Use of crossbreeding to produce superfine wool IV. Characterization of the hybrids obtained in the third stage of crossing

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ABSTRACT

During the first stage of the experiment, Stavropoulos Merino ewes were mated to Australian Merino rams and during the second stage, the hybrids produced during the first stage and the Stavropoulos Merino ewes were mated to Pollwart rams. During the third stage of the experiment, the Stavropoulos Merino ewes that remained from the initial herd, the offspring from the first stage, which have ½ Australian Merino blood and the offspring from the second stage, which have ½ Pollwart blood were mated to Suseni Merino rams. The herd consisted of 30 Stavropoulos ewes, 64 female offspring having ½ Australian Merino blood, 34 female offspring having½ Pollwart blood and 7 rams. The rams were used for mating for two consecutive years and 70 hybrid ewes were produced in two series. The average phenotypical values of the ewes used to start the third stage were: fleece finesse 22.90 microns, coat weight 5.31 kg, body weight 39.44 kg. The rams had the following values: fleece finesse 18.91 microns, coat weight 6.0 kg, body weight 52.57 kg. The hybrids that resulted from the cross had the following values: fleece finesse 21.02, coat weight 4.49 kg, body weight 34.42 kg. During this stage of crossbreeding, the fleece finesse was improved by 1.52 microns compared to the second stage and by 2.63 microns compared to the initial experimental stage, which supports the hypothesis of the paper.

Keywords: Merino, superfine wool, crossbreeding

INTRODUCTION

The rotational cross can be used to replace grading up as means of obtaining superfine wool from commercial herds. The rotational cross is recommended so as to avoid the adverse effects on the dam organism (lower live mass, lower wool production, lower fertility) due the genetic correlations associated to the directional selection for superfine wool in the case of reproductive isolation (Cohen., 1980; Blair, 1984; Denney, 1990).

The procedure has the advantage of a very simple organization of the activity by the producers: only one sheep herd is used and the size of the herd can increase or decrease according to the circumstances. The only requirements are to replace the rams every two years, according to the breed rotation design, and to select adequate rams (Ghiță, 1997, 1998, 2001).

This paper is part IV of the synthesis on the use of rotational cross to produce superfine wool. The purpose and hypothesis of the experiment, the description of the rotational cross program and the results obtained during the first and second stages are presented in the first three parts of the paper published in IBNA Annals (Ghiță, 1997, 1998, 2001).

MATERIAL AND METHODS

During the third stage of the experiment, the Stavropoulos Merino ewes that remained from the initial herd, the offspring from the first stage, which have ½ Australian Merino blood and the offspring from the second stage, which have ½ Pollwart blood (Barbu, 1987; Dermengi, 1981) were mated to Suseni Merino rams. The dam stock used by the experiment totaled 128 sheep, the decrease in size being due to economic reasons that had no relation what so ever to the subject of the paper. The herd consisted of 30 Stavropoulos ewes, 64 female offspring having ½ Australian Merino blood, 34 female offspring having ½ Pollwart blood. The mean values of herd performance (Table 1) do not differ essentially from the previous ones, but the hereditary consolidation of the mean values is definitely much poorer than in the previous years because of the high proportion (76.6%) of hybrid animals within the herd.

We used 7 rams, which means less than 20 ewes by rams; Tale 2 shows the individual ram performance and Table 3 shows the average performance.

Table 1 Combination of breeds and statistical data of the herd at the start of stage III

	Breed/breed combination			**Statistical indicators**		
Trait	**MS**	**MS × MA**	**PW***	**n**	$\overline{X}$	**S²**
Fleece finesse (μ)	30	64	34	128	22.90	5.03
Amount of wool (kg)	30	64	34	128	5.31	0.97
Body weight (kg)	30	64	34	128	39.44	13.75

* PW = (MS + MS x MA) × PW

Table 2 Productive traits of the Suseni Merino rams

Tag number	**Fleece finesse (μ)**	**Amount of wool (kg)**	**Body weight (kg)**	**Fleece length (cm)**
31739	20.58	5.8	53	13.5
31967	19.56	6.5	56	12.0
31998	20.04	6.1	58	13.0
40011	16.16	6.0	48	9.5
40630	18.31	5.5	49	9.5
40899	17.55	5.6	48	9.0
40916	20.20	6.5	56	12.5

Table 3 Statistical indicators of ram performance

Trait	Statistical indicators				
	n	$\overline{X}$	S^2	s	CV%
Fleece finesse (μ)	7	18.91	2.564	1.629	8.61
Amount of wool (kg)	7	6.0	0.310	0.556	9.27
Body weight (kg)	7	52.57	17.952	4.237	8.06
Fleece length (cm)	7	11.28	3.571	1.889	16.74

The table shows that the average fleece finesse (18.91μ) is lower than that of the Australian Merino (19.7μ) and Pollwarth (19.27μ) rams. This was possible because the rams were selected directly from the herd before the selection for mating, fact than can also be ascertained from the average body weight (52.57 kg) of the 7 rams, which is lower than the average performance (54/55 kg) at the first shearing, reported by the developers of the breed (Văcaru, 1991; Dumitru et al., 1992; Pascal, 1998).

The average coat weight of the rams shows that the 6 kg of sheared wool is lower than the average value of the breed as reported by its developers (7.9-8.8 kg) for the yearlings selected for mating. The offspring of these rams is expected to yield poorer performance compared to the offspring of the previous crossing stages. The higher difference compared to the rams used in the previous stages of crossing is in the average fleece length, which is 11.28 cm in the Suseni Merino rams, 12.8 cm in the Australian Merino and 11.93 in Pollwarth. Fleece diameter also varies quite largely, between 16.16 microns in rams 40011 and 20.58 microns in ram 31379. However, the coefficient of variability for fleece finesse has a value quite similar to the coefficients of variability of the other traits.

Table 4 Statistical indicators of the average performance of the hybrid ewes of the third stage

Trait	Third stage	Statistical indicators							
		n	$\overline{X}$	S^2	s	CV%	min	max	Ampl.
Fleece finesse (μ)	First series	45	20.90	5.87	2.42	11.58	16.13	25.43	9.30
	Second series	25	21.23	3.70	1.92	9.06	16.66	24.12	7.46
Amount of wool (kg)	First series	45	4.71	0.94	0.97	20.60	2.5	6.9	4.4
	Second series	25	4.08	0.39	0.62	15.30	3.3	5.7	2.4
Body weight (kg)	First series	45	36.01	18.0	4.24	11.78	29.5	46.5	17.0
	Second series	25	31.56	15.31	3.91	12.40	24.5	37.6	13.1
Fleece length (cm)	First series	45	9.79	3.27	1.81	18.48	6.5	13.2	6.7
	Second series	25	8.74	0.83	0.91	10.41	7.0	10.0	3.0

RESULTS AND DISCUSSION

In the first series we obtained 45 hybrid ewes and in the second series we obtained 25 hybrid ewes, bringing the total to 70 hybrid ewes obtained in the third stage of crossing. Table 4 shows the average performance and the dispersion factors of this offspring. Table 4 shows that there were no significant differences between the two series of the third stage.

Table 5 shows the results of the Student test on the significance of differences between the average performances of the offspring from this stage of crossing.

Table 5 Significance of the difference between the mean performance of third stage hybrid ewes

Trait	Series	Trait mean	Calculated t	Table t	Significance
Fleece finesse (μ)	1	20.90	0.589	1.96	NS
	2	21.23			
Amount of wool (kg)	1	4.71	2.93	1.96	S
	2	4.08			
Body weight (kg)	1	36.01	4.32	1.96	S
	2	31.56			
Fleece length (cm)	1	9.79	2.71	1.96	S
	2	8.74			

Fleece finesse was slightly better in the first series than in the second series of the third stage, but the difference was not significant. The data shows that in this series fleece diameters was less than 21 microns, while it was slightly over 21 microns in the seconds series, which gave a mean finesse of 21 microns for the third stage.

The amount of sheared wool was lower in the second series. The difference is significant. This character has a quite high coefficient of variability in the first series (20.6%), but it was lower in the second series (15.3%). The amplitude of variance in the first series was large too (4.4 kg), which shows a great variability of the character within the herd.

Table 6 Statistical indicators of the average performance of the hybrid ewes of the second and third stage

Trait	Stage	Statistical indicators				
		n	$\overline{X}$	S^2	s	CV%
Fleece finesse (μ)	1	112	22.54	5.472	2.339	10.37
	2	70	21.02	5.056	2.248	10.69
Amount of wool (kg)	1	112	5.13	0.550	0.741	14.44
	2	70	4.49	0.834	0.913	20.34
Body weight (kg)	1	112	38.61	21.296	4.614	11.95
	2	70	34.42	21.410	4.62	13.44
Fleece length (cm)	1	112	11.68	2.328	1.526	13.06
	2	70	9.42	2.639	1.624	17.25

Body weight was lower in the second series compared to the first one, the difference being significant. The lower body weight and amount of sheared wool is accounted by the fact that the offspring of this series had poorer feeding conditions.

Fleece length was shorter in the second series than in the first one. The difference is significant.

We compared the performance of the offspring from the third stage with those of the offspring from the second stage, to see the effect of the third stage crossing. Table 6 shows the data. We than used the Student test to reveal the significance of the differences between the average performance of the offspring from the two stages of crossing (Table 7).

Table 7 Significance of the difference between the mean performance of the second and third stage hybrid ewes

Trait	Crossing stage	Trait mean	Calculated t	Table t	Signif.
Fleece finesse (μ)	2nd 3rd	22.54 21.02	4.33	1.96	S
Amount of wool (kg)	2nd 3rd	5.14 4.49	1.69	1.96	NS
Body weight (kg)	2nd 3rd	38.61 34.42	2.25	1.96	S
Fleece length (cm)	2nd 3rd	11.68 9.42	9.48	1.96	S

Analyzing the statistical indicators of performance of the ewes from the second and third crossing stage, one can observe that fleece finesse increased by 1.52 microns in the third stage compared to the second stage. The difference is significant. The higher finesse acquired from stage to stage supports the hypothesis of the work.

The amount of wool was 640 g lower in the offspring of the third stage compared to second stage offspring. The difference is not significant. Notice worthy also is the increase of the coefficient of variability from 14.44% in stage two to 20.34% in stage three.

Body weight was lower in stage three than in stage two. The difference is significant. This lower body weight is due to the influence of the environmental conditions and due to the feeding toxic infection of the ewes from stage three which affected their growth rate. Their resulting body weight was lower than in the other series of hybrid ewes.

The fleece length was also better in the ewes from stage two than in the ewes from stage three. The difference is significant. The coefficient of variability was higher for stage three than for stage two.

The correlation coefficients between fleece finesse, amount of wool and body weight were calculated in order to ascertain the reciprocal dependence of these traits. Table 8 shows that the correlations are poor in all three stages of crossing, which supports the veraciousness of the hypothesis proposed by the paper.

Table 8 Coefficients of correlation

Stage and series of crossing	Coefficients of correlation between:	
	Fleece finesse – amount of wool	**Fleece finesse – body weight**
Stage 1 – Series 1	+0.092	+0.139
Stage 1 – Series 2	+0.217	+0.005
Stage 2 – Series 1	+0.253	+0.008
Stage 2 – Series 2	+0.172	+0.193
Stage 3 – Series 1	+0.029	+0.122
Stage 3 – Series 2	+0.177	+0.139

In stage four of crossing, the Stavropoulos rams should have been used again, but because of the economic conjuncture of the Romanian agriculture it was not possible to get those rams at that time so that we used Merion rams with infusion of Palas Merino but they had many deficiencies of breed purity. Supporting this statement is that many offspring had brown or rusty wool, some had un-uniform wool as finesse, some of them even had thick fleece with marrow. These results were not even processed, the subsequent herd being formed without the offspring of this generation. In the future the herd will reproduce as any other commercial herd of sheep with fine wool.

PARTIAL CONCLUSIONS

Analysing the statistical indicators of the fleece finesse of stage three ewes compared to the fleece finesse of stage two ewes, one can notice that fleece finesse increased by 1.52 microns compared to stage two, the difference being significant.

The amount of wool was 640 g lower in stage three ewes compared to stage two ewes, the difference not being significant.

Body weight was lower in stage three ewes compared to stage two ewes, the difference being significant. The difference is significant. This lower body weight is due to the influence of the environmental conditions and due to the feeding toxic infection of the ewes from stage three which affected their growth rate. Their resulting body weight was lower than in the other series of hybrid ewes.

The fleece length was also better in the ewes from stage two than in the ewes from stage three. The difference is significant.

GENERAL CONCLUSIONS

The major economic traits of the ewes producing superfine wool are the fleece diameter, coat weight at the first shearing, body weight at the first shearing for the stock of ewes.

After the three stages of crossing, the final average values of the hybrid ewes show a 1.67μ reduction of the fleece diameter, which means 7.06% of the initial value; wool coat weight decreased by 0.35 kg, which means 6.57% of the initial value and body weight decreased by 2.34 kg, which means 5.9% of the initial value.

Table 9 Initial and final herd performance and ram performance

	Nr. of animals	**Fleece finesse, μ**	**Amount of wool, kg**	**Body weight, kg**
Initial herd	165	23.65	5.32	39.65
Australian merino rams	10	19.70	8.86	59.70
Pollwarth rams	8	19.27	5.73	57.00
Suseni Merino rams	7	18.91	6.00	52.57
Final herd	142	21.98	4.97	37.31

The gain is fleece finesse is higher as relative value than the loss of performance as amount of wool or body weight.

The first conclusion to be drawn is that the traits are inherited independently and that by choosing rams that associate the high finesse of the fleece with a large weight of the wool coat at the first shearing and a body weight higher than the average one, acceptable values for all three traits are inherited by the offspring. The influence on the average performance of the offspring was induced exclusively by ram selection.

Considering some traits of the offspring from stage 4, the success of the rotational crossing in general and the production of superfine wool in particular depends on the use of pure race rams, coming from consolidated populations. The use of genetically unconsolidated rams will fail the use of this procedure.

The rotational crossing can be applied as the simplified model used by our work using a single herd of dam ewes, without a mandatory selective reform of the offspring. The only technical requirement of the procedure is to select the rams by the criterion of fleece diameter and of minimal standards of the economic traits: wool coat weight and body weight at first shearing.

The values of the coefficients of correlation between the fleece diameter and the other two traits in the rams can be traced in the final herd too. This means that there is no risk that a coupling of the productive traits similar to the one resulting from directed selection for fleece finesse based on a single trait – fleece finesse, would result in the subsequent generations resulting from the rotational crossing.

Given that the experiment run on a long period, 8 years, starting from an important herd (Stavropoulos Merino), it would have been expected that the measured performance differ from stage to stage and within the stage in relation to the changes in the special environment of each offspring.

The environmental effect was felt strongest in the stage three offspring, where the average performance of body weight at first shearing was the lowest. A similar performance was noticed the year before, when the first obvious decrease of the performance was noticed. The same decrease in performance was also observed to a certain extent in the wool coat too. The values of the coefficients of variability were not influenced analogously because all the specimens from the same series undergo the same changes in the environment. The environmental effects are least expressed as fleece diameter and it is normal to be so since the heritability of this trait is much higher than the heritability of the other two traits (Gregory, 1981, 1982).

The environmental effect could express phenotypically with a higher influence in the traits with lower heritability.

The pattern effect was evaluated in relation to its specificity, namely that the intensity of the directed selection in the dam stock was null. Therefore, the pattern effect was evaluated as being half of the size of the difference of average performance of the fathers compared to the average performance of the mothers corrected for the effect of the sexual dimorphism and heritability of each trait.

This finding allows us to say that the hypothesis of the work is correct, namely it is possible to decrease the average diameter of the fleece in commercial herds without accompanying this reduction by a drastic reduction of the wool coat and body weight of the animals at the first shearing. Furthermore, the paternal effect can be evaluated if the environmental changes, particularly the feeding deficiencies, are not very large.

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