DEVELOPMENT OF A WHITE KARAKUL FLOCK

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ABSTRACT

A white Karakul sheep flock was developed from black Karakul sheep with white markings on the tail and head. Animals were selected on the basis of the degree of whiteness. 1020 records from the period 1962 to 1982 were analysed to determine the heritability, environmental and genetic trends and to investigate the inheritance of white markings.

Economic important traits namely, hair quality, pattern score and curl type were analysed and heritability values of 0.33, 0.38 and 0.68 have been calculated, respectively. A heritability of 0.91 was calculated for degree of whiteness with a genetic change of 0.17 score units per annum. This is an indication of the possibility of a major gene involved in the trait. Selection for degree of whiteness was highly effective. The experimental flock was changed from almost black (average degree of whiteness = 10% white) to almost entirely white (average degree of whiteness = 80 % white).

INTRODUCTION

In the past an attempt was made by the University of Halle, Germany, to breed a white Karakul from purebred black parents with white markings. This effort was unsuccessful and discontinued in 1948 as the white sheep obtained were of a piebald nature. No further selection towards the breeding of a white sheep was made. Other evidence of attempts to breed white sheep are those of Cook (1950) who mentioned a white Karakul bred in America from light brown Karakul sheep with white markings and Gigineschvyli (1971) who mentioned the "gagarin"-white in the USSR, which was selected from Platinum-Sur Karakul sheep.

Since 1954, an effort has again been made at the Experimental Farm Gellap-Ost in Namibia to breed white Karakul sheep from black stud Karakul sheep with white markings. The 1954-1963 data were analysed by Nel (1967). He felt that, with the slow progress in Namibia and the unsuccessful attempt by the University of Halle, a completely white Karakul will not be obtained easily. An attempt was nevertheless made at the Gellap-Ost Research Station by the Department of Agriculture in Namibia, to try to breed a pure white Karakul from this experimental flock.

MATERIALS AND METHODS

Source of data.

Black Karakul sheep with white markings from the Gellap-Ost Karakul stud flock were used as basic stock (Tables 2 - 4). Animals were selected for a high degree of whiteness and 38 rams with a mean degree of whiteness of 7.12 were used from 1962 to 1982. Data for 1978 and 1979 is not available because the project was temporarily discontinued. During that time those animals were mated to dominant white animals in a crossbreeding pro-gramme in order to improve the pelt quality of the flock (Chapter 4). Most of the lambs were born during three lambing seasons per year, namely March/April, June/July and September/October.

The data consists of 1020 records of animals born during 1962 to 1982.

Observations

Observations were done on day old lambs and on both sexes. Initially selection was applied for the degree of whiteness only. At a much later stage some emphasis was placed on improving pelt quality. Three traits namely curl type, hair quality and pattern score were considered. These traits were considered by Nel (1967), Schoeman & Nel (1969) and Van Niekerk (1972) to be the most important traits in the Karakul.

In order to present the degree of whiteness, a point system was compiled to describe the extent and distribution of colour together with the estimated amount of white as a percentage of the total colour (Table 1).

TABLE 1: SCORES AND PERCENTAGE WHITE ALLOCATED ACCORDING TO THE EXTENT AND DISTRIBUTION OF COLOUR. (SCORES ALLOCATED BY NEL (1967) ARE SHOWN IN BRACKETS).

	Score	% White
Self-black	1 (1)	0
White tip to the tail	2 (2)	5
White crown on head	2 (3)	5
White tip and crown	3 (4)	10
White tip, crown, extremities (i.e. other areas of the head, or ears, or legs, or tail)	4 (5)	20
White tip, crown, extremities and body (where white markings encroach the body)	5 (6)	30
Piebald	6 (7)	50
Predominantly white	7 (8)	75
White with few pigmented spots	8 (9)	95
Practically all white	9 (10)	100

Curl type, hair quality and pattern score were subjectively evaluated on a one to nine scale. This was according to the procedure laid down by the Karakul Breeders Association of Southern Africa (Anonymous, 1982). Each curl type classification was converted to a numerical code from one (Galiac or smooth with no curl development) to nine (pipe curl or fully developed). All three traits were considered to be continuous.

Statistical analysis

Heritability estimates were obtained by using a single-trait derivative-free animal model REML programme (DFREML) of Meyer (1989). The same model has been fitted on all four traits.

It is important to note that the percentage white gradually increased (Table 2). Fenotypically the trait was expressed like a true quantitative trait. This was accepted and the below mentioned model fixed onto the data.

The following mixed model was fitted to the data for the estimation of variance components (heritabilities) and prediction of breeding values:

$$Y_{ijklm} = \mu + A_i + B_j + C_k + D_l + Z_m + e_{ijklm}$$

where:

Y_{ijklm} = the individual observation for the appropriate trait.
μ = the population mean for the appropriate trait.
A_i = the fixed effect of the ith year of birth (1962 to1982).
B_j = the fixed effect of the jth month of birth, with 12 levels.
C_k = the fixed effect of the kth birth weight group (7 groups).
D_l = the fixed effect of the lth sex of lamb.
Z_m = the random genetic (breeding value) effect of the mth animal (1112 animals).
e_{ijklm} = random error.

DFUNIS, a more general estimation programme was used. It uses the Simplex method to locate the maximum of the likelihood function as was discussed by Meyer (1989). Convergence criterion was set at 0.1 x 10-9. This criterion was reached after 7, 10, 6 and 10 iterations for quality, curl type, pattern score and degree of whiteness respectively. The number of likelihoods evaluated were 16, 22, 14 and 22 for the four traits hair quality, curl type, pattern score and degree of whiteness, respectively.

RESULTS AND DISCUSSION

Degree of whiteness

The average degree of whiteness per year for the lambs, rams and ewes, is shown in Table 2.

TABLE 2: AVERAGE DEGREE OF WHITENESS PER YEAR.

	Average Degree of Whiteness		
Year	Lamb	Ram	Ewe
1962	3.8	4.0	3.4
1963	3.5	4.5	3.1
1964	4.3	5.0	3.1
1965	3.8	5.0	3.2
1966	4.3	5.0	3.4
1967	4.3	5.3	3.5
1968	4.0	5.2	3.4
1969	4.2	5.2	3.7
1970	4.2	5.5	3.8
1971	4.4	6.3	4.0
1972	5.0	7.7	4.1
1973	5.4	7.7	4.8
1974	6.3	7.8	4.7
1975	6.2	8.1	4.6
1976	6.5	8.2	5.9
1977	6.4	8.2	5.6
1978	-	-	-
1979	-	-	-
1980	7.1	8.0	6.3
1981	7.0	8.2	6.8
1982	7.2	7.9	6.5

The average degree of whiteness for the ewes used throughout the years did not exceed a piebald stage (Table 1).

Breeding data

The results shown by Nel (1967) for the 1954 to 1962 data were transformed and combined with the present data and are shown in Table 3. The average score between the ram and ewe was taken as the mating type.

With an increase of the white area according to the mating type (Table 3), the average degree of whiteness (% white) increased in the progeny. Mating types of 5.0 and higher produced some progeny which were practically all white.

The average degree of whiteness for ewes and their progeny, mated to rams that differ in degree of whiteness, is shown in Table 4.

The average degree of whiteness of the progeny (Table 4) shows an increase with an increase in the degree of whiteness of the sires. On average the progeny was 12 percent more white than their dams, but 8.6 percent less white than the midparent value.

TABLE 3: BREEDING RESULTS WITH REGARD TO THE DEGREE OF WHITENESS OF THE MATING TYPE AND PROGENY, 1954 -1985.

Average	Distribution of progeny by whiteness score											%
mating type	1	2	3	4	5	6	7	8	9	n*	X **	White
2.0-2.5	4	8	7	-	-	-	-	-	-	19	2.2	5.8
3.0-3.5	4	3	20	8	4	-	-	-	-	39	3.1	12.6
4.0-4.5	7	3	55	112	39	5	3	-	-	224	3.9	19.9
5.0-5.5	8	2	27	55	48	18	6	8	3	175	4.5	29.9
6.0-6.5	-	1	8	30	88	53	46	26	4	256	5.7	48.0
7.0-7.5	-	-	1	2	17	46	98	71	11	246	7.0	73.4
8.0-8.5	-	-	2	-	1	7	24	52	29	115	7.8	87.3
9.0	-	-	-	-	-	1	-	3	1	5	7.8	87.0
TOTAL	23	17	120	207	197	130	177	160	48	1079	5.2	45.5

* Number of progeny
** Average

TABLE 4: THE AVERAGE DEGREE OF WHITENESS FOR EWES AND THEIR PROGENY MATED TO RAMS THAT DIFFERED IN DEGREE OF WHITENESS.

	DEGREE OF WHITENESS				
n*	Ram	Ewe	(S.E)**	Progeny	(S.E)
203	5	3.9^a	(0.24)	4.6^{ab}	(0.20)
42	6	3.5^a	(0.65)	4.0^a	(0.16)
119	7	4.9^a	(0.36)	5.2^b	(0.28)
522	8	5.9^b	(0.20)	6.7^c	(0.13)
107	9	6.3^b	(0.47)	7.0^c	(0.35)

a,b,c Means in the same column with different superscripts differ significantly ($P < 0.05$).
* Number of progeny
** Standard Error

Mean, standard deviation, coefficient of variation and heritability.

The mean, standard deviation, coefficient of variation and heritability of the degree of whiteness are presented in Table 5.

TABLE 5: MEAN ($\bar{X}$), STANDARD DEVIATION (SD), COEFFICIENT OF VARIATION (CV%) AND HERITABILITY (H^2) OF THE DEGREE OF WHITENESS FOR LAMBS BORN DURING THE TEST PERIOD (N=1020).

	$\bar{X}$	SD	CV%	h^2
Whiteness	5.74	1.82	31.63	0.91

The large standard deviation and coefficient of variation (Table 5) are, according to Van Niekerk (1972), normal features of subjectively evaluated traits. The exceptional high heritability of degree of whiteness may be a possible indication of a major gene or genes involved in the expression of the white colour. According to Hanset (1982), a higher heritability is expected in a population where major genes are segregating. Modifying genes can also play a role in the expression of these major genes. Lasley (1972) mentioned the example of spotting of the coat in Holstein cattle, where modifying genes are responsible for the expression of the genes for spotting.

Adalsteinsson (1976) estimated the heritability of the tan colour on the Iceland sheep on 0.46 by regression of offspring on midparent values. Heritability estimates of 0.54 (Nel, 1967) and 0.64 (Gouws, 1974) were obtained for the intensity of the grey and brown colour respectively.

Genetic trend

The genetic trend for degree of whiteness is illustrated in Figure 1.

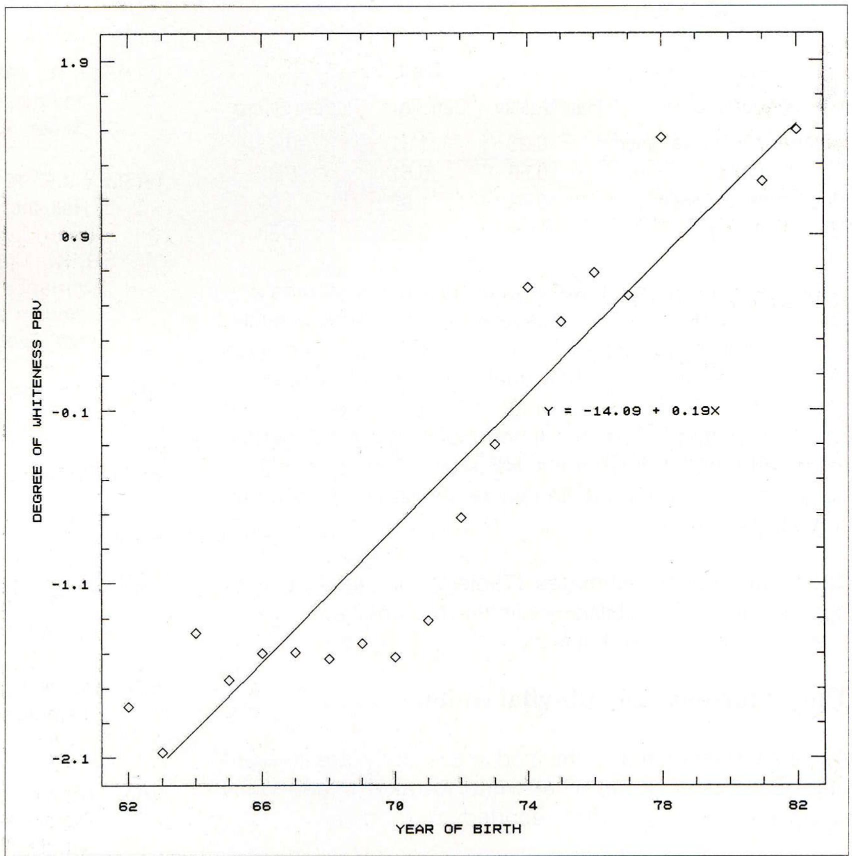

FIGURE 1. GENETIC TREND FOR DEGREE OF WHITENESS. (R^2 = 88.4%)

It is clear that selection for degree of whiteness was effective (Fig. 1). The genetic change for degree of whiteness was positive with 0.19 score units or a 5% increase per annum. The initially slow progress could possibly be due to the small selection differential in the beginning of the experiment. The average degree of whiteness for rams used in 1969, 1970, 1971 and 1972 were 5.2, 5.5, 6.4 and 7.7 respectively (Table 1).

No progress was made from 1974 to 1977. During this period, the number of animals born was the highest, which possibly indicate that the intensity of selection in the proceeding years dropped in order to increase the number of breeding animals.

The progress in 1980, after the two year of interruption, was the highest. According to Table 1 only one ram with a degree of whiteness of 8 (95% white) was used in 1980 which could have caused the markedly increase.

Important traits

Hair quality, curl type and pattern scores were considered and included.

Means, standard deviation and coefficient of variation.

The means, standard deviation and coefficient of variation of the three traits are presented in Table 6.

TABLE 6: MEANS (X), STANDARD DEVIATION (SD) AND COEFFICIENT OF VARIATION (CV%) FOR THE THREE TRAITS (N =1020).

	Trait		
	Hair Quality	Curl Type	Pattern Score
$\bar{X}$	5.90	4.86	2.74
SD	0.87	1.52	1.08
CV%	15.52	32.45	39.54

The low mean value of 2.74 for pattern score (Table 6) is probably the result of selection which was based on the degree of whiteness only. The mean value of 4.68 for curl type represents a shallow-watersilk type which is the more popular type in Karakul breeding.

The relative large standard deviations are normal since these traits are all evaluated subjectively. The coefficient of variation for hair quality is lower than for the other traits. This was also found by Van Niekerk (1972) and according to Schoeman (1968), this could be due to the differences in the way in which hair quality has been evaluated. Most judges usually score values close to the mid-value (5, 6 or 7) while others may tend to include the extreme values (2, 3, 4, 8, or 9) in their evaluation.

Estimates of heritability.

Table 7 presents the components of variance and the heritability estimates for hair quality, curl type and pattern score.

TABLE 7: VARIANCE COMPONENTS AND HERITABILITY (H^2) ESTIMATES OF THE THREE TRAITS RECORDED (N = 1020).

	Trait		
Parameter	Hair Quality	Curl Type	Pattern Score
Additive genetic variance	0.26	1.31	0.42
Error variance	0.53	0.61	0.67
Phenotypic variance	0.79	1.92	1.09
Heritability (h^2)	0.33	0.68	0.38

Schoeman & Albertyn (1992) reported several studies and showed a range of h^2 estimates as well as the median values for hair quality, curl type and pattern score. According to this, the h^2 estimates of hair quality, curl type and pattern score (Table 7) are in the range of h^2 estimates, but curl type and pattern score are much higher than the median value reported for these traits. Heritability for hair quality is complying to with the median value showed by Schoeman & Albertyn (1992).

These heritability estimates (Table 7) are also in good agreement with heritabilities estimated by Greeff *et al.* (1993) in a black control Karakul flock.

The occurrence of sub-vital white.

As these white animals, obtained in this study, are inherent black no cases of sub-vital white Karakul sheep were expected. None have been reported.

CONCLUSION

Selection for increased white seems to be effective as the heritability for degree of whiteness is quite high. A more than expected (5% per annum) increase in degree of whiteness was obtained in this experiment. This together with the exceptionally high h^2 indicate the possibility of major gene(s) involvement.

The only way to increase the numbers of these white animals is upgrading black Karakul sheep. This is time consuming with a lot of undesirable low value piebald pelts being produced before white animals can be obtained. Selection for better pelt quality will further slow down this process.

Breeding white Karakul sheep from black Karakul sheep with white markings is therefore possible but not feasible.

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