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Genetic parameters for growth, muscularity, feed efficiency and carcass traits of young beef bulls

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ABSTRACT

Genetic parameters were estimated for feed efficiency and live performance traits of 678 Blonde d'Aquitaine (BA) and 708 Limousin (LI) bulls born between 1991 and 2007, and for carcass traits of 3755 BA and 5263 LI progeny. Records at weaning were registered on-farm in 277 BA and 298 LI herds having provided purebred males for the French selection scheme of progeny tested bulls destined to artificial insemination. Analyzed traits included weight (WW) and muscle score (WM) recorded at weaning, and weight (LW) and muscle score (LM) recorded on bulls in performance test stations at 15 months. Feed intake (FI), residual feed intake (RFI) and feed conversion ratio (FCR) were also recorded in performance test stations. Carcass traits recorded in progeny test stations were age-adjusted carcass weight (CW), dressing percentage (DP), European commercial score for carcass muscularity (CM) and carcass internal fatness score (CF). Multivariate analyses were performed on different trait combinations using BLUP animal model and REML methodology. Heritability estimates for WW, WM, LW, LM, FI, RFI, FCR, CW, DP, CM and CF were 0.27, 0.31, 0.57, 0.64, 0.30, 0.26, 0.30, 0.53, 0.62, 0.47 and 0.47 for BA, respectively, and 0.35, 0.35, 0.63, 0.51, 0.48, 0.45, 0.23, 0.61, 0.47, 0.54 and 0.38 for LI, respectively. Genetic correlations (r_g) between live performance traits and the corresponding carcass traits were strong in both breeds, ranging from 0.52 to 0.98. Thus, an early selection on live traits recorded at weaning should improve carcass value of young bulls. In both breeds, genetic correlations were null to weak between growth and muscularity at weaning and feed utilization traits ($|r_g| < 0.30$). LW was strongly genetically correlated with FI ($|r_g| > 0.71$) but weakly to moderately negatively with RFI and FCR ($|r_g| < 0.30$). In both breeds, RFI was genetically independent from CF and weakly related to DP. Over the period 1991–2007, realized genetic trends estimated on males entering AI bull test stations were clearly positive on CW. For BA and LI bulls, annual trends were equal to 3.9% and 5.0% of genetic standard deviation (σ_g) per year, respectively. Estimated trends were lower for CM (1.3% and 3.7% σ_g per year, respectively), for RFI (−1.5% and 0.0% σ_g per year, respectively) and FCR (−1.0% and −2.3% σ_g per year, respectively).

1. Introduction

For decades, selection to improve the beef carcass value in France has been based on growth and muscularity of young bulls. Beef traits of artificial insemination (AI) bulls have been improved by a 3-step sequential selection since the end of the 1980s. The first step of the selection is based on pedigree and performance at weaning of candidate bull calves. The second step is based on growth and fattening performance of bulls recorded in central test stations. Because feed is a major cost in beef cattle production, feed intake is also recorded in those performance test stations to select bulls not only with high growth and muscularity performance, but also efficient

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animals via the limitation of their residual feed intake. The last step is based on carcass traits of a sample of their male progeny fattened in progeny test stations.

Heritability estimates for growth, based on live weight and weight gains, and carcass traits abound in the scientific literature as reviewed by Koots et al. (1994a) and Rios-Utrera and Van Vleck (2004). However, there are limited references concerning genetic parameters for live muscularity traits (Renand et al., 1986; Robinson et al., 1993; Fouilloux et al., 1999; Afolayan et al., 2007; Fouilloux et al., 2008), feed intake and feed utilization traits (Arthur et al., 2001b; Schenkel et al., 2004; Robinson and Oddy, 2004). Therefore, the first objective of this paper was to estimate the genetic correlations between i) growth and muscularity of bulls at weaning and 15 months of age, ii) their feed intake and efficiency and iii) progeny carcass traits. This will allow us to assess the efficiency of each step of selection of AI bulls to improve beef production. The second objective was to estimate the realized genetic trend for feed utilization traits and the slaughter value of animals in the French AI beef programme over the period 1991–2007.

2. Material and methods

2.1. Data

Data were extracted from the French national databases used for beef cattle genetic evaluations on-farm, in central performance test stations and in progeny test stations. During the period 1991–2007, 558 059 Blonde d'Aquitaine (BA) and 1 495 219 Limousin (LI) male and female calves were evaluated on weaning performance. Owing to the huge information available for cattle at weaning in the French on-farm recording system, data had to be sampled in order to estimate variance components. A first edit consisted in selecting data from the 277 BA herds and 298 LI herds that sent males to performance test stations since 1991. The 277 BA herds provided 680 males to the central test stations of bulls. Among those males, 145 bulls were progeny tested to estimate their slaughter value. In those herds, 97 139 calves have been controlled at weaning since 1991. In the LI population, the 298 herds provided 708 males to the central test stations. In those stations, 162 bulls were selected to be progeny tested. LI data from those herds had to be sampled because those herds bred 252 175 calves at weaning since 1991. In that breed, a nucleus of herds regularly provided males to performance test stations. Thus, for the AI Limousin scheme, variance components were estimated with data collected from 88 LI herds which provided at least 3 males to the AI programme since 1991. Since 1991, 91 730 animals were controlled at weaning in these 88 herds. Those herds provided 440 males to the LI performance test station and 88 bulls were progeny tested.

2.2. Feeding and management of animals in French AI selection schemes

Those programmes were set up in the 1980s to select AI bulls on their slaughter value for purebred young bull production in Charolais, Blonde d'Aquitaine and Limousin breeds. The Charolais AI selection scheme had already been fully described and analyzed by Fouilloux et al. (1999) and Arthur et al. (2001b). Therefore, the present study focused on the two other breeds.

First, calves were evaluated for on-farm performance, i.e. birth and weaning weights and morphology at weaning. In 1991, 7200 BA and 28 600 LI bull calves were controlled at weaning in the 277 BA and 298 LI analyzed herds. In those herds, a strong increase in the number of recorded animals was observed over time because 18 420 BA and 54 600 LI males were controlled at weaning in 2007.

Since 1991, 680 BA and 708 LI young bulls were controlled in performance test stations after being selected among the best ones at weaning. Each year, about 40 weaned males of each breed entered the performance test station between 7 and 9 months of age. At their arrival in the station, young males were split up into 2 or 3 control groups. Those control groups were made up of animals born within a 6-week period. Performance testing started for a fixed period of 18 weeks after 9 weeks of adaptation to the testing regime. In both breeds, bulls were weighted every 4 weeks. The amount of food distributed per bull was not strictly *ad libitum* and adjusted weekly in order to obtain an expected average daily gain of 1.3 kg/day in the Limousin breed and 1.5 kg/day in the Blonde d'Aquitaine breed. The whole test diet was composed of pellets composed of 29% alfalfa hay, 29% dehydrated beet pulp, 4% corn, 8% of other cereals (wheat and barley), 21% wheat bran, 4% sunflower oil cake and about 5% of other ingredients (including urea and minerals) to make a balanced diet. The composition of the test diet was assessed to be 0.73 Unité Fourragère Viande (UFV), the net energy of 1 kg of standard barley. Details on the French feed evaluation system can be obtained from Jarrige (1978). At the end of the test, the best bulls were selected according to an index combining final live weight (LW) adjusted to 450 days, residual feed intake (RFI) and muscle score (LM) recorded in the performance test stations (Fouilloux et al., 1999).

On average, 8 to 10 BA and 10 to 12 LI bulls were selected each year in the central test stations to be progeny tested on their slaughter value. Management in progeny test stations was similar to management in commercial fattening units. At their arrival in the test station, male progenies were gathered in age-contemporary groups (born within a 1 month-period). Performance tests of male calves started after a 1-month adaptation period. At the beginning of fattening tests, BA and LI calves were 8 and 10-month old, respectively. During the test period, calves were intensively fattened with corn silage distributed *ad libitum* and supplemented with protein feed. Live weight measurements were made monthly. Young bulls were slaughtered at a fixed age of 450 days for BA (410 days in the last 5 cohorts) and 480 days for LI animals. Carcass traits were recorded. In each progeny test station, different year batches were genetically connected through the use of 3 national reference sires (Foulley et al., 1983). Eventually, about 5 bulls per breed were selected each year for AI use, according to a total merit index including post-weaning growth, dressing percentage, carcass conformation for the BA breed and, in addition, the fatness carcass score for the LI breed.

2.3. Trait description

Among the diverse traits concerning growth, morphology, feed intake and carcass characteristics which were recorded