# GENETIC IMPROVEMENT OF AUSTRALIAN ANGORA GOATS


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## INTRODUCTION

One can anticipate that any future large-scale Australian mohair industry will be based on commercial herds which produce virtually all the fibre and meat from Angoras and that studs will constitute only a small proportion of the total population. The commercial herds will purchase replacement bucks from studs and therefore will be dependent on selection policies in the studs for permanent genetic improvement. Hence it is essential that the breeding objectives in stud herds include those traits which make an important contribution to the income of the commercial Angora goat producer.

Alternatively, part or all of the industry could be organised in the form of co-operative breeding groups. However, irrespective of the structure of the industry, the traits in the breeding objective would be the same.

## DEFINITION OF THE BREEDING OBJECTIVE

The first and most important step in the design of a breeding program is the definition of the breeding objective. The development of the breeding objective involves the following three steps:

(i) Identification of the various sources of financial returns and costs to the commercial producer.

(ii) Determination of which animal charisteristics influence the financial returns and costs.

(iii) Calculation of the relative economic value of each characteristic.

With a commercial herd of Angora goats, income is generated from the sale of mohair, surplus offspring, and cast-for-age animals. The income sources and the animal traits influencing them can be summarised as follows:

| *Income Source* | *Traits Influencing Income* |
|---|---|
| Mohair – quantity | Clean fleeceweight |
| – quality | Fibre diameter |
| | Medullated fibres |
| | Staple length |
| | Colour |
| Surplus offspring | Number of kids weaned |
| | Sale weight |
| Cast-for-age animals | Sale weight |

The major costs associated with a commercial Angora herd involve feeding, health, labour, and marketing. However, a lack of economic and genetic information about animal traits influencing such sources of costs makes their inclusion in the breeding objective difficult at present.

## CHOICE OF SELECTION CRITERIA

Once the breeding objective has been defined, it is necessary to choose selection criteria; that is, characteristics that are measured or assessed on the individual goat itself or its relatives. These characteristics are used by the breeder to assess the breeding value of potential replacement animals and so decide which animals will become the parents of the next generation.

### Culling for Faults

The first step in choosing replacement animals should be the visual appraisal of all animals and the rejection of those with physical defects or with fleece faults such as presence of pigmented fibres.

### Selection Among 'Acceptable' Animals

Selection criteria should have the following attributes:

(i) Provide genetic information about the traits in the breeding objective.
(ii) Be measurable or assessable, preferably before breeding age is attained.
(iii) Provide the desired information at minimum cost and technical difficulty.

Some potential selection criteria appropriate for the breeding objective defined earlier are listed below:

| *Selection Criteria* | *Bucks* | *Does* |
|---|---|---|
| Greasy fleeceweight | √ | √ |
| Clean fleeceweight | √ | |
| Yield | √ | |
| Fibre diameter | √ | |
| Staple length | √ | |
| Kemp score | √ | √ |
| Percentage medullated fibres | √ | |
| Number of kids born or weaned (dam's – one or more records) | √ | √ |
| Number of kids born or weaned (own – one or more records) | | √ |
| Bodyweight (at various ages) | √ | √ |
| Face-cover score | √ | √ |

Expensive measurements such as those required for fibre diameter or percentage medullated fibres should be taken from bucks only. Because of the low selection intensity that it is possible to achieve among does, only measurements that do not involve great costs should be taken from them.

## PHENOTYPIC AND GENETIC PARAMETERS OF ANGORA GOATS

It is essential to have a knowledge of the phenotypic and genetic parameters for the traits in the breeding objective and for the characteristics chosen as selection criteria. Such parameters include repeatability, heritability ($h^2$), and phenotypic and genetic correlations. Estimates of these parameters are necessary for the formulation of efficient breeding programs to improve the economically important production traits of Angoras.

There is a severe lack of reliable information on phenotypic and genetic parameters for characteristics of Angora goats, both in Australia and overseas. Early studies on these parameters concentrated on the estimation of heritability of a single trait; for example, greasy fleeceweight (Sincer 1963); face-cover (Shelton 1960; Sincer 1967); lock length and fibre length (Shelton *et al.* 1965); and weaning weight of kids (Davis & Shelton 1965). They were usually based on limited data. Yalcin (1972) reported heritabilities for skin follicle characteristics. Estimates of phenotypic and genetic parameters for a wider range of traits and from larger data sets were reported by Shelton and Bassett (1970) and Yalcin *et al.* (1979); values for these parameters were tabulated and summarised by Yalcin (1982).

Repeatability values for bodyweight, greasy and clean fleeceweights, fibre diameter, and yield were high (from 0.40 to 0.72), and those for birthweight, weaning weight, and staple length were of moderate size (from 0.27 to 0.35). These values indicate that a single early measurement, taken before breeding age, is a reliable estimate of future performance for that trait and can be used as the basis of selection for fleece traits and bodyweight.

Accepting that few heritability values are available and that reservations have been expressed about the reliability of some (Turner 1982), we suggest that until further reliable estimates are available, especially from Australian studies, traits be considered to have the following heritability statuses:

*High* (0.30 or over) – Per cent clean yield, face-cover, kemp score, skin follicle characteristics.
*Medium* (0.15 to 0.30) – Bodyweight at all ages, staple length.
*Low* (under 0.15) – Greasy and clean fleeceweights, fibre diameter.

In general, estimates of heritabilities of bodyweight and fleece traits in the Angora goat are sufficiently high to indicate that some genetic progress could be expected in these traits by undertaking an objectively based selection program. There are no published estimates of heritability of reproduction rate in Angora goats.

Phenotypic correlations among the economically important production traits of Angora goats have, in most cases, been positive and significant (Imeryuz 1963; Shelton *et al.* 1965); Shelton & Bassett 1970; Marincowitz 1971; Eppleston 1978; Yalcin *et al.* 1979). Greasy fleeceweight was strongly correlated with clean fleeceweight. Greasy fleeceweight was low-to-moderately correlated with both fibre diameter and staple length, while clean fleeceweight was more strongly correlated with those two traits. In general, the phenotypic correlations indicate that gain from selecting replacement does for any of the traits reported will be accompanied with some increases in the level of performance of the other traits in the herd.

The genetic correlations reported by Shelton and Bassett (1970) were based on small numbers of animals and none was significant. Their reported positive correlation between clean fleeceweight and fibre diameter was not confirmed by Yalcin *et al.* (1979) who reported virtually no relationship. Significant and strong genetic correlations exist between yield and staple length (Yalcin *et al.* 1979). The strong correlation between greasy and clean fleeceweights means that greasy fleeceweight can be used as a selection criterion in preference to clean fleeceweight, especially for does. Yalcin *et al.* (1979) reported genetic correlations between skin follicle characteristics and fleece traits and suggested that while follicle density would be of little value in overall fleece improvement, the number of secondary follicles per primary follicle ($\frac{s}{p}$ ratio) measured at five months of age could be used as an early and indirect selection criterion for fibre fineness; the genetic correlation between $\frac{s}{p}$ ratio and fibre diameter was – 0.84. The significant genetic correlations reported by Yalcin *et al.* (1979) are favourable for our breeding objective; however, more phenotypic and genetic information is required before it is possible to devise a selection index, combining bodyweight and fleece traits, to aid in the selection of replacement animals.

## SOUTH AUSTRALIAN ANGORA GOAT RESEARCH

Since 1979 the South Australian Department of Agriculture, in co-operation with the Glenstrae Pastoral Company, has been conducting a research project which has the following two main objectives:

(i) To obtain estimates of repeatability, heritability, and phenotypic and genetic correlations for the economically important production characteristics of purebred Angora goats.
(ii) To estimate the effects of environmental factors, such as age of dam and type of birth/rearing, on the same production characteristics.

Buck and doe progeny are assessed for bodyweight, greasy fleeceweight, and kemp score at their first and second shearings. In addition, at their second shearing, the animals are assessed for face-cover score, staple length, clean scoured yield, clean fleeceweight, fibre diameter, and percentage of medullated fibres. At all their subsequent shearings, does are assessed as at their second shearing.

The need for large bodies of data to estimate accurately phenotypic and genetic parameters is an inherent problem in animal breeding. Detailed analyses to obtain estimates of heritabilities and genetic correlations from our study will not be undertaken until the data collection and fleece analyses are completed early in 1985. However, preliminary repeatability and phenotypic correlation estimates have been obtained from simple correlation analyses, and are presented in Tables 1 and 2, respectively.

The repeatability estimates for bodyweight, greasy and clean fleeceweights, fibre diameter, and face-cover score were high (0.44 to 0.74) and in broad agreement with those reported by Yalcin *et al.* (1979). The estimates for yield, kemp score, and medullation percentage were of moderate size (0.23 to 0.28), while the estimate for staple length was not significantly different from zero. Thus for all characteristics excepting staple length, a single early measurement would be a reliable estimate of future performance and selection on the basis of that measurement would result in improvement in the performance of the current herd.

Table 1: Repeatabilities of different production characters

| *Character* | *Repeatability Estimate* |
|---|---|
| Greasy fleeceweight$_{12}$* | 0.44 § |
| Bodyweight$_{12}$ | 0.66 § |
| Kemp score$_{12}$ | 0.23 § |
| Greasy fleeceweight$_{23}$† | 0.55 § |
| Bodyweight$_{23}$ | 0.74 § |
| Kemp score$_{23}$ | 0.28 § |
| Clean fleeceweight$_{23}$ | 0.57 § |
| Yield$_{23}$ | 0.23 § |
| Fibre diameter$_{23}$ | 0.61 § |
| Staple length$_{23}$ | 0.11 |
| Medullation$_{23}$ | 0.28 § |
| Face-cover score$_{23}$ | 0.46 § |

* subscript 12 means that estimates are from observations at the first and second shearings of bucks and does; number of paired observations (n) = 350.

† subscript 23 means that estimates are from observations at the second and third shearings of does; n = 160.

§ P <0.01.

Table 2: Phenotypic correlations among different production characters at the second shearing of bucks and does

| | CFW | YLD | FD | STL | MED | KEMP | FC | BW |
|---|---|---|---|---|---|---|---|---|
| GFW* | 0.98 § | −0.24 § | 0.42 § | 0.69 § | −0.06 | −0.27 § | 0.15 § | 0.03 |
| CFW | – | −0.08 | 0.47 § | 0.63 § | −0.003 | −0.25 § | 0.14 § | 0.08 |
| YLD | | – | 0.16 § | −0.38 § | 0.34 § | 0.17 § | −0.10† | 0.27 § |
| FD | | | – | 0.29 § | 0.35 § | −0.01 | −0.08 | 0.22 § |
| STL | | | | – | −0.24 § | −0.23 § | 0.10† | −0.23 § |
| MED | | | | | – | 0.11† | 0.03 | 0.13† |
| KEMP | | | | | | – | −0.28 § | 0.30 § |
| FC | | | | | | | – | −0.36 § |

* GFW = greasy fleeceweight, CFW = clean fleeceweight, YLD = clean scoured yield, FD = fibre diameter, STL = stable length, MED = medullation, KEMP = kemp score, FC = face-cover score, BW = bodyweight.
†

* GFW = greasy fleeceweight, CFW = clean fleeceweight, YLD = clean scoured yield, FD = fibre diameter, STL = stable length, MED = medullation, KEMP = kemp score, FC = face-cover score, BW = bodyweight.

† P < 0.05, § P < 0.01.

Estimates involved data from 400 animals or more.

Greasy fleeceweight was strongly correlated with clean fleeceweight, and both greasy and clean fleeceweights were strongly correlated with fibre diameter. Neither greasy nor clean fleeceweight was correlated with bodyweight; also, no relationships existed between medullation percentage and greasy or clean fleeceweights. Animals with heavily covered faces tended to be of lower bodyweight, a finding similar to that of Shelton (1960).

## CONCLUDING REMARKS

Details of a suggested comprehensive breeding objective for Angora goats were outlined earlier in the paper. It included clean fleeceweight, fibre diameter, staple length, percentage of medullated fibres, reproduction rate, and hogget bodyweight. The few available heritability estimates for these characters are of low-to-moderate magnitude, and indicate that improvement through selection based on own performance alone would be relatively slow. However, more estimates of phenotypic and genetic parameters are required before definite recommendations can be made.

The phenotypic and genetic correlations among the important production characters indicate that there are no serious antagonisms to the simultaneous improvement of the economically important characters through selection. Selecting replacement animals on the basis of clean fleeceweight may lead to an increase in fibre diameter in the current generation, but to no change in the percentage of medullated fibres. The lack of a significant genetic correlation between clean fleeceweight and fibre diameter (Yalcin *et al.* 1979) suggests that selection for clean fleeceweight would not lead to an increase in fibre diameter in future generations.

The correlations of both greasy and clean fleeceweights with face-cover score were positive and significant ($P<0.01$) but low. Our finding of a negative phenotypic correlation between bodyweight and face-cover supports the recommendation of Shelton (1960) that animals with heavily covered faces should be culled.

The lack of a strong positive phenotypic correlation between kemp score and medullation suggests that other characteristics of the fleece were assessed, in addition to percentage of medullated fibres, when assigning the kemp score to fleeces.

It is recommended that for the improvement of mohair production breeders concentrate their selection efforts on clean fleeceweight, fibre diameter, percentage of medullated fibres, and bodyweight, and limit subjective appraisal to an initial culling of animals with gross physical and fleece defects.

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