test-day**

Daily milk (ml)



New traits under study: fine milk composition



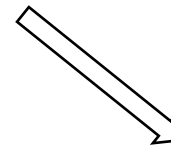
Mid InfraRed spectrometry

Estimation equations



F%

P%



Fine milk composition

Fatty acid & protein

+mineral,

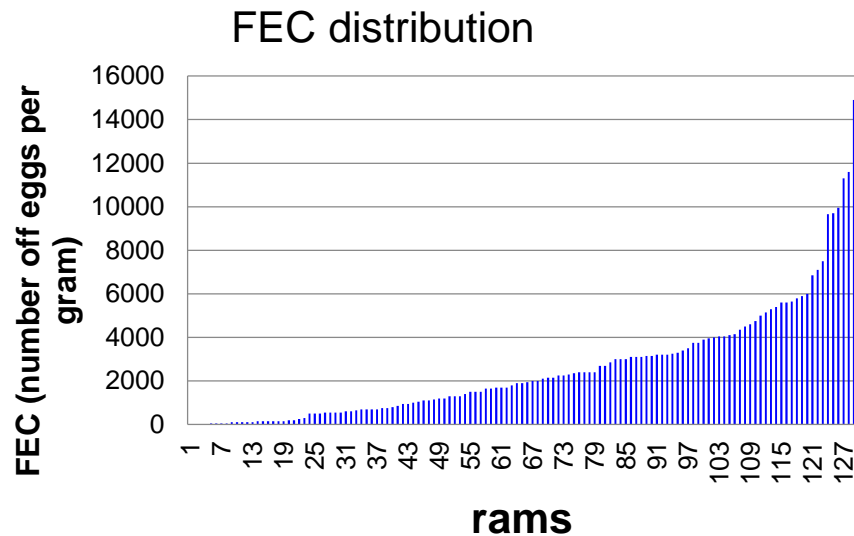
+metabolic disorders,

+body tissue mobilization,

+reproduction status

New traits under study: resistance to parasites

In France : protocol of experimental infections applied to rams



- Important phenotypic variability between rams
- Moderate h^2 (0.20-0.40)

Increase resistance of rams to gastro-intestinal parasites:

- Decrease economic losses
- Increase animals' health & welfare
- Mitigate use of chemical treatment
- Fight resistance to anthelmintic
- Improve quality of soil (increase coprophagous beetle)

Efficiency and resilience in the SMARTER project



Improve
efficiency &
resilience

Focus on efficiency of feed resource used by animals

Feed efficiency, dynamics of body tissue mobilization, impact on the environment (GHG)

Ability of an animal/system to either maintain or revert quickly to high production and health status when exposed to a diversity of challenges

Parasitism, footrot, mastitis, lamb survival, neonatal vigour, functional longevity

Benefit from international cooperation

Harmonization of phenotypes

Across-countries genetic and genomic evaluation

Towards across countries breeding organization



THE GLOBAL STANDARD
FOR LIVESTOCK DATA

SMARTER
H2020 2018-2023





Research, Development and
Innovation in sheep

Interreg
POCTEFA



Conclusion

- ✓ **Classical selection** has worked in French dairy sheep ... but it has been a long and not-so-easy-to-reproduce process
 - ✓ **Genomic selection** opens new opportunities to generate more (diversified) genetic gain (but not as much as in dairy cattle). International cooperation should be useful in the future
 - ✓ To face **new challenges** (eg. global warming)
 - Either artificialize production system (eg. housing) 
 - Or **adapt the animals** 
 - **Selection on-farm** => progressive adaptation
 - Select for **new specific traits** such as resistance to diseases, efficiency and resilience
- => Balanced genetic goals for sustainability**

New breeding goals and role of genomics on adaptation and resilience traits: the case study of French dairy sheep



Jean-Michel ASTRUC,

Diane BUISSON, Hélène LARROQUE, Gilles LAGRIFFOUL

EAAP Annual Meeting 2018 Dubrovnik (Croatia)

**Session 65: Practices and prospects for adapting to a challenging
Mediterranean environment**

30 Aug. 2018