GENETIC EVALUATION OF DAIRY SHEEP IN FRANCE

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INTRODUCTION

In France, the selection of dairy sheep has been implemented on the basis of local purebred breeding programs : the Lacaune breed in the Roquefort area (south of Massif Central), the Red-Faced and Black-Faced Manech and Basco-Béarnaise breeds in the western Pyrenean mountains and the Corsican breed in the Corsica island. The breeding schemes, started in the seventies, are now fully efficient, and based on a pyramidal management of the population, with the selection nucleus flocks (about 20% of the whole population) producing the genetic gain, and the commercial flocks utilizing it. Table 1 shows how widely the genetic tools are used. Such breeding schemes allow for accurate genetic evaluation of the animals. In France, as for cattle and goats, the genetic evaluation is being developed by INRA. The current dairy sheep genetic evaluation has been running since 1992 for dairy traits using a BLUP animal model with repeated records (Barillet *et al*., 1992, Astruc *et al*., 1995), and has benefited since then from the evolutions of dairy cattle genetic evaluation such as heteroscedastic model (Robert-Granié *et al*., 1999). Nevertheless, many characteristics of dairy sheep have been included in the genetic evaluation of dairy sheep.

MATERIALS AND METHODS

Milk recording. Until now, genetic evaluation has concerned only dairy traits using records from official milk recording in the nucleus flocks. A national database stores on-farm collected records from all breeds. As ewes are milked after a suckling (or suckling plus milking) period of the lambs, milk recording is carried on during the milking-only period, as proposed by ICAR guidelines (ICAR, 1992). The AC design is used for milk yield. As the cost of qualitative testing is high in dairy sheep, milk contents are measured using a simplified design: 2 to 4 samplings per lactation, during the first 4 monthly test-days, combined and standardized in equivalent annual contents (Barillet, 1985). Although they are less heritable, milk contents determined from those reduced samplings are highly correlated (close to 1) with contents provided from the standard A4 method over the complete lactation. The loss of precision is balanced for males by adding 2 or 3 more daughters in the progeny test. Qualitative testing is carried on in Lacaune breed (ewes of parity 1 and 2) and in Pyrenean breeds (parity 1 only).

Data. Analyzed data include performances recorded since 1978, from parities 1 to 10. Five dairy traits are analyzed : milk (MY), fat (FY) and protein (PY) yields, fat (F) and protein (P) contents. Yields are pre-adjusted for milking length (ML) and parity with the following multiplicative coefficient : Q 220 / (ML+60), with Q being 1, 0.9 and 0.85 in parity 1, 2, 3 or more respectively. Fat and protein contents are adjusted for the average lactation stage at the

time of milk quality recording. In-progress lactations are extended using a method of prediction of the complete lactation based on the partial daily production. Data are described in table 2.

Table 1. Importance of the dairy sheep breeding schemes in France (year 2001)

Breeds	Ewes in nucleus flocks (# flocks)	Ewes recorded in commercial flocks (# flocks)	AI rate in nucleus flocks	Rams progeny tested yearly
Lacaune	173,419 (394)	567,698 (1,520)	85%	420
Red-Faced Manech	65,825 (214)	19,086 (73)	55%	130
Black-Faced	16,588 (63)	2,411 (10)	53%	30
Manech	18,357 (76)	3,283 (18)	52%	40
Basco-Béarnaise	17,230 (62)	1,744 (9)	39%	25
Corsican				

Table 2. Description of the data set in 2001

Breeds	Lacaune	Manech & Basco-B.	Corsican
Females	1,013,783	399,952	77,617
Males	15,212	5,932	173
Records : milk	2,886,042	1,286,638	215,214
Flock year parity (FYP)	22,317	17,540	3,021
Fixed effects other than FYP	1,449	1,449	943
Groups	20	25	6

Model. A univariate BLUP animal model with repeated records is used. Since 1999, the evaluation takes into account heterogeneity of variance, using a model close to the one set up in French dairy cattle genetic evaluation (Robert-Granié *et al*., 1999): variances (genetic, residual and permanent environment) are allowed to vary according to flocks, year and parity. Heritability and repeatability are 0.3 and 0.5 respectively for yields, 0.45 (lower than the one estimated on the whole lactation since contents are measured with only 2 to 4 test-days) and 0.7 respectively for contents.

The main fixed effect is the flock-year-parity (FYP) combination where parity has three classes (1, 2, 3 and more). It may be accurately estimated given the size of the flocks, respectively 440, 287 and 278 in the Lacaune, Manech (and Basco-Béarnaise) and Corsican breeds. The other environmental fixed effects depend on the traits and are adapted to the breed. They are always defined within year and usually within parity.

- in Lacaune, the effect (L) of age at lambing within year and parity,
- in Manech and Basco-Béarnaise, the effect (L) of age at lambing (parity 1) and preceding lambing interval (later parities) within year and parity,
- for milk yield, the effect (M) of period of lambing and the effect (I) of the lambing-first test-day interval within year and parity,
- for fat and protein yield, fat and protein content, the effect (C) of qualitative recorded category (defined with the number of test-days and the average lactation state at recording) within year and parity,

- In Manech, Basco-Béarnaise, Corsican the effect (N) of parity, within the class of 3 and more. Genetic groups of unknown parents are defined by breed and birth year of progeny.

Publication of EBV and edit rules. Three runs are performed each year : 2 in spring, mainly in order to select the males before mating. A third run is performed in autumn after the drying-off of the ewes. This run is used to select young males for breeding centers. EBVs are published for each trait, as well as a global dairy criterion of selection (Barillet, 1997) defined as FY + 0.925 PY + 0.2 P (Lacaune) or FY + 0.925 PY (Pyrenean breeds). Published EBVs are expressed as deviations from a rolling base updated each year. Minimum reliability for EBV release is 0.30.
After each run, checking and validation are carried on : standard statistics, correlations between runs, genetic trend. Genetic trend is checked regularly (Barillet *et al*., 1996) using the methods proposed in cattle by Boichard *et al*. (1995).

RESULTS AND DISCUSSION

Accounting for heterogeneity of variances since 1999. AI rams EBVs have been hardly affected, since the correlation between EBVs estimated with and without accounting for heterogeneity of variances ranged from 0.995 to 0.999 according to the traits and the breeds. Main impact has been on females EBVs, however. For example, in the Lacaune breed, on the same data set, only 86% of the elite females were present in both evaluations with and without accounting for heterogeneity of variances. The clearest effect of the heteroscedastic model on the genetic trend was found in the Lacaune breed with an increase of 5% for MY.

Table 3. Genetic trend for males (1986-1999) and phenotypic gain (1988-2001)

Breed	Trait	Annual genetic trend for males	Phenotypic gain (current mean)
Lacaune	MY (liters)	5.75 ± 0.16	59 (270)
Lacaune	F (g/l)	0.21 ± 0.03	1.2 (72.4)
Lacaune	P (g/l)	0.14 ± 0.02	0.4 (52.8)
Red-Faced Manech	MY (liters)	4.33 ± 0.16	44 (141)
Black-Faced Manech	MY (liters)	3.19 ± 0.45	34 (116)
Basco-Béarnaise	MY (liters)	3.53 ± 0.33	29 (129)
Corsican	MY (liters)	0.81 ± 2.07	18 (111)

Genetic trend. The table 3 summarizes the estimated annual genetic trend for the males born between 1986 and 1999. The genetic gain for MY varies according to the breed, from 5.75 liters in the Lacaune breed to 0.81 liter for the Corsican breed. The Pyrenean breeds are intermediate. These differences may be connected both to the age of the breeding scheme and to the more or less extensive use of the selection tools, especially the AI in the nucleus flocks, which directly determines the number of progeny tested rams. The Lacaune breeding scheme started in the end of the sixties, and the AI rate reaches 85% in its nucleus flocks, with 420 males progeny-tested each year. On the other hand, the Corsican breeding scheme was implemented only in the nineties, and the current AI rate of 39 % allows to sample only about 25 rams per year. With a same history of selection and a comparable use of the selection tools,

the Pyrenean breeds can be distinguished by the number of rams progeny tested, with 130, 30, and 40 individuals, respectively in the Red-Faced Manech, Black-Faced Manech and Basco-Béarnaise. The genetic gain for MY is high in the Lacaune breed despite the addition of fat (+0.21 g/l per year) and protein (+0.14 g/l per year) contents as selection criteria since 1987. Moreover, the recent effort to eradicate the non resistant alleles to scrapie at the *PrP* locus has not affected the dairy genetic progress, since the breeding schemes have been adapted to face this new goal (Barillet *et al*., 2002).

CONCLUSION

Genetic evaluation in dairy sheep provides three times a year EBV estimated with the more recent methodologies applied in French dairy cattle evaluation. Future evolutions such as test-day model will be evaluated in dairy sheep. The fixed effects included in the model are closely adapted to the situation of dairy sheep production, as well as to the specificity of each breed involved. The efficiency of the French dairy sheep breeding schemes and the strong increase in phenotypic production, especially in Lacaune and Pyrenean breeds, are an indirect check on the quality of dairy sheep genetic evaluation.

The next prospects concern the evaluation of new traits. A first genetic evaluation for milk somatic cell score as an indicator of mastitis resistance was performed in 2002 in order to provide EBV for the males (Rupp *et al*., 2002). On the other hand, on-farm collected udder type scores will be evaluated in the near future. As done for qualitative traits, these new EBVs will be included gradually in the selection index according to the efficiency of each breeding scheme.

Other perspectives are the possible inclusion of molecular information since QTLs have been detected through a collaborative program implemented between France and Sardinia (Italy) on a back-cross Sarda x Lacaune resource population (Carta *et al*., 2002) and on granddaughters families in French dairy sheep breeds (Schibler *et al*., 2002).

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