GENETIC PARAMETERS OF FEEDING TRAITS IN MEAT SHEEP

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INTRODUCTION

Selection in meat sheep concerns usually two groups of traits, on the one hand the reproductive performances and on the other hand the meat traits such as growth and body composition. One way to improve lamb production may be to increase the efficiency of feed transformation by lambs. To avoid behaviour problems it was necessary to be able to estimate individual feed intake of group-tested lambs. In order to do that, the first step of the study was to develop an automatic feeder adapted for young rams. Then from 1997 to 1999, several groups of young rams included in Individual Performance Tests also had their feed intake measured.

The genetic parameters have been estimated for feed intake, feed intake adjusted for weight, residual feed intake estimated by regression of feed intake on growth, weight and body composition. Traits used in selection : growth, adjusted weight, body composition and conformation were also considered. The opportunity of the use of these feeding traits in meat sheep selection will be discussed.

MATERIAL AND METHODS

The experiment took place at the experimental INRA farm of La Sapinière near Bourges in the centre part of France. Here, a total of 981 young rams of the breed INRA401 (Ricordeau *et al.*, 1992) were involved from 1997 to 1999 in French Individual Performance Test for Rams. The Test involves 2 weeks of adaptation and standardization for the young rams which are aged about 80 days when they are gathered from birth-flocks, and then 8 weeks of actual control from about 100 to 160 days of age (Perret *et al.*, 1994). The animals are fed *ad libitum* in order to exhibit their genetic potential. Weight is recorded at the beginning, mid and end of the control. Echotomography for backfat thickness and muscle depth (*longissimus dorsi*) is performed halfway through and at the end of the control. Conformation scoring and body defaults are checked at the end of the control. Rams are selected according to a synthetic index which combines indexes for growth, adjusted weight, body composition and conformation, every breed society defines its own weighting for the combination.

Among the rams controlled as previously described, 752 of them had their feed intake recorded. The concentrated pellet was composed of wheat, barley, soya and colza cake, beet pulp and molasses. The individual intake of these group-tested reared sheep was recorded with mono-place feeders for young rams, while they could get some unrecorded amount of hay. This automatic feeder is derived from the one developed for pig performance testing (Labroue *et al.*, 1999). Each time an animal visits the feeder the following data is recorded : its identification number encoded in an electronic tag, the exact time of entrance and exit, the difference of the weight of feed in the trough between these two within one gramme precision. A preliminary times experiment showed in 1996 that the growth of 80 rams fed with this apparatus was

equivalent to that of rams fed with collective feeders 371 g ± 52 g vs 358 g ± 54 g (François *et al.*, 1997). For each electronic or collective feeder twenty rams were penned in together.
The data was recorded by the feeders, then stored on the hard disk of the computer that drives the system and finally transfered to a data base. The estimation of the genetic parameters was performed with VCE Software (Neumaier and Groeneveld, 1998) under an animal model.

RESULTS AND DISCUSSION
Means and standard deviations are shown in table 1. The daily feed intake was on average 1,794 kg during the 8 weeks of the test with a standard deviation of 242 g. When adjusted for the weight at the start of the test, the standard deviation decreases to 189 g. The residual feed intake was zero on average by definition and 117 g on standard deviation.

Table 1. Statistics for feeding traits and selection traits

Variable	Description of the variable	N	Mean	Standard deviation
DFI	Daily Feed intake during 8 weeks	752	1794 g	242 g
AFI	DFI adjusted for Weight at start of test	752	1794 g	189 g
RFI	Residual feed intake adjusted for Weight at mid test, ADG, backfat and muscle depth	739	0	117 g
FE	Feed efficiency ADG/DFI adjusted for Weight at start	734	19.3 %	2.0 %
ADG	Average daily gain during 8 weeks	981	339 g	52 g
Backfat*	[backfat at mid + backfat at end]/2	969	81**	10.0**
Backfat50*	Backfat adjusted at 50kg from backfat at mid and backfat at end	967	79**	10.5**
Muscle*	[Muscle at mid+ Muscle at end]/2	969	255**	18.5**
Muscle50*	Muscle adjusted at 50kg from Muscle at mid and Muscle at end	967	255**	19.9**
Wmid	Weight at mid test	981	47.2 kg	5.4 kg

* Backfat and Muscle measured by echotomography at mid and at end of the test
** in 1/10mm (uncorrected for the velocity of ultrasounds)
Backfat = thickness of the backfat plus the skin.

Genetic parameters estimates. The heritabilities of the gross variables (Table 2) are 0.43 for the daily feed intake, 0.43 for the ADG, 0.46 for backfat thickness, 0.36 for muscle depth. They are rather high for ADG and backfat and rather low for muscle depth compared to those estimated with younger lambs in the same breed by Moreno *et al.* (2001) and Bibé *et al.* (2002). The genetic correlations of the DFI are very high with ADG (0.83) and with liveweight (0.85), consistent with backfat (0.31) and muscle depth (0.32). These strong correlations were then avoided by the adjustment of feed intake with weight, growth and body composition.

Table 2. Estimates of genetic parameters[A]
2.a. gross traits

Traits	DFI	ADG	Backfat	Muscle	Wmid
DFI	0.43	0.83	0.31	0.32	0.85
ADG		0.43	0.17	0.31	0.74
Backfat			0.46	0.26	0.18
Muscle				0.36	0.33
Wmid					0.36

2.b. adjusted traits

Traits	RFI	AFI	ADG	Backfat50	Muscle50	FE[B]
RFI	0.30	0.59	0	-0.05	0	-0.63
AFI		0.36	0.80	-0.16	-0.09	0.19
ADG			0.43	-0.33	-0.13	0.74
Backfat50				0.37	0.15	-0.42
Muscle50					0.23	-0.12
FE[B]						0.36

[B] FE=feed efficiency= ADG/DFI=1/FCR for 'feed conversion ratio'
[A]Heritabilities on the diagonal, genetic correlations above the diagonal

Regarding adjusted variables of feed intake, we firstly verify that residual feed intake is effectively independent of ADG, Backfat50 and Muscle50, the genetic correlations are close to zero. Consistent values of heritability are found for RFI (0.30), AFI (0.36) and FE (0.36).
FE is strongly linked to ADG (r=0.74), despite a great relation between growth and weight-adjusted feed intake (r=0.80). Muscular development is neutral whereas backfat is unfavourable: the genetic correlations are respectively –0.12 and –0.42 with FE.
RFI is linked to the adjusted daily feed intake (r=0.59) and with feed efficiency (r=- 0.63). RFI expresses the wasted feed by unefficient lambs in comparison to efficient ones both having the same phenotypic level for growth and body composition.
Such group-tested sheep feed intake references do not exist except for that of Cummins *et al.* (1997) who measured the individual intake of 17 yearling rams over a 2 month period and found about 2.7 kg/day for a liveweight of 79 kg. With beef cattle Arthur *et al.* (1999) found a higher heritability of RFI (0.43) but low genetic correlations with growth traits. The link between FE and growth is also found with beef cattle and pig (0.51 and 0.52, Bishop, and Cameron and Curran, cited by Cameron, 1998). In a one-generation divergent selection experiment, Arthur *et al.* (1999), found a very little genetic correlation between RFI and ADG (0.02) but a consistent one between RFI and liveweight at 365 days (- 0.25). With pig, Mrode and Kennedy (1993) found heritabilities of RFI ranged from 0.30 to 0.38, Labroue *et al.* (1999) found 0.24 both with Large White and French Landrace, Johnson *et al.* (1999) found a range from 0.10 to 0.17 for different calculations of RFI with Large White. With hens, Bordas *et al.* (1992) found a direct response in RFI significant in both sexes.
FE is undirectly improved in the current French sheep Individual Performance Test by the way of the favourable relationships with growth and lean. RFI direct selection could be relevant if

the cost of these electronic tools (Bibé *et al.*, 1997) is recouped by the genetic progress expectable with a genetic standard deviation 65 g.

CONCLUSION

The prominent results of the study show first a quite good feeding behaviour of group-tested sheep, a gregarious specy, with an individual feeder : less than 10% of lambs need a human assistance during the first 2 weeks. Then the growth was found to be similar in collective and electronic feeder. The results in term of feed intake and residual feed intake remained stable for the 4 years of the experiment. The genetic parameter estimates of RFI (consistent heritability, favourable genetic correlations with growth and body composition) allow the proposal of the selection for this trait. Since the year 2000, the experiment is carried out with other pellet without hay so the total feed intake is now measured. The effect of RFI on the growth of ewe lambs will also be studied.

ACKNOWLEDGEMENTS

This work was supported by a grant from the French Ministry of Agriculture and Fisheries and by a grant from the Region Centre.

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