SHEEP AND GOAT BREEDING AND GENETICS

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INTRODUCTION

At the First World Congress on Genetics Applied to Livestock Production, the corresponding Plenary Session covered a wide range of topics on sheep breeding and genetics. There were extensive reviews on the objectives and scope for improving meat, milk and wool production, and reproductive performance. Crossbreeding studies in the United States and in Europe were reviewed and these indicated the potential for improving production by utilising between-breed genetic differences. Finally there were two papers on improvement programs in arid and semi-arid environments.

The Plenary Session at this Congress differs from its predecessor in that it contains a paper on goat improvement programs. Its inclusion recognizes the economic importance of goats in many communities and the growing research interest in goat breeding. The topics on sheep breeding have been selected to complement those presented at the First Congress, and are oriented towards commercial application. While it is important to establish that we can improve individual production characters by selection (Dalton and Baker, 1979; McGuirk, 1982) or cross-breeding, the commercial goal is to improve profitability or economic efficiency. For this reason we are

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interested in all characters that influence returns or production costs and our breeding objectives should reflect their relative importance. Performance recording schemes and selection practices should then be designed and implemented to meet these objectives. These topics and others related to industry improvement programs are discussed at length in the following papers, and here I propose only to comment on points that I find of particular interest.

Breeding Objectives

Animal breeding programmes are likely to be of greatest economic value if they reflect the long-term economic objectives of commercial producers in an industry. In the past, a description of breeding objectives has often meant little more than a list of characters influencing returns and perhaps costs of production, but with little indication of their relative importance. PONZONI has provided a valuable overview of conceptual and procedural developments in this field, and has summarized objectives established for different industries. The approach he has advocated is both comprehensive, in that all characters which contribute to returns and costs can and should be included, and quantitative, so that they can then be ranked in relative importance.

One key element in the procedure outlined by PONZONI is that each character, and each expression of a character, should be included as a separate trait in the objective. This approach has a number of important advantages. Most importantly it enables us to account for variations in the age structure and sex composition of a flock, with a corresponding description of the numbers of times characters are
expressed. For example, castrated males will often be sold for slaughter while relatively young, having been shorn once or perhaps twice in their lifetime. By contrast ewes might be shorn six or more times and have the opportunity for five or more lambings before they are disposed of for their meat value. By including each expression of a character as a separate trait in the objective we can allow for age and sex differences in production, and it would also simplify the inclusion of discounted economic values.

The need to describe production systems in this sort of detail can of course be quite a challenging task. It will certainly help identify areas in which further information is needed before objectives can be established with confidence. Here I am thinking specifically of the need for estimates of genetic parameters for production characters expressed throughout the life of the animal. As an example, there are now numerous estimates of the heritability of fleece weight and other fleece characters for animals shorn as yearlings or hoggets (see McGuirk, 1982). By contrast there are almost no corresponding estimates for ewes after they have entered the breeding flock (see Etikje, 1975), nor estimates of the genetic correlations between these measures of wool production and other production traits.

The second point highlighted by Ponzoni's paper is the need to determine the sensitivity of a set of breeding objectives to variations in genetic parameters, economic values, flock composition and even discount rate. Many assumptions will necessarily be made in attempting to define objectives. In particular estimates of genetic parameters will often be assumed, either because none are available or are only available for other breeds. There will also be considerable
uncertainty in predicting future economic values, especially as the profit associated with a unit increase in production may also vary widely between producers. By estimating the correlations between sets of objectives (PONZONI & WALKLEY, 1981), sensitivity to these assumptions can be assessed and the general value or robustness of a particular set of objectives established. Where the outcome is found to be sensitive to variation in a particular parameter, future efforts can be directed to improving the quality of information in that area.

Crossbreeding and the Utilization of Breed Resources

It has long been recognized that breeds of sheep can differ markedly in their productive characteristics when run under the same conditions. Our awareness has been further heightened in recent years by evaluation studies using high fecundity breeds, and the continuing concern to improve the performance of many of the indigenous breeds of the world. Yet while the scope for genetic improvement through breed replacement or crossing no doubt exists, it is often not clear how this might best be achieved.

CLARKE in this Symposium has emphasized one of the major difficulties in interpreting the results of evaluation studies, namely deciding the basis on which the evaluation should be made. In New Zealand studies of dual-purpose breeds, differences were observed in wool production and in such measures of total lamb production as the weight of lamb weaned per ewe joined. Differences also occurred in ewe liveweights, so that we might expect differences in feed requirement and hence in farm carrying capacity. CLARKE & MEYER (1982) attempted to account for these differences by assuming a wool:lamb price ratio of 4:1, and by expressing total productivity per unit of ewe liveweight. While the procedure clearly requires extension to include other attributes of economic importance, it does
attempt to measure overall economic merit. It would also be an obvious advantage to allow for possible variations in relative prices and in absolute level of production.

The number of breed evaluations which can be conducted under the direct control of animal breeding research workers is clearly limited and there will always be dangers in extrapolating the results of such studies to a range of commercial conditions. In Australia, for example, breed evaluations are often criticized retrospectively because the experiments did not reflect the particular set of conditions for which the breed is prized commercially. These conditions might be the timing of particular management practices (joining, age at slaughter, etc.), or the appropriateness of the environment. This sort of criticism takes on an added dimension if we include the sociological adaptation claimed for many native breeds. Perhaps we should undertake less intensive evaluations, but in a range of environments. If genotype x environment interactions, taken in the broadest possible sense are possible or likely, greater attention could then be given to sampling these environments (DICKERSON, 1962).

CLARKE has discussed in considerable detail how breed differences in production may be exploited commercially. One of the arguments used against specific crosses or rotational crossbreeding programmes is the doubt concerning future genetic improvement, due in part to the small size of many purebred flocks and the fact that their objectives do not always reflect the economic needs of the total industry. On the other hand, synthetics would have an initial disadvantage if the heterosis exhibited by the $F_2$ generation is generally less than half the superiority of the $F_1$ over the parental breeds. At the same time,
synthetics are likely to prove a popular means of exploiting high fecundity breeds such as the Finnish Landrace and the Romanov, to overcome some of the production deficiencies of those breeds.

Industry Improvement Programs

Industry improvement programs are often described simply in terms of performance recording schemes and breeders who participate are encouraged to use the collated production information they provide as a selection aid. STEINE rightly points out that they are much more than this. Breeding objectives have already been discussed in detail by PONZONI and I propose to discuss briefly two other topics raised by STEINE, namely population structure and the overall efficiency of breeding programs.

(a) Population Structure

While livestock populations can take many different forms, I would like to comment briefly on three general types.

Firstly there are the many breeds throughout the world that have arisen through a mixture of economic, social and genetic forces. Generally the breeding of male replacement breeding stock is restricted to a small proportion of the breed, and these flocks are often referred to as studs. Because there is usually very little if any movement of breeding stock from commercial flocks into the stud it is the rate of genetic improvement in the ram breeding flocks which will determine progress in the industry as a whole (BICHARD, 1971).

Attempts to promote performance recording and the use of measurement as a selection aid have been directed at the studs and specifically at those ram breeding flocks likely to have the greatest future genetic influence on the breed. The ram breeding blocks are usually responsible for their own breeding programs and are free to pursue their own objectives, which may not coincide with those of commercial
producers. Very rarely is a commercial producer able to buy rams with
the aid of reliable information on the relative genetic merit of
alternative ram breeding flocks.

Within-flock selection programs are less efficient when flock
sizes are small. QUARTERMAIN for example has suggested that small
herd sizes hamper the development of effective breeding programs in
many goat populations. Small flock size in Norway prompted the
establishment of ram circles so that rams could be progeny tested over
a number of flocks, a key feature of their national sheep breeding
program (GJEDREM, 1969). The Norwegian program also stresses the need
to use the same selection indices in all flocks and ram circles, in
identifying the rams to be progeny tested, the top rams on progeny
test results and elite ewes.

The third structure I wish to mention is that of the nucleus or
group breeding scheme. Here, in contrast to the traditional breed
structure, the ram breeding nucleus is formed from the best ewes in
all contributing flocks. There is generally a continuing two-way
flow of genetic material, with replacement breeding ewes for the
nucleus coming both from the nucleus itself and from the contributing
flocks. If effective, the co-operative nature of these schemes should
ensure that the breeding objectives for the nucleus are also those of
the contributing flocks.

A nucleus breeding scheme should show greater genetic progress
than a traditionally structured population of the same size, given
that they use the same selection criteria. However, the difference in
the expected rate of progress is not great, generally of the order of
10-15 per cent (JAMES, 1977). For the group breeding scheme to show
any substantial genetic superiority, there must be a long-term
commitment of group members to well-defined objectives and appropriate
selection methods. The change in breeding structure enables more
rapid gains to be made; it does not guarantee them. The long-term stability of group breeding schemes would certainly be helped if the legal and financial interests of members were adequately safeguarded (PEART, 1976).

(b) Efficiency of Selection

Production information can be of considerable value as a selection aid when the characters we wish to select on can be measured objectively. For these characters, measurement should be more reliable than a ranking based on traditional methods, based on a visual assessment of merit. The benefit of performance recording are likely to be greater if identifiable environmental factors (age, age of dam, birth type etc.) affect performance and appropriate adjustments are made to the data, or if information on a number of characters is to be combined into a measure of overall merit.

Unfortunately there is very little published information on the efficiency with which breeders using production records approach the maximum possible selection differentials for the characters they wish to improve. One example should be sufficient to demonstrate the involvement in a performance recording scheme does not necessarily mean efficient selection. EIKJE (unpublished information) examined the efficiency of ram and ewe selection in six New Zealand Romney flocks in the National Flock Recording Scheme (NFRS), the forerunner of the current Sheepplan program (DANIEL & CALLOW, 1982). Efficiency was defined as the selection differential achieved expressed as a percentage of the maximum possible selection differential. For the suggested NFRS index, ram and ewe selection efficiencies were only 36 and 54 per cent respectively. These selection efficiencies tended to improve over the six years studied, suggesting that breeders were becoming more convinced of the merits of the index proposed and more familiar with the use of measurement as a selection aid. The
calculation of realized selection differentials and selection efficiencies should perhaps be seen as a routine feature of performance recording schemes; the information would be of considerable interest to the breeder.

The ultimate test of the efficiency of a breeding program is the rate of genetic progress which is achieved. Apart from the Norwegian results referred to by STEINE, I know of no other estimate of genetic change in commercial breeding programs, and perhaps more of our resources should be devoted to their calculation. In flocks in which pedigree and production information is recorded, estimates of progress can be made by statistical procedures, without the need of special matings (SYRSTAD, 1974). However there may be general benefit in using frozen semen (SMITH, 1977) to provide breeders with more tangible evidence of progress.

CONCLUSIONS

In my previous remarks I have made little direct mention of goat improvement programs. QUARTEMAIN has pointed out the need for more information on the world's goat population. Both to compare their genetic merit, and to obtain estimates of genetic parameters for production characters. No doubt we will find much the same picture as we have with sheep, that there is considerable genetic variation both between and within populations. The challenge in both sheep and goat populations is how best to utilize that variation.

REFERENCES


