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PHENOTYPIC AND GENETIC ASPECTS OF PRODUCTION IN THE DOHNE MERINO
II. ESTIMATION OF HERITABILITIES OF PRODUCTION TRAITS*

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OPSOMMING: FENOTIPIESE- EN GENETIESE ASPEKTE VAN PRODUKSIE BY DIE MERINO
2. BERAMING VAN OORERFLIKHEDE VAN PRODUKSIE-EIENSKAPPE

Produksiedata van 366 individue uit die Ontwikkelingsprogram van die Dohnemerino te Dohne Landbounavorsingsinstituut is gebruik vir die beraming van die oorerflikhede van 15 produksie-eienskappe. Die data is ontleed voor en na korreksie vir sekere identifiseerbare omgewingsfaktore en 'n halfsib-analisetegniek is toegepas.

Die grootte van die oorerflikheidswaardes vir liggaamsmassa het toegeneem van geboorte (0,208 ± 0,142) tot op 180-dae-ouderdom (0,528 ± 0,189) behalwe die waarde vir 42-dae-ouderdom (0,017 ± 0,109) wat laer was. Die oorerflikhede vir 12- en 18-maande-liggaamsmassa (0,365 ± 0,166 en 0,341 ± 0,163) was ook laer as dié vir 180-dae-massa. Hiervolgens wil dit voorkom asof 180-dae-ouderdom die beste stadium van seleksie mag wees vir vetlamproduksie met die Dohnemerino.

Vir rouvagmassa op 18-maande-ouderdom was die oorerflikheid 0,292 ± 0,155. Al die beraamde waardes (behalwe dié vir 42-dae-liggaamsmassa) val binne die grense van die hoogste en laagste waardes wat vir soortgelyke kenmerke by ander skaaprasse, gepubliseer is. Bevredigende genetiese vordering kan dus by die Dohnemerino verwag word met individuele seleksie vir hierdie kenmerke.

SUMMARY:

Production data of 366 individuals in the Dohne Merino Development programme at the Dohne Agricultural Research Institute, were used for the estimation of the heritabilities of 15 production traits. Halfsib analyses were applied to data corrected for identifiable environmental factors and to uncorrected data. The magnitude of heritabilities for body mass increased from birth (0,208 ± 0,142) to 180 days of age (0,528 ± 0,189). The value for 42 days of age (0,017 ± 0,109) however, approached zero. The heritabilities for 12 and 18 month body mass (0,365 ± 0,166 and 0,341 ± 0,163) were also lower than that for 180 days of age. According to these results 180 day body mass appears to be the most promising selection criterion for lamb production with the Dohne Merino.

Greasy fleece mass had a heritability of 0,292 ± 0,155 at 18 months of age. All the estimated heritabilities (excluding 42 day body mass) fell within the ranges of highest and lowest values published for similar traits in other breeds of sheep. Satisfactory genetic improvement may be expected therefore, when selecting Dohne Merino sheep for these characters on an individual basis.

Knowledge of the genetic parameters of farm animal flocks is a basic requisite for meaningful formulation of efficient breeding plans. The degree of heritability is the most important genetic parameter as it indicates not only the appropriate method of selection but also the expected genetic response (Falconer, 1961). When a production trait has a high heritability and is expressed in both sexes, a satisfactory response may be expected when practising individual selection combined with random mating. Production traits with a medium to low heritability will respond more rapidly to some form of family selection (Turner & Young, 1969).

The Dohne Merino is a new wool-mutton sheep breed developed for the grassveld regions by mating South African Mutton Merino rams to South African Merino ewes. The present paper reports the first heritability values estimated for this young sheep breed.

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Procedures

Production data extracted from the Development Programme of the Dohne Merino was used for the estimation of heritabilities of production traits. The data were collected from 1969 to 1976 and included observations of 366 individuals sired by a total of 41 rams, giving an average of 9 progeny per sire (7 to 11 progeny/sire). The 366 individuals measured for wool traits, ranged in age from 1,5 to 9,5 years, the smallest age group (9,5 years) containing 24 ewes and the largest (3,5 years) 72 ewes. Least-squares analysis procedures (Harvey, 1960) were applied to correct the data for identifiable environmental factors. This included year of birth, type of birth, sex and age of a dam. Heritabilities were estimated by halfsib analyses on corrected as well as uncorrected data.

The reason why the data of only 366 individuals were selected for the estimation of heritabilities, may be explained as follows. The Dohne Merino Development Programme required a balance between growth, conformation and wool traits with the result that some highly merited rams were used for longer periods than desirable for an optimum experimental layout for the determination of genetic parameters. This situation was responsible for an insufficient number of rams used within years as well as for an unequal number of progeny per ram. Therefore, it is imperative that experiments designed for the estimation of genetic parameters should include a sufficient number of rams per year and special care must be taken that individual rams are not used over too long a period.

Results and discussion

Predictions of selection response in production traits are dependent on the degree of resemblance between the phenotype and the breeding value of farm animals. Heritability values of the body mass and wool traits of the Dohne Merino will be discussed separately.

Body mass traits

Growth rate is one of the most important traits in mutton producing sheep. Body mass at a specific age and body mass gain both indicate growth rate. The heritability estimates of 8 body mass traits are presented in Table 1.

With regard to the uncorrected data it was found that the between sire variance was significant ($P \leqslant 0,01$) in all the body mass traits except for mass at 42 days of age. The heritabilities for body mass at 60 days, 120 days and 180 days of age were higher for the corrected than for the uncorrected data. Shelton & Campbell (1962) found that the heritability of weaning mass in Rambouillet lambs increased when correction factors were applied. It must be stated however, that due to the small amount of data in the present study, differences between heritabilities were not tested for significance. In contrast, however, the heritabilities of body mass at 12 and 18 months of age were lower in the corrected data. Similar results were obtained by Heydenrych (1975) in Merino sheep. This is of course an unexpected result as the application of proper correction factors should decrease the environmental variance so that the additive genetic variance forms a larger proportion of the total phenotypic variance.

Table 1

Heritability estimates of 8 body mass traits of Dohne Merino sheep

Characteristic	Uncorrected		Corrected	
	h^2	SE	h^2	SE
Birth mass	0,403	0,172	0,208	0,142
42 day body mass	0,023	0,110	0,017	0,109
60 day body mass	0,321	0,160	0,399	0,171
100 day body mass	0,444	0,177	0,390	0,170
120 day body mass	0,447	0,178	0,454	0,179
180 day body mass	0,433	0,176	0,528	0,189
12 month body mass	0,398	0,171	0,365	0,166
18 month body mass	0,604	0,198	0,341	0,163

The heritability for birth mass (0,208 ± 0,142) was in agreement with values reported for other breeds (Vosloo, 1967 and Kotze, 1976 working with South African Mutton Merino and Heydenrych, 1975 working with South African Merino sheep). The relatively large standard error of this estimate may be caused by the unsatisfactory experimental outlay as the Dohne Merino Development Programme was not originally designed to accommodate the estimation of genetic parameters. However, the procedure followed to record birth mass may have also contributed as birth mass of lambs was recorded only once every 24 h when newly born lambs were ear tagged. Campbell (1974) found that the weighing of lambs even as soon as 12 h *post partum* was too late for an accurate estimate of heritability.

The heritability of body mass at 42 days of age (0,017 ± 0,109) was very low as was also found by Heydenrych (1975) for Merino sheep and by Van der Merwe (1976) for Dormers. Although the present value is inaccurate it indicates a large contribution by one or more non-genetic factors to the total phenotypic variance. The influence of the ewe's milk production on the growth of single lambs in comparison with twins, may be an important causal factor in this case.

With regard to the other preweaning traits, the estimated values were in agreement with those of Osman & Bradford (1965) for a Targhee x Corriedale crossbred flock and those of Dass & Acharya (1970) for Bikaneri sheep; both papers reporting values greater than 0,3. The finding of Owen (1971) that the heritability of body mass at a fixed age decreases with the age at measurement, is substan-

tiated by the present results. On the other hand, it was found that body mass at 12 and 18 months of age had lower heritabilities than body mass at 180 days of age. The values of 0,365 ± 0,166 and 0,341 ± 0,163 for 12 and 18 month body mass respectively, are acceptable, however, they are lower than most published values (Turner & Young, 1969 and Heydenrych, 1975 for Merinos, Dass & Acharya, 1970 for Bikaneries and Van der Merwe, 1976 for Dormers). It is surprising that the heritability of body mass increased from 60 days of age (0,399 ± 0,171) to 180 days of age (0,528 ± 0,189), but then decreased sharply (35%) to 18 months of age. This tendency contradicts the results of Heydenrych (1975) and Van der Merwe (1976) for Merinos and Dormers respectively. These workers found that the heritability of body mass increased up to 18 months of age.

Wool traits

Sheep wool is still one of the most important textile fibres and consequently it has also an appreciable economic value, even in breeds which are presently classed as wool-mutton types. Thus, it is imperative that the traits, wool quantity, as well as wool quality, should also be improved in wool-mutton types of sheep. The heritabilities estimated on uncorrected data of 6 wool traits of sheep ranging in age from 1,5 to 9,5 years, as well as of greasy wool mass at 18 months of age are presented in Table 2.

The standard errors in Table 2 show that although only 366 sheep were included in the sample, the heritabilities of the 7 wool traits were estimated with reasonable accuracy. For greasy fleece mass at 18 months of age, the heritability estimated on corrected data (not shown in Table 2) was 0,292 ± 0,155. This value is lower than the heritability of 0,42 ± 0,05 estimated for 18 month greasy fleece mass of Merino sheep by Brown & Turner (1968) and the estimate of 0,47 ± 0,13 by Bosman (1957) and 0,398 ± 0,081 by Heydenrych (1975) for the same breed. On the other hand, the present value for Dohne Merino sheep compares very well with the estimates of 0,31 ± 0,10 for Rambouillets (Veseley, Peters, Slen & Robinson, 1970) and 0,30 ± 0,071 for Corriedales (Mullaney, Brown, Young & Hyland, 1970).

Table 2

Heritability estimates of 7 wool traits in Dohne Merino sheep, using uncorrected data collected from 1969 to 1979

Characteristic	h^2	SE
Greasy fleece mass at 18 months of age	0,545*	0,191*
Staple length	0,627	0,201
Fibre diameter	0,595	0,197
Crimp frequency	0,465	0,191
Greasy fleece mass	0,398	0,171
Percentage clean yield	0,330	0,161
Clean fleece mass	0,251	0,149

*Values based on observations made at a fixed age; all other values are based on data from sheep of different age groups.

With regard to the other 6 wool traits, heritability estimates were also made on corrected data, however, the estimates proved to be inaccurate. Apparently this phenomenon was caused by inaccurate correction factors. The correction factors for greasy fleece mass at 18 months of age were based on 4552 sheep and proved reasonably accurate. On the other hand, the factors for the other 6 wool traits were based on only 366 sheep; these being the only animals for which complete wool data were available.

Nevertheless, the heritabilities estimated on uncorrected data for the 6 wool traits in the present study, compared fairly well with values estimated on uncorrected data for Merino sheep by Heydenrych (1975). It must be remembered however, that the present data included sheep from different age groups, while Heydenrych's (1975) data included only 2 tooth sheep (18 months of age). Furthermore, the similarity of the present heritability values with those of Heydenrych (1975) does not give sufficient evidence for the assumption that the present estimates also apply to the same traits in 18 months old Dohne Merino sheep.

General discussion

As expected some production traits had a higher heritability when estimated with corrected data than with uncorrected data. However, the reverse situation was also observed. Most probably this tendency was caused by the confounding of ram and year effects. Nevertheless, the between sire component of variance was significant ($P \leqslant 0,01$) for all traits except 42 day body mass in the uncorrected data, and for all traits except birth and 42 day body mass in the corrected data.

Van der Merwe (1979) discussed evidence indicating that the preweaning growth rate of lambs is an inefficient selection criterion for increased mutton production. Postweaning growth rate must therefore be considered. In contrast to the general policy that 2 tooth body mass must be used as selection criterion for increased mutton production, the present results indicate that 180 day body mass (h^2 = 0,528 ± 0,189) may be a more efficient selection criterion than 12 month (h^2 = 0,365 ± 0,166) or 18 month body mass (h^2 = 0,341 ± 0,163) in Dohne Merino sheep. The apparently higher heritability at 180 days of age may be an indication of precocity in this sheep breed. Since growth rate is such an important economic trait in lamb production which should be included in breeding plans for Dohne Merino sheep, further investigation of 180 day body mass as a selection criterion is justified.

The heritability estimate for greasy fleece mass at 18 months of age ($h^2 = 0{,}292 \pm 0{,}155$) indicates that reasonable response may be expected for this character when mass selection is applied. With regard to the other wool traits, it is expected that their true heritabilities at 18 months of age will not differ greatly from the present values based on data from sheep of different age groups (1,5 to 9,5 years). Although insufficient observations (366) were available for accurate estimation of correction factors or for heritability values it gave at least some idea of the magnitude of these values and of the appropriate selection methods.

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