Genetic management of cryptorchidism and horn mutations in Manech tête Rousse dairy sheep breed

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PRÉSAGE Préparer la création d'un observatoire des anomalies génétiques en petits ruminants
UMT STAR Sélection génétique pour la Transition Agroécologique des petits Ruminants
SCA C.D.E.O.
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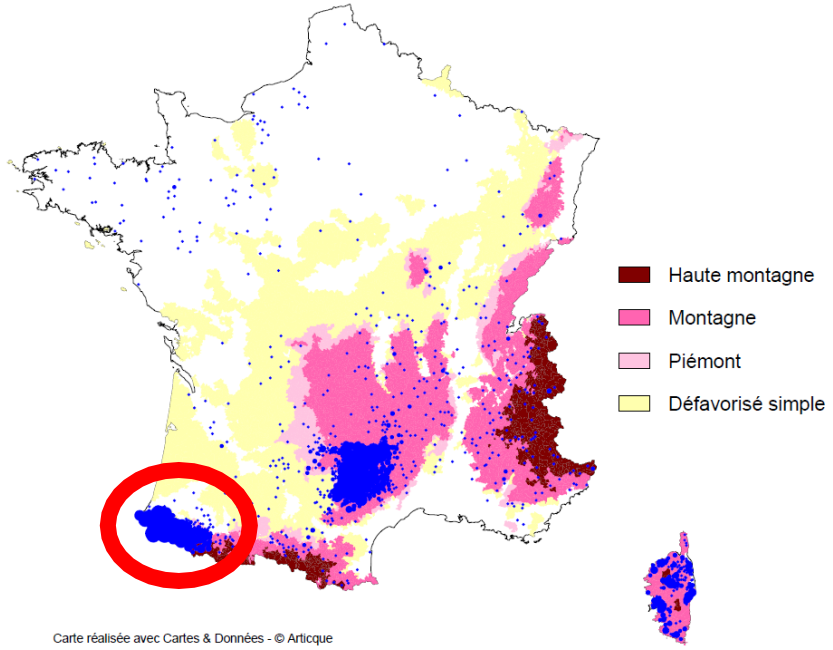
La responsabilité du ministère en charge de l'agriculture ne saurait être engagée

Manech tête rouge breed



<u>Western Pyrenees</u>

- 34% of dairy ewes

Production of PDO cheese

Counter selection of horns

polled Horned

Breeders want hornless animals:

Mass selection on phenotype since the 90's:

- **Horned females are not selected as elite Dams**
- **Elimination of 30% of candidates in 2022**

Source : Ben Braiek *et al.*

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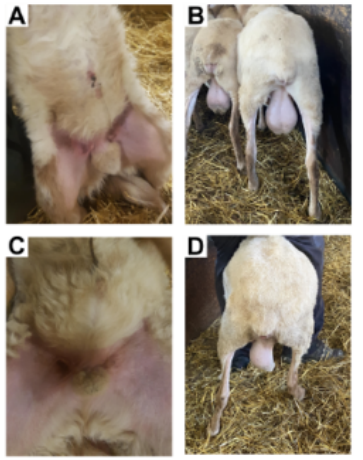


normal

cryptorchid

→Appearance of cryptorchid lambs

Lambs are unfertile

Source : Ben Braiek *et al.*

Genetic determinism in MTR breed

Horn/cryptorchidism phenotype according to the genotype at RXFP2 gene

Source : Ben Braiek *et al.*

Combination of SNP and a deletion in the RXFP2 gene

➔

3 haplotypes :

H Horn (Freq≈0.5)

Pn Poll non-crypto (Freq≈0.3)

Pc Poll crypto (Freq≈0.2)

Genotypes and phenotypes

Genotype RXFP2

[HH] females and males are horned

[HPn] females are polled, ½ of males are horned

[HPc]

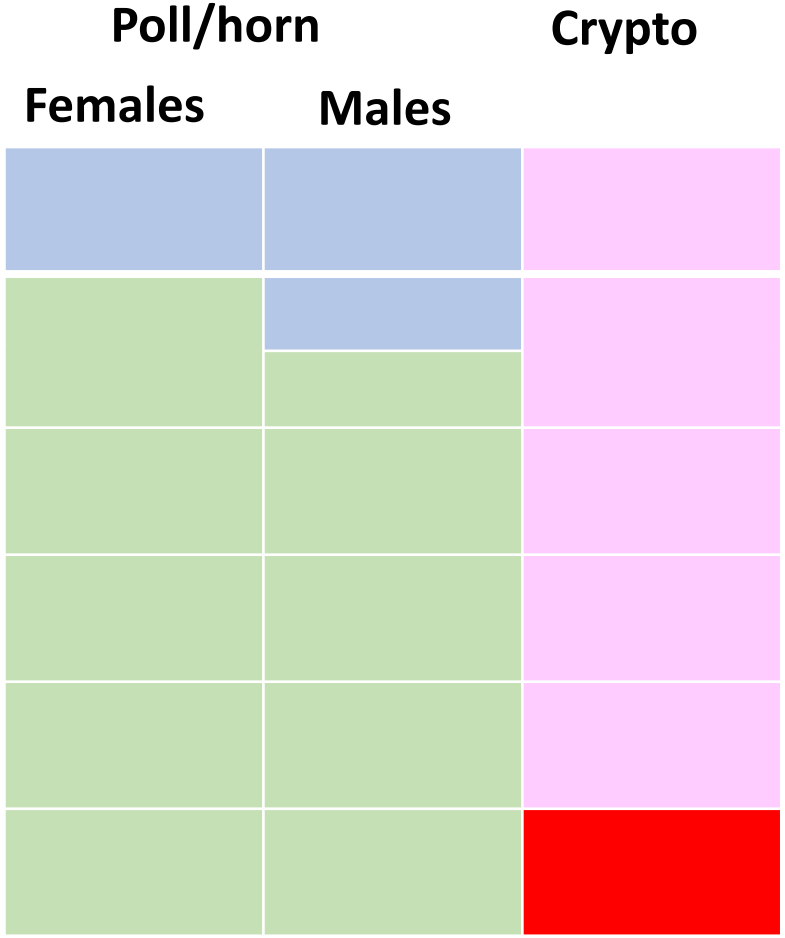
[PnPn]

[PnPc]

} females and males are polled

[PcPc] : females and males are polled, male crypto

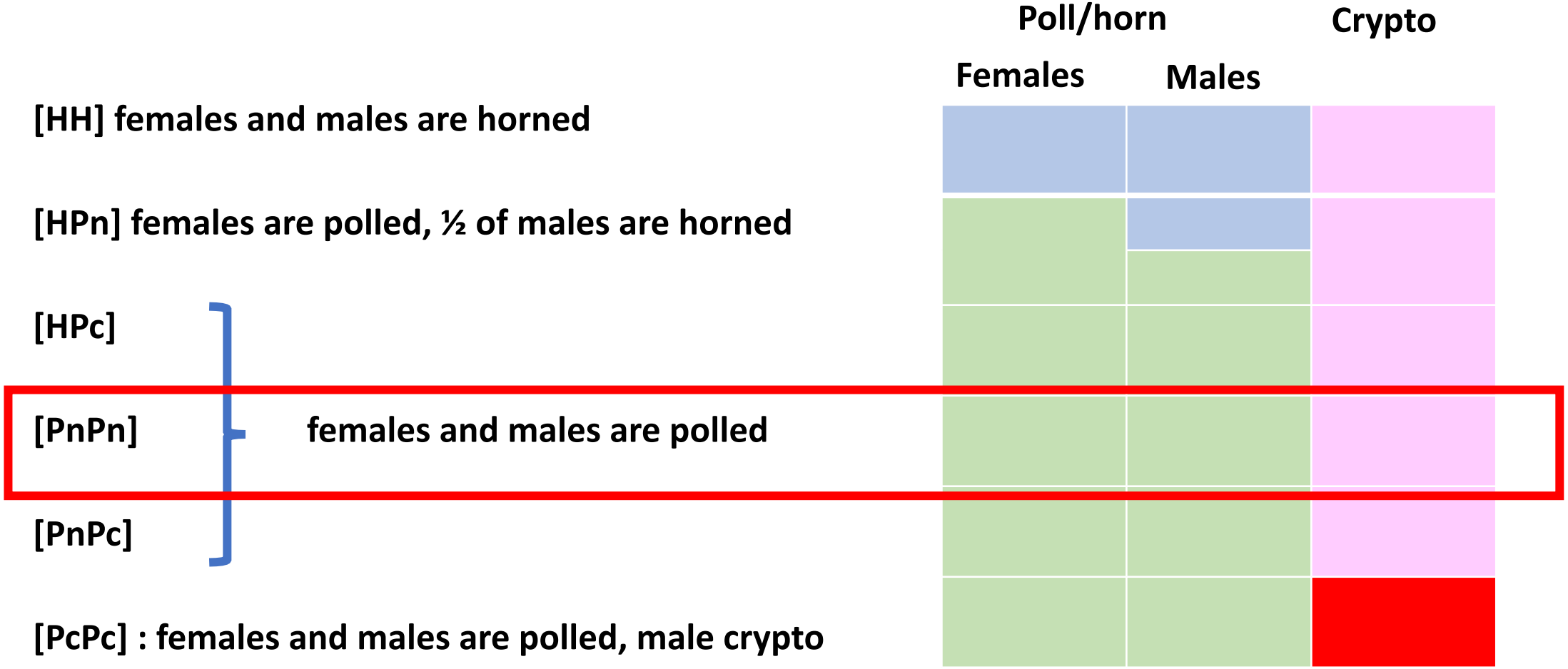
Phenotype



Genotypes and phenotypes

Genotype RXFP2

Phenotype



[HH] females and males are horned

[HPn] females are polled, ½ of males are horned

[HPc]

[PnPn] females and males are polled

[PnPc]

[PcPc] : females and males are polled, male crypto

How to manage this haplotype ?

Idea: reintroduce horned elite dams to avoid breeding cryptorchid lambs?

→ Would prevent the procreation of crypto lambs.

→But would induce an increase in the frequency of the "horned" allele...

→ simulation study to evaluate the effect of different strategies on the genetic gain and the evolution of "horn/crypto" haplotype frequencies

Overview of the model

Full stochastic model (homemade fortran program using real 50K genotypes)

- All animals and their genome are simulated
- No LD between « Horn/Crypto » haploptype and SNP markers

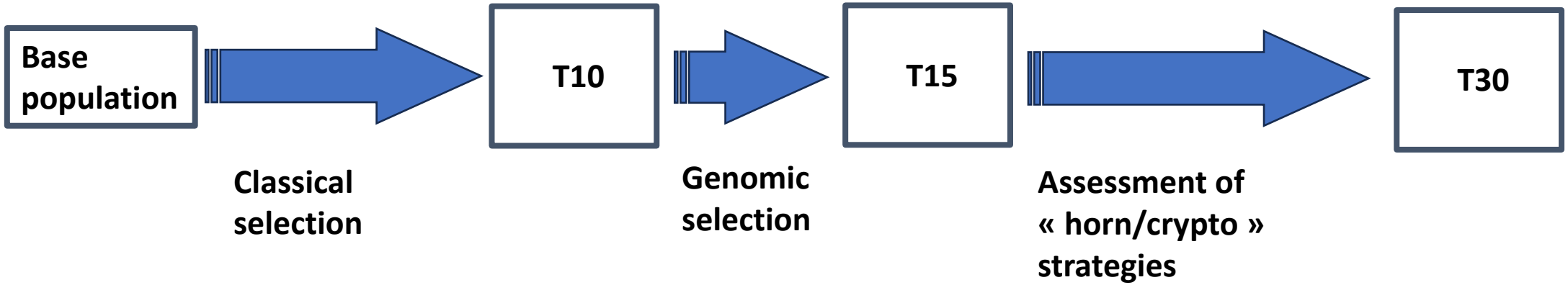
Genetic architecture of the selected trait (h^2=0.3 : rep=0.5)

- Based on 1000 QTLs randomly selected among SNP markers
- QTL Effects drawn from a normal distribution

Population under selection :

- 50 000 ewes / 150 flocks
- 55 young AI males per year (375 genotyped animals) / 175 adult AI males
- Half of adult ewe inseminated per year

Overview of the model



Annual EBVs/GEBVs computation using Blupf90 software

- Pedigree
- From T10 : genotypes of AI sires born since T1
- Annual Phenotypes of ewes (derive from their TBV and additional random effects)

No genotype available for ewes

30 replicates / strategy

Strategy assessed

Selection step	Phenotypic/Genetic criteria
Ewe lambs	
Elite dams	
Elite rams (before genotyping)	
	Haplotype criteria (prority cull)
Elite rams (Based on the genotype)	

Strategy assessed

Selection step	Phenotypic/Genetic criteria	
Ewe lambs	Parental GEBVs	Polled + Parental GEBVs
Elite dams	GEBVs	Polled + GEBVs
Elite rams (before genotyping)		
	Haplotype criteria (prority cull)	
Elite rams (Based on the genotype)		

Strategy assessed

Selection step	Phenotypic / Genetic criteria		
Ewe lambs	Parental GEBVs	Polled + Parental GEBVs	
Elite dams	GEBVs	Polled + GEBVs	
Elite rams (before genotyping)	**Parental GEBVs**	**Polled + Parental GEBVs**	
	Haplotype criteria (prority cull)		
Elite rams (Based on the genotype)	**GEBVs**	**Pc Carriers**	**H Carriers**

Results

No managment

=

Frequencies → starting frequencies

Freq(H) = 0.50

Freq (Pn) = 0.30

Freq (Pc) = 0.20

Results

No managment

=

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Freq(H) = 0.50

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Freq (Pc) = 0.20

Add criteria

=

decrease in genetic gain

-11 to -23%

Results

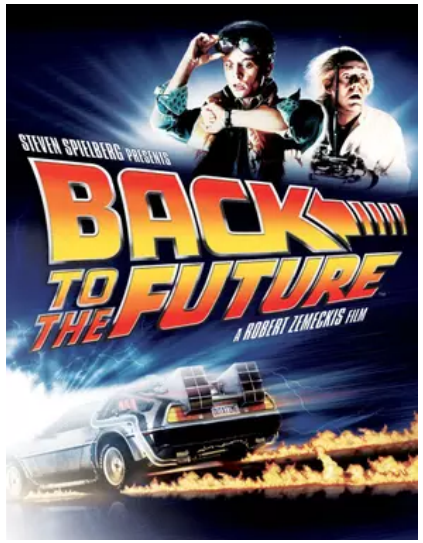
Only Phenotypic/Genetic criteria

Some strategies with a limited decrease in genetic gain but!

Either polled and crypto both increased
Or
Small increase in polled (freq(H) : 0.5 → 0.4)

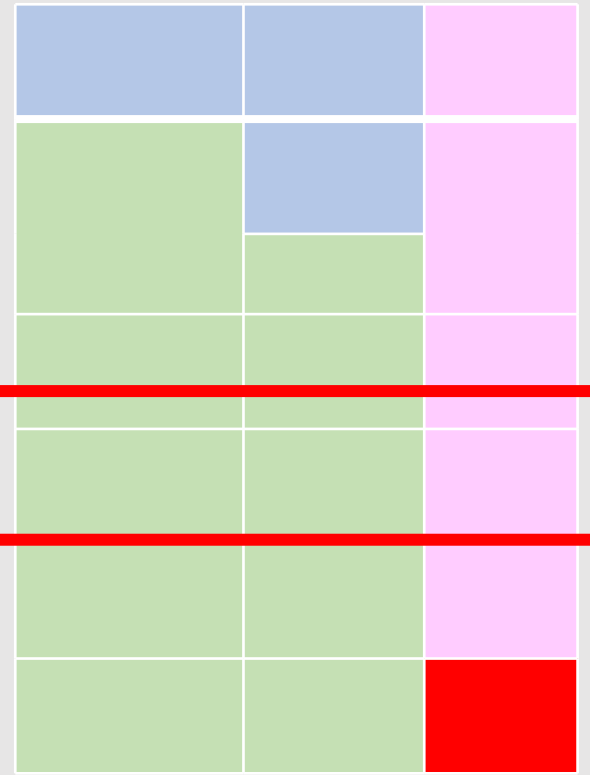
Results

Adding haplotype criteria



All strategies converged towards the similar genotypic frequencies at T30 but trajectories were different

Starting values : 25%	[HH]	1%
30%	[HPn]	18-23%
20%	[HPc]	1%
9%	[PnPn]	70-74%
12%	[PnPc]	5-8%
4%	[PcPc]	<0.1%



Results

Selection step	Phenotypic / Genetic criteria	
Ewe lambs	Parental GEBVs	Polled+ parental GEBVs
Elite dams	GEBVs	Polled + GEBVs
Elite rams (before genotyping)		**Polled + parental GEBVs**

	Haplotype criteria (prority cull)	
Elite rams (Based on the genotype)	Pc Carrier	H Carriers

Cull horned male candidates

=

High decrease in the genetic gain (-18 to -23%)

Polled males with low GEBVs were selected as long as the freq(H) was high

Results

Selection step	Phenotypic/Genetic criteria	
Ewe lambs	Parental GEBVs	Polled+parental GEBVs
Elite dams	GEBVs	**Polled + GEBVs**
	haplotype criteria (prority cull)	
Elite rams (Based on the genotype)	Pc Carrier	H Carriers

Among the last 8 strategies (-11 to -16%)

Selecting only polled females to be elite dams gave the lower decrease in genetic gain : -11 to -13%

Conclusion

- ✓ It is possible to prevent the presence of horn animals and cryptorchid lambs combining both phenotypic and genomic criteria
- ✓ Depending on the strategy, the loss of genetic gain varied from simple to double
- ✓ Combining genomic criteria on elite sires and phenotypic criteria on elite dams seems promising