National genetic evaluations in dairy sheep and goats in France
Introduction
Introduction

Sheep dairying in France

1,500,000 ewes
5,000 breeders
250 (ML) milk

Corsica island
Corsican breed
95,000 ewes

Roquefort area
Lacaune breed
870,000 ewes

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

Sources: FAOSTAT, Institut Elevage
Introduction

Goats dairying in France
888,000 goats
4,900 breeders
584 (Mkg) milk

West and south
2 main breeds:
Alpine (59%)
Saanen (38%)

Sources: FAOSTAT, IE
Pyramidal management of the populations
Pure breeding selection programs

Assortative matings \Rightarrow \text{ progeny tested AI males}

- **Sheep**: 700 AI \( \sigma \) / year
  - fresh semen
- **Goats**: 70 AI \( \sigma \) / year
  - frozen semen

Selection herds (nucleus)
- Official milk recording
- Identification (electronic)

Production herds
non-official milk recording/identification
(or non-recorded)

National central database
## Breeding programs

<table>
<thead>
<tr>
<th>Breed</th>
<th>Population Size</th>
<th>% Official milk recording</th>
<th>%AI in nucleus</th>
<th>AI progeny tested sires</th>
<th>Milk yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine</td>
<td>530 000</td>
<td>30</td>
<td>20</td>
<td>40</td>
<td>833 kg (273d)</td>
</tr>
<tr>
<td>Saanen</td>
<td>360 000</td>
<td>30</td>
<td>20</td>
<td>30</td>
<td>861 kg (277d)</td>
</tr>
<tr>
<td>Lacaune</td>
<td>870 000</td>
<td>20</td>
<td>85</td>
<td>445</td>
<td>288 l (165d)</td>
</tr>
<tr>
<td>Manech red faced</td>
<td>480 000</td>
<td>23</td>
<td>50</td>
<td>151</td>
<td>194 l (155d)</td>
</tr>
<tr>
<td>Manech black faced</td>
<td></td>
<td></td>
<td>45</td>
<td>36</td>
<td>142 l (140d)</td>
</tr>
<tr>
<td>Basco Béarnais</td>
<td></td>
<td></td>
<td>50</td>
<td>52</td>
<td>167 l (143d)</td>
</tr>
<tr>
<td>Corsican</td>
<td>95 000</td>
<td>21</td>
<td>30</td>
<td>31</td>
<td>144 l (186d)</td>
</tr>
</tbody>
</table>

Source: Institut Elevage (2010)
Genetic improvement in France:

a national collective organization

Ministry of agriculture
legislation, control,
financial supports(-)

France Génétique Elevage (France Livestock Genetics):

a grouping of professions and users

Operational management
(breed organization, identification and performance registration, AI organizations, data management)
Recording traits
Production traits recording programs

For Sheep a simplified recording system:
- AC design for MY
- part lactation sampling for milk composition and SCC

Lambing  Weaning  Drying off
suckling  milking (twice a day)

AC method

Part lactation sampling (parities 1 & 2)

Monthly recording of MY morning milking (adjusted for milk tank)
F%, P%, SCC not available in corsican
average: 3 test days
Production traits recording programs

For Goats 3 types of approved methods:
- A, AT(46%), AZ(2%)
- 4 weeks or 5 weeks between records

As dairy cattle for protocol and milk recording management

⇒ a simplified design (3 controls) under study
Udder traits recording programs

Sheep: since 2000
♀ Lacaune 1st parity
nucleus flocks
15 classifiers

Goats: since 1998
♀ Alpine & Saanen
parity 1 or 2
registered herds
12 classifiers
Data organization

- Central data base
- CTIG
- Jouy-en-Josas

Molecular analysis laboratories

INRA softwares

EBVs

Milk analysis laboratory

Breed organizations

AI organizations

Computing regional center

Field technician
(from milk recording organization)
Breeding objectives
## Genetic parameters: production traits

<table>
<thead>
<tr>
<th>Trait</th>
<th>$h^2$</th>
<th>Rep.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Yield (MY)</td>
<td>0.30</td>
<td>0.50</td>
</tr>
<tr>
<td>Protein Yield (PY)</td>
<td>0.30</td>
<td>0.50</td>
</tr>
<tr>
<td>Fat Yield (FY)</td>
<td>0.30</td>
<td>0.50</td>
</tr>
<tr>
<td>Protein content (P%)</td>
<td>0.45</td>
<td>0.70</td>
</tr>
<tr>
<td>Fat Content (F%)</td>
<td>0.35</td>
<td>0.60</td>
</tr>
<tr>
<td>LSCS (Lacaune)</td>
<td>0.13</td>
<td>0.31</td>
</tr>
<tr>
<td>LSCS</td>
<td>0.21/0.20</td>
<td>0.50/0.45</td>
</tr>
</tbody>
</table>

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**Used for genetic evaluations**

- Sheep
- Goats: Saanen/Alpine
### Genetic parameters: udder traits

<table>
<thead>
<tr>
<th></th>
<th>Udder depth</th>
<th>Udder cleft</th>
<th>Teat direction</th>
<th>Rear udder attachment</th>
<th>Rear udder attachment S.V.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Udder depth</td>
<td>0.19</td>
<td>0.14</td>
<td>-0.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.35/0.31</td>
<td>0.22/0.10</td>
<td></td>
<td>0.74/0.71</td>
<td>0.09/0.14</td>
</tr>
<tr>
<td>Udder cleft</td>
<td>0.26</td>
<td>-0.37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.23/0.31</td>
<td></td>
<td></td>
<td>0.12/-0.02</td>
<td>-0.39/-0.54</td>
</tr>
<tr>
<td>Teat direction</td>
<td></td>
<td>0.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rear udder attachment</td>
<td></td>
<td></td>
<td></td>
<td>0.29/0.27</td>
<td>0.19/0.19</td>
</tr>
<tr>
<td>Rear udder attachment S.V.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.25/0.37</td>
</tr>
</tbody>
</table>

Source: Institut Elevage

Sheep: Lacaune  
Goats: Saanen/Alpine
Genetic correlations:

- MY: Udder depth
- LSCS

Sheep: Lacaune
Goats: Saanen/Alpine

<table>
<thead>
<tr>
<th></th>
<th>FY</th>
<th>MY</th>
<th>PY</th>
<th>P%</th>
<th>F%</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY</td>
<td>0.2</td>
<td>0.2</td>
<td>0.8</td>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td>MY</td>
<td>0.6</td>
<td>0.8</td>
<td>0.9</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>PY</td>
<td>~0.2</td>
<td>~0.2</td>
<td>~0.4</td>
<td>~0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>P%</td>
<td>0.7</td>
<td>0.8</td>
<td>0.9</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>F%</td>
<td>0.5</td>
<td>0.7</td>
<td>0.6</td>
<td>0.7</td>
<td>0.5</td>
</tr>
</tbody>
</table>

- FY: 0.2
- MY: 0.6
- PY: ~0.2
- P%: 0.7
- F%: 0.5

Sheep: Lacaune
Goats: Saanen/Alpine

- FY: 0.2
- MY: 0.6
- PY: ~0.2
- P%: 0.7
- F%: 0.5
Selection objectives


Alpine Saanen

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MY</td>
<td>PY+P%</td>
<td>FY+PY+F%+P%</td>
<td>FY+PY+udder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lacaune

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MY</td>
<td>FY+PY</td>
<td>FY+PY+F%+P%</td>
<td>FY+PY+SCC+udder</td>
<td>F%+P%+udder</td>
<td></td>
</tr>
</tbody>
</table>

Production traits

0%
50%

Functional traits

Manech red faced
Manech black faced
Basco Béarnais

Corsican

MY
Genetic evaluations
Model: milk production traits and LSCS (lactation traits - all breeds)

BLUP single trait
repeatability animal model
unknown parents genetic groups

Assuming (not LSCS):
  heterogeneous residual variances
  known constant variance ratios
Log-linear model for residual variances

fixed effect of year*parity *area

random effect of herd*year*parity

(without autocorrelation)

Goats
# Environmental fixed effects

<table>
<thead>
<tr>
<th></th>
<th>MY</th>
<th>FY, PY, F%, P%</th>
<th>LSCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd<em>year</em>parity</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Age at lambing/kidding*</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Period of lambing/kidding*</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Interval: lambing-1st test-day*</td>
<td>✗</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number &amp; times of sampling* (AC)</td>
<td></td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>Parity (corsican/western pyrenean)</td>
<td>✗</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of dry period*</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

+: within year*parity
Sheep: effects defined according to area
Goats: effects defined within 4 areas
Model: udder traits (Lacaune – Alpine/Saanen)

BLUP multiple-trait animal model

environmental fixed effects:

<table>
<thead>
<tr>
<th>Lacaune</th>
<th>Saanen/Alpine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd</td>
<td>Herd*year</td>
</tr>
<tr>
<td>Year</td>
<td>Lactation stage</td>
</tr>
<tr>
<td>Classifier</td>
<td>Age at scoring</td>
</tr>
<tr>
<td>Time milking-scoring</td>
<td></td>
</tr>
<tr>
<td>Age at lambing</td>
<td></td>
</tr>
<tr>
<td>Lactation stage</td>
<td></td>
</tr>
<tr>
<td>Litter size</td>
<td></td>
</tr>
</tbody>
</table>
# Figures of the genetic evaluations

<table>
<thead>
<tr>
<th>Breed</th>
<th>Nb. records (MY)</th>
<th>Nb. Animals (pedigrees)</th>
<th>Nb evaluations/year</th>
<th>Published EBVs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine</td>
<td>7,273,465</td>
<td>2,760,612</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Saanen</td>
<td></td>
<td></td>
<td></td>
<td>Rolling base</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reliability:0.30</td>
</tr>
<tr>
<td>Lacaune</td>
<td>4,278,634</td>
<td>1,392,483</td>
<td>January/June/September</td>
<td></td>
</tr>
<tr>
<td>Manech red faced</td>
<td></td>
<td></td>
<td></td>
<td>3 in spring</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 September</td>
</tr>
<tr>
<td>Manech black faced</td>
<td>2,088,443</td>
<td>618,663</td>
<td>3 in spring</td>
<td></td>
</tr>
<tr>
<td>Basco</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Béarnais</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corsican</td>
<td>368,331</td>
<td>117,583</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Actual genetic gain of selected traits: Lacaune breed

Actual annual $\Delta G$ (1990-2008):
MY: +5.3 liters ($; 0.15 \sigma_g$)
F%: +0.19 g/l ($; 0.05 \sigma_g$)
P%: +0.16 g/l ($; 0.07 \sigma_g$)

Birth year of $\varnothing$
Actual genetic gain of selected traits: Alpine breed

**Actual annual ΔG (1990-2009):**
- MY: +12.7 kg (± 0.12 σ)<sup>g</sup>
- F%: +0.05 g/kg (± 0.02 σ)<sup>g</sup>
- P%: +0.07 g/kg (± 0.05 σ)<sup>g</sup>
Phenotypic and genetic trends of LSCS
Experimental evaluation – Saanen breed

LSCS (parity 1) vs EBV (in std unit)

EBV:
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2

Birth year:
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

SB:
4
4.2
4.4
4.6
4.8
5
5.2
5.4
5.6
5.8
6

EAAP2011: Caillat H.
Actual genetic trends of LSCS and Udder: Lacaune breed

![Graph showing genetic trends of LSCS and Udder from 2000 to 2009.]

EAAP2011: Rupp R.
New phenotypes for new breeding goals
New phenotypes and EBVs…

✓ Fine composition (fatty acids & proteins): the French national program PhénoFinLait

- 72,000 goats / 58,000 ewes
- Feeding and management recording
- Genotyping
- Phenotyping => fine milk composition based on MIR available for FA/ in progress for proteins

- How genetic and feeding strategies impact fine milk composition
- Genetic parameters
- QTL detection
New phenotypes and EBVs…

✓ Milking ability and tolerance to once-daily milking

**Goats:**
Expected a major gene
Milking speed: milk emission recorded with Lactocorder®

**Sheep:** Roquefort’In project
Milking speed: specific ongoing technical developments of Lactocorder®
Consequences of ODM
Traits to predict ability to tolerate ODM

...longevity, female fertility
... for new breeding goals

✓ Total merit index from technical assumptions
✓ New traits
✓ Genomic evaluations
✓ New production systems

OSIRIS project:
Economical study of production systems/traits
A computing tool of weights
New total merit index

EAAP2011:
Baloche G., Robert-Granié C.
Aknowledgements

J.M. Astruc
V. Clément
G. Lagriffoul
A. Piacère

SAGA - Toulouse
F. Barillet
I. David
I. Palhière
C. Robert-Granié
R. Rupp

GABI- Jouy-en-Josas
A. Barbat
D. Boichard
B. Bonaiti
Thank you for your attention