
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

EVALUATION OF THE FLEECE IN RELATION TO BREEDING METHODS.

by

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In the past wool has been in an unassailable economic position with no real competitors. Ten years ago products claiming to imitate wool were a very poor substitute for the real article, giving the wool grower some grounds for complacency. Nevertheless, at the present time world production of artificial fibres has reached an impressive total, and is increasing at a colossal rate, even though the type of fibre so far produced falls short of possessing all the valuable characteristics of real wool. Already it has been found that up to 50 per cent. of substitute can be used without seriously harming the wearing ability of a fabric. Although abnormal conditions associated with war and preparation for war have maintained a good demand for wool during the past five years, there seems little doubt that when conditions stabilise, a reorientation of ideas on the subject of wool prices will be necessary. The foreboding takes even more definite shape when we remember the enormous growth of knowledge in the science of fibre structure, both for natural and man-made fibres. Advances in this field are already enabling the rayon and staple fibre manufacturer to produce filaments with properties not merely equal to those of wool, but in some respects superior. It is significant that the latest production, seaweed rayon, possesses valuable hygroscopic qualities hitherto exclusive to wool, and has been evolved in the laboratory of a scientist who has previously devoted his attention to the molecular structure of animal fibres (Speakman 1941).

HAND AND EYE EVALUATION OF WOOL CHARACTERISTICS:

The trends just mentioned have an important bearing on our sheep breeding policy, and, in particular, on the type of wool research most likely to be of profit to the industry. It seems obvious that the only ground on which the wool grower can combat, ultimately, an artificial fibre, produced under controlled conditions, is that of cost of production. Consideration of the meat aspects of cost of production can safely be left to other workers at this Conference, but from the fleece aspect, producing cheaper wool means producing more wool per sheep - concentrating on fleece weight improvement rather than on attempts to improve quality beyond the standard of our best strains. Even now, on an open market, a relatively small price differential is paid for quality wools, and although accurately standardised techniques are available for measuring such characteristics of the fleece as mean diameter and diameter distribution, mean fibre length and length distribution, strength and elasticity of fibres, or amount of medullation, it is not easy to justify their large scale use in a latter day wool breeding programme. On the other hand application of these slower objective methods to the results of sorting wool by visual and tactual judgements has shown that a person trained in handling wool can make reliable and accurate distinctions. Indeed the hand and eye of the wool sorter can distinguish almost as fine differences as those evident with the very best instruments. Although the human element introduces greater fallibility, this is balanced by a speed of working generally several hundred times as fast, and a given personnel can make just so many more measurements in a given time, enabling work to be undertaken of a type not otherwise possible. It must be remembered too, that it is upon hand and eye judgements that our wool is sold, and that it is unnecessary to make finer distinctions in a breeding programme than can be made by the wool buyer, if, as is invariably the case, other important characteristics of the fleece or carcase must, as a result, be neglected.

With the expansion of work involving subjective fleece judgements, trials have been undertaken (McMahon 1941) to determine the repeatability of gradings made by different persons on the same animals using observers of average training and experience and under typical practical working conditions. Full details will be published elsewhere in due course, and it is sufficient to note that while judgements of some features, such as Handle, Lustre, and Density, did not mean very much, on the average, except in extreme cases, Length, General Character and Count estimations can give useful results in investigations where large numbers of fleeces must be considered, where time is an important element and where the prime emphasis is to be on weight of fleece.

THE SURVEY TECHNIQUE:

It is unfortunate that in the past there has been an all too strong tendency for wool to be studied in vitro, so to speak, rather than in vivo. Even where studies of the growing fibre have been carried out, they have been essentially academic and divorced from immediate bearing on everyday problems of the woolgrower. The scientist has given the practical man no guidance in making decisions as to what breed of sheep will be most efficient on a given type of country under specified management conditions. He has no soundly based answer to the question of which, of the wool types within a breed or cross, will give the greatest return, and, if it is possible economically to change the type of wool being grown on a given environment, how can the change be most rapidly brought about? Scientific answers to such questions as these can only be given from work involving many animals, and with the limited resources available to the wool research worker in New Zealand they cannot be attempted if objective methods of quality appraisal are to be used. Research workers seem to have overlooked one fact: that at least some important features of the fleece can be satisfactorily appraised by hand and eye, which enables us to study wool in the field, on the sheep, wherever the animal is being run, at shearing time and in the wool store - in fact to obtain useful information about wool as a living and growing substance; the product of a delicately balanced animal organism reacting to alterations in nutrition and management, and changing in a continuous attempt to adapt itself to nature's economy.

The possibilities of such an approach to the problems of the sheep farmer can be illustrated from results of wool survey research carried out in the 1940-41 season by the author and co-workers (McMahon 1941). With a simple set of gear for weighing fleeces as they came from the sheep, a ruler to measure length of staple and a box for samples for yield determination and to enable our standards to be checked and compared, we are able to say that, whereas on a particular environment Romney wool of type A will grow fleeces one and one half pounds heavier than B type, on another environment A type fleeces will be one pound lighter and almost invariably cotted. Type A is a popular wool at present and many farmers are endeavouring to run such sheep on unsuitable country. We are able, too, to show that for a given plane of nutrition there is an optimum count, or fineness of fleece - to grow fleeces finer than this means a loss in weight, while coarser fleeces give no gain in weight to compensate for their lower value. On one property as much as six per cent. loss in gross weight can be ascribed to the apparently erroneous belief on the part of the owner that the country is only suitable for fine Romney wool. Again, we find that sheep of breed X grow wool of a certain type more efficiently than sheep of breed Y. Details of this work await confirmation by a second season's observations, but there is good reason to believe that an exploitation of the results of the application of the survey technique to wool production problems, using subjective methods of evaluation checked by impersonal tests, will yield very satisfactory profits both to the nation and to the individual. Further, and perhaps of more importance, these extensive studies prove particularly valuable in indicating the most necessary problems for attack by critical intensive studies and in providing a practical background against which such studies can be viewed in perspective. Before such critical studies can be adequately planned, however, it is necessary to determine whether an attack through control of environment or through breeding will be the more profitable.

ESTIMATING THE RELATIVE IMPORTANCE OF NATURE AND NURTURE:

The importance of determining the relative potency of genetic and nongenetic forces (Lush 1935) in determining the grade of an economic character, as a preliminary to attempts at constructive modification, seems to have been frequently overlooked by research workers in animal production. Quite arbitrary distinctions have often been made between hereditary and non-hereditary characters with the general expectation that for the former, mass selection and the mating of best to best would achieve any desired result. Carefully controlled experiments, however, have recently shown mass selection to be a very inefficient breeding technique and during the last decade there has been rather a change in outlook on the part of scientific animal husbandmen.

Lush 1939, 1940, has recently summarised methods for estimating how much of the variation in economic characters in an animal population can be ascribed to genetic differences inherited from parents and likely to be passed, in turn, to the next generation. In general this is done by studying the changes brought about in individual animals subjected to changing environmental conditions, by observing differences between identical twins, and by measuring the likeness of various sorts of relatives. In all cases dependence is placed on the extent to which animals with similar genotypes resemble each other more than a random sample from the population, and by the use of a modification of the survey technique appropriate information can be obtained from commercial stud and grade flocks without the necessity for expensive breeding projects, which are notoriously difficult with larger animals. For reliable results fairly large numbers of animals must be dealt with, calling for rapid techniques of evaluation. Although visual and tactual judgements fulfil this requirement in the case of the fleece and have the added advantage that the results of the investigation can be immediately applied in estimating the efficiency of different breeders' methods, where such techniques are in general use, a separate estimate of the error involved in the judgments, taking the form of repeat determinations after a short interval of time, is essential. It is important to note that the methods used in estimating strength of inheritance include errors of measurement under the heading of non genetic effects, because an apparently low result is sometimes due to inaccurate measurements or to inconsistent judgments, which can in some cases be improved.

The analysis of variance technique (Fisher 1936) and its extensions (Wright 1934) is admirably suited to the reduction of this type of data, but simple averages of the subsequent gradings or productions of animals previously recorded as above or below average, or comparisons of the offspring of high and low graded parents, provide figures which, although they do not extract the maximum of information from the records, are easily explained to the breeder and which can be obtained with somewhat less expenditure of time and effort in calculation. An investigation of this type has already been undertaken by the author for the various features which affect the economic return from sheep, and with certain exceptions, which will be discussed more fully in other publications, hereditary effects appear to be relatively weak. Thus, in the case of fleece weight in the Romney not more than ten to fifteen per cent. of the total variance in a given flock can be regarded as due to simple additive hereditary effects.

PROGENY TESTING TECHNIQUE:

It has been shown that where intensity of inheritance is low, the progeny test is essential as a means of securing modification of a population within a reasonable time (McMahon 1940). In considering the application of the progeny test to fleece characters we are, at first sight, once again faced with the necessity for examining lage numbers of animals, for to pick the best sire of ten we must examine not merely the ten sires themselves but some two or three hundred of their offspring - a much more extensive project to which slow methods for the measurement of excellence are not well suited. Fortunately, however, the very feature which makes the progeny test essential, not only makes for considerable simplification but also allows the efficient use of some slow methods of evaluation. Where heritability is low the characterisation of the animal is such a poor indicator of genetic make-up that the genotype of dams used in test matings must be assumed random unless they have been selected on strain or pedigree. In other words, the correction which would be applied to the progeny test of the sire, on account of phenotypic deviations in his mates from the average, becomes so small that it can be neglected and the average characterisation of his get gives a good index of his breeding ability. With the sire's offspring group as the unit of study, rather than individual progeny, an efficient sampling technique enables mean values and, in some cases, indices of variability to be obtained directly from single objective determinations, on composite samples for the group, for such characters as yield, fineness, and length of fibre, which, when combined with fleece weighings and eye and hand judgments made on individual animals, provide a very complete picture of the sire's desirability. It is interesting to note that a simplified progeny test is more easy to work in this way with sheep than with dairy stock where it is not usual to raise the offspring of a relatively large number of sires under identical conditions - a practice which is standard for sheep.

Wherever the flock is reasonably large Hagedoorn's (1939) Nucleus System of breeding seems to give the ideal method of exploiting the progeny test. Rams must be used and it is simple to progeny test them by examining their progeny produced under normal stud conditions and run together until appraised. Following Hagedoorn the best rams, on progeny test, and their near relatives, daughters and half sisters, form the nucleus, or top flock, almost irrespective of phenotype. Rams which do not stand up to the test are culled, and replaced by young sires bred in the nucleus. These sons of nucleus rams, which may be closely bred if desired, are in turn progeny tested and compared with their own parents as prospective candidates for nucleus honours. Although not making the most intensive use of top sires, the programme is well suited to the circumstances of the average New Zealand stud, especially at the present time, when labour for hand service and artificial insemination is not available. The only change in management required is a systematic examination of the young stock at some suitable age, and with a little organisation this can easily be fitted into normal routine.

It is interesting to calculate the possibilities of improvement through the use of the progeny test from the component of variance associated with differences between sires for gross fleece weight in our Romney data. This would amount to more than 0.8 pound in the first generation if three rams were selected from every twenty subjected to an accurate progeny test, although full advantage cannot be taken of this potentiality if only small numbers of progeny are available - a contingency which does not arise if the Hagedoorn system is in use. Small numbers of progeny, however, are very useful if betting chances of less than 19 to 1 are acceptable, and for fleece weight in the New Zealand Romney, seven to ten offspring of a sire are sufficient to give a much more accurate picture of his breeding ability than can be obtained from his own characterisation. Actually, with such small numbers of progeny the rate of increase possible with odd of 19 to 1 has been calculated by Miss Helen Newton Turner (1941) of the McMaster Laboratory, Sydney, for Romney data as being nearly 0.4 pound per generation using three rams from every twenty-five tested. More rapid improvement would be obtained with somewhat less certainty and the fact that examinations based on such a small number of progeny can give a high rate of change is due to the increasingly slow rate of gain in accuracy after the first seven to ten offspring have been obtained.

No discussion of technique in relation to wool investigations can be complete without reference to Dry's important work on the early recognition of fleece characterisation. By studying the fibre type array (Dry 1933 and 1934) he has discovered a wealth of detail for which inheritance is strong. Statistical examination of halo hair data from his multifactorial stock, for example, gives a mean parent-offspring correlation as high as 0.7 for the density of halo hairs on the backs of the lambs - almost the maximum for a heterozygous situation - though possibly selection has helped to make this figure so high. Similarly strong inheritance is reported for the fibre type array of the birthcoat. We are looking forward now to the possibility of establishing relationships between these strongly inherited early features and the average of several seasons' characterisations for later features of economic importance, perhaps even with the progeny test results of sires. If these possibilities are realised we shall have a wool breeding technique adding much to the efficiency of the progeny test, or even rendering progeny testing, for some purposes unnecessary.

SUMMARY:

1. Competition to wool from artificial fibres is becoming more intense and because the chemist and physicist will ultimately produce a superior product, competition can be met effectively only by lowering costs of production of the natural fibre.

2. Already, in view of the small premium paid for quality in crossbred wools, the most feasible way of reducing costs is to increase fleece weight or production per sheep.

3. Two methods of achieving a rapid increase in weight are:

   (a) To get sheep which are suited to the environment through exploitation of the possibilities of the survey technique.

   (b) To improve the genetic capabilities of the stock through the use of the progeny test.

4. Methods of hand and eye evaluation are rapid and sufficiently accurate for use in projects where weight is to be a prime consideration, leaving the slower objective methods for use where the number of units to be examined can be kept small, for checking subjective gradings, and for the preparation of standards of comparison.

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