INSTITUT DE L'ELEVAGE

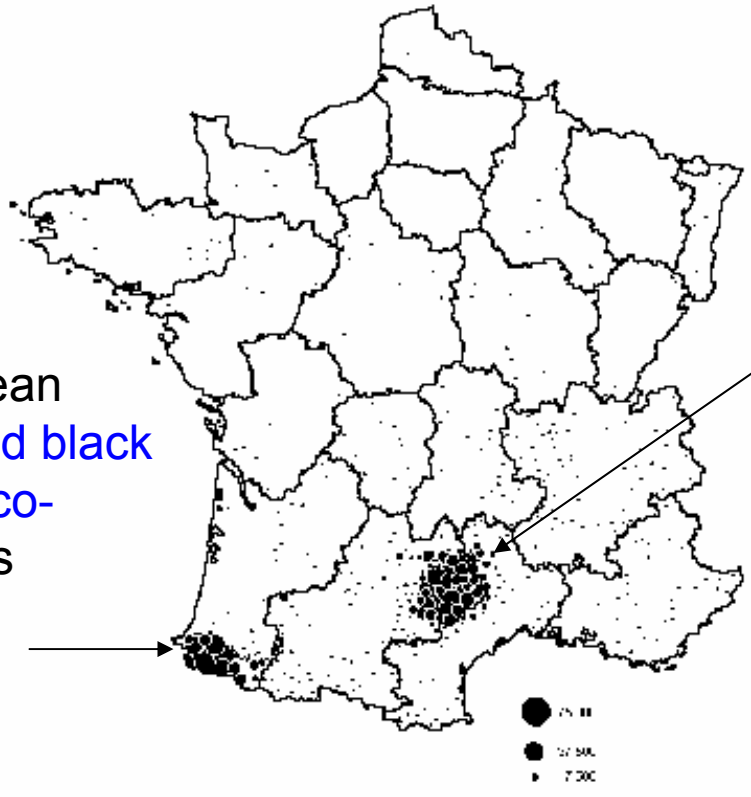
INRA
Institut National de la Recherche Agronomique

37th ICAR Session,
Riga (Latvia),
31 May-4 June 2010

Use of genomic data in French dairy sheep breeding programs: results and prospects

Jean-Michel Astruc,
Gilles Lagriffoul, Hélène Larroque, Andres Legarra, 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

INSTITUT DE L'ELEVAGE

Dairy Sheep Breeding Programs in France

- 5 breeds – 5 programs
- Pyramidal organization of the population

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

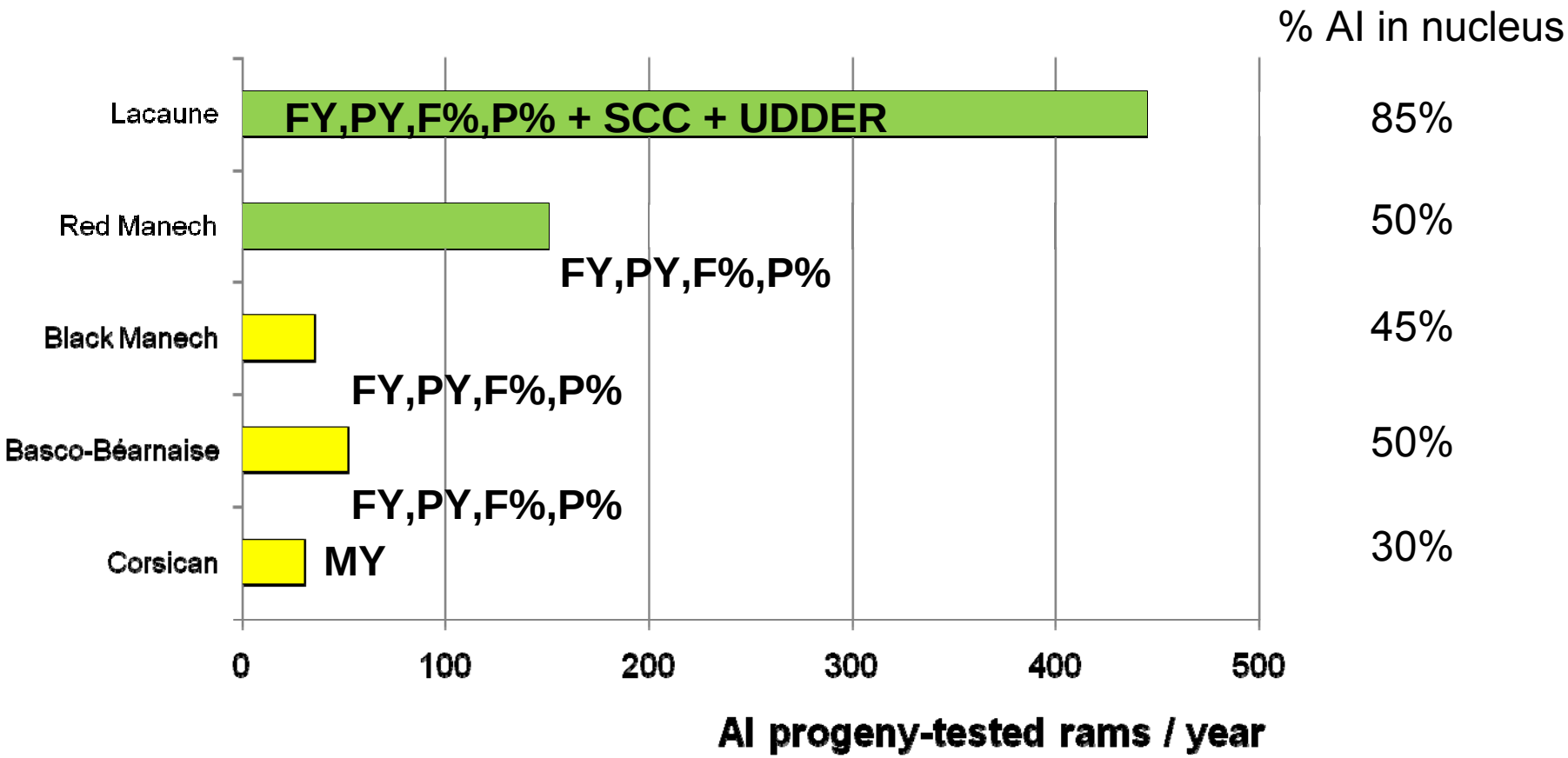
  Production flocks (**commercial**) : non official D method
  or non-recorded flocks

- Extensive use of heat synchronization & AI : 480,000 AI (1/3 total ewes)
- Progeny-test and assortative matings :

More than 700 rams/year - differences between breeds

INSTITUT DE L'ELEVAGE

Size of the breeding programs and selection criteria



INSTITUT DE L'ELEVAGE

Efficiency of the programs

	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 (0,20σ_g)
Red-Faced Manech	150	50	180	3.8 (0,19σ_g)
Black –Faced Manech	36	45	134	1.2 (0,06σ_g)

INSTITUT DE L'ELEVAGE

PrP and Scrapie : a Gene Assisted Selection (GAS)

- 2000 : BSE crisis

- 2001 : implementation of a national plan based on genetics

  Gene Assisted Selection based on PrP genotyping : 160,000 over the last 10 years

  Select for favorable ARR allele & eradicate unfavorable VRQ allele

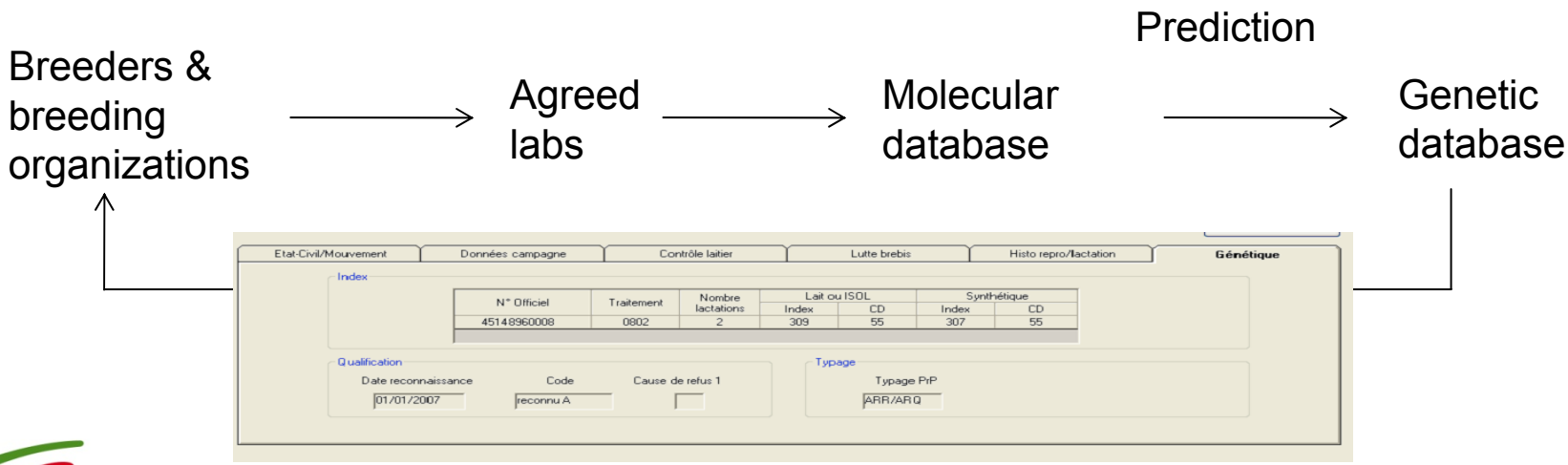
  While maintaining selection on production and functional traits + maintaining genetic variability of each breed

INSTITUT DE L'ELEVAGE

PrP and Scrapie : a Gene Assisted Selection

➢ **Implement specific tools**

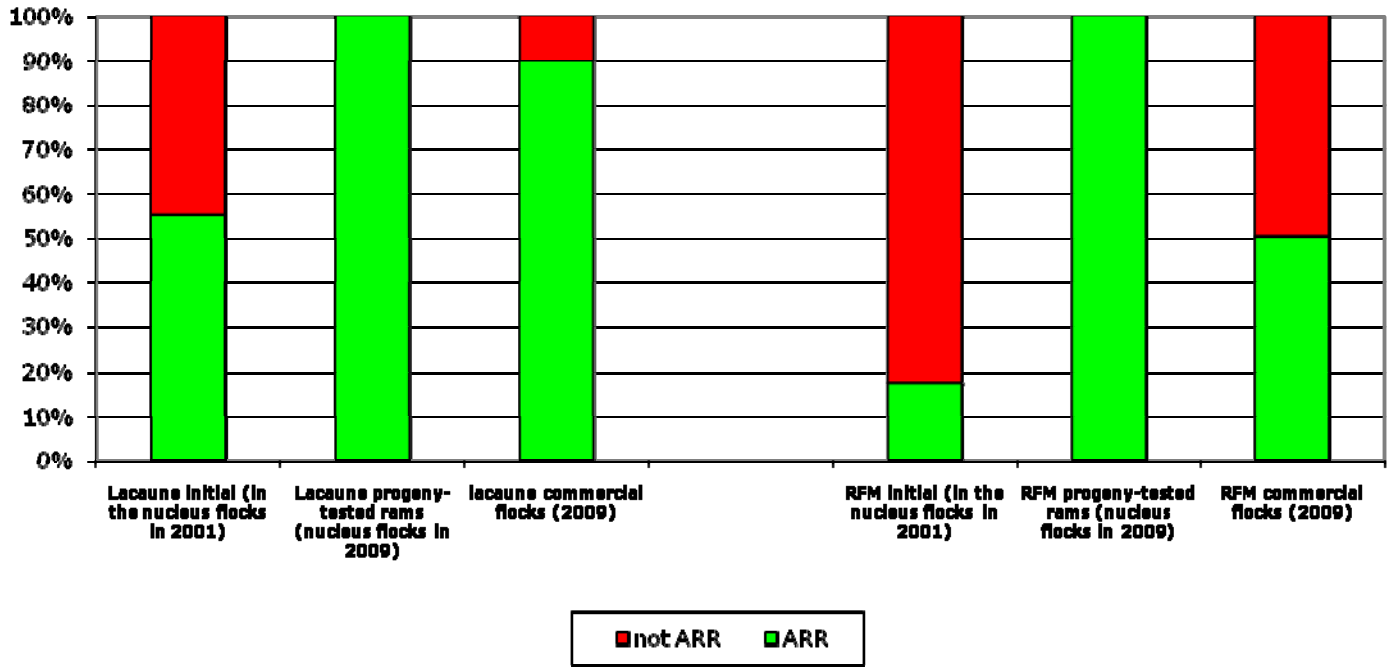
- Genotype young rams before entering breeding center (< 1 month-old)
- Set up a national molecular information system, in relation with the genetic information system
- Compute genotype predictions on relatives



INSTITUT DE L'ELEVAGE

Efficient Gene Assisted Selection

- **Dramatic increase of the ARR allele frequency**



Evolution of the PrP allelic frequencies in the Lacaune and Red-Faced Manech (RFM) breeds between 2001 and 2009.

INSTITUT DE L'ELEVAGE

Going further towards Genomics

An 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

✓ Breeding schemes in dairy sheep with high number of AI progeny-tested rams and efficient

✓ PrP plan : collection of DNA-samplings of AI-progeny-tested rams.

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

DNA-collection

9,100 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

INSTITUT DE L'ELEVAGE

Developed strategies

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

On-going projects on QTL/gene detection

On-going project	Founding	Purpose
SheepSNPQTL	Research & breeding organizations	Fine detection of QTL (Lacaune & Red Manech)
PhenoFinLait	Research & breeding organizations	QTL for milk fatty acid profiles and milk proteins. 2,000 genotypings. Lacaune and Red Manech
3SR	Research	Major gene and QTL detection (resistance to mastitis, gastrointestinal parasites)

INSTITUT DE L'ELEVAGE

On-going projects on genomic selection

On-going project	Founding	Purpose
SheepSNPQTL	Research & breeding organizations	First set of procedures to calculate GEBV. 1,000 genotypings. Lacaune.
Roquefort'in	Breeding organizations	Increasing accuracy of GS (training population of 3,000 rams). Experimenting GS on 2 batches of progeny-test and comparing EBV and GEBV with official proofs. 4,000 genotypings. Lacaune.
Genomia	Breeding organizations (across-border areas project)	Testing across-breed GEBV approach + GEBV in Red Manech. 2,600 genotypings. Red and Black Manech / Blond and Black Latxa.

INSTITUT DE L'ELEVAGE

Great expectations

Increase selection efficiency

Decrease generation interval.

Obtain a reliability at birth not so far from reliability after progeny-test

	Age of the rams at first issue (year)	**Reliability** First issue after progeny-test
Lacaune	2.5	60
Red-Faced Manech	3.5	50
Black-Faced Manech	4.5	40

Select elite sires very early

Consequences on the breeding schemes

Expected higher efficiency of selection oriented towards :

- Either speeding up selection on actual routinely recorded traits
- Or implementing selection on new traits (milk fatty acid profiles, milk persistency, once-a-day milking ability, disease resistance [mastitis, nematodes]…)
- Or reducing costs (removing progeny-test of AI rams and reducing total number of AI rams)
- Or (more probably) mixing the 3 objectives

INSTITUT DE L'ELEVAGE

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 (on-going project GENOVICAP to cope with these issues)

INSTITUT DE L'ELEVAGE

Conclusion

- French dairy sheep breeds : efficient on classical phenotypic selection
- PrP gene and selection for scrapie resistance : a success story
- 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
- Collateral issues : new organizations of breeding schemes, legal aspect with GEBV