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PRESIDENTIAL ADDRESS

SOME ASPECTS OF HILL COUNTRY SHEEP IMPROVEMENT.

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PROBLEMS of improvement in the efficiency of livestock production on hill country, as elsewhere, are by no means problems only of animal improvement. Management, nutrition, disease control and all such things termed environmental will probably offer greater scope for improvement in production for many years to come. In particular it can be anticipated, I believe, that pasture improvement over vast areas of our hill country especially in the North Island will be achieved.

With the advent of successful aerial topdressing of hill country, accompanied by a widespread consciousness of the role of clovers in pasture improvement, we have entered a phase of improvement, which because of the areas involved, is likely to be as great or greater than that which saw for example the transformation of the Waikato Basin from an area of ill-repute as farmland to one which is responsible for one-third of New Zealand's butterfat production. To-day, at its very inception and in its pioneer form, using homely adaptations of existing aircraft, aerial topdressing is already an efficient operation and an economic proposition. Areas of hill country can be topdressed by one plane at the rate of up to 300 acres and more per day at a total cost of between £1 and 30/- per acre.

This development coinciding as it does with an unprecedented sellers' market for our pastoral products augurs well for the future development of our hill country and much marginal and deteriorated land.

Can we likewise visualise steady and marked improvement in our hill country sheep stocks? Much is heard of the gradual failure of the Romney in particular as a sheep stock on the poorer hill country. It is suggested that consequent upon pasture deterioration the environment is often no longer quite suitable for this versatile breed, which has fulfilled our needs so well for over half a century. Such criticisms are identical with those levelled at other breeds in other environments and in particular at the Scottish Blackface in its traditional environment. Defenders of this breed, notably Allan Fraser (1949), claim that rather than a change in the environment being responsible, the cause of deterioration in the breed lies in the artificial ideals aimed at notably large size and early maturity and in breeding rams in a soft and artificial environment to achieve such ideals.

Similar criticisms can be made and indeed have been made from time to time, of the methods of breeding in this country and of the artificiality of many show and sale ring ideals.

In the light of present scientific knowledge it is difficult to find justification for traditional methods of judging and breeding but it must be admitted that our modern breeds have been produced without the aid of science. It can also be said that these results have been achieved in spite of the additional handicaps imposed. I think it is widely admitted to-day that there is a tendency to over-stress many points of livestock and often to stress quite unessential points. Also there is much experimental evidence on growth and development and on the intensity of inheritance of characters to show that differences and often quite major differences in phenotype have little or no genetic origin. [Hammond (1940), McMeekan (1940-41), Verges (1939), Phillips (1948), Clarke (1949).]

Factual evidence is lacking with which to assess any changes in the quality and productivity of our livestock in recent years. In the dairy industry Hamilton (1944) attributes the improvement in production, in the main to a change of breed and improved management and feeding. In the sheep industry it would be indeed remarkable if most of the improvements which have occurred are such a kind as not to be explained similarly. It is probably true of all farm livestock that the major improvements occurred in the early years of the formation of the breed and there has been only comparatively minor improvement in more recent times. Such a suggestion is difficult to support with facts, but the converse is equally true.

The early history of the older breeds is often obscure, and claims of purity of breed from the outset are made. As Fraser (1949) so aptly puts it "This is neither unusual nor surprising since it would seem to be the universal policy of breed societies to consign the ultimate sources of their fancy, without admixture, which they judge defilement, right back to the original procession in Noah's Ark!" Such obscurity is particularly true of Bakewell's Leicester, cogent arguments to support the view that crossbreeding was used by Bakewell are given by Fraser (1949). In the case of nearly all breeds evidence can be found that crossbreeding was used in their formation. In some cases where documentary evidence is lacking or authoritatively denies such a practice, unbiased critical observation cannot fail to detect evidence of crossbreeding e.g. Border Leicester and South Australian Merino. In the case of more recently formed breeds evidence of crossbreeding is in most cases undeniable. The exhaustive researches of Austin (1944) have undeniably disclosed the mixed origin of Australian Merino types and moreover show that little real improvement can be attributed to the efforts of breeders since those earlier days. Prentice (1942) has done a similar work in the case of dairy cattle. The origins of most modern breeds such as the Corriedale and the Columbia are frankly recorded. In the case of the New Zealand Romney its early history is most incomplete. Its obscurity has enabled a legend of breed purity to be perpetuated and widely believed to-day.

In the 40 years between the earliest record importation of Kent sheep in 1853 and the formation of registered flocks, considerable changes were taking place in the country's sheep stocks. Experience was proving the greater worth of British longwool breeds over the Merino on most of the North Island sheep country, and over much of the South Island also. Refrigeration gave a big impetus to the grading up of flocks from Merino origin, using chiefly Lincoln, Leicester, Border Leicester and Romney rams, and most probably in the above general order of popularity judging from the fact that at the formation of the New Zealand Sheep Breeders' Association in 1894, 125 Lincoln, 112 Leicester, 67 Border Leicester, and 51 Romney Marsh flocks were registered. Could it be that records were so accurate, integrity was so high, or inspection so rigid that all sheep registered were descendants only of the relatively few imported Kent sheep? Consider also the number of characters so frequently seen in the New Zealand Romney which are so much the hallmarks of sheep contemporaneous with the first Romneys in New Zealand—for example the level back and early maturity of the Leicesters, the lustre, crimp and staple formation of the Lincoln and Leicester once so common in the strong wool types—to a less marked degree the density, handle, brightness and character seen in the finer types and suggesting some little Merino influence. Add to these the remarkable versatility and adaptability over a wide range of environments. Can these improvements over the imported Kent sheep so few in number be solely the result of selective breeding? Orthodox genetics cannot, I think, offer a parallel anywhere in the livestock field. If it is true then the Kent must be the richest source of mutations ever known.

The contentions that the New Zealand Romney owes something to genes drawn from other breeds than the Kent sheep is not intended to be in any way derogatory. Purity of breed and prepotency however are terms which have long been linked. Bakewell nevertheless achieved prepotency in his Leicesters in a few generations. The New Zealand Romney since the registration of flocks in 1894, has achieved a unique position and stands firmly on its merits not only in New Zealand but in many parts of the world. Its position would seem to be beyond assail by suggestions that its remote ancestry is in any way in doubt.

The question is by no means merely an academic one. Important principles are involved. In the case of the New Zealand Romney, as in the case of all or at any rate, nearly all breeds of livestock, the early breeders worked on a range of variation widened by crossbreeding. These Bakewells of the past were not imbued with any mysterious powers or intuitive genius for animal breeding. Rather were they men well versed in the arts of husbandry, with clear cut ideals of the type of animal required, and with a keen stockman's eye for the merits aimed at in the stock they bred. Initial progress from selection from the diversity of types available would necessarily be rapid and often spectacular as shown by the records of men like Bakewell, Booth and Collings. Rigid selection, involving even progeny testing, in-breeding etc., rapidly evolved the new breeds which soon exhibited that prepotency, particularly in the more simply inherited and usually striking breed points, and reduced range in variation. Since that stage progress would seem to have been slow and uncertain (Austin, 1944, Prentice 1942). The breeders of to-day are better equipped in every way than the Bakewells of the past, but theirs is the much greater task of working with a gene complex already deeply exploited and reduced by earlier selection, and prescribed by purity of breed. Changes there certainly are of no mean magnitude in such things in the Romney for example, as face cover, head type, length of cannon bone, and wool count; characters which modern genetics labels as strongly inherited. Other important commercial qualities such as fleece weight, wool quality, meat quality, longevity, hardiness, economy of food conversion etc. are said to be weakly inherited, complicated by environmental interactions and but weakly responsive to existing methods of selection.

In what respects do existing methods of selection fall short of the ideal? Mention has been made of the artificiality of the environment of stud flocks. This has been a topic of much contentious argument for many years and with respect to many classes of livestock. In New Zealand the fountain head for the improvement of our hill country flocks, the stud flocks, are located invariably on the rich lowland flats. In addition every device, every art to promote rapid growth, early maturity and size is brought to bear in rearing and fitting rams for show and sale display. "Fat is a pretty colour" say the critics. Condition can cover a multitude of faults. Of greatest significance I think is the criticism that for hardiness, and best adaptation, the animals should be bred and selected in the environment and under the natural conditions in which they are to perform. No one would question the logic of this nor, having in mind the principles of evolution and the many clearly demonstrated heredity and environmental interactions, question its basic soundness. If it is true that the Romney under some conditions is failing to give satisfaction surely not all the blame is to be attributed to pasture deterioration. The mere emphasis on size alone is contrary to known facts of ecology which show that other things being equal the smaller animal is better adapted to an unfavourable environment (Phillips 1948). At the beginning of this century in New Zealand the order of breed popularity in the North Island was Lincoln, Leicester, Border Leicester and Romney—the order of decreasing size and increasing fineness. The first 40 years saw a complete reversal of this order and the overwhelming supremacy of the Romney. This, I believe, was at least in some measure attributable to ecological considerations

and followed a fairly general decline from the high initial fertility following the primary forest burns. If further deterioration is occurring at the present time the emphasis should be on genetically smaller sheep. The trend to-day towards a finer wool type however is in line with results of ecological surveys (McMahon 1945).

Hammond (1932) and many subsequent workers have shown that twins are slower in reaching maturity than singles. Arguing from this it has been suggested that emphasis on size in selection could explain some of the low fertility in our sheep stocks. Barton (1948) has found however that of the rams sold at the Feilding fair in 1947, about 40% were recorded as twins and these met with the keenest demand as evidenced by average price paid. Nevertheless marked increases lambing percentage by the use of sires which were twins are reported by Stevens (1951).

Apart from genetic consideration it should be mentioned that the sudden transfer of rams from the "cake and ale" conditions of the stud farms to the austerity of the hills is conducive to impaired fertility (Webster 1951).

In defence of the location of the stud flocks two main arguments are used. It is pointed out that livestock breeding is a business dependent for its success on ability to supply what the buyer wants. It is claimed with much justification that he is prepared to pay for and demands the well grown, big ram in show ring condition. Some few breeders who have attempted, using the best blood lines, to breed rams on hill country and sell them in natural condition can testify to the truth of the foregoing statement. This argument throws the responsibility back on the buyer. It is not however entirely fair in that the show ring has as a prime objective the creation of a demand for the stock displayed.

The second argument points out that it is only under a favourable environment that the fullest expression of the genotype is achieved. This of course has no reference to such an important consideration as hardiness. This argument also is probably not true. Recent work by Hancock (1951) on the effects of high and low planes of nutrition on the production of dairy stock shows that the order of merit in terms of dairy production of cows on high plane feeding was substantially the same in their identical twin sisters on low plane feeding. Is it stretching on analogy too far to suggest that sheep production might be just as efficiently measured under hill country conditions whence also thrift and hardiness, fertility, milking ability etc., can show their true colours?

Another respect in which methods of selection fall short of the ideal, is in the multiplicity of characters considered, many of which certainly have, and many probably have no real worth or in many cases no genetic basis. Allied to this is the problem of assessing in simple objective terms the real commercial value of an animal. Lush (1935) (1938) has clearly drawn attention to two aspects of selection namely that "natural fertility and longevity set serious limits to the intensity of selection which may be practised" and that "intensity is weakened (much more than is generally realised) by the inclusion of more and more items in the ideal." These concepts are epitomised by Lush as follows: "In the idealised case, where n independent equally important characteristics are to be considered in the selections and x is the proportion of the population which must be saved for replacements, the selection intensity for each characteristic singly is the same as if the n th root of x were the proportion which must be saved." "This," he continues, "is the only general basis of real antagonism between breeding for production and breeding for 'fancy points' namely, that each additional point considered must necessarily weaken the selection which might otherwise have been practised."

I know all this is now as familiar as Mendel's first principles. I repeat it, if only to emphasise the importance of work aimed at disentangling the effects of nature and nurture and of the need for simplification and rationalisation of ideals.

Criticism of breed and show ring "fancy points" is as old as the show ring itself. In "Satirical Poems on Agriculture"—Anon—published in 1808 is a description of the judging of a pig class. An otherwise flawless sow was rejected because in the words of the judge

"I cannot choose but say—'od rot 'em!
'Twas e'en thy lovely jet black bottom."

The poet goes on to say—

"Farmers! who covet pig sty riches,
Let not your grunTERS wear black breeches.
In fairest titles they're a flaw.
This judges have laid down as law.
On such assurance, sure I am,
The very plumpest jucieSt ham,
Once parcel of a black-rumped hog
Unsavoury as haunch of dog,
Most needs disgust a knowing glutton,
Not less than leg of fir-fed mutton—"

In spite of criticism and satire, breed "fancy points" still have retained an importance to the present day as hallmarks of purity, "undefiled" ancestry and prepotency.

In hill sheep breeds in New Zealand there are very few characters of even those considered in the show ring which can be definitely be said to have no economic importance. Of some it can be said that in our present state of knowledge they are primarily due to environmental factors. The assumption that all differences in phenotype are genotypic and yield to selection, is still widely held. The classical example of such a wrong assumption is the story of "steely wool" in Australia. From earliest times onwards "steely wool" has been described as a serious fault in Merino wool. (Hawksworth, 1920, Fegan, 1946, and others). Under various pseudonyms, "glassy," "shiny," "slippery" etc. it has appeared from widely separated areas of Australia; its increase viewed with alarm and evidenced as lack of care in the selection of sires.

Growers, on advice from all quarters changed the sources of their rams in an unremitting search for "better bred" sheep. Because the incidence of the fault varied seasonally and yearly and with individual sheep graziers and sheep-classers could point to evidence that certain studs brought about improvement or vice-versa. Its genetic origin was unquestioned. Recent work has shown "steeliness" to be a symptom of copper deficiency, which disappears when the deficiency in the diet is made good. Variations in its incidence in a flock would seem to have been associated with rate of pasture growth and level of intake of sheep. Before leaving this question of environment and nurture, might I suggest that the concentration of most of New Zealand's outstanding Romney studs in two relatively small areas, and their continued supremacy is not perhaps without significance.

Much work has been done which throws some light on the relative importance of heredity and environment in the characterisation of live-stock, and much which has been directed at assessing the productive value of the animal. Let us now consider briefly some of the characters comprising the ideal in sheep selection, in the light of such recent work.

As a starting point consider the head. Head type is a strongly inherited characteristic (Rae 1947) and this has probably been responsible for much of the emphasis which is laid on this character. Like all early developing characters it tends to be more strongly inherited (or less subject to environmental influences in its development) than the later developing productive qualities. Hammond (1940) in tracing the course of improvement in mutton qualities has shown that in the

improved meat type the head is wide with a short face. From his own and Palsson's work, he concludes—"When the neck, a low priced joint, is shortened and the head is light then the spinous processes are shortened too and a broad shoulder instead of a sharp shoulder is formed. Thus a short small head and neck and broad shoulders go together with short cannons and 'well let down' legs; they are all features correlated with a high internal level of nutrition. They can be used to judge the value of the animal from a breeding point of view even though it is in poor condition at the time of inspection." Here the emphasis is on a small head, short and broad, three qualities readily capable of being simply assessed and combined into single score.

Other qualities of the head such as ears (thickness, setting and texture) profile, and poll, quality of face cover, nostrils and lips have at most a doubtful value based on supposed correlations with vigour and meat and wool qualities better judged more directly as has been emphasised among many others by Hagedoorn (1939). From the earliest times the "eye fine and lively" as described by Bakewell has featured in every breed description. As an indicator of health the eye is important as is the "vibrant nostril." Selection based on performance in the natural environment should surely need no such indications of vigour. With regard to amount of face cover, this has been assumed to be associated with heavy fleece. Marshall (1920) and Spencer (1923) found the converse to be true in Rambouillet ewes. More recently Terrill (1949) has shown that while covered-faced Rambouillet ewes produced a non-significant and economically unimportant increase in wool weight, the open-faced sheep produced over 11.3% more lambs and 11.1% more pounds of lamb per ewe bred and this in spite of 3 periodic clippings of those covered ewes subject to wool blindness. Face cover has been shown to be strongly inherited in the Rambouillet (Terrill et al 1946) and readily subject to change by selection, and this is in line with common experience with the New Zealand Romney and the Corriedale. As a character in a simplified selection ideal it should probably be regarded as a cull point when it is likely to result in any degree of wool blindness. If apart from the extra wool grown on the face it also indicates a heavier body cover, it is a poor substitute for direct measurement of fleece weight.

Teeth and jaw are characters intimately associated with the animal's ability to live, thrive and produce. It may be again argued that production would be the best measure of suitability of these characters. This would be true if selection did not have to be made at the earliest possible age for maximum progress to be achieved. There is much variability in the wearing qualities of teeth and while much of this would seem to be environmental (Barnicoat, 1948), there is most probably an important genetic aspect of this question which well warrants investigation, so that proper emphasis can be placed on teeth in a selection programme. Regarding jaw setting, much variability is found from the "parrot mouth" condition found in cattle (Ranstead, 1946) and in merino sheep (Kelley, 1942) to the prognathic condition where the under-jaw is overshot. In the dairy production studies of Hancock, previously quoted there was included one pair of identical twins with a marked undershot lower jaw. Under high plain feeding this animal showed the best production (358lb. of fat). Under low plain feeding its identical twin gave the lowest production of its group (168lb. fat). This pair of cows was responsible for the only serious anomaly in the similarity of the ranking of the cows in both levels of feeding. This result is important not only in demonstrating a strong genetic-environmental interaction in the case of a simply inherited character but emphasise strikingly the danger of selecting in an easy (or artificial) environment animals which are to be used in a hard environment. In cattle the condition known as "Parrot beak" has been shown by Ranstead to be due to a simple recessive autosomal

lethal factor. In the Merino, Kelley's data suggests a similar simple inheritance. Whilst the extreme condition of under-shot lower jaw occurs in the Romney what is more common is a range in jaw setting seen within flocks as well as within the breed, from slightly overshot ($\frac{1}{8}$ in. to $\frac{1}{4}$ in.) to undershot to the extent of $\frac{1}{4}$ in. to $\frac{1}{2}$ in. Here again information is required not only on the mode and intensity of inheritance but on the significance to production in different environments of the various degrees of the fault. In the meantime, any marked departure, at least, from the "normal" jaw setting must be regarded as potentially harmful to production and the widespread distribution of abnormal lower jaw guarded against.

An attractive well-balanced head, proudly carried and with a lively gait is an important selling point in rams. None will deny that robust health is a virtue and should command a price. As in all animals there is in each sheep an assemblage of qualities sometimes very distinctive which marks it out from other sheep and which might be termed personality. There are also many men gifted with that keen "shepherd's eye" which sees each sheep as a distinctive individual. Suggestions however that some can read the breeding worth of a sheep, almost as if divinely inspired do not warrant serious discussion.

Concerning the carcass of the animal we are well supplied with information, in objective terms, as to which constitutes good quality. The work of the Hammond School on growth and development and of the Lush School of genetics clearly demonstrates the predominance of environment over heredity in the development of meat quality and has given rise to the concept of a "ceiling value" imposed by heredity. This "ceiling value" may or may not reach its expression in the phenotype according to the environment (in its widest sense) but it does impose the upper level of genetic expression. In selection aimed at raising this ceiling level, the phenotype cannot be accurately measured in simple and practicable objective terms (since for one reason many meat qualities are internal) nor is it on the average strongly correlated with the genotype.

Growth and development studies suggest the use of indices based on early developing measurable characters which are strongly inherited (i.e., less subject to environmental modifications and accurately measured) and which have been found to be strongly correlated with meat quality. The character best fulfilling these requirements from the work of Hammond (1932), Palsson (1939-40), McMeekan (1940-41), Verges (1939) and others, would seem to be length of cannon bone. Is cannon bone length, or an index derived from it and the head measures mentioned previously the *ne plus ultra* in selecting for the desired genotype? Could the breeders using such a simple index have achieved what has been achieved in shorter time? From the growth and development studies it can be argued that the breeders did in fact use some such index.

Once the ideal of a short-legged sheep with a blocky carcass was clearly formulated, provided the emphasis was always on shortness of leg (a subjective estimate of cannon length) progress would be marked. The superimposition of blockiness whilst complicating selection, would in the kindly environment of highest plane feeding, have less effect on intensity of selection than might have been the case under natural conditions. The emergence of the accompanying head type and "heavy bone" at first as consequence of the ideal would soon be capitalised as an indicator of the ideal. Thus once again the practical man finds the method and science subsequently explains and rationalises it.

The simplicity of such explanation cannot however, be accepted as beyond all doubt. It is based on results of growth and development studies, made for the most part on small populations with a wide

variability either as a result of extreme treatments or the inclusion of several breeds. Walker and McMeekan (1944) found that strong correlations demonstrated by Palsson between external measures and carcass composition were in many cases of low order and non-significant within a breed. While the general principles however are not questioned, it must be admitted that the use of such simple indices of selection must be tempered with much commonsense and that their efficiency awaits much needed confirmation by direct experiment. Furthermore techniques of measurement on the live animal require investigation. I would like to emphasise in this connection that an absolute measure of cannon bone length is probably an inefficient index. What is required is cannon length relative to body size so that for example the bigger animal in low condition, which gives an impression of legginess can be correctly evaluated against the smaller animal in perhaps better condition. The latter, while being actually shorter in the leg, may in fact be the relatively longer-legged animal.

There are some features of conformation believed to be of importance apart from meat quality. Thickness and depth of chest it is postulated are necessary for adequate heart and lung room. There is no factual basis for such argument. Bred in a natural environment deficiencies in these respect will manifest themselves in impaired performance. Likewise shoulder setting is said to be important in relation to ability to climb and in the Cheviot, for example, the characteristic shoulders and withers are said to confer agility. This may be true, but the importance of such qualities can easily be distorted. If one is in no hurry, the easiest way to the top of the hill is to follow the sheep. It should too be remembered that over activity does not fall in line with maximum food utilisation. "Balance" is another term often spoken almost with reverence. Is it supposed for example that a sheep could be evolved, under natural conditions at any rate, mostly hind-quarters and loin? Extra development at the brisket, for example, it is claimed is extra meat. Even so it could not be less valuable anywhere else on the carcass. Consideration of characters such as these could unduly complicate a selection ideal while making no worthwhile contribution to progress in a natural environment.

Before leaving the consideration of carcass conformation brief reference should be made to the studies of McMeekan and Walker (1949) on the influence of type of ewe on fat lamb quality since efficiency in this direction is required of our hill-bred ewes. These workers found that there was very little superiority in lambs from ewes of the best conformation over those from ewes of the worst conformation selected from the same flock and mated to the same South-down rams. These results confirmed over three years, they claim, might be interpreted as indicating marked dominance of the Southdown breed or alternatively that the results substantiate the low heritability estimates for carcass conformation. A necessary and logical extension of this work is the determination of the performance of such divergent types of ewes (and rams) under hill conditions, so that carcass conformation in the live sheep can be placed in proper perspective in a selection index. I would stress again, however, the necessity of measuring legginess in objective terms and expressing it relative to body size.

The fleece of the sheep is perhaps more complex than conformation in the multiplicity of features of economic importance which might be considered. The assessment of the relative importance and economic worth of fleece and wool characters in commerce as well as in relation to efficiency as a cover for the animal) is probably quite impossible. There is much truth in the statement that every type of wool is ideal for some purpose, even though in some cases the ideal often may lie in the relative cheapness of some types. The complexity of the wool

manufacturing industry is not always fully realised and it is this very complexity which leads to much of the conflicting opinions held regarding essential wool characters. Regarding the ultimate destination of our wools we are very ill-informed. Wool quickly loses its identity in the course of manufacture, is sorted, blended with other wools and with other fibres, may be resold and scoured, as tops and again as yarn. Some types are useful for many purposes, others meet a more restricted demand, but if in short supply may command a higher price. For reasons such as these, manufacturing trials to assess the significance of differences in quality are difficult to plan and it is difficult to simulate commercial conditions. Townend and McMahon (1944), for example, carried out manufacturing trials on two lots of wool drawn from the same fleeces but differing in amount of medullation. Because of the small difference (about 3%) in the amount of medullation, their results, which substantially showed no difference in the products, were not surprising. To have chosen wools differing greatly in medullation would have introduced not only many other variables, but also the complication that such different wools are normally used for very different purposes. This situation is by no means novel. We have had, for example, reports in New Zealand wools from men prominent in the wool trade in England. Because the reports emanated from single yarn trade interests they expressed concern at the poor quality and the deterioration which was occurring in our national clip. This opinion was based on the decreasing proportion of first grade lustre and braid types which was consequent upon nothing more than the decline in popularity of the Lincoln and Leicester breeds and the grading up of our flocks to the Romney type, an excellent hosiery wool, for example. Furthermore farmers were advised to use stronger and longer woolled rams.

Further complications emanate from the terminology which has evolved and which is peculiar to wool. Many common words have a special meaning and many terms defy precise definition. The best example is the term "count" synonymous with "quality number" which is commonly contracted to "quality." This is perhaps the most widely used term in all branches of the industry. It defies definition and it defies measurement. It is strongly correlated with fineness, but is not fineness; it is also correlated with crimp and other physical fibre attributes. (Clarke, 1949). Furthermore, it is not a standardised concept and yet is a most potent factor governing price per pound. The safest simplification is to say that it refers mainly to fineness.

From such complexities emerges a generalisation that characters such as softness, length, strength, crimpiness, regularity of all attributes, and freedom from pigmentation, medullation, extraneous materials and stains in general are preferable and command a premium. This premium for quality is not a marked one, however, particularly in periods of keen demand. Crossbred wool is second grade to Merino types in the world trade, and is used in articles in which quality in its broadest sense is of less importance. It is often used only because better wools are more costly. On a falling market it is first and most affected.

In a selection programme fleece weight is a character of definite economic importance. It is readily measurable and strongly correlated with clean scoured fleece weight (or of the order of 0.9). It is, however, weakly inherited. McMahon (1945), Rae (1947), Phillips (1948), but under progeny test, rams which give a marked improvement have been found. McMahon (1945), Moreley (1948), Euston Young (1948), and others. Mention has been made of the importance of face cover, but attention must also be drawn to two other features related to fleece weight. Webster (1951) has drawn attention to a possible association between wool on the scrotum and infertility in rams. It has also been claimed that under wet and muddy conditions sheep "wooled to the

fetlock" can suffer a soreness of the legs due to the accumulation of mud on the wool of the lower limbs. Selection for fleece weight, therefore, may not be without complications. A further point in this connection is that selection for fleece weight could quite conceivably mean selection also for body size and beyond a certain point to impairment of adaptability and reduction of efficiency, if carried out in an artificial environment.

The components of clean scoured fleece weight are density, fibre length and fibre diameter and to these must also be added the area of wool-producing skin. The measurement of these individual components, the establishment of precise relationships between them and the study of their inheritance has not been neglected as we are well aware. The biggest problems to be overcome are concerned primarily with efficient sampling and rapid evaluation of these characters. It may be claimed that when these components can be efficiently evaluated selection for fleece weight can be channelised along the most rapid and efficient lines. In the meantime, however, and for a long time to come I believe, measurement of fleece weight, the end product, is the only useful line of attack.

Except for fibre diameter the components of fleece weight are positively correlated with weight. Selection, therefore, for weight means an increase in length and density. Sidey (1931) has drawn attention to there being something of an optimum staple length for many types of wool and while this opinion is widely held in the trade, the optimum defies definition for any type, and opinions from different sections of the wool trade are most contradictory. Whilst the existence of an optimum in length cannot be ignored, it would appear to be of small moment as yet. Fibre diameter, a strongly inherited character (McMahon, 1945), (Rae, 1947) is negatively and strongly correlated with fleece weight. McMahon's surveys (1945) have illuminated the general relationship between fleece weight, fineness and nutritive level respectively and demonstrates the fairly regular increase in fleece weight with decreasing fineness. In general the better the country the better can the stronger wools be grown. Wool values are notoriously unstable and the premium for fineness fluctuates widely. To-day, for example, the increased value of 50's wool over 48's is equivalent to less than the value of 2 ounces of wool, or about $\frac{1}{4}$ of the average difference in weight between these counts. The counsel of commonsense would seem to be to grow the greatest weight of wool of the type that can best be grown on the country. In other words, the strongest wool that can be well grown and free from fault (break and crotching in particular).

In this connection it is evident that over the last 20 years or so the stronger wools have almost disappeared probably due to breed changes. To-day over 80% of our clip falls within the range of 46's to 54's, and 66% within the range of 48's to 50's. We are tending to put our eggs very nicely in one basket. With the advent of widespread pasture improvement, however, it might be anticipated that the production of strong wools will increase.

Count is accurately determined subjectively and expresses the trade concept of fineness. It cannot be ignored in a selection programme, but because some range in count would seem to be not undesirable and because it is strongly inherited, it need not enter very directly, into a simplified selection ideal, but be considered only to the extent of restricting range in count.

As already mentioned there is a relatively low premium for quality. Furthermore in the trade, quality substantially means well grown wool free from breaks, tenderness crotching, discolouration and such faults, largely environmental rather than genetic. Crotching and unsoundness

are most probably indicative of lack of adaptability and are reflected in loss of fleece weight. There are some faults, however, which are strongly hereditary and cannot be overlooked in selection. Harshness or lack of softness would seem to be important (Sidey, 1931) and is detectable tactually. Work by Dry (1936) suggests harshness of one kind at least can be simply and strongly inherited in a dominant manner. Kempiness and non-kemp modulation, both strongly inherited (Dry (1944), Goot (1946), Rae (1947)), can both assume proportions constituting serious fault in our crossbred wools, although to-day this is relatively rare. For such reasons they must, I think, be kept in mind but once eliminated would not usually complicate a selection index. The remaining characters contributing to quality are difficult to assess and also to define in simple terms. Such things are regularity of fibre length and diameter, fibre contour, elasticity and such like physical properties, scaliness and crimp. Crimpiness is probably the buyers' chief index of desirability in many of these characters and is also indicative of well grown wool. It largely constitutes what is referred to as character, although previously mentioned features also play some part in determining character. Character is weakly inherited and furthermore can only be subjectively assessed in practice.

For such reasons and because of the lack of a real premium for quality, it would seem that the trade subjective estimate of quality, intelligently made is the only practicable solution to its evaluation. Furthermore, selection potential should not be unduly squandered in emphasising quality, but be devoted to the much more valuable character, fleece weight. Serious departures from recognised standards of quality in particular those strongly inherited, should, however, be watched for. It should be stressed, too, that there is no evidence whatever that quality and fleece weight are incompatible. Rather is the converse true (McMahon, 1945). The suitability of the fleece as a covering for the animal should in a realistic environment take care of itself.

Thus in the light of present-day knowledge and in spite of inadequate measures of production it would seem possible to evolve simple indices which supported by a realistic outlook and much more common-sense might contribute to more rapid sheep improvement. It would seem to warrant serious trial on an experimental scale, bearing in mind, however, the warning sounded by Hazel and Terrill (1946), who say "index selection was only slightly more efficient than selection by general appearance for ram lambs, where a small proportion was selected, but was considerably more efficient for ewe lambs where a large number of lambs was saved. Chief advantage of the index is that it emphasises highly hereditary and economically important characters and provides a constant and objective basis for comparing individuals. Its disadvantages are that it is laborious to calculate and that some lambs must be culled for defects such as hairiness independently of the index. There remains, however, a further serious problem and that is the early assessment of productive qualities so that the annual improvement from selection can reach its highest value. This field is relatively unexplored, although the work of Dry (1944), Thomasset (1937), Galpin (1936), Carter (1947), and many others on early recognition of wool characters give some hope of ultimate success in this field.

Time does not permit consideration of various selection methods, but I would like to suggest that progeny testing has failed to live up to the promises earlier made for it. Dickinson and Hazel (1944) in a now widely known paper have spotlighted certain reasons why the progeny test may be inefficient. McMahon (1943) estimated that insofar as fleece weight was concerned the ram capable of giving a 0.8lb. improvement in fleece weight might be expected to be found once in each twenty rams tested. If a similar relative improvement in one

other character similarly inherited is desired at the same time the expected occurrence of such a ram is about once in 400 tested. For all practical purposes, bearing in mind the limitations to the number of rams which can be tested (Goot, 1947), such a ram does not exist. It is obvious that spectacular improvements cannot be anticipated, even for a single character with other characters, if not improved, at least maintained. This has been the experience of, I think, all sheep progeny test projects in New Zealand, Australia and probably elsewhere.

Future improvement by breeding using the best selection methods available can only be visualised I believe as becoming progressively slower and consisting in the main of a gradual grading up to the best which possibly already exists. "Happy" gene combinations and epistatic effects may well result in individuals of exceptional merit, but while these may serve to stimulate effort, their quality would seem to be evanescent. The use of inbreeding, and crossing between strains in the light of present knowledge would seem to be a final resort of breed improvement.

Earlier in this discussion some time was devoted to the attempt to show that crossbreeding played a major role in the foundation of most if not all breeds. We exploit crossbreeding in many ways to this day. The Border Leicester X Cheviot ewe is the fat lamb ewe par excellence in England and in a long series of experiments summarised by Bywater (1944) the superiority of the crossbred as a dam is clearly demonstrated, in higher fertility, more viable and thriffter lambs, and markedly increased economic returns. In New Zealand we note the lower death rate in the Southdown and Romney lamb compared with the Whiteface lamb under similar conditions (Wallace, 1951).

Remarkable results from the use of Cheviot and Romney ewes have been demonstrated in the trials at Massey College (Hewitt, 1947), results due almost entirely to better fertility in the ewe, and extra vigour in the lambs. Results almost identical with those from the Massey College trials are to be seen in a similar crossbreeding experiment in Scotland using the Swaledale X Blackface ewes (Mason, 1947).

Whilst steady progress within the breeds is perhaps being achieved and whilst the population geneticists are pounding their calculators and evolving ever more abstruse directives to this end, can we afford to ignore the promises of crossbreeding in our hill country production? On this note and on the plea of time I draw this discussion to a close.

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