Field genetic evaluation of beef cattle in France: from birth to slaughterhouse

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1. Introduction

The "BLUP Animal Model" methodology was put forward in 1991 to improve the French genetic evaluation of suckling breeding stock by using on-farm performance recording from birth to weaning. Based on this methodology, the IBOVAL evaluation has officially replaced the former evaluations since 1994. Today, nine breeds are concerned: either beef production specialised breeds (Bazadaise, Blonde d'Aquitaine, Charolaise, Limousine), or hardy breeds adapted to inhospitable environments (Aubrac, Gasconne, Salers) as well as dual purpose suckling breeds (Rouge des Prés - formerly known as Maine-Anjou, Parthenaise). Beside French animals, performances from Italy (Limousine and Charolaise), Luxemburg (Limousine and Charolaise), Spain (Blonde d'Aquitaine) and The Netherland (Charolaise). have also been included in the IBOVAL evaluation. Performances in these countries for the detailed breeds are recorded following the French methods and are considered as French performances.

Slaugtherhouse data has been evaluated since 2002. This evaluation would become official in 2007.

IBOVAL has been certified according to the ISO 9001 norm since 2006.

2. Organisation of on farm performances recording

Performance recording of suckler cattle from beef breeds has existed in France for forty years. During the 2005 campaign, on-farm performances recorded in suckling herds concerned about 14 500 breeders and 620 000 suckling cows (Table 1). The methods of performance recording as well as their expressions are the same for all the breeds. They consist in calving ease score, weigths at birth, 120 days and 210 days, and linear scores for muscular, skeletal and functional abilities at weaning. Calving ease scores and birth weight are recorded by farmers. The calving scores range from 1 (calving without help) to 4 (caesarean). Calves are regularly weighted and scored up to weaning by technicians from seventy performance local recording associations. Those later are independent of breed associations (UPRA), artificial insemination companies (CIA) and technically supervised by Institut de l'Elevage (IE). Carcass traits (Carcass weights (CW), EUROPA muscular score (CMS) and slaughter date) are recorded in slaughterhouses. CMS are registered by specialised technicians from independent organisms.

Table 1. Number of recorded cows in 2005.

Breed	*Number of recorded cows*	*% of the total population*
Aubrac	*1534*	*61*
Bazadaise	*40335*	*32*
Blonde d'Aquitaine	*137137*	*28*
Charolaise	*317972*	*19*
Gasconne	*10061*	*49*
Limousine	*186005*	*19*
Parthenaise	*13085*	*45*
Rouge des Prés	*17279*	*37*
Salers	*37477*	*19*

Each record is managed in the National Genetic Information System (SIG): it is first processed locally in the Regional Computer Centers (CRI) before being sent to the national data processing center (CTIG-INRA). Data are then extracted from this national database and

used by the Institut National de la Recherche Agronomique (INRA) in collaboration with IE to run genetic evaluations. Results are thereafter handed over to UPRAs to determine a genetic qualification to breeding stock. The SIG gathers data referring to more than 16 millions beef cattle born over the previous 40 years.

3. Genetic evaluations

All the genetic evaluations are based on an animal model, which may include maternal effects according to the traits. They used an home-made software, written in Fortran 90. This software can handle multitrait animal models with maternal effects. Mixed model equations are iteratively resolved according to the symmetrical successive overrelaxation method. Convergence is speeded thanks to the so-called Chebyshev acceleration method (Hageman and Young, 1981).

The genetic evaluations are within-breed evaluations, according to the dam breed. They involve pure-bred animals, except for Salers and Aubrac genetic evaluations, which include calves sired by Charolais bulls. Twins and embryo transfers are removed from the evaluations. The main fixed effects for weaning traits are: "herd- birth campaign" unit, sex of the calf, parity and age of dam, birth season. For carcass traits, fixed effects are fattening group and parity of the dam. The genetic parameters used were taken from Phocas and Laloë (2004) and Shi *et al.* (1993). They are summarized in Table 2.

The amount of data used in the genetic evaluations according to traits and breeds are in Table 3. More details about the genetic parameters and the models used in the various genetic evaluations can be found in Journaux *et al.* (2006). Currently there are four different genetic evaluations in place.

3.1. Calving performance evaluation

This evaluation is based on a two-trait model (Calving ease note and birth weight) including maternal effects. According to the results of Phocas and Laloë (2003), the calving ease note is treated as a continuous trait.

3.2 Growth evaluation (up to weaning)

This evaluation is based on an animal model with maternal effects. It is a single-trait model (210 days adjusted weaning weight) for Charolaise and Parthenaise breeds, while it is a two-trait model (120 days weight and 210 days weight) for the other breeds.

3.3 Conformation at weaning evaluation

Two evaluations are based on the conformation traits. On one hand, muscular and skeletal developments are evaluated jointly with a two-trait model without maternal effects. On the other hand, a single-trait animal model without maternal effects is run for the twenty linear scores. The heritability is assumed to be the same and is equal to 0.30 across breeds and scores.

3.4 Carcass evaluation

Young bulls carcass traits (CW, CMS and slaughter age) are genetically evaluated using an animal model simultaneously to weaning traits (weight – with its maternal effects - and weaning muscling score) of all animal involved in the growth and conformation evaluations up to weaning. Weaning traits have been taken into account to avoid bias due to selection of animals to be fattened at weaning.

4. The assessment of accuracy and connectedness.

Approximate CDs of the EBVs are computed according to the method of Liu *et al.* (2003). The accuracy of the bulls is also addressed by the number of its calves.

Attention has particularly been paid to connectedness since the beginning of IBOVAL. Connectedness has first been addressed through the number of calves sired by "link sires" (i.e. widely used Artificial Insemination bulls) in each "herd-campaign" unit.

Since 2002, the connection level between two herds is calculated according to the method of Fouilloux and Laloë (2006). First,

the connection level between two herds is calculated using the CD of the difference of the genetic levels for the 210 days weight of the two herds. Then, a clustering method similar to the complete linkage is applied, and an aggregation criterion (*Caco*) which reflects the level of connectedness of each herd is computed.

A herd is said to be connected if it meets the criterion based on the counts or if its *Caco* is greater than 0.40. At last, a bull is said to be connected if it has sired at least 10 calves in the set of connected herds. Cows and calves are connected if they belong to a connected herd.

5. Expression of the Breeding Values

The estimated breeding values (EBV) of an animal are expressed as a standardized deviation from a reference basis (basis = 100; 10 points = 1 genetic standard deviation). The choice of the reference basis depends on whether the animal is connected or not. If the animal is connected, its EBVs are expressed with respect to a national basis, which gathers all the purebred calves which have been born within the five last campaigns, and recorded for all the traits. Otherwise, EBVs are expressed with respect to a within-herd basis, which is a subset of the national one, involving only calves belonging to this herd.

Three total merit indices are computed from the EBV: 1) ISEVR is a total merit index which combines direct effects of the different traits, 2) IVMAT is a maternal weaning index, which is a combination of direct and maternal effects. 3) IABjbf is a total merit index combining direct effect of the 3 carcass traits. The weights of indices are calculated according to each breed selection economic objective.

6. Publications

The EBVs of the animals are published in various documents:

- The sire summary, which releases the EBVs of bulls which are publishable, i.e. bulls which are connected and have at least 25 progenies. ;
- Individual sheets for publishable bulls and cows;
- The suckling herd genetic summary ("Bilan Génétique du Troupeau Allaitant"), with some general information about the herd (genetic levels and trends) and lists of EBVs of bulls and cows.

7. Future developments planned regarding beef genetic evaluations.

Future work planned includes:

- Post-weaning growth and post-weaning conformation genetic evaluation,
- Maternal fertility and productivity,
- Inclusion of heteroscedasticity,
- Inclusion of crossbred animals in the abattoir genetic evaluation.

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Table 2. Range ([minimum;maximum]) of the genetic parameters.

	direct heritability	*maternal heritability*	*direct-maternal genetic correlation*
Birth weight	*[0.19;0.27]*	*[0.04;0.24]*	*[-0.37;-0.58]*
Calving ease	*[0.08;0.16];*	*[0.05;0.14]*	*[-0.35;-0.88]*
Weaning Weight	*[0.23;0.26]*	*[0.07;0.13]*	*[-0.13;0.24]*
Muscular development	*[0.32;0.32]*	-	-
Skeletal development	*[0.32;0.32]*	-	-
Linear scores	*[0.30;0.30]*	-	-
Carcass weight	*[0.20;0.32]*	-	-
Slaughter age	*[0.16;0.22]*	-	-
Carcass conformation	*[0.12;0.31]*	-	-

Table 3. Amount of data used in the genetic evaluations, according to traits and breed (IBOVAL 2006).

Breed	*Trait*	*Number of evaluated animals*	*Number of recorded animals*	*Number of campaigns*	*Number of Herds*
Aubrac	*Birth*	*432 698*	*353 144*	*36*	*1125*
	Growth	*176 112*	*135 539*	*34*	*438*
	Conformation	*162 917*	*123 176*	*23*	*379*
Bazadaise	*Birth*	*16 995*	*13 136*	*31*	*148*
	Growth	*7 554*	*4 957*	*30*	*75*
	Conformation	*6 358*	*3 810*	*23*	*57*
Blonde d'Aquitaine	*Birth*	*1 448 994*	*1 173 471*	*37*	*7 491*
	Growth	*689 757*	*555 226*	*35*	*3 562*
	Conformation	*566 641*	*430 759*	*32*	*2 982*
Charolaise	*Birth*	*5 505 562*	*4 473 887*	*36*	*16 580*
	Growth	*3 162 617*	*2 528 553*	*34*	*8 146*
	Conformation	*3 215 882*	*2 601 308*	*33*	*7 805*
Gasconne	*Birth*	*87 916*	*64 885*	*36*	*410*
	Growth	*40 865*	*28 739*	*35*	*249*
	Conformation	*33 052*	*22 542*	*17*	*167*
Limousine	*Birth*	*2 639 615*	*2 342 281*	*37*	*8 432*
	Growth	*1 861 873*	*1 666 714*	*35*	*5 544*
	Conformation	*1 620 685*	*1 430 408*	*35*	*5 006*
Parthenaise	*Birth*	*155 670*	*136 669*	*34*	*509*
	Growth	*106 389*	*92 052*	*27*	*336*
	Conformation	*105 984*	*91 694*	*26*	*337*
Rouge des Prés	*Birth*	*316 090*	*236 420*	*35*	*1 605*
	Growth	*141 554*	*107 305*	*33*	*551*
	Conformation	*128 815*	*94 472*	*24*	*505*
Salers	*Birth*	*505 875*	*391 332*	*36*	*1 991*
	Growth	*490 118*	*407 730*	*35*	*1 532*
	Conformation	*403 060*	*327 547*	*25*	*1 203*