INSTITUT DE L'ELEVAGE

Session 43

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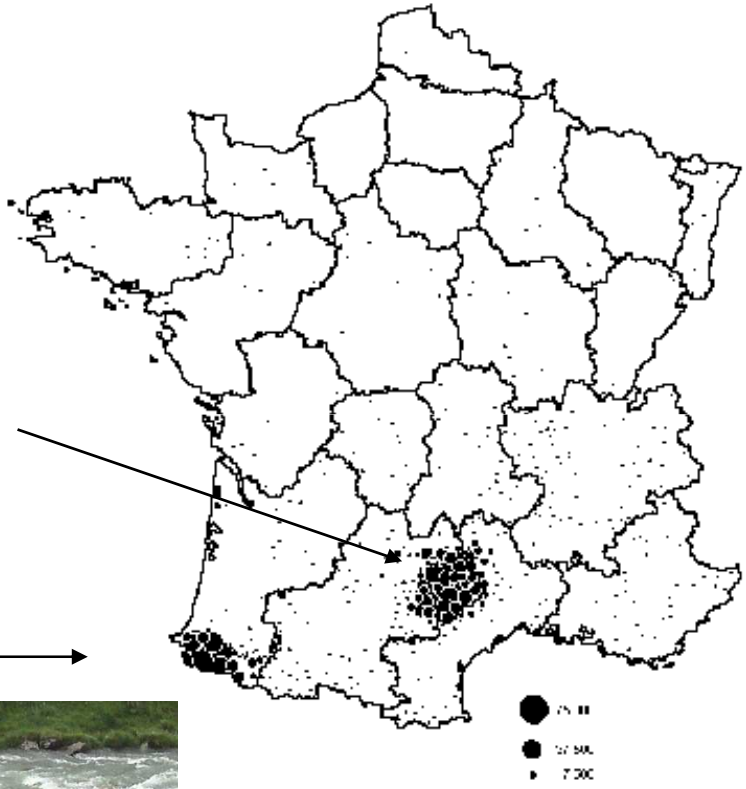
Genetic Improvement of Dairy Sheep in France : Results and Prospects

Jean-Michel Astruc,

Gilles Lagriffoul, Hélène Larroque, Francis Barillet

Sheep dairying in France

Roquefort area
Lacaune breed
870,000 ewes



Western Pyrenean
Manech (red and black faced) and Basco-Béarnais breeds
480,000 ewes

Corsica island
Corsican breed
90,000 ewes

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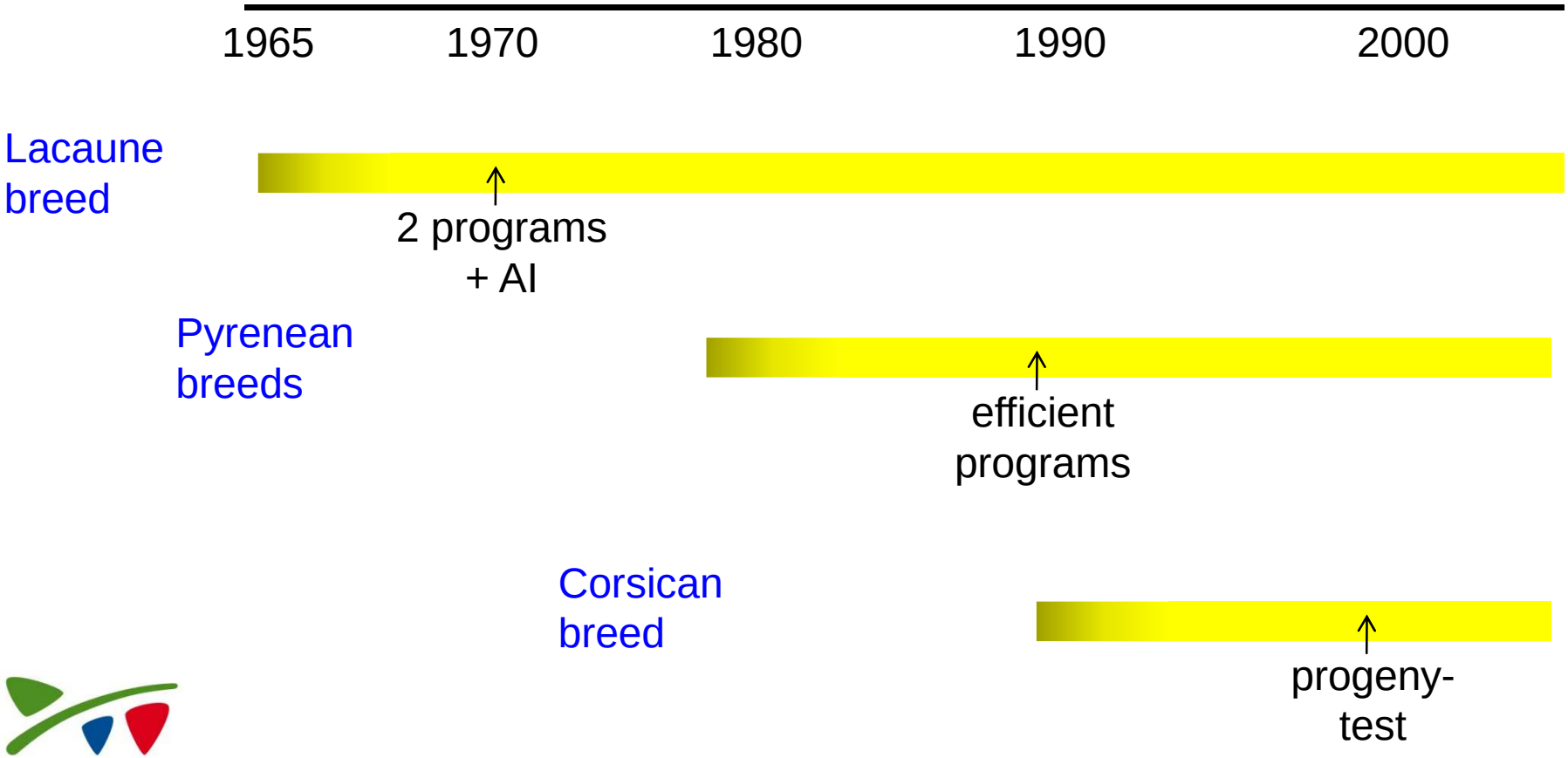
Dairy sheep breeding programs in France : historical elements

➢ **5 breeds – 5 programs**



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Dairy sheep breeding programs in France : tools and importance

- Pyramidal organization of the population

  Selection flocks (**nucleus**) : official AC recording
  (same proportion whatever the breeds – around 20%)

  Production flocks (**commercial**) : non official D method
  or non-recorded flocks

- Extensive use of heat synchronization & AI : 625,000 AI (43% total ewes)

- Progeny-test and assortative matings :

Around 700 AI rams/year - differences between breeds

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Dairy sheep breeding programs in France : tools and importance

	Breed	Lacaune	Red-faced Manech	Black-faced Manech	Basco-Béarnase	Corsican
Nucleus flocks	Size of the nucleus (AC recording)	174,000	71,000	15,000	22,000	21,000
	# AI progeny tested rams	445	130	36	52	31
	% AI in nucleus flocks	85	50	45	50	30
All flocks	Total number of AI with dairy rams	396,000	57,000	8,000	14,000	6,000

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Selection objectives and selection criteria

Genetic parameters : comparison Lacaune (121,283 first lactations) et Red Manech (58,378 first lactations) breeds

	Heritability	Genetic correlation with milk yield
Milk Yield	0,32 / 0,33	
Fat content	0,41 / 0,28	- 0,43 / - 0,39
Protein content	0,51 / 0,51	- 0,48 / - 0,44
LSCS	0,15 / 0,10	0,15 / 0.21

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Selection objectives and selection criteria

Genetic parameters : relation between production traits (MY) and udder traits (cells count & udder morphology) in the Lacaune breed.

	Milk yield	LSCS	Teat angle	Udder cleft	Udder depth
Milk yield	**0,32**	**+0,15**	**+0,05**	**-0,00**	**-0,37**
LSCS		**0,15**	**+0,12**	**-0,21**	**-0,32**
Teat angle			**0,35**	**-0,34**	**-0,31**
Udder cleft				**0,32**	**+0,19**
Udder depth					**0,26**

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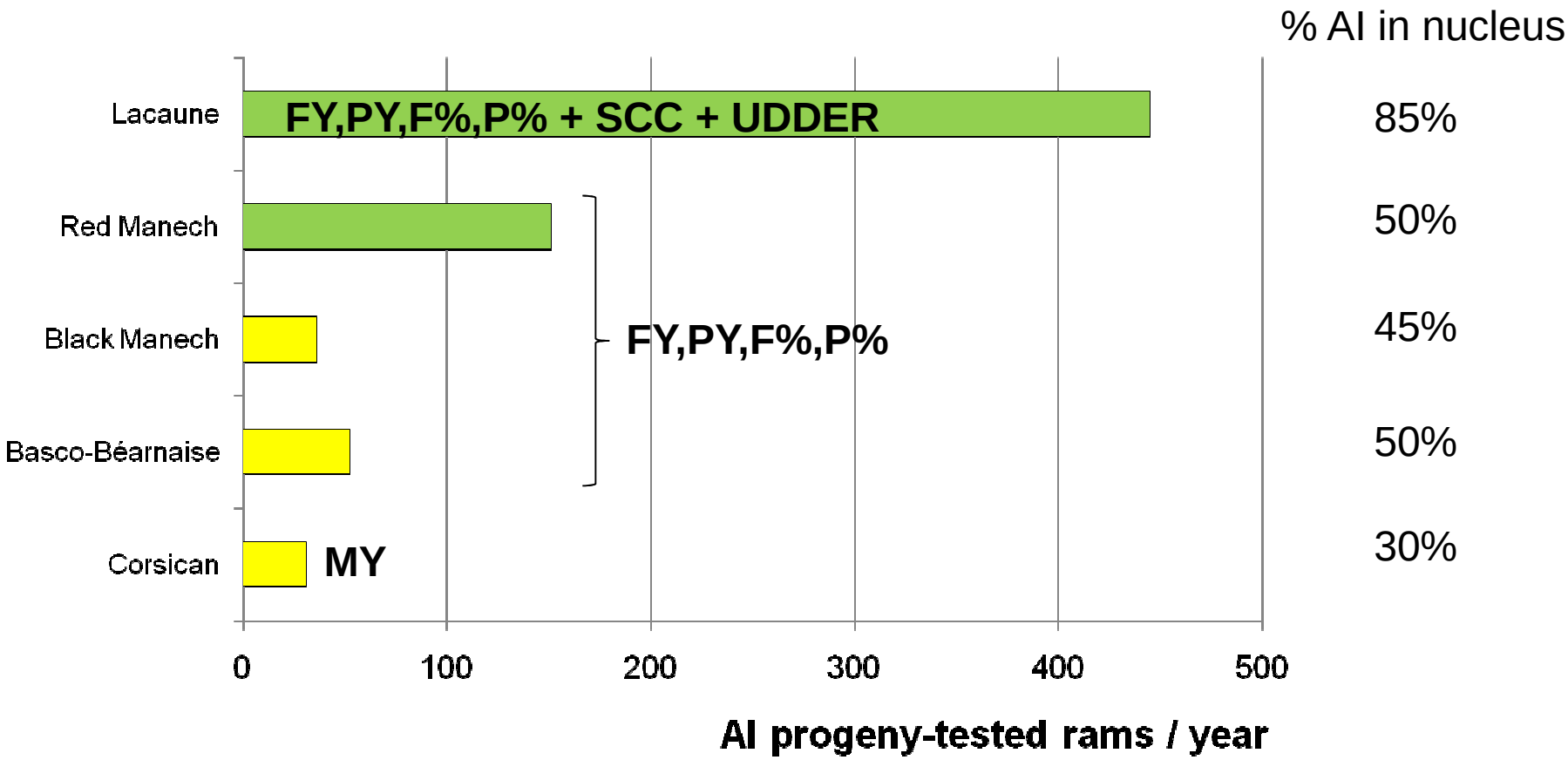
Selection objectives and selection criteria



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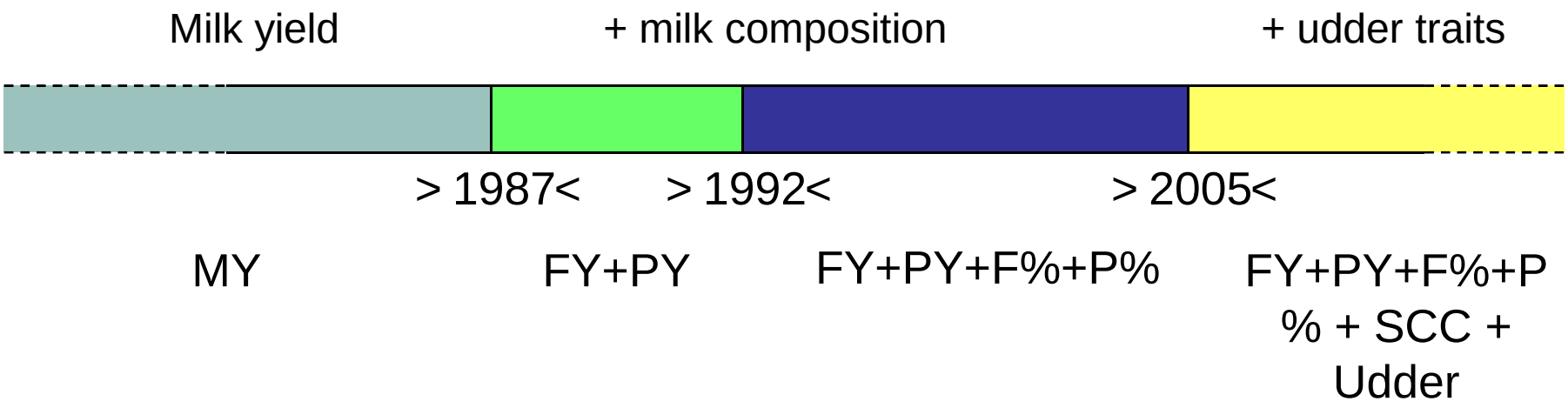
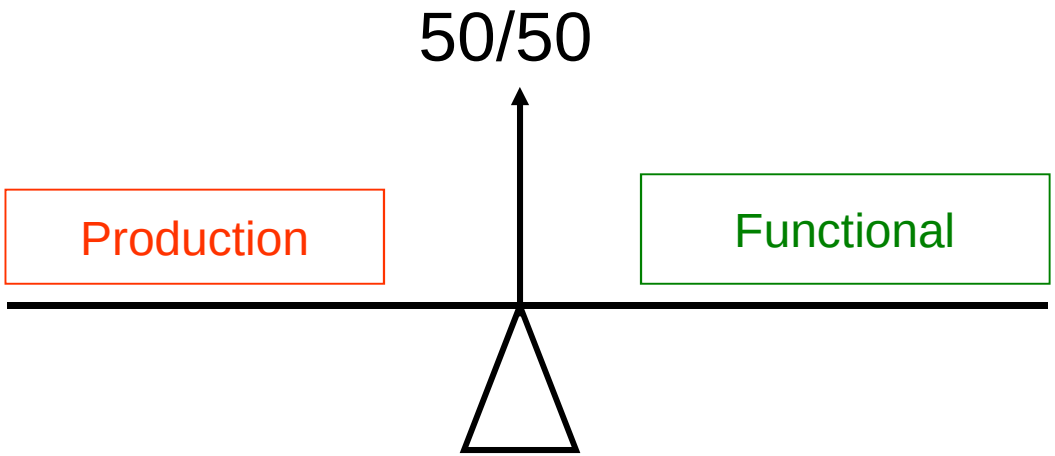
Selection objectives in the Lacaune breed : more and more traits over time





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Expected genetic gain in the Lacaune breed

% production / functional	Expected genetic trend (in 10 years)						
	MY	F%	P%	CELL	Teat angle	Udder cleft	Udder depth
100/0	**61** (1.9 σ_g)	**1,2**	**1,3**	**-0,38** (-0.7σ_g)	**-0,22** (-0.4σ_g)	**-0,18** (-0.3σ_g)	**-0,32** (-1σ_g)
50/50	**39** (1.2 σ_g)	**0,9**	**0,5**	**0,54** (1 σ_g)	**0,43** (0.7σ_g)	**0,58** (0.9σ_g)	**0,12** (0.4σ_g)

MY : -36%

Decrease by half SCS in 10 years

Increase by 4 degrees of angle

Best udder suspension

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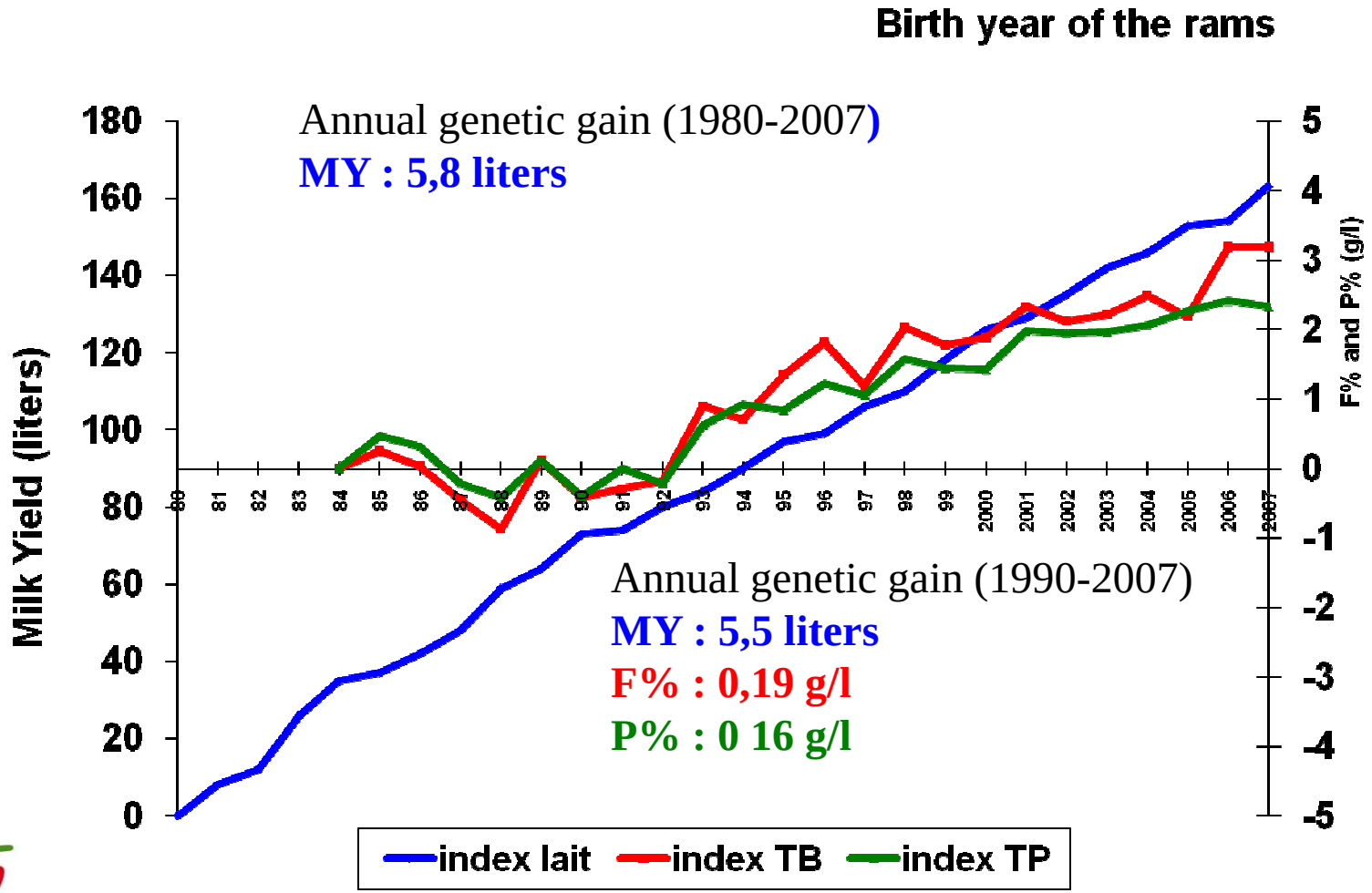
Actual genetic gain of the selected traits

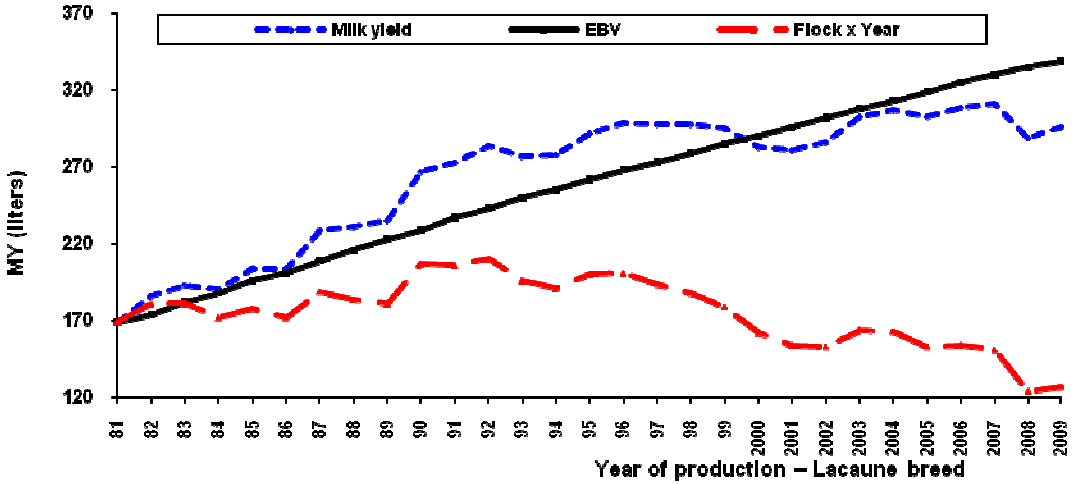
Milk yield (**MY**) & contents (**F%** & **P%**) for Lacaune rams



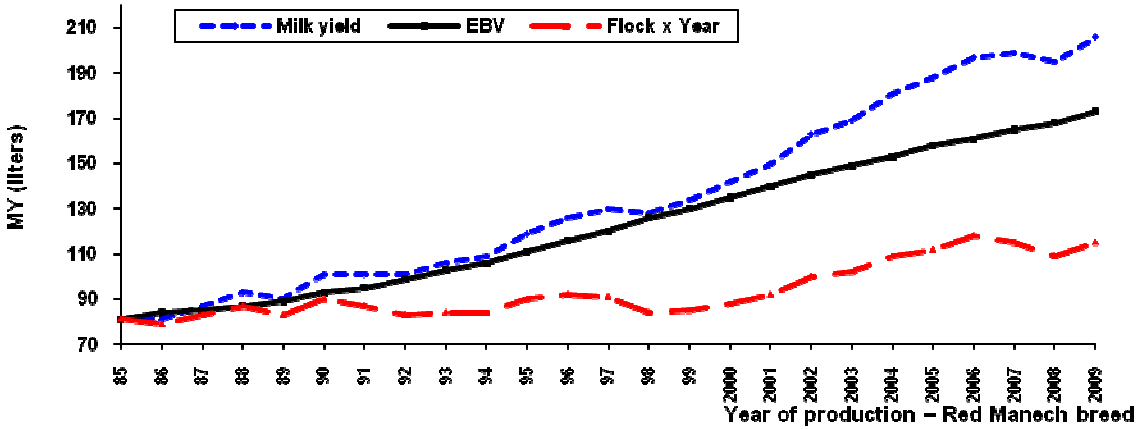
Actual genetic gain of the selected traits

Lacaune & Red Manech ewes : trend on **milk yield**, **EBV** and **flock x year** effect

Lacaune breed



Red Manech breed



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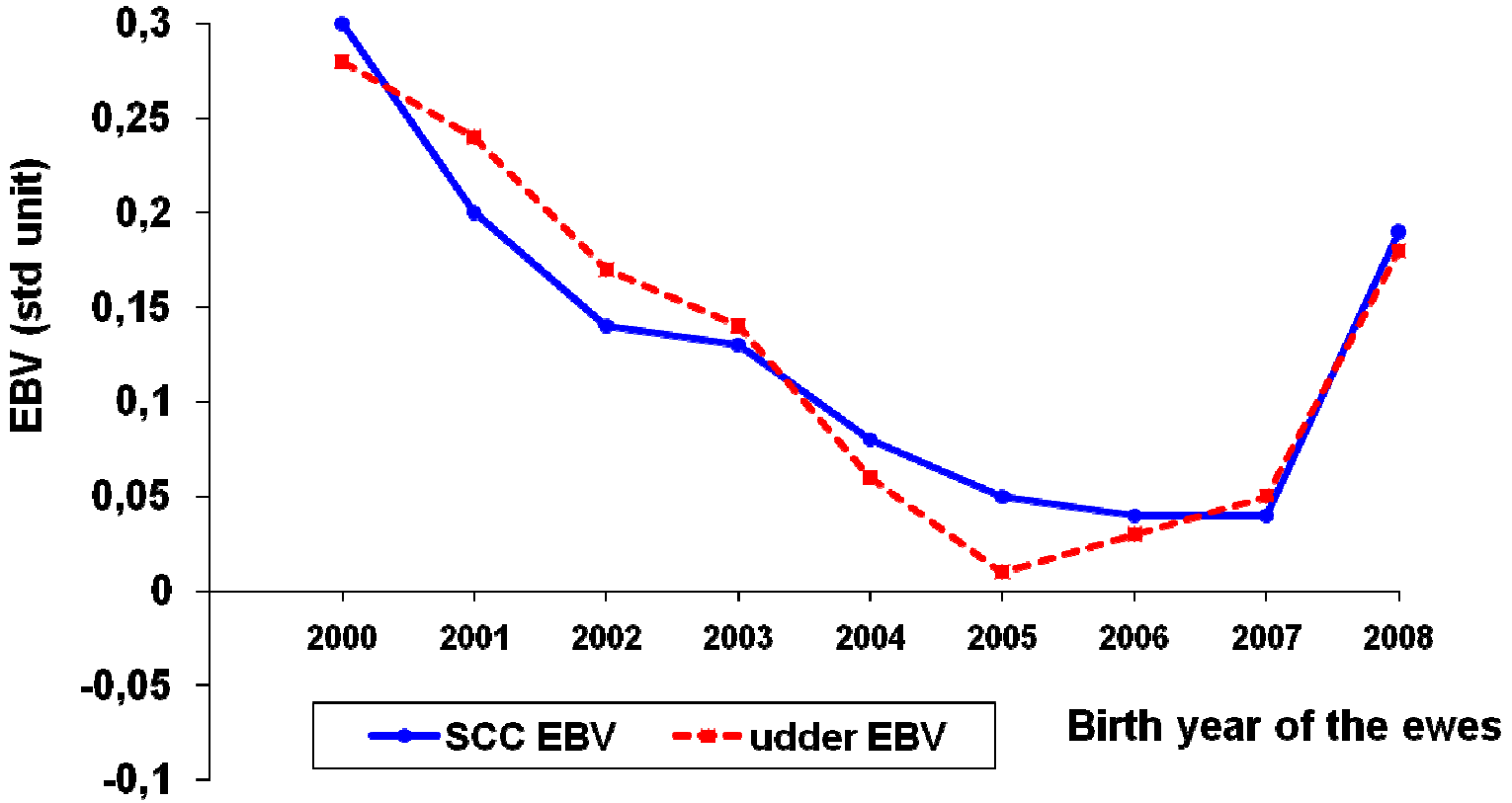
Actual genetic gain of the selected traits

SCC & udder morphology for Lacaune ewes



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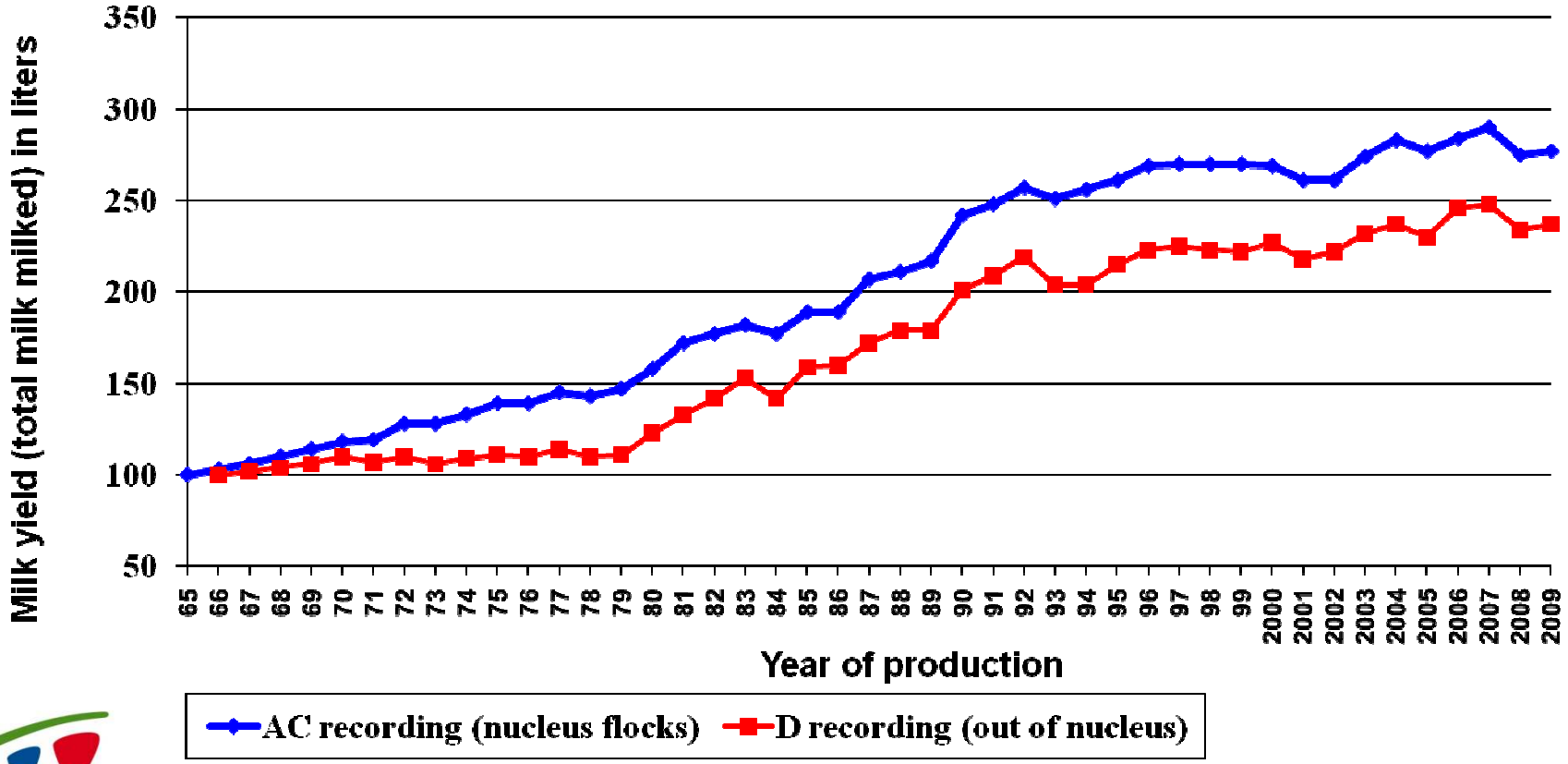
Actual genetic gain of the selected traits : some key factors

	AI progeny-tested rams / year	% AI in the nucleus flocks	Average lactation in 2009 in liters	Annual genetic gain in milk yield for rams (1995-2007)
Lacaune	445	85	272	6.4 liters ($0.20\sigma_g$)
Red-Faced Manech	150	50	180	3.8 liters ($0.19\sigma_g$)
Black –Faced Manech	36	45	134	1.2 liters ($0.06\sigma_g$)

Diffusion of the genetic gain

Phenotypic evolution of milk yield in Lacaune breed : breeders of the nucleus versus out of the nucleus



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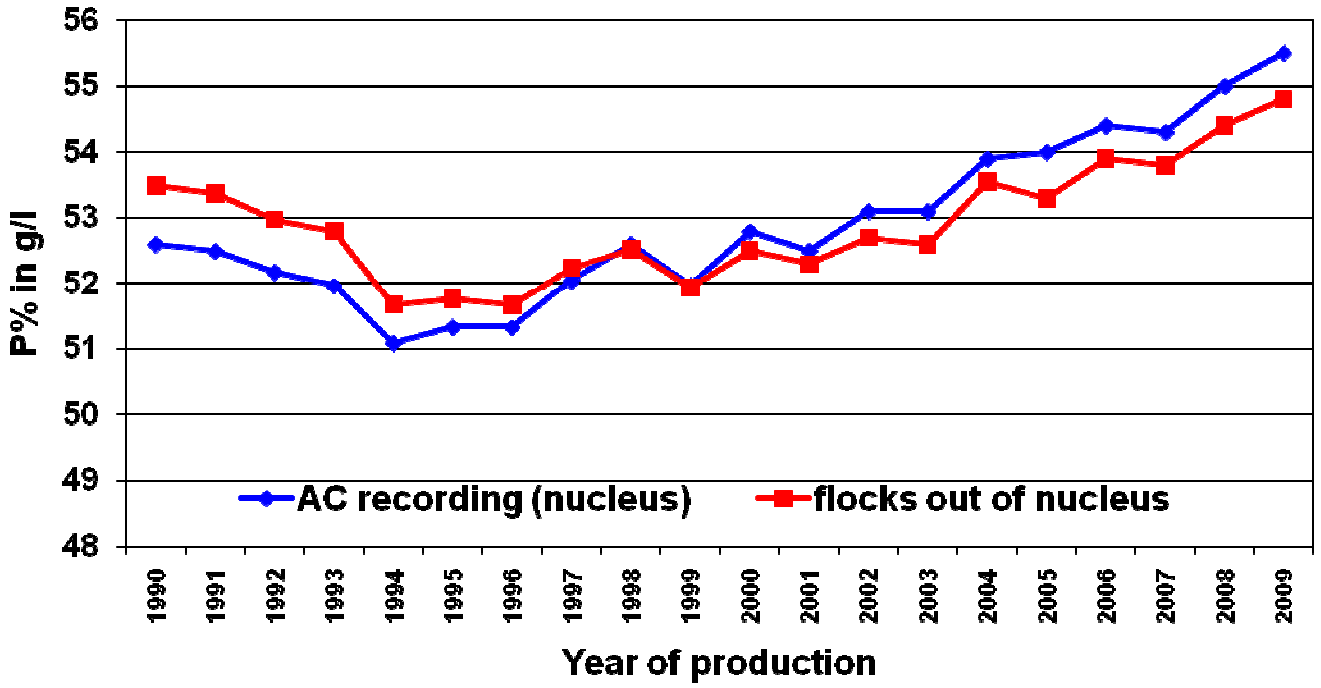
Diffusion of the genetic gain

Phenotypic evolution of P% in Lacaune breed : breeders of the nucleus versus out of the nucleus



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PrP and Scrapie : a Gene Assisted Selection (GAS)

➢ 2001 : following BSE crisis national **plan based on PrP genotyping** to eradicate scrapie

- Gene Assisted Selection : 160,000 over the last 10 years in dairy populations
- Select for favorable ARR allele & eradicate unfavorable VRQ allele, while maintaining selection & genetic variability

➢ **Implement specific tools**

- Organize and optimize animals to be genotyped (young rams, dams, ewe lambs for replacement) according to the specificity of each breed
- Molecular information system, linked with the genetic information system
- Compute genotype predictions on relatives

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Evolution of favorable ARR allele frequency in Lacaune and Red Manech breeds

Breed	ARR frequency		
	2001	2009	
	Initial	Progeny-tested rams	Natural mating rams in commercial flocks
Lacaune	55	100	90
Red-Faced Manech	17	100	50

- **Dramatic increase of the ARR allele frequency in the selection flocks**
- **Diffusion of the ARR allele in the commercial flocks**

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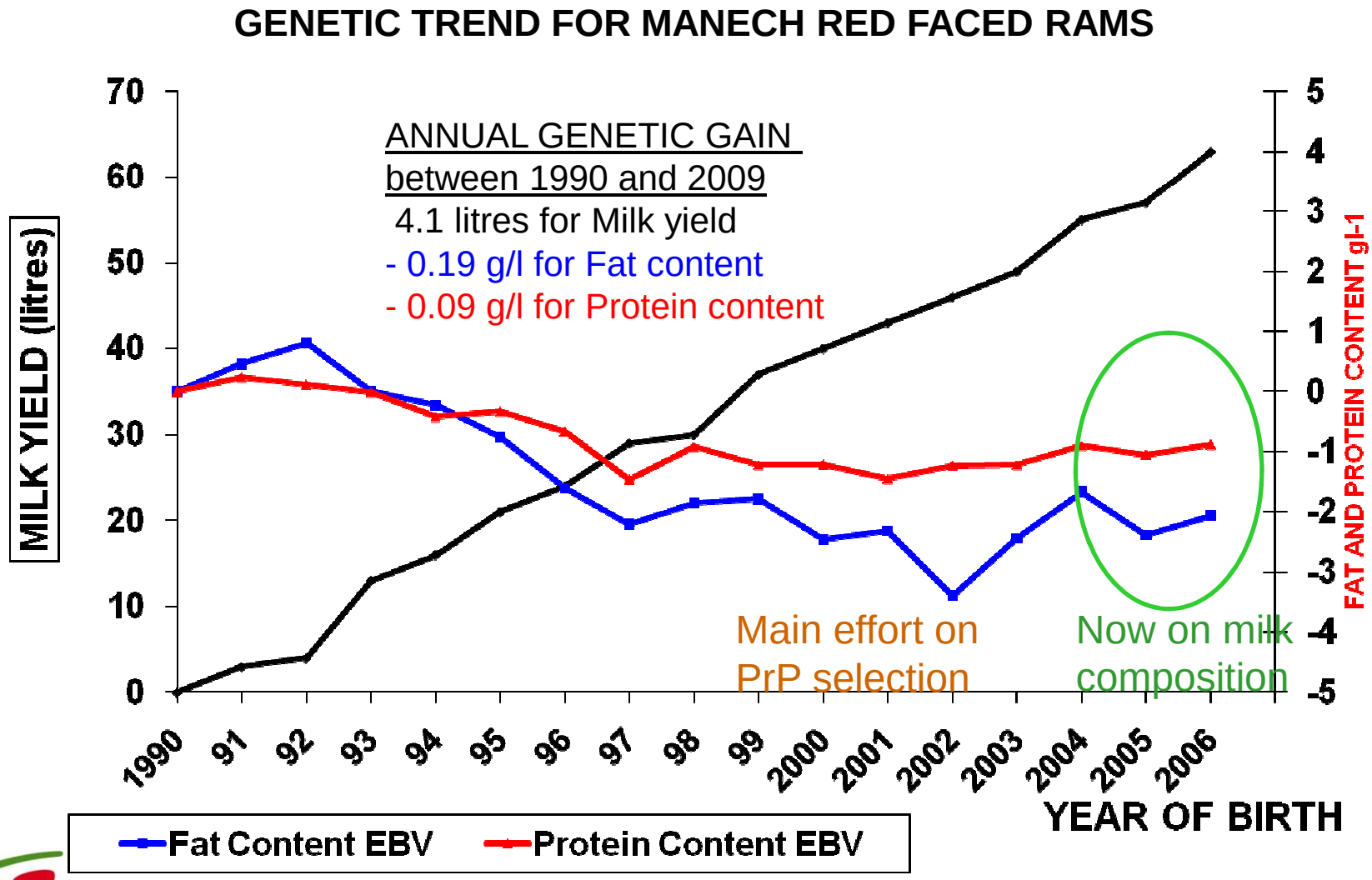
Impact of PrP selection on genetic trend



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Demand of breeders / industry / consumers :
new traits to be selected = new phenotypes to measure

- **New objective : nutritional and health value of milk (industry and consumer demand)**
  - **Milk fatty acid composition**
- **New objective : sustainable production system in accordance with both industry demand and decrease of milking labour**
  - **Milk persistency and once daily milking ability**
  - **Milk flow kinetics**
- **New objective : disease resistance and environment**
  - **Nematode resistance**

+ Longevity

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A new step for the future : going further towards Genomics

A favorable and stimulating context

✓ January 2009 : Illumina Ovine SNP50 BeadChip available

✓ Recent developments on genomic selection & application in bovine : stimulation for French dairy sheep breeding organizations

✓ Efficient breeding schemes in dairy sheep with high number of AI progeny-tested rams

✓ Collection of DNA-samplings of AI-progeny-tested rams.

➢ **Development of a strategy for using genomic tools**

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DNA-collection in dairy sheep

9,100 AI rams well known (progeny-tested) blood-sampled.
DNA stored in Labogéna (year 2009)

Breeds	**Number of AI progeny-tested rams with storage of DNA**	**Year of beginning of the DNA-storage**
Lacaune	5961	1995
Red-Faced Manech	1940	1995
Black-Faced Manech	436	1995
Basco-Béarnaise	544	1995
Corsican	219	2003

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Developed strategies in dairy sheep

Exploring 2 ways

QTL/gene detection and MAS/GAS

- Fine QTL mapping (towards MAS)
- Tracking causal mutation (towards GAS)

Genomic selection (GS)

- Large population breeds (training population higher than 1000 rams (Lacaune et MTR) (towards GS)
- Other breeds ? Relevance and feasability of across-breed genomic estimation of breeding value ?

Several on-going projects (2010-2013), with a strong implication (founding and decision) by breeding organizations

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On-going projects on QTL/gene detection in dairy sheep

On-going project	Purpose		# genotypings (SNP50 Beadchip)
	QTL & gene detection	Genomic selection	
SheepSNPQTL	X	X	1,000
PhenoFinLait	X		2,000
3SR	X		Several 1,000
Roquefort'in		X	4,000
Genomia		X	2,600
Genovicap	Engineering on genomics		

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Genomic selection: which project for which breed ?

Breed	Purpose
Lacaune (2010-2013)	Setting up a **training population up to 3,000 rams**. **Experimenting GS on 2 batches of progeny-test** and comparing EBV and GEBV with official proofs.
Red and Black Manech / Blond and Black Latxa. Basco-Béarnaise. (2010-2012)	Setting up a **training population up to 1,000 rams in Red Manech**. **Testing across-breed GEBV approach**

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Consequences on the breeding schemes

Expected **higher efficiency** (select elite sires very early) of selection to be oriented towards :

- Either speeding up selection on actual routinely recorded traits
- Or implementing selection on new traits
- Or reducing costs (removing progeny-test of AI rams and reducing total number of AI rams)
- Or (more probably) mixing the 3 objectives

Consequences on the breeding schemes

Evolution of the organization of **the breeding schemes**

- What new management of AI rams without progeny-testing
- Which size of the open nucleus population, with official perfomance recording ?

Optimize breeding schemes with genomics, re-organize engineering, take into account genomic data in the information system

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Conclusion

- French dairy sheep breeds : efficient on classical phenotypic selection.
- PrP gene and selection for scrapie resistance : a success story
- Strong demand for new traits
- Favorable context to introduce genomic data in the breeding programs, with great expectations of the breeders' organizations

- Bustling period with several on-going projects with a strong implication of the breeding organizations : exciting and structuring challenge
- Key factor to succeed the challenge : favorable economic context and sustainable breeding system implying all the stakeholders of the breed.

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