ANGORA RABBIT WOOL PRODUCTION: HERITABILITY AND GENETIC CORRELATIONS FOR FLEECE WEIGHT ACCORDING TO AGE.[1]

ALLAIN D.[1], DE ROCHAMBEAU H.[1], THEBAULT R.G.[2], VRILLON J.L.[2]

[1] INRA C.R. Toulouse, Station d'Amélioration Génétique des Animaux, BP 27, 31326 Castanet Tolosan, France.
[2] INRA C.R. Poitou-Charentes, UE Génétique Animale Phanères, Le Magneraud, BP 52, 17700 Surgères, France

Abstract - Data on 1223 angora does which have made at least one wool harvest between the first and the fifth harvest were analysed in order to study genetic variability according to age.
Heritability estimates of the total fleece weigth for the first, the second, the third, the fourth and the fifth harvest were 0.30, 0.32, 0.22, 0.18 and 0.14, respectively. A signicant maternal environment effect has been observed on each of the five first. Maternal environment estimates which were significant on each harvest, ranged from 0.08 to 0.20. Genetic correlations of the total fleece weight between the first harvest and the four following ones were low (from 0.16 to 0.28). But genetic correlation estimates between the four following harvests were moderate to high, and ranged from 0.52 to 0.93. The highest estimate (0.93) was between the second and the fifth harvest. The result suggest that the second harvest would be a good predictor of breeding value for total fleece weight in the adult Angora rabbit.

INTRODUCTION

Heritabilities, genetic and phenotypic correlations for quantity of wool produced and several fleece characteristics have recently reported (ALLAIN *et al.*, 1996) in the adult doe. However in the Angora rabbit, there are large variations on phenotypic expression of fleece weight, due to the age of the animal. The total weight of wool harvested in the French breed increases rapidly up the fifth harvest (MAGOFKE *et al.*, 1982; ROUGEOT and THEBAULT, 1984; ROCHAMBEAU *et al.*, 1991). Total fleece weight at the first harvest is about 5 times lower than those observed at the fourth or fifth harvest (THEBAULT and ROCHAMBEAU, 1988). A knowledge of the extent of genetic variability according to the age of the animal and between the following harvest is a prerequisite for determining the optimal age to replace the animal stock.

This paper reports results from the estimation of variance components and genetic parameters of angora wool production according to the age of the animal when analysing data in the young and the adult Angora rabbit of the French breed.

MATERIAL AND METHODS

Data

The data available were from the angora rabbit farm of Institut National de la Recherche Agronomique at Le Magneraud, BP 52, Surgères, France. Studies were made on wool production of a total of 1223 angora does which have made at least one wool harvest between the first and the fifth harvest, and born between 1 January 1983 and 31 November 1995. The young rabbits were sexed at birth and most of the males were eliminated. In this way the size of the litters were reduced to less than six rabbits just after birth. The young rabbits were weaned four weeks later. At the age of eight weeks, the young rabbits were weighed and defleeced for the first time. At the age of 21 weeks, rabbits were weighed and defleeced a second time. Thereafter, they were defleeced every 14 weeks. At each harvest total fleece weight was recorded.

Management, feeding and housing conditions of the experimental population were previously given more exactly (ALLAIN *et al.*, 1996).
Characteristics of the data structure are summarized in Table 1.

[1] The authors dedicate this paper to Gabriel Blanié, technician of the experimental herd, who recently died.

Table 1 : Characteristics of the data structure

No. records in data		1223
No. animals in total		2055
	with own records	1364
No. Sires		200
	with own record	0
	with progeny in the data	174
No. dams		398
	with own record	287
	with progeny in the data	350

Analysis model

The estimates of variance components for different variables were obtained by using REML VCE, a multivariate multi model restricted maximum likehood variance component estimation (GROENEVELD, 1995) with an animal model.

Earlier investigations using fixed models of variance analysis have shown that in the growing young and the adult angora does, six fixed factors were considered to be important for the quantity of wool produced: live body weight as a covariable for the first two harvests, harvest number, birth season, harvest season, year of harvest and reproduction (ROCHAMBEAU *et al.*, 1991). Due to the experimental design, harvest number and harvest season effect were not introduced in the model. The five first harvests were considered as five different traits. Does being defleeced at regular interval from the birth, the birth season and the harvest season effects were confused.

The random part of the model consisted of a additive animal effect and an maternal environment effect as the total number of young does (n = 1223) were issued from 350 different dams and up to 16 doe were borned from different litters of the same dam along the whole experiment.

The general model is:

$$Y = Xf + Za + Qm + e$$

where

- Y is a vector of animal records (5 variables),
- f is a vector of fixed effects consisting of:
- year of first harvest production (13 levels),
- harvest season effect (4 levels) and,
- reproduction effect (2 levels: females which had litters or not) at the third, the fourth and the fifth harvest respectively.
- live body weight at 8 and 20 weeks of age as a coviable for the first and the second harvest respectively.
- a is a random vector of direct additive genetic effects of animals (n = 2055),
- c is a random vector of the maternal environment effect (n = 350),
- e is a random vector of residuals.

X, Z and Q are known design matrices which connect a, f and c with Y. X and Z depend on the trait considered because of missing values (only 608 does have 5 known harvest records).

RESULTS AND DISCUSSION

The total weight of wool harvested in the French breed increased rapidly from the first to the fifth harvest as shown on Table 2. This is in agreement with earlier observations (MAGOFKE *et al.*, 1982; ROUGEOT and THEBAULT, 1984; ROCHAMBEAU *et al.*, 1991).

Table 2: Mean and standard deviation of the total fleece weight for the first five harvests in female angora rabbits

Harvest number	# records	Mean	Standard deviation
1	1183	33.45	9.00
2	1080	150.86	31.41
3	977	200.20	35.14
4	880	228.76	38.89
5	780	235.67	42.63

Estimates of genetic and phenotypic parameters for total fleece weight at each harvest are given in Table 3. Heritability estimates were moderate to high and ranged from 0.14 to 0.32. The highest heritability was observed for the first and the second harvest, 0.30 and 0.32 respectively. The results observed from the third to the fifth harvest are lower than those obtained in a previous study (ALLAIN *et al.*, 1996). This difference could be due to the model as in the present study, a maternal effect has been taken into account for each harvest. Maternal environment estimates shown table 4 were positive and low to moderate at each harvest and ranged from 0.08 to 0.20. One explaination of this a maternal effect could be due to hair follicle development in the Angora rabbit. Hair follicle initiation occurs from the 12th day before birth and up to the age of 8 to 14 weeks when the young rabbit reaches the weight of 2 kg (ROUGEOT *et al.*, 1984). Thus any maternal influence *in utero* and/or before weaning could modify initiation and multiplication of hair follicles in the growing rabbit and consequently the number of active or producing hair follicles. Such a maternal effect could affect the Angora rabbit along its whole lifetime production. This hypothesis seems to be consistent with our results as a significant maternal effect was still observed on the fifth harvest when rabbits are 63 weeks of age.

Table 3: Heritability (on diagonal, heavy character) and genetic (above diagonal) and phenotypic (below diagonal) correlations of total fleece weight for the first five harvests in female Angora rabbits.

	1st harvest	2nd harvest	3rd harvest	4th harvest	5th harvest
1st harvest	0.30	0.21	0.16	0.16	0.28
2nd harvest	0.25	0.32	0.63	0.71	0.93
3rd harvest	0.08	0.20	0.22	0.52	0.60
4th harvest	0.27	0.23	0.37	0.18	0.70
5th harvest	0.22	0.44	0.19	0.37	0.14

Table 4: Maternal environmental variances relative to phenotypic variance (on diagonal) and maternal environmental correlations (off diagonal) on total fleece weight for the first five harvests in female Angora rabbits.

	1st harvest	2nd harvest	3rd harvest	4th harvest	5th harvest
1st harvest	0.14	0.25	-0.01	0.27	0.33
2nd harvest		0.15	0.09	0.29	0.32
3rd harvest			0.20	0.06	0.48
4th harvest				0.08	0.40
5th harvest					0.13

Genetic correlations of total fleece weight between the five first harvests were higher than phenotypic correlations. The first harvest was not highly correlated to the following harvests, estimates are low and ranged from 0.16 to 0.28. But between the four following harvests genetic correlations were positive, moderate to high and ranged from 0.52 to 0.93. Especially, genetic correlation estimates between the second harvest and the third, the fourth and the fifth harvest were 0.63, 0.71 and 0.93 respectively. This would indicate that the second harvest would be a good predictor of breeding value for total fleece weight in the Angora doe. Up till now, selection schemes are based on the performance recorded on adult animals for one year minimum or 4 succesive harvests from the third harvest (ROCHAMBEAU and THEBAULT, 1990).

The results suggest that for genetic improvement programme selection decision about animal stock replacement could occur with a good accuracy as soon as performance at the second harvest is known i.e at the age of 21 weeks.

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Production de poils chez le lapin Angora : héritabilité et corrélations génétiques pour le poids de la toison en fonction de l'âge - Nous avons analysé la production totale de poils à chaque récolte chez 1223 femelles angora au cours des 5 premières récoltes afin d'étudier la variabilité génétique en fonction de l'âge.
L'héritabilité du poids total de la toison à chacune des 5 premières récoltes est de 0,30, 0,32, 0,22, 0,18 et 0.14, respectivement. Pour chacune des récoltes étudiées, il existe un effet d'environnement maternel significatif compris entre 0,08 et 0,20. Les correlations génétiques entre la première récolte et les récoltes suivantes sont faibles (de 0,16 à 0,28). Par contre, les correlations génétiques entre les récoltes 2 à 5 sont élevées, en particulier entre la seconde récolte et les 3 suivantes: 0,63, 0,71 et 0,93 respectivement. Ce résultat suggère que la seconde récolte est un bon prédicteur de la valeur génétique du lapin angora adulte. Nous discutons les conséquences de ces résultats pour la sélection du lapin angora.