Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

SOME ASPECTS OF THE PROGENY TESTING OF NEW ZEALAND ROMNEY MARSH RAMS.

Being a Thesis presented by "393" for the Animal Husbandry Section of the M. Agr. Sc. Degree.

A.L. Rae (1948)
M.Agr.Sci thesis

CONTENTS.

INTRODUCTION.

Present animal breeding methods were devised empirically, many of them having their beginnings far into pre-historic and pre-scientific times. Men found by actual experience that certain procedures generally gave more desirable results than other procedures although the basic reasons for this were unknown. Selection, or the choosing for breeding purposes of those animals deemed to be superior, has been the most important of these methods and indeed, fundamental to the application of any breeding system. The quality of all types of livestock as we know them to-day is largely the result of its consistent application as a breeding method.

Selection has as its objective the identification and propogation of those superior individuals which are believed to be capable of reproducing their good qualities in their offspring. The major emphasis must be placed on the word "identification". It is in this word that are embodied the essential differences in the methods of application of selection to livestock breeding. Three methods can be used for the identification of superior animals; by the individual merit of the animal, by the evaluation of its pedigree and finally by the evaluation of its offspring.

While the history of animal breeding shows that all three methods of identification of superior animals have been used, the emphasis placed upon them at different times has varied. The word "prepotent", used by breeders long before the advent of the science of genetics is an indication of the recognition given to the progeny as a guide to the breeding value of the individual. But, prior to the discovery of the laws of inheritance, emphasis was largely placed on selection on individual merit and on pedigree rather than on the use of progeny testing.

Research of recent years into the fundamental basis of selection has emphasised with increasing force that for many characters of economic importance in livestock, selection on individual merit is sufficient only to maintain the existing standard of quality. It has further shown that the most accurate method of selection is based upon the evaluation of an unselected sample of the offspring of the individual animal and that this application of progeny testing in some form is an essential part of any breeding program designed for the improvement of livestock.

The principles involved in the progeny testing of sires have been widely discussed by many writers (Lush, 1943, Hagedoorn 1944). It is based on the fact that each offspring receives a sample of its parents genotype. When the evaluation takes into account a number of offspring of the same animal, opportunity is given for the deceiving effects of environment and non additive gene effects to be cancelled out. Consequently the fundamental genetic effect of progeny testing is that it makes selection more accurate and more effective. It does not change any genetic process.

While the principles underlying progeny testing are simple, its integration into sheep breeding practice presents more serious problems. Essentially, the application of progeny testing has been limited by the difficulties inherent in sheep breeding itself. Any attempt, therefore, to associate the principles of progeny testing with the practice of sheep breeding is hampered by the inadequacy of factual information on the problems of sheep breeding.

These problems may be briefly summarised as

(1) The lack of or inapplicability of objective measures for many characters of economic significance.

(2) Largely in consequence of this lack of objective systems of measurement, there is a paucity of knowledge on the inheritance of these characters.

(3) The necessity for taking into consideration meat production as well as wool production.

(4) The difficulty in defining "improvement" in quality of wool in particular, because of its wide range of types and uses and the marked, unpredictable changes in demand for these different types.

(5) The wide range of environmental conditions under which stock of the same breed are expected to produce. This emphasises the necessity for considering breeding in relation to adaptability to various environmental conditions.

(6) The lack of adequate study of the environmental factors affecting fleece and meat productivity.

It is against this formidable background of largely unsolved problems that the application of progeny testing in sheep must be considered.

REVIEW OF LITERATURE.

In recent years, an extensive literatue has accumulated on the subject of progeny testing as a selection method, its application, accuracy and repeatability. Generally, however, it is found that most attention has been paid to it in connection with dairy cattle and poultry breeding while only limited study has been given to sheep and other domestic livestock. In this section, it is intended to summarise only those papers in which the approach to progeny testing is general in outlook and those which deal specifically with progeny testing in sheep.

That the general idaa is not a new one is attested by comments made by Varro some 2,000 years ago on the advisability of determining a ram's quality by his get (as quoted by Lush 1943) while in 1826, Andre recommended progeny testing as a main reason for the keeping of stud books for sheep. Robert Bakewell (1726-95) whose renown as an animal breeder was recognised in his own time and still lives to-day, initiated sire testing by leasing his sires to other breeders and then bringing back into his own flock those which proved most satisfactory. Austen (1943) cites Randall writing in 1862 in his book "Fine Wool Husbandry" as stating that no one can proclaim confidently that he has a first class sire until it has been actually tested. "Unless found to produce highly excellent and highly uniform offspring, then the showiest and costliest ram should be promptly abandoned." Austen further quotes from an additional source "The Jondaryan Woolgrower" who wrote in 1868 that "One method of finding out as near as possible the inherited tendencies is to put ram lambs, selected for stud purposes, when six months old, to a few ewes (20 to each ram) similar to those with which they are intended".

Despite these exhortations, the paramount importance of progeny testing did not appear to be properly realised and breeding on the basis of external appearance and pedigree remained in favour. A renewal in the interest taken in progeny testing resulted largely from its successful application with dairy cattle in Denmark at the end of the last century. Its efficacy in producing improvement lead to wide investigation and advocacy of the method in many countries and gave rise to the formulation of its theory to the proving of dairy bulls. Numerous indices to indicate the breeding value of the dairy sire have been proposed (Hansson, 1913, Goodale 1927, Edwards 1932, Yapp, 1925, Wright 1932 and later Rice 1944). The usefulness and accuracy of these have been discussed by Lush (1944). Schemes based on the use of progeny testing have been developed on a national scale in most dairying countries.

The advances briefly mentioned above in the use of progeny testing in dairy cattle have not been paralleled by any similar advance in sheep breeding. From the literature, it appears that the first approach to progeny testing was made on the continent.

Zorn, Kruger and Bauer (1933) working with Hampshire sheep in Germany deprecate the high rate of culling required because the offspring were inferior to their parents. Because mutton production is most important, they considered live weight at four weeks of age and after correction used this as a measure for comparing sires on the basis of a comparison between dams and offspring. By this method they considered the best sires could be selected with greater accuracy.

Arapov (1934) discusses the results of using seven proven sires for artificial insemination in Russia. The lambs born of proven sires were of much higher quality than the average lambs of the same farm for the same year; and improvement over the previous year was of the order of 8 to 11%.

Davydov (1934) shows the comparison of progeny of different sires in regard to live weight to be difficult. He suggests that the best method is to determine the value of k, or the intensity of weight developement, from the formula $y = A \ (1 - e^{kt})$ (where t is the age and e the exponential factor.) for each lamb and to average these values. In this way he shows significant differences between three sires and shows one to be an outstanding improver.

Holomeizer (1935) in progeny testing for fleece characters found differences in most fleece qualities except that of fibre diameter and was able to classify the sires according to the amount of improvement which they brought about in the daughters in comparison with the dams. Kardymovic (1937) discusses a similar type of project on dollective farms in the Levokum district in Russia. He considers that an index of overall quality is unsatisfactory because the breeder does not require a "universal" improver but rather a sire that will bring about improvement for specific characters. Three rams were detected on each farm that were superior and they were widely used by artificial insemination. Sannikov and

Sarygina (1939) in the same area also report on the progeny testing of Rambouillet rams for fleece quality and show wide differences between sires.

In Russia, a great deal of attention has been paid to birth weight and live weight in the evaluation of sire differences. Kardymovic and Viebe (1937) quote results of a study of the effect of multiple births and sex on birth weight and give corrections for these factors. They use them for correcting for these effects in progeny evaluation. Moiseev (1937) working with the Précoce breed found correlations of 0·6 - 0·8 between live weight at weaning and at one year. He thus advocates this early evaluation of sires and shows that the results at the two ages correspond. He further studies the effect of the use of rams at six months of age and found that they could be successfully used even for artificial insemination with no deleterious effect on subsequent growth. He thus demonstrates the possibility of the early proving of rams.

Glembockii (1939) also discusses the effect of sex and twinning on birth weight and concludes that there is no need to correct for twinning provided the ewes are kept under the same conditions and the number of lambs is about 100. He gives correction factors for smaller numbers. Sannikov (1939) is also occupied with the relation between weanling and yearling characters and finds the relationships sufficiently high to be useful in evaluating the progeny of a sire at weaning age.

Attention has also been given to the progeny testing of Karakul sires. Langlet (1935) has devised a form for recording data of the entire progeny of a sire, the various items being evaluated on a scale of ten points. These values are related to those of the dam in order to show whether the sire is producing improvement. Panfilova (1939) gives results of progeny testing and states that the best ewes gave the best offspring. Later he makes the unqualified statement that the progeny testing of rams gives more reliable results if tested on groups of ewes of different quality. Pomanskii (1939) criticises the method of basing the progeny test solely on pelt quality at birth and shows the lamb pelt to be greatly affected by external conditions. He found a good relationship between pelt quality of the lamb and constitution of the adult and hence stresses the importance of constitution.

Work on progeny testing with sheep in America has also advanced at a relatively slow rate. The survey of "superior germplasm" conducted by the United States Department of Agriculture and published in the 1936 Year Book of Agriculture contains the significant statement that only three of the twenty-four circularised experimental stations are reported as using progeny testing as part of their program. This survey lays stress on the necessity for more knowledge of the inheritance in sheep, adequate methods of measurement of productive characters and the use of systematic breeding methods to produce improvement.

Subsequent to this survey, however, considerable stress has been laid upon the investigation of progeny test methods and the problems involved therein. Phillips et al. (1940) summarise the difficulties in progeny testing sheep as being mainly due to lack of objective measures for production and the necessity for considering more than one form of production. Using body weight, fleece weight and fleece length as objective measures of production, they analyse sire and seasonal differences for Corriedales and Rambouillets. Their results indicate that differences are shown even though the sires were to some extent proved rams prior to use in the flock and they conclude that the chances of finding differences among untried rams should be very good. They finally give details of a simple method of application to usual stud breeding conditions.

Ensminger et al. (1943) discuss the application of progeny testing in small flocks - a problem of major import in the United States. Data on birth weight, weaning weight, slaughter grade and type score were analysed, and they outline a procedure for testing rams when flock numbers are small. They emphasise that the system does not guarantee a rapid rate of improvement, because the number of rams that can be tested at one time is obviously low.

In New Zealand, the advisability of progeny testing has been strongly advocated for the improvement of sheep productivity. McMahon (1940) discusses culling and shows that for those characters that are weakly inherited, it is virtually ineffective as a means of producing improvement in the next generation. He compares the rate of improvement attainable by this method with that by the use of progeny testing and concludes that selection of rams on the basis of their progeny test would enable improvement corresponding to one pound in fleece weight to be obtained almost in one generation.

In the same year, the same writer (McMahon 1940 b) discusses problems of breeding for wool in relation to measurement of fleece characters. Emphasis is laid upon the use of the nucleus system of breeding (Hagedoorn 1939) whereby the best rams on progeny test and their near relatives form a necleus or top flock. The remainder of the flock is then used as a testing flock for trying out sires for use in the nucleus.

McMahon (1943) reports analyses of sire differences in conjunction with a study of heritability of fleece and body characters. Highly significant differences are demonstrated between sire means, and calculations are made of the expected superiority of top sires and the number of offspring required for an adequate test. His results draw attention to an important problem - that of repeatability of progeny tests on the same sire. The correlations are not high and indicate individual progeny tests to be less reliable. The same writer (McMahon 1946) gives results of attempts to locate high producing strains of sheep. The fact that there was a close similarity in fleece productivity between strains is disappointing and emphasises again the necessity for progeny testing.

Wheeler (1945) has given a statement of the application of progeny testing in a commercial stud flock. He outlines methods of mating so that the sire of each lamb is known and in particular emphasises the standards used in evaluating the sire's worth. The offspring must show improvement on the standard of the dams, freedom from any bad fault and evenness throughout. It is necessary to consider all the progeny sired by the particular ram.

Kelley (1946) in discussing the progeny testing of fine wool sheep in Australia deplores the lack of knowledge on the inheritance in sheep. He considers that further knowledge is required on the following points:

(1) Definition of component characters of the fleece and their associations.

(2) The methods of inheritance controlling these characters.

(3) Techniques for measuring characters of economic worth.

(4) The degree of variability occurring among offspring by the same sire in order to fix the number of offspring required for an adequate progeny test.

He considers, however, that much can be done at the present time by appraisal and scoring of progeny of the rams used. He says, "If any sheep breeder carries the process suggested for progeny testing as far as having identifiable progeny groups, he will find much to interest him and many ways of comparing the groups."

Nichols (1945) quotes carcase grading for export as conducted in New Zealand and Australia as a bulk form of measurement suitable for progeny evaluation in lamb and mutton sires. Birth factors such as weight at birth, sex, birth rank, season of birth as discussed by Phillips et al. (1940) are also considered as important, for ordinarily there will not be sufficient lambs from each sire to include equal numbers for each of these factors. He further points out the necessity for estimates of early production, as indicators of later production.

Wide divergence of opinion is found among different writers with regard to the number of offspring required for testing a ram. Frölich (1933) claims that 150 lambs are required for evaluation of the genotype in the Karakul breed. Lush (1935) discusses the relative accuracy of the progeny test and the parents' own performance as measures of breeding value. His conclusion is that only under rare conditions will a progeny test on as few as four offspring be as accurate as a dam's own record (in dairy cattle.) McMahon (1940) considered that 7 lambs would be a sufficient test but later (McMahon 1943) he states that 15 progeny are sufficient to establish the superiority of a ram leaving fleeces 0·8 lbs. above the average, with odds of 19 to 1. Wheeler (1945) is of the opinion that 10 to 15 lambs is sufficient, while Ensminger et al. (1943) indicate that considerable information is gained for each additional offspring up to 8 or 10, while little extra is gained by going above 15. In general, the answer to this problem is supplied by a knowledge of the variability among offspring by the same sire which leads to its accurate formulation as given by McMahon (1943).

A most important aspect of progeny testing has recently been dealt with by Dickerson and Hazel (1944). They approach the subject from the viewpoint of the average genetic improvement expected yearly from early selection alone as compared with that expected when use is made of the progeny test. They illustrate the important factor of the time required to obtain progeny tests by comparing selection for weanling and yearling traits in sheep. When heritability is low (.10) use of the best progeny tested ram is expected to increase progress about 11% for weanling traits and 3% for yearling traits. These values are increased to 22% and 37% respectively by testing as ram lambs and using an auxiliary testing flock. Their conclusions are that a regular plan of progeny testing is unlikely to increase and may reduce progress unless

(1) the progeny test information becomes available early in the tested animal's lifetime.

(2) the reproductive rate is low.

(3) the basis for early selection is relatively inaccurate.

These conclusions do not conflict with the fact that unbiased progeny test information always increases the accuracy of selection for poorly inherited characters. Rather they mean that, in the time required to carry out the progeny test, the genetic progress from individual selection may be more than that obtained from selection on progeny test. The above conclusions virtu lly define the frame-work within which progeny testing is likely to be successful.

SECTION II. OBJECTS OF THE INVESTIGATION.

The review of work which has been reported on the application of progeny testing to sheep breeding in New Zealand indicates the necessity for controlled investigation into the various aspects of the problem. Broadly, therefore, the purpose of the project may be defined as an examination of problems associated with the development of a practical method of progeny testing in Romney Marsh sheep. In particular, the aspects which have received attention in this thesis are -

1. methods of measuring productive characters of sheep with particular reference to their accuracy, rapidity and their incorporation into breeding practice.
2. The amount of variation in productive characters which can be attributed to heredity.
3. The value of the lamb fleece and carcase characters in predicting those of the hogget.
4. Measurement of the degree of variation among offspring by the same ram in order to estimate the number of offspring required for a test of known accuracy.

In addition, other aspects have been included among the objects of the experiment, but detailed data will not be available till the next phase of the experiment is completed when it will be possible to consider the repeatability of progeny tests of the same ram on the same ewes in different seasons and other aspects of repeatability. Also, a considerable bulk of data will have accumulated which should allow of a study of correction factors for various environmental and non-genetic conditions.

Finally, close attention is being paid to the data and technique for indications of further problems which may be involved in the use of progeny testing.

SECTION III. PLAN OF EXPERIMENT.

A EXPERIMENTAL ANIMALS.

(a) RAMS.

Ten mixed age Romney Marsh rams were procured from widely different sources for use in the experiment. In selecting them, the rams were chosen to be as phenotypically variable as possible and it was hoped that, in obtaining them from different flocks, they would show under progeny test a considerable amount of genotypic variation. A brief individual description is given of these rams which have been designated by the numbers 1 to 10. Definitions of the quality gradings used in these descriptions are given in Section III C.

SIRE No. 1. This ram was a two-tooth at the time of starting the experiment and could be classed as an average quality flock ram. Its fleece was of 46's quality, and gave distinct evidence of tippiness. The grading for "fleece as a whole" was "good + ". The major conformation defect was a distinct narrowness behind the shoulders.

SIRE Nº 2. Also a two-tooth ram and according to commercial standards was a good quality flock ram. The fleece was 46/8 in count and graded as "very good" for fleece quality. Its conformation was good with no particularly outstanding features.

SIRE No. 3. This ram was born in 1939, and died after the first year of the experiment. In regard to average quality it was placed as a first class flock ram. Fleece quality was only medium, while the important feature of conformation was the shortness of leg.

SIRE No. 4. Also an aged ram born in 1939 and classed as a good quality flock ram. The fleece of this ram was considerably finer than the others and staple formation was poor giving the impression of "fuzziness". The grading for fleece as a whole was "poor."

SIRE No. 5. This sire was typed as a poor quality two-tooth ram, with a noticeably uneven fleece. The fleece showed distinct tippiness and was of 48's quality.

SIRE N. 6. Also a two-tooth ram of only average quality. This was the longest legged animal used in the experiment. Its head type although good, was quite distinctive and what would generally be termed heavy. In addition it was narrow behind the shoulders.

SIRE No. 7. A two-tooth ram of good flock quality. This sire had the strongest fleece of all the sires used (44/6) but most important was the obvious extreme variation of fibre diameter within the staple. The upper half of the staple was strong, while the lower half became perceptibly finer -

SIRE No. 8. This ram was a twin to Sire No. 6, but not as good in overall quality. The fleece was particularly even throughout, and was graded very good for quality. The main conformational defect was length of leg.

SIRE No. 9. An aged sire born in 1939 and considered to be of good flock quality. The fleece exhibited features which are frequently found in very find Romney wool - shortness of staple, and lack of clear cut staple formation. There were no outstanding features of body conformation, the body as a whole being classed as medium grade.

SIRE No. 10. This was an inbred animal of average quality. The prominent features of the fleece were, firstly, the staples were not clean opening due to a large number of cross fibres from one staple to another, and secondly, the fibres seemed to be inadequately supplied with yolk giving the fleece a harsh, dry handle. It has been suggested in some quarters that this latter feature may be hereditary.

The above descriptions show that there was considerable phenotypic variation among the rams. In addition, a number of important faults which are worthy of study are also included. In the case of the aged rams; nothing was known of their previous breeding history.

(b) EWES.

The female stock used in the experiment were hill country Romney crossbred ewes from three different sources.

(1) 150 College bred. 5½ year old ewes.

(2) 100 bought-in. 5½ year old ewes.

(3) 150 two-tooth ewes also bought-in.

The 5½ year old bought-in ewes were of excellent quality from a flock which has been considered one of the top lines coming onto the Feilding market for a number of years. When judged in relation to ordinary commercial standards, the three groups of ewes considered as a whole constituted a flock of good quality.

(c) SELECTION OF SIRE GROUPS.

An important difficulty in progeny testing arises from the consideration that half of the inheritance of the offspring is supplied by the dam. In order to give a fair representation of the effect of the sire, this contribution of the dam must be standardised. This was accomplished in the experiment by assigning the ewes at random to their various sire groups. The randomisation was accomplished by the use of slips of paper numbered from 1 to 10. As the ewes came through a race they were placed in the group indicated by the drawing of a number. This number was then left out and the process continued till one animal had been placed in each of the groups. The cycle was then recommenced until the 250 5½ year old ewes had been randomised to 10 groups of 25 each. A similar process was adopted with the two-tooth ewes. The efficacy of the randomisation is indicated in most of the analyses, by the very small variation in mean differences between the 10 groups.

B. EXPERIMENTAL PROCEDURE AND MANAGEMENT.

The experimental flock ewes were grazed for the whole period on the "Pahiatua" block of the College Farm. The history and description of this block is given by Peren et al (1938). All the area was sown down with improved strains of English pasture species mainly certified pedigree perennial ryegrass, certified mother seed or pedigree white clover, Montgomery red clover, certified Akaroa cocksfoot and crested dogstail. At the present, the sward is mainly dominant perennial rye grass white clover topdressed periodically with 2 - 3 c.w.t. of superphosphate per acre.

(a) MANAGEMENT OF THE EWES.

The ten rams were put out with their respective mobs of ewes on 25th March, 1944. The rams were raddled red for the first 17 day period and then changed to blue and finally to yellow. The ewes did not take the rams well during the first week of tupping although feed was good and weather conditions excellent. Later on, however, there was some improvement and by the end of the first 17 day cycle, on the average only 14 ewes were left in each group to be served. The rams were removed on May 19th having been out for eight weeks.

From the beginning of May onwards considerable trouble was experienced with scald and as a curative measure, the ewes were put through the foot-rot bath (bluestone solution) approximately twice a week. After the removal of the rams, the ewes were run in one mob on a rotational grazing system, and this was continued throughout the winter. The stock wintered well and at no period was there a shortage of feed.

About the beginning of August, the ewes were drafted into early and late lambing groups for convenience of work at lambing time. The first lamb was born on August 19th and despite the lag at tupping time the lambing season was not unduly protracted. In the first three weeks 62% of the total lambs born were dropped, and by the end of six weeks 97% of the total had been born.

For some unexplained reason, considerable trouble was experienced with malpresentations. Approximately 25% of the ewes were recorded as having to be assisted at lambing. Three cases diagnosed as sleepy sickness occurred and were injected with glucose, two of them subsequently dying.

At birth, the lambs were eartagged and note also taken of the eartag number of the ewe. Birth weight, birth date, sex, and number born were also recorded.

Docking was carried out when the lambs were approximately three weeks of age, and at this time they were also recorded for body weight prior to the operation.

During lambing, the rotational grazing system was abandoned, but after three mobs of sufficient size had been built up, this practice was recommenced and carried on throughout the remainder of the season. About the beginning of December, the ewe flock was brought in and described for fleece characteristics as detailed in the following section. They were then shorn in the second week of December, and fleece weight was recorded. Approximately six weeks after shearing and after weaning, when sufficient time had elapsed for any uneveness produced by shearing to have been smoothed out, they were described for body conformation and then in the case of the old ewes, the majority of them were sent to the Freezing Works. Opportunity was taken to record a number of carcase measurements after slaughter.

(b) WETHER LAMBS.

The procedure adopted with the wether lambs was as follows. Body Weight was recorded at intervals until they reached a live weight in the paddocks of approximately 74 lbs. Lambs attaining this weight were then picked out and transported by lorry to the woolshed. Fleece descriptions detailed in the following section were made. Samples were taken at the mid side position, at Position No. 5, on the Hindquarter (as described by Goot (1945) and also a sample from the britch for yield determination in the future if required. They were then shorn and fleece weight recorded. This was followed by a description of the body conformation.

The lambs were kept overnight in the woolshed and the following morning were slaughtered and graded under the export system of grading. The carcases were stored in a Cooler overnight at 42° Farenheit and on the next day the measurements described in Section III C were made and the Cambridge Block Test points awarded.

The killing of the wether lambs extended over quite a long period starting on 3rd November, 1944, and finishing on 4th May, 1945. The usual practice was to kill once a week if lambs were coming forward, but at the height of the season about mid January, it was necessary to kill twice a week in order to keep the number of lambs down to a level which could be handled comfortably with the facilities available, and with due regard to accuracy of the collection of data. The aim in selecting the lambs for slaughter was to have them killing out at a dressed carcase weight of about 34 lbs. Some variation in the live weight in the paddock was necessary, however, during the season to achieve this object, notably on account of the increase in weight of wool as the lambs became older. In the latter part of the season, therefore, the lambs had to be picked at a live weight as high as 79-80 lbs.

(c) EWE LAMBS.

Insofar as the ewe lambs were concerned, the object was to retain them in the experiment for a study of fleece and body characters at the hogget and later stages. In accordance with this aim, they were described for fleece characters at the end of December, and were shorn on the 8th January when fleece weight was recorded. At this time also all the lambs including wether lambs not yet killed) were weaned and were run separately n grass. Some weeks later they were described for body conformation.

Throughout the autumn and winter, the ewe hoggets were run together s a mob. The management was specifically designed to be as standardised s possible, and no special treatment was given to any groups or individ-als. Routine drenching with Bluestone and Nicotime was carried out at hree weekly intervals for all animals to control worm infestation. On ay 6th 1945 they were put onto a crop of cabbages that was available on he block and then later, on June 20th they were put onto swedes, and then returned to grass in the spring. Losses over the winter were ight, only 5 hoggets or 2.4% of the total dying during the period May 1st to October 1st.

During the first week in October, the hoggets were described for fleece characters, then grouped according to their sires, and a general summation of the quality of the groups was made. Body weight was also taken at this time and they were then shorn and fleece weight taken. They were subsequently returned to pasture on the Block, and later were described for Body conformation, under the usual system.

Summarising, it can be said that, as regards the management, every care has been taken to treat every animal and group as nearly alike as possible. This was attained in the main, both in the case of ewes and hoggets, by running all the groups together in mobs as described previously except at times when this was impossible, as, for example, at tupping time. In this way, any special effects if they did occur would be randomised over all sire groups and should in no way affect the validity of the results.

1945 SEASON.

A new line of 450 good quality 5½ year old ewes were bought in for the second season of the experiment in order to allow of a study of repeat-ability of the progeny test of the same ram on different ewes. Only seven of the original sires were available for this second year of the experiment, the fertility of the remainder no longer being reliable owing to age. Sires No. 3, 4 and 9, were eliminated on this account.

The management and experimental procedure of the experiment was substan-tially the same as that detailed above. In this report, consideration is only given to the wether lambs from this second year, full data not yet being available for the ewe hoggets.

C. DATA COLLECTED.

As far as possible an attempt was made to collect data on all aspects of productivity, both quantitative and qualitative. This was considered advisable on the grounds that the data could subsequently be used for more fundamental studies on the importance and interrelationship of the fleece and carcase characteristics, a problem on which there is a singular lack of information. Moreover, in the case of many fleece and carcase characters their heritability and, consequently, their importance from the point of view of progeny testing, is unknown.

In general, the evaluation of quantity of production does not present any major difficulties but quality in both fleece and carcase is involved considerably by the largely uninvestigated interrelationships of the various characters and the inadequacy or lack of objective methods of measurement. Therefore, for the most part the quality aspects of both fleece and body had to be estimated by subjective methods of eye and hand impression. Using a range of seven grades as follows: Excellent, Very Good, Good, Medium, Poor, Bad and Cull, which were recorded using the symbol system, advocated by Waters (1939). In certain characters (specified later) a smaller number of grades was used and in others the range was increased by the subdivision of the grade into two categories by the use of the plus sign.

Most of the description work was carried out by three judges. Each character on the animal was evaluated independently by each judge, and then the various opinions stated. When variation occurred in the grade assigned by the judges, the character was reviewed once more and discussed till unanimity of opinion was reached. The grade assigned was then noted by a recorder on forms cyclostyled for the purpose. The animals were described more or less at random and every care was exercised to ensure that at no time, did the judges know the sire group to which they belonged. In this way, any possible bias in favour of a particular sire group was eliminated.

DATA COLLECTED AT LAMBING TIME.

(a) Date of Birth.

(b) Sex of lamb.

(c) Eartag number of the Dam.

(d) Birth Weight.

The weight of each lamb was recorded to the nearest tenth of a pound as soon as possible after it was dry.

(e) Remarks.

Any notable feature, such as condition of ewe and lamb, malpresentations, whether or not the ewe had to be given assistance at lambing, milk supply of the ewe, was mentioned in remarks.

FLEECE DATA.

The following data were recorded for all rams, ewes, ewe and wether lambs and ewe hoggets. Unless otherwise stated, seven grades were used.

(a) QUALITY, NUMBER OR COUNT.

This was defined for present purposes as the visual impression of fibre fineness, and the numbers applied to the wool are considered to be in close agreement with the counts generally in use in the wool trade in New Zealand. The estimate was made on the wool growing on the mid-side region of the fleece and was judged by looking at a spread film of fibres. The fineness was judged to the nearest half interval e.g. 44's 44/6 e.t seq. In general variations in count over the fleece was taken into consideration under the estimate of evenness.

(b) HANDLE.

Handle refers to the way in which wool affects the tactile sense and soft handling wool is considered more valuable from the trade point of view. This character was judged with the tips of the fingers, and away from the weathered portion at the tip of the staple without holding the wool taut. In the light of previous experience, only three grades were used for this estimation - Good, Medium and Poor.

(c) LUSTRE.

This character may be defined as the way in which wool reflects light after the manner of spun glass, and it has been shown to be related to fibre fineness within the Romney breed. An attempt was made to grade for this feature within comparable groups.

(d) COLOUR.

This estimate takes into account the presence or absence of discolourations in the fleece. Ideally, it is considered that Romney wool should show a light olive oil colour, and this attribute in description work has been given the grade of Excellent.

(e) GENERAL CHARACTER.

This estimate primarily takes into account, evenness, size and type of crimp as well as staple formation, tip, and freedom from cross fibres, from one staple to another ("clean opening" fleece). There is a relationship between type of crimp and quality number of wool, and in general this was taken into account. The description was made on the three places specified below.

(1) Side
(2) Forequarter
(3) Hindquarter.

(f) BACK WOOL.

An estimate, using seven grades was made on the soundness and general character of the back wool, taking into account also, the extent to which it had withstood the effects of weathering and acted as a protection to the animal.

(g) EVENNESS.

This evaluation applies to the variations in type, general character and count over the fleece.

(h) STAPLE.

Under this heading, remarks were made on the staple formation of the fleece with particular reference to "stringiness" of staple. Three grades were used if this feature was present. S.S.S. (Slightly Stringy Staple) S.S. (Stringy Staple) and V.S.S. (Very Stringy Staple)

(i) TIP.

When noticeable tippiness of the staple was present it was remarked on under three grades - S.T.T. (Slightly Tippy Tip) T.T. (Tippy Tip) and V.T.T. (Very Tippy Tip.)

(j) TYPE.

Where variations occurred from usual Romney type wool, they were specfically noted under this heading.

k) FLEECE AS A WHOLE GRADING.

This estimate was intended to be a general summation of the characters mentioned and to give an evaluation of the excellence of the fleece considered as a unit. Half grades were used giving in all a range of fourteen categories.

l) STAPLE LENGTH.

This was measured with a ruler to the nearest centimetre on the midside region of the fleece. The measurement was made from the skin to a position midway between the point where the staple starts to taper and the tip, taking care not to stretch the staple unduly.

m) FLEECE WEIGHT.

This was recorded by weighing each fleece to the nearest tenth of a pound prior to skirting and rolling. The belly was also included.

n) MEDULLATION.

Samples were taken from position No. 5 of the Hindquarter (Waters 1935) and the medullation determined by the Fleece Testing Department of the College.

(o) REMARKS.

Any noteworthy features not considered under the above headings were included in remarks e.g. Face covering, wool covering of the extremities, pigmented patches or fibres, cotts, kempiness, break or tenderness, obvious hairiness etc.,

BODY DESCRIPTION.

The conformation of ewes, ewe hoggets, ewe and wether lambs was described under the following headings. Unless mentioned specifically to the contrary, seven grades were used.

(a) HEAD.

Primarily, this estimate was based on the length of the head in relation to width, the smaller length: width ratio being awarded the higher grading. Malformations and undershot or overshot jaws were mentioned specifically in remarks.

(b) SHOULDERS.

This grading takes into account the width through the shoulders, flatness over the withers and general conformation of the Fore Quarter.

(c) BACK.

Reference was made in this case to the levelness of back and spring of rib as well as width. In addition, a close check was made for narrowness behind the shoulders and when present this resulted in a grading down of the back estimate. Narrowness behind the shoulders was also mentioned in Remarks.

(d) LOIN.

A grading, to take into account width and flatness of loin as judged by hand was made.

(e) HINDQUARTERS.

Width and fullness of the hindquarters was judged. Tail setting was also included in this estimate, and if it was noticeably poor in this respect, mention was made of it in remarks.

(f) LEGS.

This estimate referred to the length of leg judged in relation to the size of the animal.

(g) BONE.

Thickness and quality of bone, was taken into account in this estimate. Only three grades were used owing to inaccuracy of further subdivision in this case.

(h) CONDITION.

This refers to the degree of fatness of the animal and was judged by hand and eye into seven grades.

(i) BREED TYPE.

This character was based on the degree to which the animal conformed to the standard of the Romney Marsh breed, as laid down by the Breed Society. In general, the characters taken into account were Head Type, Length of Leg, Quality of Bone and absence of any outstanding fault. The full range of seven grades was utilised.

(j) BODY AS A WHOLE GRADING.

A general summation of the carcase from the point of view of carcase quality was included in this estimate. Head quality was not considered in this connection. Half grades were used to give a range of fourteen subdivisions.

(k) REMARKS.

Mention was made under this heading of any departures from normality and any Breed fancy points not considered in the above scheme. Colour of face and legs, Jaw Formation, Face Covering, Tail Setting, Feet colouring and abnormalities. Straightness of Hock, and weakness of pasterns were points that were noted.

It must be emphasised that, with all of the body conformation characters considered, they were judged in relation to the size of the animal and with due regard to balance in the proportions of the various parts. The consequence of this feature of the scoring system, will be discussed later.

DATA COLLECTED AT SLAUGHTER.

The following data was collected on wether lambs prior to or immediately after slaughter.

(a) EMPTY LIVE WEIGHT.

Prior to slaughter the lambs were weighed to the nearest tenth of a pound.

(b) WEIGHT OF HEAD.

The head was severed at the anterior atlas joint and its weight noted to the nearest tenth of a pound.

(c) CANNON BONE MEASUREMENTS.

The left fore cannon bone was collected from each carcase. The bone was scraped to remove all flesh and its green weight recorded immediately to the nearest tenth of a gram. Each bone was labelled and subsequently the length measurement was recorded.

(d) HOT CARCASE WEIGHT.

The weight of the carcase (with kidneys removed) was taken immediately after slaughter to the nearest 0·1 lb.

(e) CARCASE GRADING.

Within a few hours after slaughter, each carcase was graded and evaluated for the points quoted below. A range of five points was used, 5 indicating maximum quality.

(1) Hindquarter.

(a) Conformation.

An estimate of the length of leg, fullness of crutch and depth of meat in the hindquarter.

(b) Finish.

An estimate of the fat cover over the leg. The ideal is an even covering of fat sufficiently deep to prevent the colour of the muscle from showing through.

(ii) Loin.

(a) Conformation.

Width and flatness of loin.

(b) Finish.

Referring to the development of fat cover over the loin.

(iii) Forequarter.

(a) Conformation.

General conformation of the fore-quarter with particular reference to width and squareness of shoulder.

(b) Finish.

Again referring to the fat covering of the Forequarter region.

(iv) Colour.

(a) Muscle.

The colour of the muscle should be a bright pink and this was awarded the maximum points while reductions were made for darkness which is considered a defect.

(b) Fat.

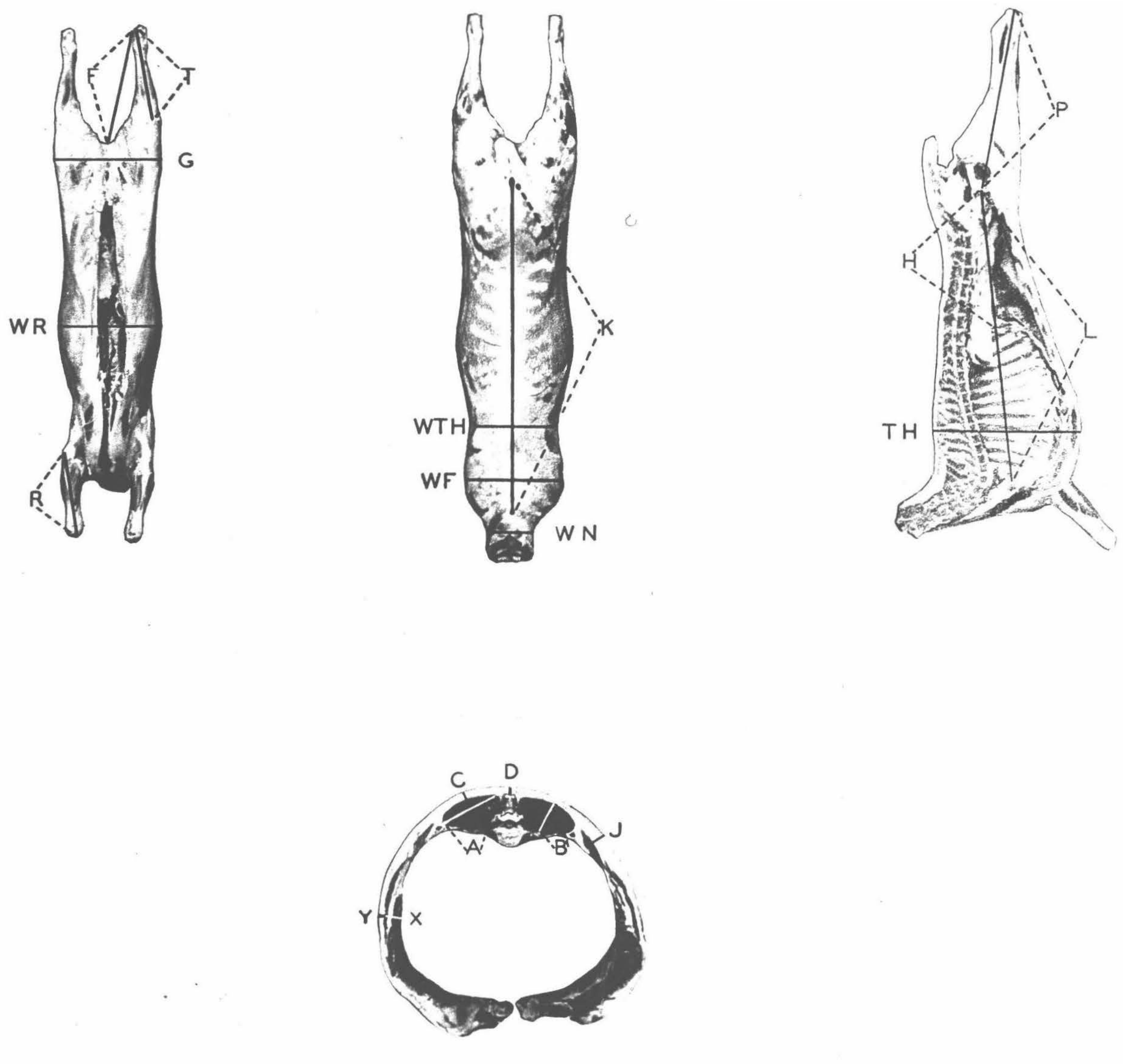
Yellowness of fat is considered a disadvantage from the point of view of quality. Consequently deviations from the ideal white fat in the lamb were graded down.

(v) Grade.

Every carcase was graded on the basis of the export system of grading, as described by Stephens and Barnicoat (1936). Because the weight range was limited to 28-36 pounds, only three grades were used. i.e. Prime Down Crossbred, Prime Crossbred and Second quality.

(vi) Remarks.

Any outstanding feature of the carcase was noted under this heading e.g. Extreme yellowness of fat, and diseased condition, and general suitability of lamb for trade purposes.


F
T
G
WR
R
K
WTH
WF
WN
P
H
L
TH
C
D
A
B
J
Y
X

CARCASE MEASUREMENT DATA.

After having been hung overnight on a gamble of standard width in a cooling chamber, the carcase was weighed to determine cold carcase weight, and various measurements made.

The measurements included in the study of carcase quality have been made in accordance with the technique described by Palsson (1939) and are given in detail below.

EXTERNAL MEASUREMENTS.

F - Leg Length.

G - Width of gigots.

W.R. - Maximum width of Ribs.

W.F. - Maximum width of forequarter in line with the Shoulders.

W. Th. - Minimum width behind the scapula.

Th. - Depth of Thorax. The maximum depth of the chest behind the shoulders.

W.N. - width of neck.

T. - Length of tibia and tarsus from the tubercle on the proximal end of the tibia to the anterior edge of the distal end of the tarsal.

R. - Length of the radius-ulna from the olecranon process to the styloid process.

K - Length of body from the tail head to the base of the neck.

L. - Length of body from the symphysis pubis to the anterior edge of the middle of the first rib.

H - Length from the symphysis pubis to the posterior edge of the last rib, at the junction with the vertebra.

F - Length of leg from the symphysis pubis to the anterior edge of the distal end of the tarsal.

INTERNAL MEASUREMENTS.

The carcase was divided into two portions by cutting vertically through the union of the last thoracic with the first lumbar vertebra and allowing the knife to follow along the posterior border of the last rib on each side.

The following measurements were then recorded from the anterior surface of the section.

A - "Length" of "Eye Muscle" the maximum distance across the cross section surface of the longissimus dorsi from end next the spinal process outwards along the rib.

B - Depth of "Eye Muscle" the greatest distance at right angles to A on the same surface.

C - Thickness of back-fat over the deepest part of the "Eye Muscle".

D - Thickness of fat over the spinous process.

X - Maximum thickness of muscle layer (mixed with fat, plus rib but not including subcutaneous fat) on the lower half of the rib.

Y - Thickness of subcutaneous fat layer over X.

J - Thickest layer of fat over the rib at the point illustrated.

The above data include the measurements necessary for the Cambridge Block Test (McMeekan 1939) with the exception of an eye estimation using a range of ten points for Fat Cover of Legs and for Width and fullness of Loin, which were also made on the carcase at the same time as the measurements. The score card used in Block Testing is given in Appendix I.

SECTION IV. THE PROBLEM OF STATISTICAL EVALUATION OF NON-NUMERICAL DATA.

The grading system as described previously introduces a classification which is purely qualitative, in that the characters are capable of being graded by a recognisable difference in category, but are not susceptible of measurement by numerical scale. This necessitates some investigation into the methods of statistical treatment and interpretation available for non-numerical data.

Similar American work on the grading of fleece and carcase characteristics in sheep has been based on a scoring system, which appears to be in general use in most of their beef cattle, sheep and swine breeding research. This system breaks up class intervals of 1, 2, 3, 4 and 5 points into two by the use of a plus or minus sign - e.g. 1+, 1, 1 - giving in all a range of 15 units (Hazel and Terrill (1946) Winters and Green (1944) and Hetzer, Dickerson and Zeller (1944). Hazel and Terrill (1945).) For statistical purposes, these grades are assigned additive values of ·67, 1, 1·33. et.seq. and the data treated statistically according to the usual methods for ordinary metrical data. A similar method has been used by Dunlop (1942) for the statistical treatment of count and fleece quality grades.

The above system can be criticised, in theory at least, that the intervals between the different grades may not necessarily be equal. Support is given to this contention by the well known Fechner-Weber law, which expresses the fundamental basis of the estimation of wool characters by eye. This law states "in order that the intensity of a sensation may increase in arithmetical progression, the stimulus must increase in geometrical progression." Barker (1931) shows that any attempt to form a gradation of wool qualities by eye will result in a scale in which successive grades will increase in geometrical progression. This same argument would probably apply to the estimation of carcase conformation of the animal, although MacDonald and Robertson (as reported by Barker, 1931) show that the Fechner-Weber law applied only to the visual sense and not necessarily to the tactile sense. which is used to a greater extent in the evaluation of carcase quality. In general, however, when the scoring system can be refined enough to give a range of 15-20 grades it would appear that the alloting of a unit sequence to those grades is accurate enough for ordinary purposes. Consequently in the case of Fleece As A Whole Quality Grading, Count, and Body As A Whole, this method has been utilised and the data treated statistically, using the ordinary method of correlation and Analyses of Variance.

In a number of other gradings, however, the accuracy obtained (see next section) did not warrant the increase of the number of grades by use of the plus and minus device. The use of only seven, and sometimes fewer grades (as in Handle, Lustre, Colour, Head, Hind Quarters etc.) and using numerical values 1 to 7, for those grades, would introduce possible inaccuracy. Moreover, as Snedecor (1940) points out, for precise work a range of 20 and preferably more classes are required. As a consequence of this difficulty, a study was made of methods of utilising this type of data.

a. MEASURES OF ASSOCIATION FOR QUALITATIVE DATA.

As a measure of correlation in quantitatively non-measurable characters, Pearson (1904), showed that the correlation between two variates, could be expressed as $C = \sqrt{\frac{\phi^2}{1 + \phi^2}}$, ϕ^2 being the mean square contingency or $\frac{\chi^2}{N}$.

This measure was derived on the assumption that the classes in a contingency table were grouped narrowly to conform to a normal correlation surface. In the ideal case, where the items are an ordered series, the distributions normal, and the regression rectilinear, C then becomes identical with r, as the number of groups is increased. These assumptions however, are usually far from fulfilment. In 1913, Pearson introduced a correction for ϕ^2 in cases involving broad categories. The major defect in this statistic is that the maximum value of the contingency coefficient is limited unless ϕ^2 is very large. Thus, although the data may be distributed along a diagonal in a contingency table, having the same number of categories, for each set of qualitative characters, the maximum contingency may not be indicated.

In an attempt to remddy this bias, Tchuproff (1925, as quoted by Yule and Kendall) proposed a coefficient T which he defines as $T^2 = \frac{\phi^2}{\sqrt{(s-1)(t-1)}}$ as a measure of association in an s x t table. Even though the frequencies may be perfectly distributed for maximum association, T^2 could only attain its maximum value when s is equal to t.

In 1942, Maung (1942) returned to the problem of the measurement of association in contingency tables, and to the solution of canonical correlations, (Hotelling, 1936) and their properties using a scoring system advocated by Fisher (1940). He shows that the sum of squares of the canonical correlations (of which (t - 1) exist for an s x t classification) is equal to χ^2/N. When perfect association exists χ^2/N equals (t -1) where $t \leqslant s$. Hence $\chi^2/N(t-1)$ represents the mean square of the canonical correlations, a measure which can only lie within the limits of 0 and 1. It has been suggested as a measure of association and varies between 0 and 1, corresponding to the limits for minimum and maximum correlation. Maung also develops a test of significance for $\chi^2/3N$ for samples where χ^2 distribution can be validly used in a contingency table.

At one stage, it was thought that this measure of association would be useful in the calculation of the broadly grouped data in this experiment. For present purposes, however, the test of significance for $\chi^2/3N$ limited the contingency table to an s x 4 classification, whereas most of the classifications included in the data contain s x 5 or more groups. Hence an approximate test of significance (using Maung's method) was worked out for $\chi^2/4N$.

The exact distribution of $\chi^2/N(t-1)$ is not known but an approximate distribution of it can be obtained from the χ^2 distribution.

According to Maung (1942), if ϕ^2 denotes /N(t - 1), the element of frequency function (f) of ϕ^2 is given by

$$df = \left\{\frac{N(t-1)}{2}\right\}^{\frac{1}{2}n} (\phi^2)^{\frac{1}{2}n-1} \frac{exp.\left[-\frac{N(t-1)}{2}\phi^2\right]}{\Gamma(\frac{1}{2}n)} d\phi^2$$

where $n = (s-1)(t-1)$

Since ϕ^2 is not greater than unity, this is not an exact expression for the distribution. The tail area between $\phi^2 = 1$ and ∞ is stated to be

$$\left\{\frac{N(t-1)}{2}\right\}^{\frac{1}{2}n} \frac{1}{\Gamma(\frac{1}{2}n)} \int_0^\infty exp.\left[-\frac{N(t-1)}{2}(1+z)\right](1+z)^{\frac{1}{2}n-1} dz.$$

which in the case of the contingency table where (t - 1) = 4 may be reduced to

$$(2N)^8 \frac{exp[-2N]}{\Gamma(8)} \int_0^\infty exp[-2Nz](1+z)^7 dz.$$

or $exp[-2N][1 + 2N[1 + \frac{1}{2}2N[1 + \frac{1}{3}2N[1 + \frac{1}{4}2N[1 + \frac{1}{5}2N[1 + \frac{1}{6}2N[1 + \frac{1}{7}2N]\cdots]$

which can be conveniently written for calculation as

$$e^{-2N}\left\{1 + 2N + \frac{(2N)^2}{2!} + \frac{(2N)^3}{3!} + \frac{(2N)^4}{4!} + \frac{(2N)^5}{5!} + \frac{(2N)^6}{6!} + \frac{(2N)^7}{7!}\right\}$$

or the first 7 terms of a Poisson distribution with mean 2N

For a sample size of 10 and 12, the tail areas beyond $\phi^2 = 1$ are respectively $7 \cdot 79 \times 10^{-4}$ and $4 \cdot 75 \times 10^{-5}$. Hence the loss of precision is negligible.

In general, in the case of $(t - 1) = 4$, the tail area under the curve

$$f = (2N)^8 \exp.\left[-2N\phi^2\right]\phi^7$$

beyond the point $\phi^2 = \lambda$ is

$$(2N)^8 \frac{1}{\Gamma(8)} \int_0^\infty \exp\left[-2N(z+\lambda)\right](\lambda+z)^7\,dz$$

which on integration yields

$$\exp[-2N\lambda]\left[1 + 2N\lambda\left[1 + \frac{2N\lambda}{2}\left[1 + \frac{2N\lambda}{3}\left[1 + \frac{2N\lambda}{4}\left[1 + \frac{2N\lambda}{5}\left[1 + \frac{2N\lambda}{6}\left[1 + \frac{2N\lambda}{7}\right] \cdots\right]\right.\right.\right.\right.\right.$$

This is a function of $2N\lambda$ and as such the equation $N\lambda$ = constant represents a hyperbola which gives a contour of equal significance for $\phi^2 \geqslant \lambda$ in a sample of size N.

The value of $2N\lambda$ has been evaluated for various levels of significance i.e. 0·1, 0·05 and 0·01, by equating the above equation to these values for the probability of ϕ^2 exceeding λ. Owing to the limitation of calculation facilities, only approximate values for the solution have been obtained.

APPROXIMATE VALUES OF THE SOLUTION.

Probability of exceeding	Value of 2N
0·1	11·75
0·05	13·16
0·01	16·00

Using $\chi^2/N(t - 1)$ a number of examples were worked out in order to investigate the usefulness of this measure. One example is given below.

TABLE I.

Handle	Lustre.					
	U	.	\	V	X	Total.
C	7	1	0	0	0	8
U	2	7	4	0	0	13
.	1	15	27	4	0	47
\	1	7	30	14	2	54
V	0	0	13	17	2	35
Total	11	30	74	35	4	157

This yielded a χ^2 value of 132·03, and a value of $\chi^2/4N$ of ·21023 with 16 degrees of freedom which is greater than $\frac{16\cdot 00}{157\times 2}$ or ·05096 which indicates significance higher than the 1% level.

As emphasised by Maung (1942) however, this method can only be used when the test of significance for χ^2 can be applied validly. In the above example a number of the expected frequencies are considerably below 5 and hence the χ^2 test is somewhat impaired in accuracy and not generally applicable. Moreover, from calculation of other examples considerable difficulty is found in interpreting definitely the value of the $\chi^2/N(t - 1)$ measure in relation to the amount of association shown by the graphical presentation of the data. This factor became particularly evident when correlations between dam and offspring were considered. An elementary proof, based on Hogbens (1933) demonstration of the dam-offspring product moment correlation, showed that $\chi^2/N(t - 1)$ gives a similar value, but this proof involved the assumptions that, firstly, only one gene substitution affected the character, and, secondly, the environment was homogeneous. No method could be found to remove these restrictions. This method was therefore abandoned.

The method finally decided upon for the correlation of the graded data is indicated by Pearson (1913) and given by Peters and VanVoorhis (1940).

In this case the assumptions are that the variates can be plausibly thought of as being quantitative in nature, but in which there is insufficient reason to believe the intervals are of uniform length. A further assumption is that the distributions are normal. The data, I believe, is in line with these postulates.

If the distance from the mean of a category to the mean of the whole distribution be designated as x, the height of the bounding ordinate at the left of the sector by z_1, and the ordinate at the right be z_2 then

$$x = \frac{z_1 - z_2}{\text{Area}}$$

The values of the ordinates can be read from a table of the Normal Probability Integral oriented in terms of q — the proportion of the total observations in one row or column of the classification. In this way mean deviations are calculated for all, the rows and columns. The correlation can be computed in the same manner as the ordinary product moment value.

$$r = \frac{\Sigma xy}{N\sigma_x\sigma_y}$$

A correction for Broad Categories is also required, and is carried out as shown by Peters and Van Voorhis (1940). Using this method on the previous table gives a value of r = ·696. An example showing the method of calculation is given in Appendix II.

The writer fully realises that this method has disadvantages and is essentially approximate in nature. However, as seen by the correlations given, in later sections, and comparison of these with the graphs it appears that it gives satisfactory results when allowance is made for the error involved in the estimations of the characters concerned.

b. DISCRIMINANT ANALYSIS APPLIED TO QUANTITATIVE DATA.

While investigating the statistical techniques for evaluation of qualitative data, the possibility of the use of Discriminant Analysis in obtaining appropriate scores was considered in relation to analysing differences between sire groups of graded data. Fisher (1938 (a) 1941) shows how a set of scores may be assigned to non-numerical observations in order that the values shall be additive. The general principle underlying the method is the fact that it is possible to determine a set of coefficients in such a way as to maximise the ratio of the sum of squares of one chosen component to the sum of squares of other components in an analysis of variance. (Fisher (1936, 1938(b) and 1940).

An example of the application of the Discriminant Analysis to graded data collected in this experiment is given

TABLE II HEAD GRADING - Ewes Lambs, 1944.

Group	U	.	\	V	Total.
1	11	12	1	0	24.
2	1	4	6	6	17.
3	2	2	5	3	12.
4	5	12	2	0	19.
5	2	6	11	4	23.
6	1	5	7	6	19.
7	2	9	8	4	23.
8	2	8	4	2	16.
9	10	8	1	0	19.
10	1	9	10	4	24.
					196.

Assuming arbitrary value of 0, x, y and 1 for the grades, Poor, medium, good and very good, the sum of squares due to variations between sire groups and total sum of squares may be expressed as quadratic functions of x and y.

Thus Sum of squares (Between Sire Groups)

$$= A'_{11}x^2 + 2A'_{12}xy + A'_{22}y^2 + 2A'_{13}x + 2A'_{23}y + A'_{33} \quad \ldots\ldots \quad (1)$$

Total Sum of Squares

$$= A_{11}x^2 + 2A_{12}xy + A_{22}y^2 + 2A_{13}x + 2A_{23}y + A_{33} \quad \ldots\ldots \quad (2)$$

In order to find values for x and y, it is necessary to maximise the ratio of the first of these expression to the second, Calling θ the ratio of equation 1 to equation 2 ; the maximum, stationary or minimum value of θ is given by the largest, intermediate, or the smallest root of the 3rd order determinantal equation.

$$\begin{vmatrix} A'_{11} - \theta A_{11}, & A'_{12} - \theta A_{12}, & A'_{13} - \theta A_{13} \\ A'_{12} - \theta A_{12}, & A'_{22} - \theta A_{22}, & A'_{23} - \theta A_{23} \\ A'_{13} - \theta A_{13}, & A'_{23} - \theta A_{23}, & A'_{33} - \theta A_{33} \end{vmatrix} = 0$$

To obtain the score values for x and y, the calculated value for θ is substituted in the following pair of simultaneous equations

$$(A'_{11} - \theta A_{11})\,x + (A'_{12} - \theta A_{12})\,y + (A'_{13} - \theta A_{13}) = 0.$$

$$(A'_{12} - \theta A_{12})\,x + (A'_{22} - \theta A_{22})\,y + (A'_{23} - \theta A_{23}) = 0.$$

The following illustration is given of the arithmetical handling of the data

ANALYSIS.

Group	N	SX_a	SX_a^2
1	24	$12x + y$	$144x^2 + y^2 + 24xy$
2	17	$4x + 6y + 6$	$16x^2 + 36y^2 + 36 + 48xy + 48x + 72y$
3	12	$2x + 5y + 3$	$4x^2 + 25y^2 + 9 + 20xy + 12x + 30y$
4	19	$12x + 2y$	$144x^2 + 4y^2 + 48xy$
5	23	$6x + 11y + 4$	$36x^2 + 121y^2 + 16 + 132xy + 48x + 88y$
6	19	$5x + 7y + 6$	$25x^2 + 49y^2 + 36 + 70xy + 60x + 84y$
7	23	$9x + 8y + 4$	$81x^2 + 64y^2 + 16 + 144xy + 72x + 64y$
8	16	$8x + 4y + 2$	$64x^2 + 16y^2 + 4 + 64xy + 32x + 16y$
9	19	$8x + y$	$64x^2 + y^2 + 16xy$
10	24	$9x + 10y + 4$	$81x^2 + 100y^2 + 16 + 180xy + 72x + 80y$
	196	$75x + 55y + 29$	

Total Sum of Squares $SX^2 = 75x^2 + 55y^2 + 29$

$$C = \frac{(SX)^2}{n} = \frac{5625x^2 + 3025y^2 + 841 + 8250xy + 4350x + 3190y}{196}$$

$$SX^2 = 75x^2 + 55y^2 + 29$$

$$C = 28{\cdot}69898 + 15{\cdot}43368y^2 + 4{\cdot}29082 + 42{\cdot}09184xy^2 + 22{\cdot}19388x + 16{\cdot}27551$$

$$SX^2 = 46{\cdot}30102x^2 + 39{\cdot}56632y^2 + 24{\cdot}70918 - 42{\cdot}09184xy - 22{\cdot}19388x - 16{\cdot}27551y$$

$-$ [illegible] $\quad - 11{\cdot}09694 \quad - 8{\cdot}13775$

$\frac{Sx_a^2}{n}$

n					
1 =	$6.00000x^2$	$+ .04167y^2$		$+ 1.00000xy$	
2 =	$.94118x^2$	$+ 2.11765y^2$	$+ 2.11765$	$+ 2.82353xy$	$+ 2.82353x + 4.23529y$
3. =	$.33333x^2$	$+ 2.08333y^2$	$+ .75000$	$+ 1.66667xy$	$+ 1.00000x + 2.50000y$
4 =	$7.57895x^2$	$+ .21053y^2$	.	$+ 2.52632xy$	
5 =	$1.56522x^2$	$+ 5.26087y^2$	$+ .69565$	$+ 5.73913xy$	$+ 2.08696x + 3.82609y$
6 =	$1.31579x^2$	$+ 2.57895y^2$	$+ 1.89474$	$+ 3.68421xy$	$+ 3.15789x + 4.42105y$
7 =	$3.52174x^2$	$+ 2.78261y^2$	$+ .69565$	$+ 6.26087xy$	$+ 3.13043x + 2.78261y$
8 =	$4.00000x^2$	$+ 1.00000y^2$	$+ .25000$	$+ 4.00000xy$	$+ 2.00000x + 1.00000y$
9 =	$3.36742x^2$	$+ .05263y^2$		$+ .84211xy$	
0 =	$3.37500x^2$	$+ 4.16667y^2$	$.66667$	$+ 7.50000xy$	$+ 3.00000x + 3.33333y$
	$31.99963x^2$	$+ 20.29891y^2$	$+ 7.07036$	$+36.04284xy$	$+17.19881x + 22.09837y$
	$28.69898x^2$	+ ~~4.86123~~ 15.43368 y^2	$+ 4.29082$	$+42.09184xy$	$+22.19388x + 16.27551y$
	$3.30065x^2$	$+ 4.86123y^2$	$+ 2.77954$	$- 6.04900xy$	$- 4.99507x + 5.82286$

This process of calculation leads to the following determinantal equation

$$\begin{vmatrix} 3.30063 - 46.30102\theta, & -3.02456 + 21.04592\theta, & -2.49754 + 11.09694\theta \\ -3.02450 + 21.04592\theta, & 4.86123 - 39.56632\theta, & 2.9143 + 8.13775\theta \\ -2.49754 + 11.09694\theta, & 2.91143 + 8.13775\theta, & 2.77954 - 24.70918\theta. \end{vmatrix} = 0$$

The left hand side of this equation was evaluated (by condensation - Aitken 1944) for 5 chosen levels of θ and the method of divided difference applied to calculate the required maximum root of the above equation as described by Fisher (1941).

TABLE III. Chosen Values of the Determinant

	Determinant	1st. Divided Diff.	2nd. Divided Diff.	3rd. Divided Diff.
0	4.856346			
2	83.730673	+394.371635		
4	-229.710214	-1567.204435	- 4903.940	
6	-2019.41695	-8,948.53368	- 18,543.323	- 22,582.35
8	-6369.3326	-21,749.57825	- 32,002.611	- 22,582.14
.32632	- .0106			

Since for any expression of the third degree, the third divided difference should be constant, the accuracy of calculation is checked by evaluating an extra determinant. The calculating machine used only allowed working to eight digits, so the small discrepancy in the final column is understandable. The value so determined for θ represents the fraction of the total sum of squares attributable to differences between sires when this fraction is maximised. The scores corresponding to the value of θ are obtained by solving the following simultaneous equations.

$$- 11.80737x + 3.84278y + 1.12339 = 0.$$

$$3.84278x - 8.04926y + 5.56678 = 0.$$

which gives $x = .3791$

$y = .8726$

Hence

Poor = 0. Medium = .38. Good = .87. Very Good = 1.

These values lie between 0 and I in the order that would be expected.

As Fisher (1941) emphasises, the value for θ and the scores obtained from it are unique, and not a consequence of the method of determination.

The differences between sire groups, may be tested by the analysis of variance using the value of θ directly with ut the necessity of recalculating using the scores. Two degrees of freedom are added to the 9 for between sire groups, and 2 is subtracted from the remaining degrees of freedom.

TABLE IV. ANALYSIS OF VARIANCE OF HEAD GRADING

Source of Variation	d.f.	Sum of Squares	Mean Square
Between Sire Groups	11	.3263	.029664
Remainder	184	.6737	.003661
Total	195	1.0000	

F Value $= \frac{.029664}{.003661} = 8.103$ Highly significant.

It is possible then to infer from this analysis that large differences occur between the sire groups in Head grading.

A test of significance can be developed to ascertain whether the data differ significantly from expectation based on any other given system of scores. For this purpose a linear series of scores for the gradings was adopted - Poor = 0, Medium = 1, Good = 2, and Very Good = 3. (designated as the Y system of scores in contradistinction to the system of scores (X) determined by the discriminant function analysis.)

By multiplying the terms in the determinantal equation above for between sire differences and total by 1, 2 and 3 and adding, the following table is obtained.

TABLE. V. SCORE SYSTEM "Y".

Between Sire Groups	Total.
- 10·241	- 29·082
15·432	33·673
11·664	46·755

(These values are obtained thus:

(3·30065 x 1) (-3·02450 x 2) (-2·49754 x 3) = -10·241)

A similar table may be drawn out using the original score system (X) and is given in Table VI.

TABLE VI. SCORE SYSTEM "X"

Between Sire Groups	Total.
- 3·875	- 11·812
5·991	18·287
4·363	13·413

By multiplying the three rows in Table V by 1, 2 and 3, and adding, an analysis of variance for Y is obtained. Similarly by multiplying the three rows by the X system of scores the covariance of X and Y is found. The analysis of variance of X is derived from Table VI by multiplying the three rows by the scores 0·38, 0·87 and 1. These analyses are given in the following table.

TABLE VII. ANALYSIS OF COVARIANCE FOR ARBITRARY SCORES.

Source of Variation	SY^2	SXY	SX^2
Between Sire Groups	55·615	21·198	8·103
Within Sire Groups	122·914	43·801	17·201
Total	178·529	64·999	25·304

Y can now be eliminated from the analysis by the usual covariance method $\left(SX^2 - \frac{(SXY)^2}{SY^2}\right)$ and the following analysis of variance results.

TABLE VIII. ANALYSIS OF VARIANCE.

Source of Variation	d.f.	Sum of Squares	Mean Square.
Between Sire Groups	10	0·047	0·0047
Within Sire Groups	184	1.592	0·0086
Total	194	1·639	

One degree of freedom is eliminated for the elimination of Y. The analysis of variance is non-significant and is thus not sufficient to show that the linear series of scores is inadequate for analysing the data. It must be emphasised that this test requires more extensive data than has been analysed in this case, and therefore, final conclusions on whether a linear system of scores is adequate must be withheld till more data ~~is~~ are available.

By introducing a second source of variation into the above analysis (e.g. it is possible to introduce the variation due to different years by including the head grading classification for a second year's crop of lambs, by the same sires) it would appear possible to reduce to a minimum the variations due to environmental conditions and variation in the standards of grading. In regard to factors of genetic significance, differences between years should be small, because the same rams and ewes have been used in both years. In the case of non-genetic factors, of which an important one will be the variation in the standards of grading, it is to be expected that the differences between years will be large, because of differences in the environmental conditions, and variation in the standards of grading.

Consequently, a system of scores which minimises the variation between years will emphasise the contrasts of genetic importance at the expense of those which happen to be most affected by variations in standards of grading and environmental conditions. The theoretical calculations are available for working out this type of analysis (Maung, 1941) and a trial analysis was attempted, but did not yield any test of the basis of the above reasoning, because of the smallness of numbers available, (It is hoped in the near future to reconsider this problem).

Although the discriminant analysis has not been used in treating the results of the experiment at this stage, a brief demonstration of its possibilities has been given. The writer claims indulgence in this matter for several reasons.

1. The fact that this problem of the treatment of qualitative data has served as a check to the utilisation of a considerable amount of data for a number of years. In New Zealand alone, there is, especially in regard to research in wool, and carcase quality a big aggregation of qualitative data of a similar nature to that discussed above. Moreover, the problem appears; from private communications (Morley 1946) to be again a limiting factor in other countries. In America despite the availability of adequate facilities, it appears that no attempt has been made to treat much of their data (with the exceptions mentioned earlier).
2. The above example has, therefore, been quoted largely to show what has been done towards investigating this problem.
3. It has also been placed on record to obtain the criticism of trained statisticians, as to its correctness of application and utility. The main reason for not using the discriminant analysis was the great amount of work in calculation - an amount of work which was not considered justified at this juncture. In addition, the method is again limited in its application by the smallness of numbers available. However, when all the data from the later years of the experiment comes to hand, it is intended to review the method again, in regard to its applicability.

χ^2 TECHNIQUE.

For testing significance between sire groups on qualitative data, the χ^2 test for Independence is available and has been used where possible. A factor which tends to vitiate its use on many occasions in this data is the smallness of the expected frequencies in many of the sub-classes. Evidence accumulated within recent years indicates that the inaccuracies which may be involved in the use of small expected numbers are not as serious as was once thought. Fryer (as quoted by Snedecor, 1940) found that in a large number of tests in cases of small expected frequencies, the results found by usual methods gave reliable conclusions about significance. Haldane (1945) has developed χ^2 technique for n x 2 tables when expectations are small and even less than unity, but this method is not applicable to the type of table in this data.

After due consideration of the various methods, the arbitrary score system has been used in the cases of Count, Fleece Quality, and Body As A Whole Grading, as indicated below.

Count.

40	1	54	13
40/44	2	54/6	14
44	3	56	15
44/6	4		
46	5	V+	12
46/8	6	V	11
48	7	\+	10
		\	9
48/50	8	•+	8
		•	7
50	9	U+	6
50/52	10	U	5
52	11	C+	4
52/4	12	C	3
		∩+	2
		∩•	1

In general, allowing for the fact that the data is of a preliminary nature, and will be supplemented as time passes, it is believed that this method is sufficiently accurate, especially so when the general error involved in the repeatability of subjective gradings is taken into account.

SECTION V. RESULTS.

Because the aspects of progeny testing in sheep, considered at this stage, fall into clearly delineated sections, it was decided to present them in that manner. The results, therefore, are given in the from of separate parts, each with its own introduction and discussion, the final integration of these parts being left to a discussion in Section VI.

PART I. REPEATABILITY OF SUBJECTIVE GRADINGS OF FLEECE AND CARCASE QUALITY.

It has been recognised since the time of Darwin, that the variations seen between different animals give scope for improvement in livestock, It is, therefore, manifestly necessary that adequate means be available for the detection of these variations. Moreover, increase in objectivity and precision of methods for recording these differences will, as Nichols (1945) has stressed, considerably simplify the task of animal improvement.

An element of chance, however, enters into every measurement and therefore, every set of measurements is inherently a sample of more or less unknown conditions. Even in the few instances where it is believed that the objective reality under measurement is a constant, the measurements of this constant are influenced by chance or unknown causes. Hence, any set of measurements of a quantity, however objective that measurement is considered to be, is a sample of an infinite set of measurements which might be made of this same quantity under essentially the same conditions. Scientific method, therefore, demands to know the accuracy and precision of the various types of measurement which it uses. This necessity is even more apparent when measurement is based on subjective evaluation and personal fallability contributes to the lack of accuracy of the score.

It is this aspect which is covered in the present section.

a. FLEECE EVALUATIONS.

Many contribution have been made to the science of objective measurement of wool characters by workers from all parts of the world. Studies on the accurate determination of fibre diameter have been reported by Barker (1932) Fraser Roberts (19 -) Duerden (1929) Winson (1931) Hardy (1933 & 1935) Stanbury & Daniels (1937) and Wildman &

Daniels (1937); of fibre length by Daniels (1942)

These techniques suffer from serious disadvantages in their application to evaluation of fleece qualities.

1. They are expensive, time consuming, and require adequate laboratory facilities.
2. Wool is still sold on the basis of hand and eye judgement of the expert and the results of the two methods can be at variance.
3. The significance of many wool characters has not beenfully investigated as regards their importance in the manufacturing process.

Hence, in this experiment resort was made to hand and eye methods of evaluation,of fleece quality as described previously. The accuracy of this method has been discussed in general terms by many writers, the general conclusion being that a person trained in evaluating wool quality can make fine distinctions, though in general the reliability of the estimates is not as great as those derived from objective methods of measurement. The speed of working, an important point in practical application, is, however, several thousands of times greater. Dunlop (1943) has reviewed the literature on the accuracy of subjective determinations of count and fleece quality, and has studied these features with New Zealand Crossbred and Corriedale wools. His results show in the case of Count, that the standard deviation of a single judgement is less than half a count interval. McMahon (1941 and 1943) has given the repeatability of a number of fleece characters and shows in most cases that the Error of Judgement is approximately half a grade.

A study of repeatability of fleece gradings was not conducted specifically for this experiment, for the same three observers who carried out the fleece description work had previously conducted a repeat-trial in connection with the Animal Nutrition Experiment (Clarke et al, 1946) Therefore these results will be merely quoted for completeness sake, and briefly discussed.

TABLE IX. REPEATABILITY OF SUBJECTIVE GRADINGS.

Character	Error of Judgement	Intra-class Correlation.
Staple Length	± 0·79	0·782
Count	± 0·62 half grade	0·801
Handle	± 0·49 grade	0·551
Lustre	± 0·56 "	0·574
Colour	± 0·65 "	0·538
Character	± 0·32 "	0·584
Evenness	± 0·58 "	0.428
Fleece As A Whole	± 0·64 half grade	0·640

The error of judgement is the standard deviation derived from the variance due to error. It can be interpreted as the limit of the deviation from the correct estimate which the judges would not exceed more than about once in three times. Only once in twenty times on the average would the judges exceed the limit of deviation set by twice this figure. The intra-class correlation indicates the consistency between the two observations of the same sheep and for perfect consistency it would give a value of 1·0.

It can be seen that for Count and Fleece As A Whole the judges seldom are in error by more than half a grade 9i.e. a difference say between 48 and 48/50's, or between medium and medium plus fleece grading). These estimations are thus remarkably consistent. No doubt this is due to the relatively clear-cut nature of the determinations and in the case of Count, at any rate, due to constant practice.

Character has about the same order of error of judgement as Count and Fleece As A Whole, but the lower correlation indicates that the judgement is not so consistent possibly due to variation in the emphasis placed upon the various features which are included in the estimate and to the variations in the standards with fineness.

The other characteristics are not so accurately determined, but it is seldom that the error would be greater than one grade. This disadvantage is partly offset by the fact, that, relatively, the characters Handle, Luster, and Colour are not as important as the more accurate estimates of character and Fleece Quality As A Whole.

The error in measuring staple length is due to the variation in determining the points between which the measurement is made, and to some extent to the degree to which the staple is extended in making the measurement.

These results indicate the subjective methods of eye and hand grading can be usefully employed in respect to fleece characters in the practice of sheep breeding and in experimentation. In the absence of objective measures, it is obvious that they are the methods which have to be relied upon at the present for wool improvement and so it is important to know the extent to which they are accurate.

b. CARCASE CHARACTERS.

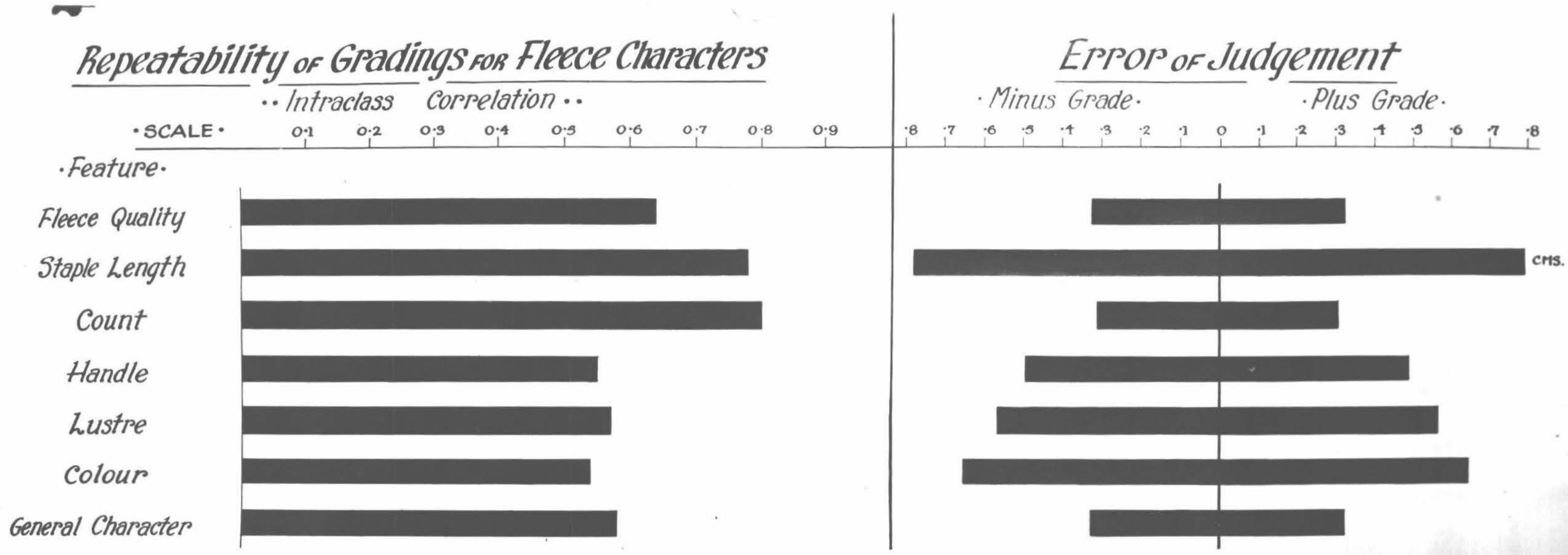
As with Fleece quality characters, there is no definite objective method of describing body form and carcase quality in the sheep, so that again, the subjective method of scoring had to be adopted.

There are a number of factors which complicate the issue in subjectively describing body form in meat producing animals.
Primarily, the importance of general balance and relationship between the parts of the body must not be lost sight of. The use of any score card in which the detailed points of an animal are summed up tends to lead to this state of affairs where the animal is considered as a number of isolated parts eith no relationship betwenn these parts. In the scoring system for body conformation described in Section III C, this factor of balance in relation to other parts has been allowed for in the Boday As A Whole grade where any imbalance has resulted in the marking down of the animal in its final appraisal.

A further difficulty in describing body conformation lies in the comparison of animals in differing degrees of condition. It is a well known fact that a high degree of fatness can obscure to a very large extent the conformational defects of a poorly bred animal while poor condition can lead to the marking down of an animal because full development of the body is not shown. To a limited extent some mental allowance was made for the effect of condition in describing the stock used in the experiment, but it is realised that this allowance was certainly very arbitrary.

The changes of body conformation with age (as shown by Hammond (1932) McMeekan (1940) Verges (1939), and Palsson (1939) again have a considerable effect on body descriptions of animals at different ages. This factor undoubtedly is of some importance in the case of the description of the ewe lambs where increase in the relative size of the loin and decrease in the relative size of the head and lower parts of the limbs with age would inevitably result in the older lamb being graded higher than the younger lamb. Because comparisons have been made mainly between animals of a similar age, however, this difficulty has been reduced to a minimum and it is doubtful whether it would be likely to have a major effect in the body descriptions of the ewe hoggets.

These factors combined with the fact that the gradings are subjective



Repeatability of Gradings for Fleece Characters
·· Intraclass Correlation ··
Error of Judgement
· Minus Grade ·
· Plus Grade ·
· SCALE ·
0·1
0·2
0·3
0·4
0·5
0·6
0·7
0·8
0·9
·8 ·7 ·6 ·5 ·4 ·3 ·2 ·1 0 ·1 ·2 ·3 ·4 ·5 ·6 ·7 ·8
· Feature ·
Fleece Quality
Staple Length
Count
Handle
Lustre
Colour
General Character
CMS.

in nature, lead to the necessity of a study of the Repeatability of the scores for Body Conformation features.

Previous studies of this nature have been reported by other workers. Phillips, Krantz and Lamber (1938) reported the results of repeatability of scores made on draft horses. As judged by the coefficient of variation, the range in accuracy for a large number of scores was 9·21% to 14·22%. They stress the necessity for a more objective method of scoring and found that no increase in accuracy resulted from the use of pictorial standards.

Hetzer and Phillips (1938) give results of a study of scoring in swine using two methods; that of scoring the pigs by use of descriptive terms, and secondly, by using a series of drawings to assist in the description. They found no significant difference between the two methods in accuracy. Knapp, Black and Phillips (1939), in a study of accuracy of scoring on beef cattle, conclude that scoring as a technique for evaluation of differences between animals is subject to considerable error, and is probably of little value where differences between animals are small. Where large differences occur, then the scoring technique is the simplest method available.

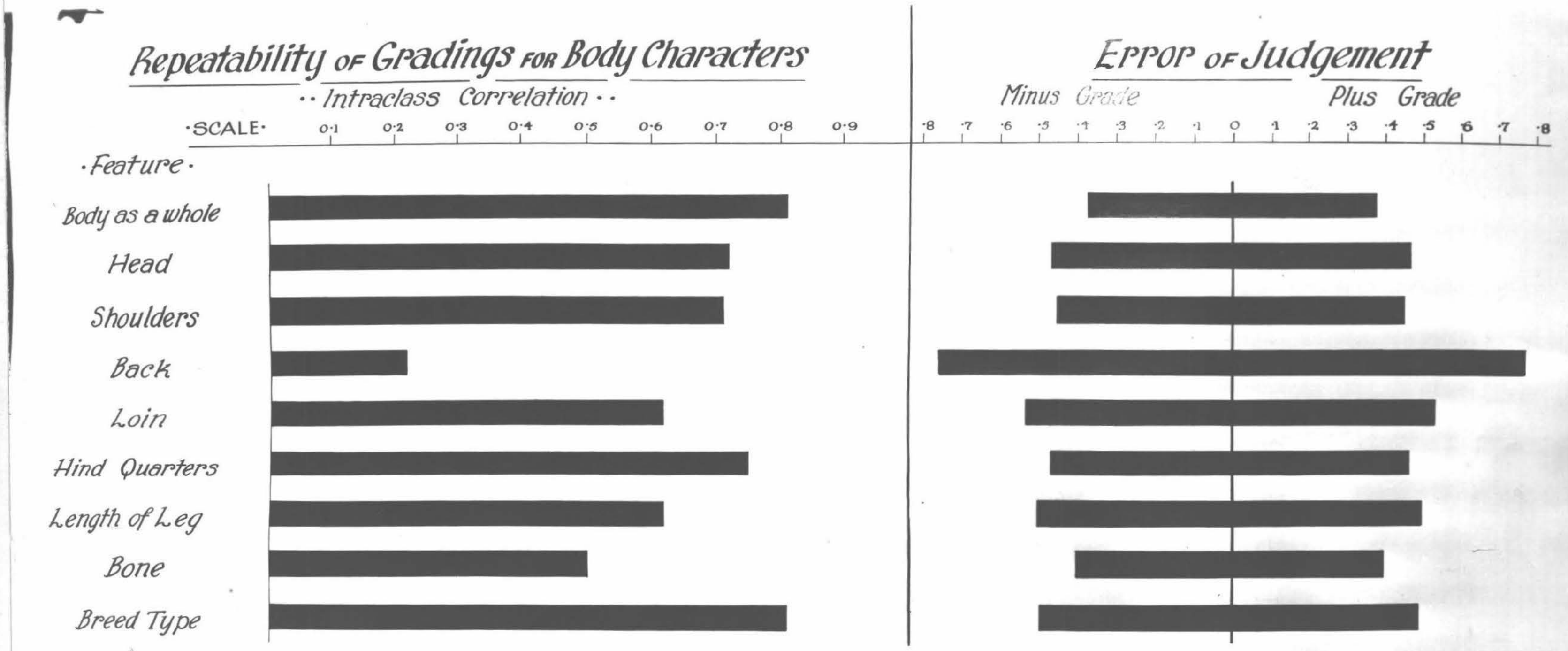
McMahon (1943) qotes his results on repeatability of gradings for several conformation features on sheep and finds that for Head Grading, Breed Type and Fleshing, that the Error of Judgement is of the order of half a grade.

MATERIAL AND METHODS.

In order to establish the limits of error of the method of evaluating carcase conformation, determinations were repeated on 105 of the experimental 2½ year old ewes on two consecutive days by the three judges. The sheep were scored in random order on both occasions and no attempt was made, nor was it possible, to remember the gradings for individual animals from the previous day.

RESULTS.

The data were analysed by the analysis of variance technique, (Snedecor, 1940) into the components due to differences between sheep, differences between repeats, and error. The standard deviation of the grading was cal-


Repeatability of Gradings for Body Characters
·· Intraclass Correlation ··
·SCALE·
0·1
0·2
0·3
0·4
0·5
0·6
0·7
0·8
0·9
·Feature·
Body as a whole
Head
Shoulders
Back
Loin
Hind Quarters
Length of Leg
Bone
Breed Type
Error of Judgement
Minus Grade
Plus Grade
·8
·7
·6
·5
·4
·3
·2
·1
0
·1
·2
·3
·4
·5
·6
·7
·8

culated from the error variance and is quoted as the error of judgement. Intraclass correlations were also calculated as a measure of the consistency between pairs of observation on the same animal. The results are summarised in Table X.

TABLE X. REPEATABILITY OF SUBJECTIVE GRADINGS OF BODY CONFORMATION.

Character	Error of Judgement.	Intraclass Correlation.
Head	- ·46 grade	·72
Shoulders	- ·45 "	·71
Back	- ·77 "	·22
Loin	- ·53 "	·62
Hindquarters	- ·46 "	·75
Legs	- ·50 "	·62
Bone	- ·40 "	·50
Breed type	- ·49 "	·81
Body As A Whole	- ·74 Half grade	·81

As indicated earlier, the error of judgement term shows the limits of the deviation which on the average the judges will not exceed more than once in three times, while twice this value will be exceeded on the average only one in twenty times.

Surveying the results, it can be seen that on the average the repeatability is of the same order as that for fleece character estimations. The estimation of Head Type, Shoulders, Loin, Hindquarters, Legs and Breed Type, are all about on the same level of accuracy and will seldom vary from the true value by more than one grade. The Back and Bone grading, however, show a lower level of consistency. A possible explanation for this lower consistency in the Back grading lies in the degree to which the judges took into account the feature of narrowness behind the shoulders in making this estimation. In comparing the remarks made at the end of the description of each animal on the two successive days, it was noticed that there was considerable variation in the extent to which this feature was remarked upon. The prevalence of this fault of narrowness behind the shoulders was very marked in the flock as a whole)as is often the case with Romney Marsh sheep) and consequently, it would appear advisable that this feature be included as a separate entity in the scoring card, particularly where the fault is present to any marked degree. In addition, the back grading includes an estimation of levelness of back line, which can be considerably influenced by the stance of the animal at any particular time. Again it would appear advisable to include this feature as a separate item in body description work.

The Body As A Whole grading is estimated with a small error and a high degree of consistency. The error of judgement of 0·74 of half grade or ·37 of a grade indicates that seldom would the judges be in error by much more than half a grade.

It must be emphasised that these figures for repeatability apply only to the observers who carried out the gradings, but in general they do give a picture of the limits of accuracy under average conditions. From the point of view of strict scientific accuracy, the method of subjective grading leaves much to be desired. The speed achieved using hand and eye evaluations and their general applicability from the point of view of practical breeding is however, a major consideration which tends to make up for their lower level of accuracy.

THE RELATIONSHIP BETWEEN SUBJECTIVE GRADINGS ON THE LIVE ANIMAL AND MEASUREMENTS ON THE CARCASE.

In view of the limited accuracy of the subjective body grading detailed in the previous section, the relationship of the subjective gradings to measurements and gradings on the carcase are of considerable importance. It is a well known fact that judgements made on the hoof frequently are not supported by judgements made on the carcase, a fact which is so often demonstrated at Fat Lamb Competitions where the animals are judged first on the hoof, and then later on the hooks, after slaughter. Moreover, the final test of improvement in body conformation is naturally estimated by the degree to which this improvement is shown by slaughter test. Under stud conditions, it is, of course, impossible to carry the test of body conformation to this ultimate conclusion, and therefore, emphasis must be placed upon the productive significance of the gradings, made for conformation on the live animal.

These relationships were able to be investigated from data collected in this experiment. The wether lambs were described prior to slaughter under the system detailed in the preliminary sections and then carcase measurements and gradings were made on the carcase after slaughter.

RESULTS. The relationships shown in Figures II - X were calculated by means of the correlation technique described in Section IV and the results are shown in Table XI.

TABLE XI. CORRELATIONS BETWEEN SUBJECTIVE GRADINGS ON THE LIVE LAMB AND MEASUREMENTS ON THE CARCASE.

Body Grading	Carcase Measurements	n	r	P
Body As A Whole	Export Grade	169	0·70	S.S.
Loin	Loin Conformation	168	0·67	S.S.
"	"A"	169	0·12	N.S.
"	"B"	169	0·50	S.S.
Shoulder	Forequarter Conformation.	169	0·70	S.S.
"	W.F.	169	0·62	S.S.
Leg Length	Length of Cannon Bone	169	- 0·57	S.S.
"	T	169	- 0·64	S.S.
Bone	Weight of Cannon Bone	165	0·07	N.S.

In general, the effect of inaccuracy in the grading technique will be to reduce the correlation coeffients derived for these relationships.

The relationship between Body As A Whole, and Export Grade is highly significant and sufficiently high to lead to the conclusion that the grading on the live animal gives a reasonably accurate estimation of the Export Grade that the animal would be placed in if slaughtered. There will, however, be some discrepancy between the two.

The Loin grading on the live lamb is seen to give a close approximation to the width of the loin as shown by the relationship with the more accurate estimate made on the carcase. It must be remembered, however, that personal errors of judgement enter into both these estimates and will generally reduce the correlation coefficient.

The relationships between the Loin grading and A. and B. measurements were calculated in an attempt to determine the significance of width of loin in relation to carcase quality. The association of width of loin with length of eye muscle (A) is non-significant, whereas there is a highly significant association with depth of eye muscle. (B) This at first appeared contradictory in that it would be a priori expected that length of eye muscle would be more likely to be associated with width of loin, than would depth of eye muscle. It must be remembered that the Loin estimate takes into account, and is considerably modified by, the flatness of the loin. It therefore appears that the sloping type of loin (which in addition is usually narrow), on account of this structure, does not allow of the full depth development of the eye muscle. This explanation must be tentative especially in view of the low relation reported in the next section between the measurement of width of loin on the live animal and "B" measurement on the eye muscle.

The highly significant correlations between the Shoulder and Forequarter conformation and W.F. measurement indicate that the estimate of shoulders give a sound indication of the width and general conformation of the forequarter.

The correlation coefficients between Leg length estimation and length of cannon bone are highly significant, but not high for predictive purposes. The importance of length of leg in carcase grading emphasises the disadvantages of this low correlation and generally the inaccuracy of the eye estimate of leg length.

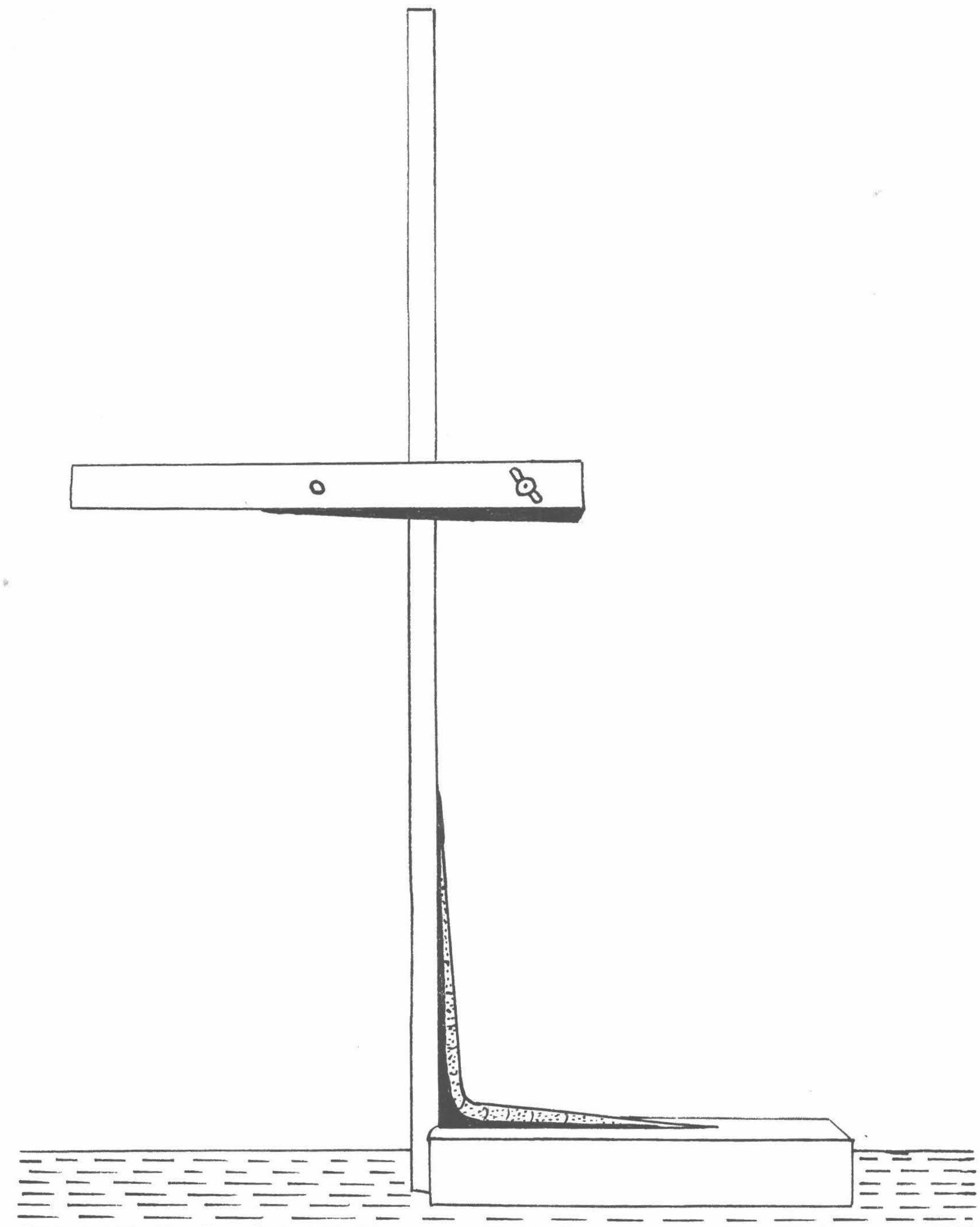
The quality of Bone estimate as used in the description obviously bears no relation to the weight of cannon bone. This fact is of interest in connection with the complex interaction of weight and length of cannon bone, in relation to meat production. Hammond (1932) has shown that, in imporvément for meat production, the weight of the bone has been considerably increased by extra thickening, and at the same time the muscles have also been increased in thickness and weight but the proportion of muscle to bone is slightly decreased. Hence, although the thick short bones, with short thick muscles have been favoured in livestock improvement, this has not increased the proportion of muscle to bone in the carcase. He states "The problem of how to get the increased developement of body generally without the extra thickening of the bones is one which if solved, would do much to help the improvement of livestock". The above correlation indicates that the estimation of bone quality as made in this experiment, (which is mainly in line with the estimate as made by breeders) does not lead to any increase in weight of cannon bone.

PART III. THE ACCURACY OF CERTAIN BODY MEASUREMENTS ON THE LIVE ANIMAL.

It is indeed a truism to state that progress in breed improvement is primarily dependent on the development of accurate measures of performance and quality. The disadvantages and inaccuracy of the subjective gradings for conformation on the live animal, as discussed in the previous section indicate the advisability of attempting to develop more accurate and objective descriptions in numerical terms. Therefore, it was decided to investigate measurements on the live animal to discover to what extent they would be applicable.

Measurements of various parts of the animal have been used to a considerable extent in studies of dairy and beef cattle, and to a more limited extent on horses, sheep and swine. Lush and Copeland (1930) have investigated the accuracy of a wide range of body measurements in dairy cattle. They found that only in a few measurements was the standard error of measuring much larger than 2% of the measurement, and in about one-third of the measurements it was less than 1%. They consider that the main objection to the extensive use of body measurements with dairy cattle, is not their inaccuracy but their inadequacy to describe the animal in a complete way. The accuracy of body measurements in swine have been fully investigated by Phillips and Dawson (1936) Whately (1941) and Hetzer and Phillips (1938). Phillips, Krantz and Lambert (1938) determined the degree of accuracy attained in the measuring of a number of features in draft horses. In most of the characters, the coefficient of variation is below 2%.

In sheep, little attention appears to have been paid to the use of body measurement, Lamont (1934) in a preliminary study of skeletal correlations in Romney Marsh sheep considered some forty measurements on the live animal, but in nine of them he indicated that they were unreliable. No systematic study of the error involved was made, but in a discussion of the accuracy of the measurements he states that the mean error of repeat measurements was within 4% of the initial recording, a figure which seems gratifyingly low. Phillips and Stoehr (1945) considered the accuracy of measurements and weights taken in experiments conducted by the Bureau of Animal Industry. They conclude that accurate results can be obtained with height at withers, length from mid front of scapula to pin bones, width at shoulders, depths of chest



and middle, circumference of chest and middle and circumference of foreshank. They criticise the use of measurements however, on the fact that little has been done to determine the relation between these measures and real productive ability of the animal.

Since the problem of body measurement in sheep seemed to offer some possibility of usefulness, it was decided to investigate them. So far, the investigation has only been of a preliminary nature, and only a few chosed measurements have been considered.

MATERIAL AND METHODS.

Four body measurements were chosen for the purposes of determining the amount of error involved in repeat measurements on the same lamb. They were:-

(1) HEIGHT AT WITHERS.

This measurement was chosen because of the importance of length of leg in relation to carcase quality. It is also a measure which Phillips and Stoehr (1945) have shown to be remarkably accurate (a coefficient of variation of ·1·7%) a fact which is also supported by the results of the workers mentioned previously in dairy cattle, beef cattle, and pigs.

It was measured as the vertical distance from the highest point over the withers to the ground level while the lamb was standing in what was considered to be its normal stance. While being measured, the lambs were standing on a level wooden floor. A device as illustrated in Figure XI was used, and the heights were read to the nearest millimetre. Throughout the experiment, a check was maintained on the accuracy of the instrument.

(2) WIDTH OF LOIN.

The significant correlation obtained in the previous section between Loin grading and the B measurement of the eye muscle suggested the investigation of the accuracy and significance of a width of loin measurement.

A steel caliper was used for this measurement, the points being placed against the sides of the loin. No more pressure was exerted than was necessary to ensure that the caliper points were resting against solid flesh. The measurement was taken about half way between the anterior edge of the pelvis and the rear edge of the last rib, and therefore somewhere about the region of the third and fourth lumbar vertebrae.

(3) WIDTH OF HINDQUARTER.

The importance of the Width of gigots measurement (G), from the point of view of carcase quality influenced the selection of this measurement. Again, as with width of loin, the steel calipers were used. An initial attempt was made to locate sharply delineated skeletal features, which would not be affected by the stance of the animal. Trial attempts however, showed that the points of reference considered gave very highly variable results and therefore were discarded. The measurement was finally taken as the greatest width of the legs when the lamb was standing in a normal position.

(4) WIDTH OF FOREQUARTER.

As with the previous measurement, well defined reference points could not be found. The measurement was, therefore, taken as the width at the shoulders, when the lamb was standing normally. The calipers were again used for this purpose.

All measurements were taken to the nearest millimetre.

The lambs used in the study were 20 Romney wether lambs which ranged in weight from 74 to 78 pounds and were born in the experiment in the 1945 lambing season. No particular considerations were taken into account in selecting these lambs. They were merely those which had reached killable weight at the end of one week, and, therefore, can be considered a random sample. Prior to the commencement of measuring, they had been removed from pasture, described for fleece characters, shorn and finally described by eye for body conformation characters in the usual routine adopted.

Measurements, of the previously mentioned items were taken, on the 20 lambs by three observers. Then, after a small interval of time, the same measurements were repeated by the same observers. The lamb was held in what was considered to be its normal stance, by one observer while the measurements were being taken by another. The third recorded the results as given by the measurer. No particular order was used in making the measurements, nor was there any known tendency for any observer to remember previous measurements for the same animal. Even if this had been the case, it is unlikely that it would have affected the results, because the calipers had to be removed from the lamb and read off a metre rule placed near by. In the other repeatability experiments quoted earlier, it was usual to do the repeat measurements after an interval of at least some days. This was impossible in the present case, because the lambs were part of the Progeny Test Experiment and every endeavour had to be made to treat them in conformity with the other wether lambs in the experiment. Presumably, day to day variation, such as differences in the fullness of the stomach, state of health, etc., would be eliminated by this procedure, but as to actual repeatability of measurements on the same animal, it could not have any appreciable effect. The individual measurements are presented in Appendix III.

RESULTS.

The data was analysed by the method of analysis of variance described by Snedecor (1940). The mean squares were then apportioned to their various sources as shown by Winsor and Clarke (1940), and the variance attributable to these sources was expressed as a percentage according to a plan first used by Lush (1938) in a similar investigation.

(2) HEIGHT AT WITHERS.

The analysis for height at withers is shown in Table XII.

TABLE XII. ANALYSIS OF VARIANCE OF HEIGHT AT WITHERS.

Source of Variation	d.f.	Sum of Squares	Mean Square.
Total	119	448·46	1
Sheep	19	349·20	18·38 xx
Repeats	1	2·64	2·64 xx
Observers	2	16·74	8·37 xx
Sheep - Observers	38	39.98	1.05
Sheep - Repeats	19	19.55	1.03
Repeats - Observers	2	0·46	0·23
Sheep - Observers - Repeats.	38	19·89	0·523

The mean squares between sheep, between repeats, and between observers are all highly significant, while none of the interactions are significant.

In table XIII the partition of the variance is given.

TABLE XIII. PARTITION OF VARIANCES.

Source of Variation	d.f.	Partition		Value	Value as a %
Sheep	19	E + 2F + 3G + 6S	S	2·804	70·42
Repeats	1	E + 3G + 20A + 60R	R	·032	·80
Observers	2	E + 2F + 20A + 40 O	O	·190	4·77
Sheep - Observers	28	E + 2F	F	·264	6·63
Sheep - Repeats	19	E + 3G	G	·169	4·24
Repeats - Observers	2	E + 20A	A	- ·015	-
Sheep - Observers- Repeats.	38	E	E	·523	13·13

E = Variance due to triple interaction of sheep, observers and days.

G = Variance due to interaction between sheep and Repeats.

F = Variance due to interaction between sheep and observers.

A = Variance due to interaction between observers and repeats.

R = Variance in average measurements on different repeats.

O = Variance in average measurements made by different observers.

S = Variance in average measurements between sheep.

In this table, by far the largest item is that due to variance between sheep which is gratifying from the standpoint of repeatability. Although based on highly significant mean squares, the variance due to differences between repeats (R) and between observers (O) represent only very minor contributions to the total variance.

The variances contributed by the different interactions, in general, account for differences in measurements not explained by differences in the specific factors concerned. It can be seen that they are non-significant, and contribute only in very small amounts to the total variance. They indicate that there is no real tendency for a differential response between the three factors concerned.

The second largest item of variance is that due to the triple interaction of sheep, observers, and days. This portion contains, in addition to differences in measurements which are unexplained by differences in repeats, by differences in sheep, by differences in observers, or by interaction between any two combinations of these, an element which is due to random errors in measurement. It is, therefore, appropriately used as an error term to give an estimate of the uncontrollable variation involved in the determinations. The square root of this error term gives the best single measure of the accuracy of the measurement, and is interpreted as the standard deviation of a single judgement. In this case it is equal to ·523 = ·72 centimetres.

This indicates that only once in three times will the observer's measurement deviate from the true value by an amount greater than this standard deviation.

The mean values of the measurements for observers and repeats are given below.

Observer A = 56·37	First Repeat = 56·24
Observer B = 55·95	Second Repeat = 56·54
Observer C = 56·87	

The coefficient of variation derived from the standard deviation and the mean value is 1·22% a figure which is in close agreement with the values of 1·3 to 1·8% quoted by Phillips and Stoehr (1945) and fully supporting their conclusion that the height at withers is an accurate body measurement.

(b) WIDTH OF LOIN.

Table XIV shows the analysis of variance of the width of loin measurements.

TABLE XIV. ANALYSIS OF VARIANCE OF WIDTH OF LOIN.

Source of Variation	d.f.	Sum of Squares	Mean Square.
Total	119	38·200	
Sheep	19	9·125	·4803 xx
Repeats	1	0·006	·0060 xx
Observers	2	14·556	7·2780 xx
Sheep - Observers	38	10·954	0·2883 xx
Sheep - Repeats	19	0·842	0·0443
Observers - Repeats	2	0·012	0·0060 xx
Observers - Repeats - Sheep	38	2·705	0·0712

Using the triple interaction for the purposes of testing significance, it can be seen that the differences between sheep, between observers, and sheep - observers interaction are highly significant. In the case of the differences between repeats and the observers - repeats interactions, they are highly significant negatively. They are, however, based on only a very small number of degrees of freedom and for this reason the low values of the mean squares may be due to sampling errors.

In Table XV, the variance attributable to various sources is shown and is based on the same scheme of interpretation as given in Table XIII.

In this analysis, only a relatively small part of the variance could be attributed to differences between lambs in loin measurement, the highest source of variance being differences between observers. This resulted largely from variation in the pressure applied to the calipers by the different observers in making the measurement.

TABLE XV. INTERPRETATION OF MEAN SQUARES.

Symbol	Absolute Value	% of Total Variance.
S	·0365	9·29
R	-·0017	-
O	·1731	44·08
F	·1086	27·65
G	-·0090	-
A	·0033	·84
E	·0712	18·13

Second in order of importance, is the sheep-observer interaction (F) accounting for 27·65% of the variance. This indicates that there was a real tendency for the three observers to place the sheep in different order. This trend was borne out by inspection of the data where it can be seen that the lambs with greatest loin measurement according to one observer did not have the greatest width as measured by the other observers.

The error term E of ·0712 which contributed 18·13% to the variance is not markedly greater than the error in height at wither analysis. It yields a standard deviation for a single measurement of 0·27 cms.

The means for observers and repeats are given below.

Observer A. 12·95   1st Repeat 12·62

Observer B. 12·75   2nd Repeat 12·60

Observer C. 12·13

The coefficient of variation is 2·14%. This value is of sufficiently small magnitude to warrant placing some reliability on the measurement. The importance of the sheep-observer interaction, however, must be taken into consideration in relation to the accuracy of this measurement. While measurements taken by the one observer appear to be repeatable, the fact that different observers disagree in placing the sheep in order of magnitude vitiates against the general applicability of the measurement.

(c) WIDTH OF HINDQUARTER.

The analysis of variance of this measurement as presented in Table XVI shows that there are highly significant differences between sheep, observers and repeats, while the sheep-observers interaction is significant at the 5% level.

TABLE XVI. ANALYSIS OF WIDTH OF HINDQUARTER.

Source of Variance.	d.f.	Sum of Squares	Mean Square
Total	119	143·01	
Sheep	19	57·75	3·039 xx
Repeats	1	2·16	2·160 xx
Observers	2	24·91	12·455 xx
Sheep - Observers	38	34·23	·901 x
Sheep - Repeats	19	7·21	·379
Observers - Repeats	2	0·74	·370
Observers - Sheep - Repeats	38	16·01	·421

In this measurement, uncontrollable inaccuracies which cannot be ascribed to any of the main components or their interactions, were the most important source of error, as indicated by the partition of the sources of error given in Table XVII. Second in importance are the variances in average measurements of the sheep, and of the observers while differences in the repeats made only a very small contribution though derived from a highly significant mean square. As in width of loin measurement the interaction of sheep and observers is again of some importance in the analysis and can be interpreted as in the previous section.

TABLE XVII. INTERPRETATION OF MEAN SQUARES.

Symbol	Actual Value.	% of Total Variance.
S	·363	26·99
R	·031	2·30
O	·290	21·56
F	·240	17·84
G	- ·013	-
A	- ·003	-
E	·421	31·30

The standard deviation derived from the analysis is ·65 centimetres and the coefficient of variation is 2·91% a value which is considerably lower than that given by Phillips and Stoehr (1945) for a similar measurement width of legs, which they found to have a coefficient of variation of 5 to 7%.

The accuracy of this measurement however, is considerably poorer than that of height at withers. The main discrepancies are due to the variation in the pressure applied to the calipers and to the variation in the stance of the lamb. With recently shorn lambs, it requires considerable patience to coax them to stand in normal fashion in order to take the measurement accurately.

(d) WIDTH OF FOREQUARTER.

The results of the analysis of width of forequarter determinations are recorded in Table XVIII.

TABLE XVIII. ANALYSIS OF VARIANCE OF WIDTH OF FOREQUARTER.

Source of Variation.	d.f.	Sum of Squares	Mean Squares.
Total	119	63·56	
Sheep	19	21·59	1·136 xx
Repeats	1	·67	·670 xx
Observers	2	24·63	12·315 xx
Sheep - Observers	38	9·89	·260 xx
Sheep - Repeats	19	2·77	·146
Observers - Repeats	2	·10	·050
Sheep-Observers-Repeats	38	3·91	·103

The variance between sheep, between repeats and between observers, are all highly significant. The only significant interaction is again the sheep-observers interaction. The partition of the mean squares is shown in Table XIX.

TABLE XIX INTERPRETATION OF MEAN SQUARES.

Symbol	Actual Value.	% of Total Variance.
S	·139	21·38
R	·010	1·54
O	·305	46·92
F	·079	12·15
G	·014	2·15
A	- ·003	-
E	·103	15·85

The principal source of variance is that due to differences in average measurements made by different observers (O) which includes 46·92% of the total. This can be explained by the difference between observers in the pressure that they applied to the calipers in making the measurements. The variance due to average measurements in different repeats is negligible. Moreover, despite the significance of the interaction of sheep-observers, it does not represent a notably important source of variation.

The error term of ·103 (giving a standard deviation of a single measure of ·32 cms.) yields a coefficient of variation of 1·66%, which is considerably lower than the similar term in the measurement of the width of hindquarter. This is explained by the fact that usually, it was not found so difficult to induce the lamb to stand normally on its forelegs, as it was with its hindlegs. The means of the observations by the three observers and for the two repeats are quoted.

Observer A 19·90 cms. First Repeat 19·34 cms.

Observer B. 18·95 cms. Second Repeat 19·19 cms.

Observer C. 18·94 cms.

This measurement, therefore, can be considered to be of considerable accuracy.

CONCLUSIONS.

The salient points of the four analyses are assembled in Table XX.

TABLE XX. MEANS, STANDARD DEVIATIONS AND COEFFICIENTS OF VARIATION OF FOUR BODY MEASUREMENTS.

Measurement.	Mean (cms)	Standard Dev. of a Single Measure.	Coeff. of Variation %
Height at Withers	59·10	·72	1·22
Width of Loin	12·61	·27	2·14
Width of HindQuarter	22·31	·65	
Width of Forequarter	19·26	·32	1·66

In surveying the results of the analyses, it is noted that, in all cases, there is a significant difference between observers. As regards the percentage of total variance due to this factor, however, it is only of real importance in the case of width of loin, and width of forequarter. Highly significant differences are also observed between repeats but in no case is the variance of average measurements in these different repeats of any importance. These two facts and also a comparison of the means of measurements by the three observers, indicate that each observer is consistent in his own measurements, but tends to work at a different level from the other observers. This feature does not invalidate the use of these measurements. Providing measurements for experimental or breeding work are taken by one observer, a high degree of consistency can be obtained. In addition, it is statistically possible to correct for differences between two or more observers, if comparisons between them are required. The sheep-observer interaction presents a greater difficulty and where it includes an appreciable portion of total variance (as in width of loin, and width of hindquarter), it detracts considerably from the value of the measurement.

The two major reasons for the inaccuracy of the measurements studied are firstly, the difficulty of holding the lamb in a standard natural position while the measurements are being taken, and secondly, errors of the operator resulting from varying the pressure applied on the calipers. These sources of error are only controllable to a very limited extent. An attempt was made to standardise the position of the lamb by using a crush pen, but it was found impossible to get accurate measures in this way for the lamb strained continually against the crush at its neck. Hence the method used, that of holding the animal, combined with a certain amount of patience proved to be the best compromise.

For the most part the measurements are found to be more accurate than the writer had expected. In order to give a suitable comparison it may be mentioned that the coefficient of variation quoted by Phillips and Stoehr (1945) for the body weight of ewes and lambs in fleece, ranges from 1·52% to 2·3%. It can be seen, therefore, that these measurements compare favourably in accuracy with body weight which is usually considered to be an accurate determination. It would be expected, for instance, that most of these measurements would be less affected by day to day variation than would body weight.

There were several features of the experiment which were favourable to the more accurate determination of the measurements. In the first place, the lambs had been shorn a few hours prior to measuring, and therefore no inaccuracies were introduced, as a result of having to allow for the wool covering. Secondly, the lambs had not been allowed access to food for a number of hours before measuring. This was of particular importance in the case of the loin width measurement, where it was found to be considerably easier and more accurate to make the measurements when the flanks of the animal were not distended with food. Under these conditions in a non-mutton breed like the Romney, the loin width is more clearly defined.

In the light of these considerations, the conclusion can be drawn that height of withers and width of forequarter are of a high order of accuracy, while width of loin and width of hindquarter are lower in accuracy. Their use needs consideration in relation to the requirements of the experimental technique. An important consideration is the time required for taking these measurements. It took one observer approximately 60 minutes to record the four measurements on the 20 lambs thus averaging about three minutes per lamb. Except for height at withers, it is doubtful at the moment, whether these measures could be directly applied to stud practice, but further investigation is required on this point.

PART IV.

RELATIONSHIP OF MEASUREMENTS ON THE LIVE ANIMAL TO CARCASE MEASUREMENTS.

The major criticism which can be levelled against the use of body measurements in sheep is the fact that it is not known to what extent they indicate desirable body conformation, and carcase quality. To the best of the writer's knowledge, no investigation has been conducted into the problem of interpreting body measurements in sheep in terms of relationships to carcase quality. Bonsma (1939) used body measurements to study the linear growth of various lambs up to the age of 16 weeks. These measurements were mainly concerned with skeletal growth and no analysis is made of the relationship to measurements on the carcase of the lamb after slaughter. Ritzman (1917) also used depth of chest, width of loin, and width of chest measurements, but similarly the experiment was not carried to the post slaughter stage. Obviously, until this is done, body measurements cannot yield their maximal amount of information regarding carcase desirability.

In the investigation on the accuracy of the measurements, the lambs used were part of the Progeny Test Experiment, and, in the normal routine of the experiment, were slaughtered on the day following the collecting of the data. Carcase measurement data was also taken on them and this afforded the opportunity to enquire into the relationship between these carcase measurements and the measurements on the live animal.

RESULTS.

The association between the two sets of measurements was evaluated by simple correlation technique, as given by Snedecor (1940). The mean of the six measurements taken by the three observers was used for the body measurements on the live animal.

(a) HEIGHT AT WITHERS.

The height at withers was correlated with a number of carcase measurements, which are indicative of leg length, and to other measures of carcase quality. The correlation coefficients are given in Table XXI.

TABLE XXI. CORRELATIONS OF EXTERNAL CARCASE MEASUREMENTS AND QUALITY POINTS WITH HEIGHT AT WITHERS.

Measurement	r	P	Regression	S.E. of Estimate (cms.)
Length of Cannon Bone	·772	S.S.	X = 0·340 + 0·2003Y	·298
T	·721	S.S.		
R	·797	S.S.	X = 2·844 + 0·273Y	·369
P	·725	S.S.		
F	·716	S.S.		
Block Test Points for Leg.	-·571	S.S.		
T X G	·195	N.S.		
Block Test Carcase Total.	-·627	S.S.	X = 257·393 −3·702Y	8·33

It is seen that all the leg length measurements are highly significantly correlated with height at withers. The slightly higher values for the coefficients of length of cannon bone (fore) and R measurements are reasonable in that these two measurements are in fact integral parts of the height of wither measurement. Although the correlation coefficients are not high from the point of view of predictive purposes, they definitely establish a strong relationship, as would be expected, between the height of withers and length of leg as measured in various ways on the carcase, and therefore vindicate the validity of the measurement.

The accuracy of this measurement, and its eace of application suggested that it would be worth while to investigate its relationship to indices of carcase quality, and composition. The T X G index which Walker and McMeekan (1944) showed to be strongly correlated with total weight of muscle and of bone in the lamb, was considered but the analysis yielded a non-significant correlation. For the same reason, it was correlated with Block Test Carcase Total Points, and value found proved to be highly significant (-0·627) The association between the two features is in part a consequence of the fact that 30% of the total carcase points is allotted to leg length. Doubtless, some considerable portion is due also to the association between great leg length and other features of the carcase which tend to lower overall quality. The correlation coefficient is not high enough for prediction purposes, as is shown by the magnitude of the Standard Error of Estimate. Moreover, the correlations are based on a small number of observations so that the error of the correlation coefficient is likely to be large.

(b) OTHER BODY MEASUREMENTS.

A correlation analysis was done between the width of loin, width of hindquarter and width of forequarter, and various carcase measurements with which they were likely to be related. The results are shown in Table XXII.

TABLE XXII. CORRELATION COEFFICIENTS OF EXTERNAL CARCASE MEASUREMENTS WITH BODY MEASUREMENTS ON THE LIVE ANIMAL.

Body Measurement.	Carcase Measure.	r	P
Width of Loin	A	·132	N.S.
	B	·157	N.S.
Width of Hindquarter	G	·224	N.S.
Width of Forequarter	W.F.	·528	S

The only correlation of significance is the width of forequarter and W.F. measurement, which is just above 1% level of probability. The correlation between width of loin and B. measurement does not support the relationship shown in the previous section between Loin grading and B measurement as it was thought it may do when choosing the measurements to be taken. Nevertheless, it is certain that the Loin grading as estimated by the hand and eye, takes into account other factors besides the width of loin. The grading, for instance, includes the flatness of the loin, which is usually assumed to be closely related to the depth of eye muscle in that full eye muscle development cannot take place unless the loin is flat and level. The grading is also influenced to some extent by condition.

CONCLUSION.

Although based on a small number of observations, the study of the relationships of the body measurements to carcase characteristics, shows the validity of the use of height at withers measurement in the study of conformation in sheep, while it indicates that the use of width of loin and width of hindquarter is of doubtful value. The conclusion on the usefulness of width of forequarter is difficult, and further investigation is required to establish its value.

Despite the fact that the analyses are essentially of a preliminary nature, they at least indicate the broad field of study into the accuracy and interpretation of body measurements which is essential if objectivity is to be introduced into conformation studies in sheep.

PART V. THE HERITABILITY OF FLEECE AND CARCASE CHARACTERS IN SHEEP.

The study of productive characters in sheep, like all quantitative inheritance, is of special interest and importance, because it is with quantitative characters that selection is chiefly concerned. The potentiality of a population from the point of view of selection for a given character depends on its genetic constitution, or in other words on the magnitude and number of genetic factors involved, and the nature of their dominance and epistatic relations. To study these points, the usual methods of genetic analysis is out of the question, for in a quantitative character, environmental causes very considerably invluence its expression and the different genotypes are not recognisable. In addition, if the accepted assumption of large numbers of genes-controlling the inheritance of productive characters is correct, then it would be practically impossible to extract all the genotypes possible in the usual sized breeding programme (Lush 1943). Observed measurements in such a character represent the combined effect of genetic and environmental factors, and a method of study is required which, while dispensing with the need of identifying individual genotypes, is capable of utilising these measurements. Such a method, is available in the application of biometric procedures to quantitative data to determine the degree of heritability of the character being considered.

The degree of heritability of a characteristic may be defined as a measure of the amount of the observed variance that can be attributed to the additive effects of genes. It is thus a quantitative statement of the relative importance of heredity and environment, and is in part a description of the causes of variation in a particular character in a specified population. Its value can be altered by altering variation in either the environment or the hereditary make-up of the stock, and so it may vary from population to population depending to a large degree on the extent to which inbreeding is practised and efforts are made to standardise the environment.Hazel and Terrill (1945 and 46) have shown, however, how these influences may be corrected in an analysis of heritability.

Heretability is important for the understanding of breeding methods and to the breeder for several reasons.

(1) Only that portion of the variance which is due to the additive effect of the genes is operated on by the process of mass selection. It represents, therefore, the proportion of the gain which is transmitted to the offspring through selected parents (Lush 1935) and, for that reason is useful for estimating probable genetic improvement.

(2) An estimate of heritability is essential in planning breeding systems (Wright 1939). If the desired characteristics are highly hereditary the best method available will be that of selection or individual performance with little use of pedigree, family selection or progeny testing. If, on the other hand, heritability is low, then the necessity of progeny testing, familial selection pedigree, and the possible use of inbreeding (Dickerson and Hazel 1944) is emphasised.

(3) In addition, heritability is important, in the construction of selection indexes, where it is necessary to determine the relative emphasis to be placed on each of several traits (Hazel 1943, Lush 1943).

Thus it may be stated with some justification that degree of heretability is a fundamental concept in breeding for productive characters that are inherited in a multifactorial manner.

METHODS OF DETERMINING HERITABILITY USED.

All methods of estimating heritability depend in some manner on the degree to which related animals resemble each other more than un-related ones do. Lush (1939 and 1940) has discussed the various methods of analysis, of which two, the paternal half sib correlation and intra-sire regression of offspring on dam are best adapted to the present data. Ordinary parent-offspring correlations and regressions have also been calculated from the data.

In the case of quantitative variables, such as fleece weight, fleece length and hairiness, the total variance and covariance in each sample was separated into its between sire-group and within sire-group components by the methods of analysis of variance and covariance as outlined by Fisher (1941) and as shown in Table XXXIII.

TABLE XXXIII. THE COMPOSITION OF MEAN SQUARES AND CROSS PRODUCTS.

Source of Variation.	d.f.	Mean Squares		Cross Products.
		Offspring	Dams	Dams and Offspring.
Between Sires	m-1	B + k.A.	B'+k.A!	cov(b) + k cov(a)
Within Sire Groups.	n(k-1)	B	B'	cov (b)

The components of the variance were divided up according to a method used by Winsor and Clarke (1940).

B. represents the variance between lambs by the same sire.

A. represents the additional variance between lambs by different sires.

Similar interpretations apply to the component for dams (A' & B')

"cov (b)" is the covariance common to a dam and her offspring within the sire group.

"cov (a)" is the covariance common to all dams and offspring in the sire group.

k. is the effective number of lambs per sire. Since all the sires do not have the same number of lambs, k is slightly smaller than the average number of lambs per sire. k is estimated from the formula

$$\frac{(\sum k)^2 - \sum(k)^2}{\sum k \ (n-1)}$$

where n is equal to the number of sires. (Winsor and Clarke 1940).

If G represents the variance due to the effects of genes which combine in an additive fashion and E represents the combined effects of environment, dominance and epistasis, then it is possible to apportion the above sources of variation to the two components G and E. as in Table XXIV (Hazel and Terrill 1945-b)

TABLE XXIV. RELATIONS BETWEEN COMPONENTS OF VARIANCE AND COVARIANCE AND THE GENETIC AND ENVIRONMENTAL VARIANCE FOR A NON INBRED POPULATION.

Source	Component	Non Inbred Population.
Variance of Offspring.	A	$\frac{1}{4}$ G
	B	$\frac{3}{4}$ G + E
	A + B	G + E
Convariance of Dams and Offspring	cov (a)	0
	cov (b)	$\frac{1}{2}$ G
	cov (a) and cov (b)	$\frac{1}{2}$ G

The paternal half sib correlation is then equivalent to $\frac{A}{A+B}$ which in a non inbred population must be multiplied by four to provide an estimate of heritability because the paternal half sibs in general will only have one-quarter of their genes in common.

The intrasire regression of offspring on dam will be equal to $\frac{\text{cov (b)}}{B'}$ which must be multiplied by two on the same basis of reasoning.

In the case of qualitative data for fleece and carcase characters, the dam-offspring correlation has been used and was calculated by the method outlined in Section IV. This estimate is multiplied by two to give an estimate of heritability.

FLEECE WEIGHT.

An analysis of the heritability of fleece weight was carried out under the system outlined above. The comparison was made between the fleece weights of the dams and ewe hogget offspring, with no corrections applied to the data. In the case of the dams, the fleece weight represented 12 months growth, while in the case of the ewe hoggets only 10 months growth was included. No correction was made for this factor at this stage because within both groups the time between shearing was of standard length.

TABLE XXV. MAIN SQUARES AND COVARIANCES FOR FLEECE WEIGHTS.

Source of Variation.	d.f.	Dams		Offspring		Cross Products.	
		S.S.	M.S.	S.S.	M.S.	S.S.	M.S.
Total	182	467·04	-	148·37	-	4·63	-
Between Sires	9	14·70	1·6333	10·97	1·2189	2·75	·3056
Within Sires	173	452·34	2·6147	137·40	·7942	1·88	·0109

k. = 18·24

Hence A = ·0233 cov (b) = ·0109

B = ·7942 B' = 2·6147

Paternal Half Sib. Correlation(multiplied by 4) = ·1140

Intrasire Regression of Daughter on Dam (Doubled) = ·0083

Daughter Dam Correlation (Doubled) = ·0352

Daughter Dam Regression (Doubled) = ·0198

A number of previous estimates have been made for heritability of fleece weight in sheep. Hill (1921) and Lush and Jones (1923) report correlations of ·60 between successive fleeces in range Rambouillet sheep. Phillips et al. (1940) using dam and daughter regression quotes figures for Corriedale and Rambouillet ranging from ·04 to ·54 with mean values of ·19 and ·30 respectively. Briggs (1939) quotes a dam-daughter correlation of ·575 for clean scoured fleece weight of range Rambouillet sheep. Rasmussen (1942) using several methods of estimation obtained figures ranging from·35 to·56 for Rambouillets, ·23 - ·72 for Corriedales, and ·10 - ·16 for Romneys, McMahon's (1943) study is the only other work of a similar nature to the above based on the New Zealand Romney. His results indicate a heritability of approximately ·10 - ·15 and generally that heritability is low.

The same conclusion can be drawn from the above analysis. In general the figures for intra sire regression are lower than those reported by other workers. The paternal half sib correlation method gives a result which is substantially in agreement, with both MacMahon and Rasmussen. The low values found may be explained by the fact that no corrections have at this stage been used, and that only one fleece recording is available for analysis. Moreover, such a low regression is subject to relatively large sampling errors, and the number of daughter-dam pairs included in the data is not large. Hence, it is considered that the results above support McMahon's conclusion that fleece weight is only a "weakly" inherited character, and that it does not agree with the published data on the fine-wooled breeds, where heritability seems to be higher.

STAPLE LENGTH.

A similar analysis was carried out to determine the heritability of staple length. Staple length has not previously been considered as a factor of great importance in fleece investigation because of its assumed high correlation with Fleece Weight (McMahon 1946). Preliminary investigations of the relation between fleece weight and staple length on this data (unpublished) however show that it is not necessarily a high correlation (·34 for 186 pairs of Ewe Hoggets) With this fact in mind and considering that some importance is placed on staple length in regard to manufacturing uses of crossbred wool the analysis of heritability seems justified.

The data again is based on the same method of comparison as was used in the case of fleece weight.

TABLE. XXVI. MEAN SQUARES AND CROSS PRODUCTS FOR STAPLE LENGTH.

Source of Variation	d.f.	Dams		Offspring		Cross Products	
		S.S.	M.S.	S.S.	M.S.	S.S.	M.S.
Total	183	898·09		632·60		73·27	
Between Sires	9	33·58	3·7311	86·64	9·6267	10·96	1·2178
Within Sires	174	864·51	4·9684	545·96	3·1377	62·31	·3581

k = 18·33

Hence A = ·3540 | cov (b) = ·3581

B = 3·1377 | B' = 4·9684

Paternal Half Sib Method (multiplied by 4) = ·4055

Intra Sire Regression of Daughter on Dam Method (Doubled) = ·1422

Daughter Dam Correlation (Doubled) = ·1941

Daughter Dam Regression (Doubled) = ·1632

An average estimate of heritability from the above figures would be about ·21. The only other estimates of heritability in the literature deal with Rambouillet range sheep. Phillips et al. (1940) report a number of regression coefficients for daughters on dams, which averaged

·23 for staple length, and thus gives an estimate of heritability of ·46. Terrill and Hazel (1943) report a value of ·36, for yearling (400 days) Rambouillet ewes, and ·40 for weanlings (125 days) thus suggesting that the heritability of staple length remains relatively constant with age. No other estimates have been published for Romney sheep. On the basis of this data, it would therefore, appear that again, as with fleece weight, the intensity of inheritance is weaker than in finewooled breeds.

MEDULLATION.

The importance of medullation in New Zealand crossbred wools has been discussed by a number of writers (Dry 1934, McMahon 1937) but as yet, little unanimity of opinion has been achieved in regard to the intensity of inheritance of this feature. McMahon (1940) states that 40% of the variation in medullation was due to seasonal environmental effects and that only 10% of the variation was controlled by the parents. He therefore, classes hairiness as a weakly inherited characteristic. Goot (1945-b) studied the causes of variations in the amount of hairiness. He found that 50 - 55% of the total variance is controlled by individuality alone, or, in other words, is due to genetic and such enivronomental influences which are fixed by the time of first sampling. Season on the other hand, controlled only 4% of total variance, while age was responsible of 17% of the variance. This analysis indicates that hairiness may be more strongly inherited.

The analysis of heritability of hairiness is given below, using position No. 5. samples from both ewes and ewe hoggets Goot (1945 a) has shown that the correlation between position No. 5. and Total Hairiness of the fleece, is 0·9245 and has therefore, proposed that Position No. 5 sample is sufficient for estimating Total Hairiness. The data on Medullation is supplied by the Fleece Testing Department, as "percentage of hairiness" (or photo-electric index found by dividing the galvanometer deflection by the weight of the sample) (Goot 1945 a). Because of the fact that the mean and standard deviation tend to be of the same order, the statistical treatment was carried out using a logarithmic transformation log (n 1) = log (X - 2·2 1) (The factor 2·2 is included because zero on the medullometer scale is 2·2 cm/gr. - the photo-electric index of pure wool).

TABLE XXVII. MEAN SQUARES AND CROSS PRODUCTS FOR HAIRINESS.(Nett figure)

Source of Variation.	d.f.	Dams		Offspring		Cross Products	
		S.S.	M.S.	S.S.	M.S.	S.S.	M.S.
Total	180	19·4236		17·7564		8·1419	
Between Sires	9	0·8593	·0955	2·8594	·3177	·6176	·0686
Within Sires	171	18·5643	·1066	14·8970	·0871	7·5243	·0440

R = 18·042

A = ·0128 cov (a) = ·0014.

B = ·0871 cov (b) = ·0440.

Hence Half Sib Correlation (multiplied by 4) = ·5125

Intra Sire Regression of Daughter on Dam (Doubled) = ·8103

Daughter Dam Correlation (Doubled) = ·8778

Daughter Dam Regression (Doubled) = ·8384

The results quoted above give a mean value for heritability of about ·76 which shows hairiness to be a very strongly inherited character. Because of the importance in breeding of an accurate estimate of heritability for hairiness, it was decided to convert both hogget and ewe fleeces to a lifetime average hairiness on the hindquarter by the use of the regression equations given by Goot (1945 b) They are Hogget Fleece Position No. 5. to Lifetime Average Hairiness.

$$\text{Log } Y = 0{\cdot}8448 + 0{\cdot}6742 \log X$$

Fourth Ewe Fleece Position No. 5 to Lifetime Average Hairiness.

$$\text{Log } Y = 0{\cdot}8589 + 0{\cdot}8099 \log X$$

As Goot's regression equations are based on the logarithm of gross hairiness (i.e. the logarithm of the percentage hairiness without deduction of the factor 2·2) the figures were recalculated on this basis. The results are given in Table XXVIII.

TABLE XXVIII. MEAN SQUARES AND CROSS PRODUCTS FOR LIFETIME AVERAGE HAIRINESS.

Source of Variation	d.f.	Dams		Offspring		Cross Products	
		S.S.	M.S.	S.S.	M.S.	S.S.	M.S.
Total	180	7·8445		5·8868		3·0397	
Between Sires	9	·3380	·0376	·8904	·0989	·2176	·0242
Within Sires	171	7·5065	·0439	4·9964	·0292	2·8421	·0166

A = ·0038 cov (b) = ·0166

B = ·0292 B' = ·0439

Paternal Half Sib Method (multiplied by 4) = ·4606

Intra Sire Regression of Daughter on Dam (Doubled) = ·7562

Dam Daughter Dorrelation (Doubled) = ·9004

Dam Daughter Regression (Doubled) = ·7800

This yields an average estimate of ·72 for heritability, a figure substantially in accordance with the figure previously calculated on the uncorrected data. The inescapable conclusion from this data is that hairiness is strongly inherited and that selection on individual performance will bring about a reasonably rapid reduction in the amount of hairiness present, a conclusion which can be supported by the expressed opinion of many breeders, that hairiness has been reduced considerably in many flocks and the New Zealand crossbred clip generally during the last decade as a result of selective breeding both using the medullometer test and eye estimation for hairiness in wool.

COUNT OR QUALITY NUMBER.

An analysis was carried out on the intensity of inheritance of fibre fineness in the data collected. The scoring method quoted in the Section IV was used.

TABLE XXIX. MEAN SQUARES AND CROSS PRODUCTS FOR COUNT.

Source of Variation	d.f.	Dams		Offspring		Cross Products	
		S.S.	M.S.	S.S.	M.S.	S.S.	M.S.
Total	186	1255·54		1224·45		233·73	
Between Sires	9	57·79	6·4211	197·53	21·9478	- 5·76	
Within Sires	175	1197·75	6·8443	1026·92	5·8681	239·49	1·36

k = 18·65

A = ·8622 cov (b) = 1·3685

B = 5·8681 B' = 6·8443

Paternal Half Sib. Method (multiplied by 4) = ·5124

Intra Sire Regression of Daughter on Dam (Doubled) = ·4000

Daughter Dam Correlation (Doubled) = ·3770

Daughter Dam Regression (Doubled) = ·3724

The average estimate of heritability for count is 0·41. The only other estimate of heritability of count for the New Zealand Romney is given by McMahon (1943). His estimate of the most probable value is ·35 - ·40, which is in close agreement with the estimate derived above. Count is, therefore, a strongly inherited character.

FLEECE QUALITY GRADING.

Using the scoring system detailed in Section IV, a heritability analysis was carried out on the Fleece As A Whole grading, and is presented in Table XXX.

TABLE XXX. MEAN SQUARES AND CROSS PRODUCTS FOR FLEECE AS A WHOLE GRADING.

Source of Variation	d.f.	Dams		Offspring		Cross Products	
		S.S.	M.S.	S.S.	M.S.	S.S.	M.S.
Total	185	591·02		476·24		43·42	
Between Sires	9	29·31	3·2567	51·42	5·7133	16·98	1·8867
Within Sires	176	571·71	3·2484	424·82	2·4136	26·44	0·1502

A = 0·1780 cov (b) = ·1502

B = 2·4136 B' = 3·2484

Paternal Half Sib Correlation (multiplied by 4) = ·2747

Intra Sire Regression of Daughter on Dam (Doubled) = ·0925

Dam Daughter Correlation (Doubled) = ·1470

Dam Daughter Regression (Doubled) = ·1636

The above results yield an average estimate of heritability of 16% , a figure which is in close agreement with that given by McMahon (1943) of 14%, which is the only other estimate available for the New Zealand Romney Marsh.

HERITABILITY OF FLEECE GRADINGS WHICH HAVE BEEN ANALYSED ON A QUALITATIVE BASIS.

For the evaluations of fleece qualities in which a small number of grades were used, the daughter-dam correlation was calculated as indicated in Section IV, and a correction (al o give in Section IV) applied for broad categories. By doubling the daughter-dam correlation an estimate of heritability was found. These estimates are given in Table XXXI, and graphical presentations of the data in Figures XII - XVIII.

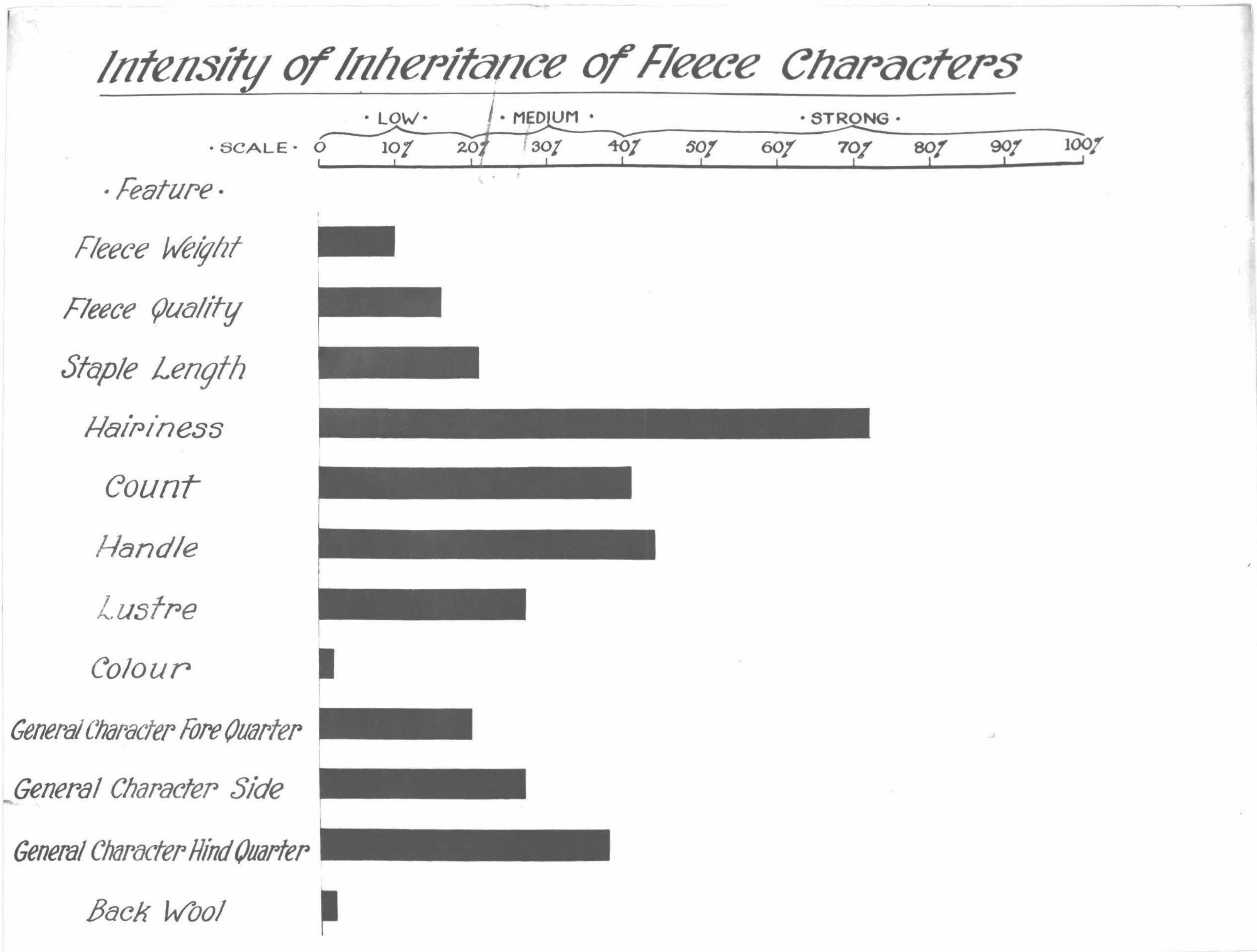

Intensity of Inheritance of Fleece Characters
· LOW ·
· MEDIUM ·
· STRONG ·
· SCALE ·
0
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
· Feature ·
Fleece Weight
Fleece Quality
Staple Length
Hairiness
Count
Handle
Lustre
Colour
General Character Fore Quarter
General Character Side
General Character Hind Quarter
Back Wool

TABLE XXXI. ESTIMATES OF HERITABILITY OF FLEECE CHARACTERS.

Character	n	Heritability.
Handle	186	·44
Lustre	185	·27
Colour	187	- low (small negative correlation)
Forequarter Character	188	·20
Hindquarter Character	186	·38
Side Character	187	·27
Back Wool	187	- low (small negative correlation)

No data has been recorded in the literature on the heritability of these characters for sheep. However, some appraisal of their probable accuracy can be made from various other considerations.

Handle, of wool is conditioned by a number of factors which may be broadly classified into genetic and environmental in character. Among factors which may be a priori classified as genetic in nature are fibre irregularity, medullation, plasticity, size, shape and disposition of the scales. Environmental effects are nutrition, and its effect on the amount and quality of yolk, possible effects of incorrect dipping and climatic conditions generally. Little is known about the interrelationships of these facotrs, but the above estimate of intensity of inheritance indicates that genetic factors are important in contributing to the handle of wool. This is supported by the success that has attended the breeders efforts to improve the handle of their wool clip by selection. This success indicates that handle is strongly inherited. It is also supported by Dry (1930) who found angularity of cross-section and kinks to be characteristic of harsh wools, and concluded that this cause of harshness is quite strongly inherited. Thus the estimate given for handle is sustained by the evidence available from other sources.

Colour grading, as shown by the data, has a very low heritability. On a-priori reasoning, it is reasonable that the colour grading is mostly affected by environment and that heredity plays but a small part in its determination. Similar reasoning can be applied to the case of Back Grading. Here, however, the greater inaccuracy of the grading and the greater number of factors which have to be considered may combine to give a lower value for heritability of back grading than is justified.

The heritability estimates derived for General Character on Forequarter, Side and Hindquarter regions call for some comment. It is noticeable that there is a gradient from low heritability on the forequarter region to higher heritability on the Hindquarter. At first sight, it is tempting to associate this apparent gradient with that of fleece growth from shoulder to the tail, as demonstrated by Thomasset (1938). But sampling errors owing to the limited number of observations and the error in grading technique vitiate against a too wide generalisation. There is some justification, however, for assuming that the Hindquarter character is more strongly inherited. It is the writer's experience that the grading for this region is markedly influenced by the amount of hairiness, as shown by the present data, is strongly inherited, the association between dam and offspring in this character is high. It is, therefore, likely that the amount of hairiness present will influence the Hindquarter character grading to a similar extent, and in a similar manner in both dam and offspring, thus leading to a greater association between the two. It should be noted that this reasoning applies to the grading for character as estimated by the eye and not necessarily to the Hindquarter character per se.

Until these estimates are supplemented by data from subsequent years, further interpretation does not seem warranted.

THE HERITABILITY OF CARCASE CONFORMATION CHARACTERS AND BODY MEASUREMENTS.

Hammond (1932), McMeekan (1940) Palsson (1940) and Verges (1939), have all shown the extreme modification which environmental variation may produce throughout the growth period, on the development of meat qualities in the sheep and pig through the differential relationships between the growth of their constituent parts. Surveying their results, it would appear that, as regards the meat qualities of animals, the environment is of paramount importance. But, their results were based on wide differences in the levels of feeding, and, in the case of McMeekan's experiment with pigs, inbred pigs were used, thus reducing the variation due to heredity to as low a value as possible. It would be expected therefore, that heredity would play a more important part when considered in relation to more average levels of feeding and management. Few results are available, nevertheless, on the heritability of visible differences in conformation in meat producing animals and in the main they deal with swine.

Lush (1936) studied the heritability of some carcase measurements obtained from data of the Danish Swine Progeny Testing Stations and quotes estimates of 0·47 for thickness of back fat, and 0·46 for thickness of belly and 0·54 for length of body. In a study of body scores, in pigs, Hetzer, Dickerson and Zeller (1944) showed that 38% of the variation between pigs within strains and season was due to the additive effects of genes and that 92% of the variations between different strains within season were heritable.

Stonaker and Lush (1942) found by regression of offspring on dam on an intra-sire intra-season basis that 20% of the variation of body conformation score in swine was hereditary in the narrow sense of the word.

In beef cattle, little investigation has been carried out on heretability. The only study to be reported up to the present, is that of Knapp and Nördskog (1946 (b),) in which they give results of 0·53 for weaning score for conformation, 0·84 for carcase grade, 0·69 for area of eye muscle and 0·01 for dressing percentage. They conclude that quality measures are less heritable than production measures which were reported in an earlier paper (Knapp & Nordskog 1946 (a).)

In sheep, Terrill and Hazel, (1943) estimate that only 12% of the variation in body score were due to heritable differences. McMahon (1943) has reported the heritability of a number of body characters in the New Zealand Romney. They are

Head Grading	·25 - ·30
Breed Type	·15
Fleshing	·13

These results are the only ones that are strictly comparable with the data given in this investigation.

BODY AS A WHOLE GRADING.

An analysis of the grading was completed using the numerical values for the gradings as given in Section IV. The results are tabulated below.

TABLE XXXII. MEAN SQUARES AND CROSS PRODUCTS FOR BODY AS A WHOLE GRADING.

Source of Variation	d.f.	Dams		Offspring		Cross Products	
		S.S.	M.S.	S.S.	M.S.	S.S.	M.S.
Total	182	515·91		460·33		31·69	
Between Sires	9	45·58	5·0633	16·93	1·881	4·77	·5300
Within Sires	173	470·33	2·7187	443·40	2·5630	26·92	·1556

k = 18·23

A = ·0374 cov (b) = ·1556

B = 2·5630 B' = 2·7187

Paternal Half Sib Method (multiplied by 4) = -.0584

Intra Sire Regression of Daughter on Dam (Doubled) = ·1145

Daughter Dam Correlation (Doubled) = ·1300

Daughter Dam Regression (Doubled) = ·1228

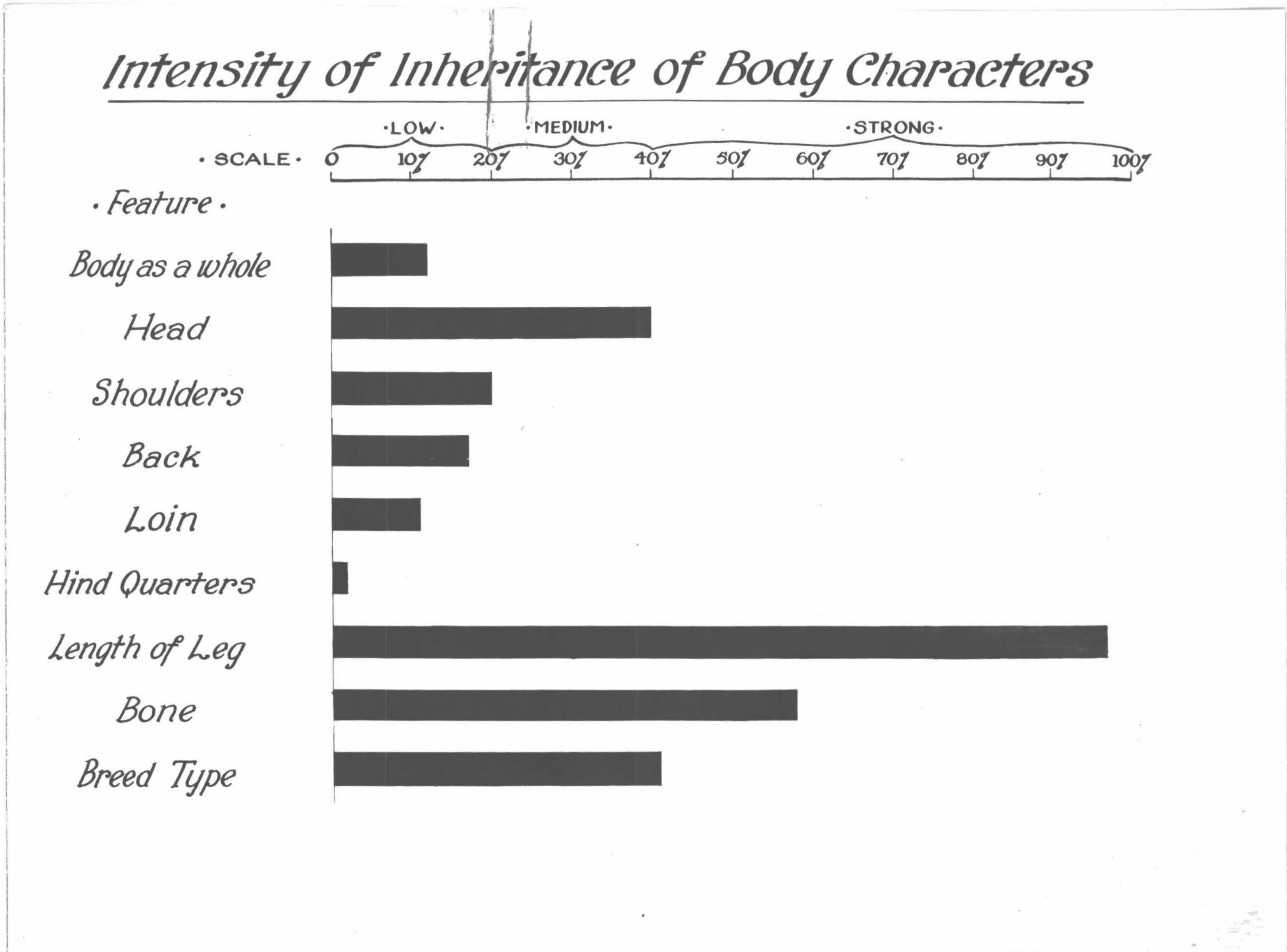
Hence the heritability of Body As A Whole grading appears to be about ·12 and so a weakly inherited character. This fact is in line with the results shown by the Hammond school of workers that the environment has a predominating influence on carcase conformation.

HERITABILITY OF OTHER CARCASE CHARACTERS.

The heritability of other carcase features, as evaluated by eye and hand appraisal have been considered. The method of analysis used was that of dam-daughter correlation with correction for broad categories. The estimates found are given in Table XXXIII (see also Figs. XIX to XXVI)

TABLE XXXIII. ESTIMATES OF HERITABILITY OF VARIOUS BODY CHARACTERISTICS.

Character	n	Heritability
Head Grading	182	·40
Breed Type	182	·41
Length of Leg	182	·97
Bone	182	·58
Shoulders	182	·20
Back	182	·17
Loin	182	·11
Hindquarters	182	low (Correlation slightly negative)



Intensity of Inheritance of Body Characters
·LOW·
·MEDIUM·
·STRONG·
·SCALE·
0
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
·Feature·
Body as a whole
Head
Shoulders
Back
Loin
Hind Quarters
Length of Leg
Bone
Breed Type

The estimate for Head grading can be seen to be in line with the figure quoted by McMahon (1943) The estimate for Breed Type from this data however indicates that it is more strongly inherited than previously reported by the above writer. The difference between the two estimates may in some measure be due to the variation between different judges in the method by which they assess Breed Type. The present writer is of the opinion that the Breed Type estimate is based primarily on type of head, length of leg and presence or absence of any major conformation or wool defect, though many other characters of secondary and minor importance are considered. As is shown in the above table, Head grading and Length of Leg at least are strongly inherited. It is, therefore, logical to expect that a characteristic compounded largely of these two strongly inherited features would itself be strongly inherited.

Some other results are available, (unpublished, 1946) which can be used for a comparison. By dam-offspring correlation between various carcase characters of Romney ewes and their Down cross offspring estimates of heritability of length of cannon bone (·84) and weight of cannon bone (·84) were found. These can be compared with Length of Leg grading and Bone grading, and in general support the conclusion which can be made from the above data, that they are strongly inherited characters though, doubtless, the estimate for Length of Leg is somewhat above its true value due to errors of sampling and grading.

With reference to Table XXXIII, an interesting relationship can be deduced. As a consequence of the thesis that the form of the animal body is a result of differential growth and development of its parts, a general order of development of these parts in post-natal life has been established. (Hammond 1932, McMeekan 1940, Verges 1939) Thus the regions of the body can be seperated out into relatively "early" and "late" developing categories. An "early" developing part, then, can be defined as one which relative to another, makes a greater proportion of its growth early in life. The same workers have also shown the marked influence of plane of nutrition on the animal body and that as a result of their differential growth the parts compete differentially for the available food supply. "Early" developing parts are believed to have a first claim on the available nutrients and consequently under adverse conditions, their growth is not delayed, to the same degree as "late" developing parts. It can be implied that even under average conditions of nutritive supply and environmental conditions, the "early" developing parts are likely to realise more of their full hereditary growth potential than are "late" developing parts. Consequently with "early" developing parts, the effect of the hereditary endowment of the animal is shown to a greater extent while that of the environment is less important. i.e. the heritability of "early" developing characters, on this reasoning, should be greater than that of "late" developing characters.

Support for this contention is given by the results shown in Table XXXIII. Head, Length of Leg, Bone and Breed Type (which is largely compounded of these features) are "early" developing characters and at the same time have high heritability values whereas Shoulders, Back, Loin and Hindquarters, which are relatively later developing characters, have lower heritability values. It is noticeable that, within these last-mentioned values tend to follow the same trend as their order of development though the inaccuracy of the methods of measurement and analysis caution against over emphasis of this point. Unpublished data on the heritability of carcase measurements indicates the same relationship between order of development and strength of inheritance.

HERITABILITY OF SOME CARCASE MEASUREMENTS.

The investigation of the additive effects of genes in controlling the inheritance of carcase measurements in sheep is a relatively untouched field and little data is available. Results found in swine and beef cattle have been reported earlier (Lush 1936, and Knapp and Nordskog 1946)

A limited amount of data was available in this experiment on external carcase measurement relations between ewes and their wether lambs. The measurements considered were F (leg length as measured from the crutch) G (width of gigots) and T (length of tibia plus tarsus from the tubercle on the proximal end of the tibia to the anterior edge of the distal end of the tarsal.) The results are given in Table XXXIV.

TABLE XXXIV. HERITABILITY OF BODY MEASUREMENTS.

Character	n	Heritability
F	69	·38
G	69	·33
T	69	low (negative correlation)

The importance of these measurements as indices of carcase composition has been stressed by Walker and McMeekan (1944). They show a correlation of 0·894 between T x G and total weight of muscle in Canterbury lamb(2's and 8's) and a correlation of ·934 for the same measurements and weight of bone. The low value for the T measurement is surprising in that it is a measure of leg length and thus from other data would be expected to be strongly inherited. However, the number of observations is small and the error likely to be large. A further explanation will also be suggested in Appendix XIV.

DISCUSSION AND APPLICATION OF RESULTS.

Strictly speaking, an estimate of heritability is applicable only to populations which have a genetic make-up and environmental treatment similar to the populations from which the estimate was derived, so that results can only be generalised in so far as this restriction is taken into account. Hence some discussion is necessary on the accuracy and applicability of the results.

(a) ACCURACY.

In general, the resemblance between parent and offspring gives the most useful estimate of the additive effect of the genes affecting the characteristic being considered. It does not include any of the variance due to dominance deviations from the additive scheme. It does, however, include some small amount of the variance caused by epistatic interactions because chance at Mendelian segregation implies that some of the gene groups, especially the simpler ones, which produce these special epistatic effects, will be transmitted in their original combination to a small proportion of gametes. As Lush (1940) indicates, an epistatic effect depending on the presence together of two genes, would be transmitted from parent to offspring only half as often as would an additive effect dependent on the presence of only one gene, a three gene effect only one-fourth as often etc. Hence, in the general situation only a small proportion of the epistatic effects contribute to the parent-offspring correlation. This epistatic contribution, however, must remain undefined and the method of analysis classes as non-hereditary the differences caused by dominance and most of those caused by epistatic deviations from the additive scheme. In the main, this cannot lead to a considerable error, for it is only the additive effects of the genes concerned (and some small part of the epistatic variance) which is acted upon by selection.

The paternal half sib method of estimating heritability suffers from more serious errors than the above method. This is mainly because the expected correlation between half sibs is smaller than the dam offspring correlation on the assumptions of no environmental effect. (·25 as against ·5) It is therefore multiplied by four instead of two and so sampling errors are likely to be increased by this larger multiplier.

From a study of the biometric relations between the phenotype of the parent and the phenotype of the offspring using Wright's method of Path Coefficient (Wright 1934) it can be shown that the correlation between these two attributes is

$$r_{P_D \, P_O} = ab\, h^2 g^2 + ab\, h^2 g^2 m + e'e \quad r_{E'E}$$

Where $h^2 g^2$ is the portion of the actual variance which is additive in effect (heritability)

ab is the path coefficient from genotype of parent to genotype of offspring.

m is correlation between genotype of sire and genotype of dam.

$r_{E'E}$ is the correlation between the environment of the dam and the environment of the offspring.

The various components of this parent offspring correlation indicate the factors that are likely to be important in giving a bias to the heritability estimate.

(i) The value of the path coefficient ab is basically an expression of the extent to which Mendelian segregation, as affected by chance, permits the genotype of the parent to determine the genotype of the offspring. Unless the parents differ widely in their degree of inbreeding from that of the offspring, this figure is in the vicinity of 0·5. As no inbreeding was included in the experiment, this source of error is presumably non-existent, and moreover, increasing the number of observations has the effect of reducing error due to Mendelian segregation to a negligble value.

(ii) The correlation between genotype of dam and genotype of sire (m) can for all practical purposes be regarded as zero in this data. It is a measure of the degree of departure from random mating. The ewes in the experiment were assigned at random to their sire groups and so this condition is fulfilled.

(iii) The major difficulty in the interpretation of dam daughter correlation is that of appraising correctly the environmental contributions to the observed ressemblance. In this data, the correlation ($r_{E'E}$) between the environment of the dam and daughter is assumed to be zero. The sire groups of both dams and daughters were run as a mob, and no special treatment was accorded to any individuals or to any group, so that as far as was possible there was no tendency for the environment of both members of a daughter dam pair to be above or below the flock average in any respect. Moreover, in so far as any environmental correlation may have existed, the intra-sire method of computation allows for this fact to a considerable extent, for the analysis is restricted to the amount of variance which is found within the groups of ewes mated to each sire (The term B' in the analysis) while differences between the groups of ewes is left unanalysed as to its hereditary or environmental nature. The fact that the intra-sire regression is not biased in any particular direction in the various estimates seems to support the conclusion that the environmental correlation is zero, as is expected from the design of the experiment. Hence, the equation for dam daughter correlation reduced to $r_{P_D P_O} = \frac{1}{2} h^2 g^2$ necessitating only the doubling of the correlation to give an estimate of heritability.

In the case of the quantitatively measureable characters no corrections have been made in this data. This is at variance with several of the heritability estimates as determined by Hazel and Terrill (1945 b, 1946) In their data, they have adjusted for sex, age of dam, type of birth and rearing, age at weaning etc., as determined from an earlier study (Hazel and Terrill, 1945 a The effect of this correction is to reduce the variance due to environmental causes, and thus increase heritability. In the cases quoted, it reduced variability in weaning weight by 50% and staple length by 20% with consequent increases in heritability. In the present data, however, it was considered that adjustment for similar environmental factors would be artificial and unwarranted because such adjustments are not ordinarily used in commercial practice, and would consequently bias the estimates towards a higher figure. A possibly important source of error, however, may have been introduced by omission of a correction for twins. The effect of this factor is to decrease the variance within the groups of ewes (reduce B' in the analysis) and hence to increase the value of the Intra Sire Regression. Moreover, it would tend to increase the effect of highly homozygous ewes, (in comparison with the average of the population) if they had twin lambs.

A further, and most important source of error in the analyses of heritability is introduced by the inaccuracy of the methods of measurement. This applies in particular to the fleece and body characters which were estimated by eye and hand. These inaccuracies result in a reduction in the estimate of heritability and an increase in the proportion of variance listed as environmental. In addition, the estimates are based on only one observation for each character on each animal, a single observation which may have been considerably affected by temporary environmental conditions.

(b) APPLICABILITY OF RESULTS.

The heritability estimates, which have been derived are statistics describing the particular population used. In order to generalise these figures, it is necessary to indicate wherein the breeding methods and environmental conditions differ from ordinary commercial practice.

The two features in which the present design differs from commercial breeding are

(1) Random Mating was used.

(2) No preferential environmental treatment was given to any offspring.

In the first case, a considerable amount of assortive mating manifestly takes place in stud breeding, both corrective mating and mating best to best. Lush (1943) points out that, although assortive mating of both types does not increase or decrease homozygosity to any appreciable degree, it does alter the resemblance between parent and offspring. This is particularly the case when strongly inherited features are considered (Head type and Length of Leg) as is usually the case in assortive mating. Where both corrective mating and mating best to best are practised simultaneously, it would appear that in general, the effect on the dam daughter correlation over a flock would tend to be cancelled out. In the case of weakly inherited characters, it is doubtful whether departure from random mating of this kind is likely to bias the estimate of heritability. In so far as line breeding or inbreeding is adopted, it will again affect the heritability estimate by altering the half sib and dam daughter correlation. Inbreeding within closed lines tends to increase the half sib correlation as compared with random mating, while daughter dam correlation and intrasire regression is decreased.

In stud practice, it is quite usual to give preferential treatment to at least the tail end of the ewe hoggets. The effect of this preferential treatment would be to alter the correlation (rE'E) between the environment of parent and offspring to some value different from zero, and thus to bias the estimate of heritability. The result is an increased variation in the environmental contribution and therefore, decreased heritability fraction for the character considered.

Bearing in mind the above mentioned differences, which on the average cancel out unless any really wide departures from the postulated conditions occur, it is considered that the estimates determined give a fair approximation to the heritability of the productive characters in the N.Z. Romney. When these conditions are fulfilled, it is possible to indicate the value of the heritability estimates by classing the characters concerned into the categories "strongly inherited" "medium inheritance" and "weakly inherited" according to the rate of progress expected in improving the characters through individual selection alone (Figures XVIII A and XXVI A.) At the same time, it shows to what extent mistakes will be made in selecting on phenotype animals which are thought to have genes for superior characterisation, and therefore can be used as an indication of those features, which have to be taken into account in a progeny testing scheme. For "strongly inherited" characters, selection on individual performance will give the fastest rate of improvement, while progeny testing is required for improvement in "weakly inherited" characters. (Dickerson and Hazel 1944)

Heritability of the character is an important factor in controlling the rate of improvement possible. Replacement rates, the other important factor in improvement, is limited by the rate of reproduction and the length of productive life in the sheep. It is interesting to calculate the extent of improvement per generation based on this data, assuming a 70% replacement of ewe hoggets and 3% ram hoggets. These rates correspond to selection differential of 0·50 and 2·27 (Pearson 1931) respectively, in normally distributed populations. The expected gain can then be calculated from the equation

Gain/Generation = Heritability x Standard Dev. x (·50 2·27) /2

and are given in Table XXXV.

TABLE XXXV. EXPECTED IMPROVEMENT PER GENERATION BY SELECTION ALONE.

Character	Heritab.	St.Dev.	Improvement/Generation
Fleece Weight	·10	·90	·12 lb.
Fleece Quality	·16	1·54	·34 (½ grade)
Staple Length	·21	1·86	·54 cm.
Hairiness	·72	·18	·18 (log Gross Hairiness)
Body As A Whole	·12	1·59	·26 (½ grade)

The possible improvement in the case of fleece weight, fleece quality, and Body As A Whole is obviously very slow, even when considered alone. When several other traits are taken into consideration it is obvious that improvement by selection in these characters is virtually non-existent.

PART VI. RELATIONSHIP BETWEEN LAMB AND HOGGET CHARACTERS.

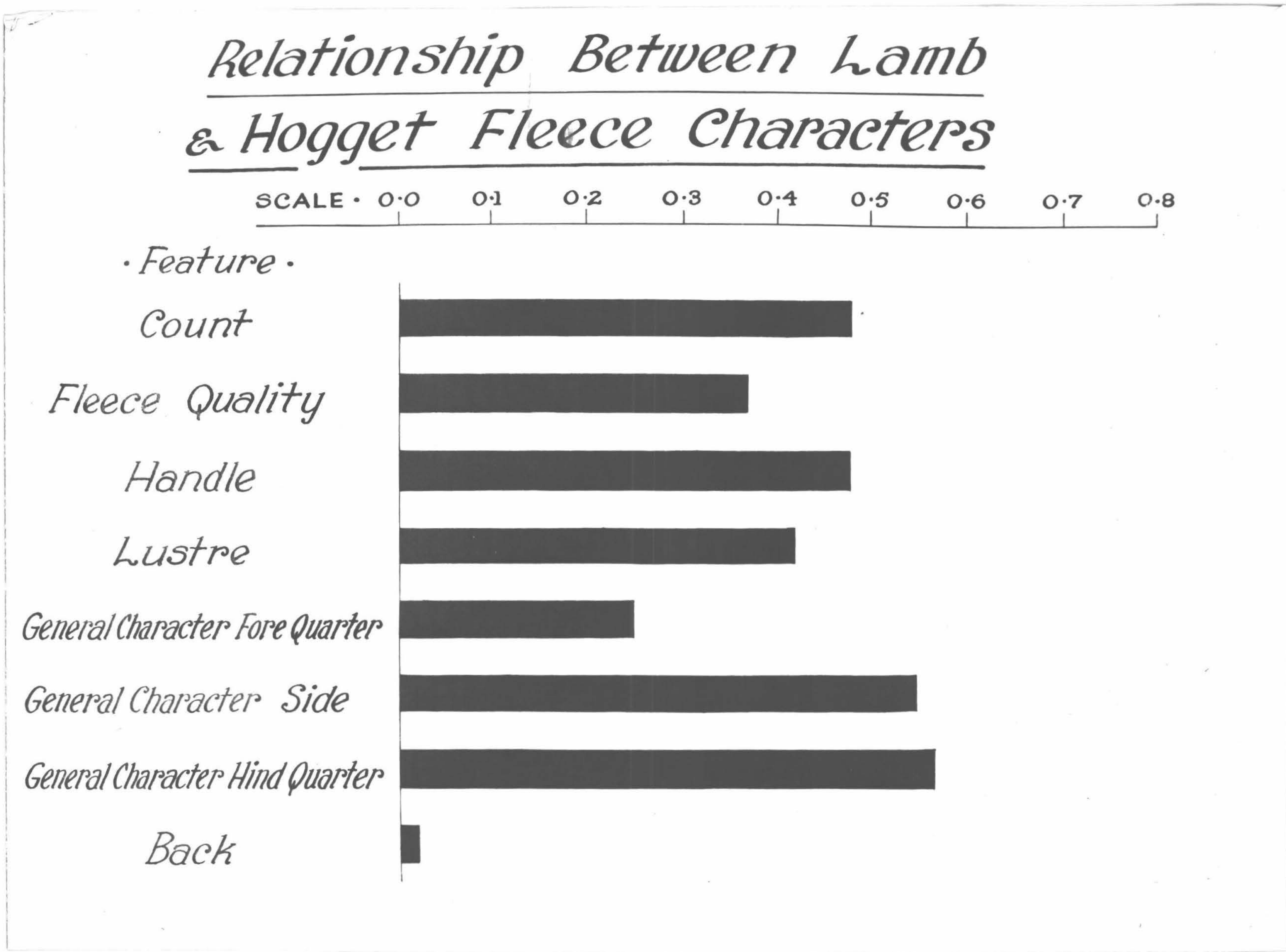
In breeding practice, the first careful analysis of fleece and carcase characters is usually made at the hogget stage. This practice suffers from various disadvantages from the point of view of progeny testing and improvement.

Firstly, no records are taken on animals which are culled at weaning time or which die prior to the hogget shearing and as a result, no cognisance can be taken of them in any progeny testing programme.

Secondly, the progeny evaluation of a ram is delayed for a further eight to ten months. As Dickerson and Hazel (1944) have stressed, the genetic progress expected from progeny testing is considerably influenced by the age of the ram when progeny test information can be obtained. The effect of the delay in obtaining this information is to increase the interval between generations and thus to reduce the expected yearly gain. Moreover, evaluation on the basis of the lamb characteristics enables the sire to be tested prior to the next tupping season, and thus eliminate the necessity of either using the sire lightly during the subsequent year because his merit is unknown, or having to use him widely merely on the basis of speculation as to his probable value.

At the same time, however, the effectiveness of selection based on the lamb stage over that based on the hogget is dependent in a large measure, on the relationship existing between the characteristics of the animal at the two ages. To the best of the writer's knowledge no investigation has been undertaken on this aspect for the New Zealand Romney, and only few results have been reported overseas.

Lambert, Hardy and Schott (1938), working with Corriedales, Columbias and Rambouillets, indicated that certain weanling characteristics could be used satisfactorily in predicting the yearling fleece characteristics. The two highest relationships were for length of wool, and per. cent. of lean wool while for density and fineness of fibre the results were low. Terrill (1939) has given results of a study of the relations between early measurements and life-time averages for body weight, fleece weight and fleece length. His correlation coefficients range between ·46 and ·69. Pohle (1942) supplemented the data of Lambert et al. (1938) and also made a test of reliability of


Relationship Between Lamb
& Hogget Fleece Characters
SCALE · 0·0
0·1
0·2
0·3
0·4
0·5
0·6
0·7
0·8
· Feature ·
Count
Fleece Quality
Handle
Lustre
General Character Fore Quarter
General Character Side
General Character Hind Quarter
Back

the sampling technique, but in essence, the previous results quoted remain unchanged.

It is the purpose of this present section to present the results of a study to determine the extent of the relationships between lamb and hogget characteristics for the New Zealand Romney Marsh. The data is derived in the case of fleece characters, from descriptions on the ewe offspring taken at approximately four and fourteen months of age, and in the case of body descriptions, at six and sixteen months of age.

RESULTS. (a) FLEECE CHARACTERS.

The results of correlation analysis between the lamb and hogget fleece characters are presented in Table XXXVI. For Count and Fleece Quality As A Whole, ordinary correlation technique was used, while for other characters, the method outlined in Section IV had to be applied. The data are presented in Figures XXVII - XXXII.

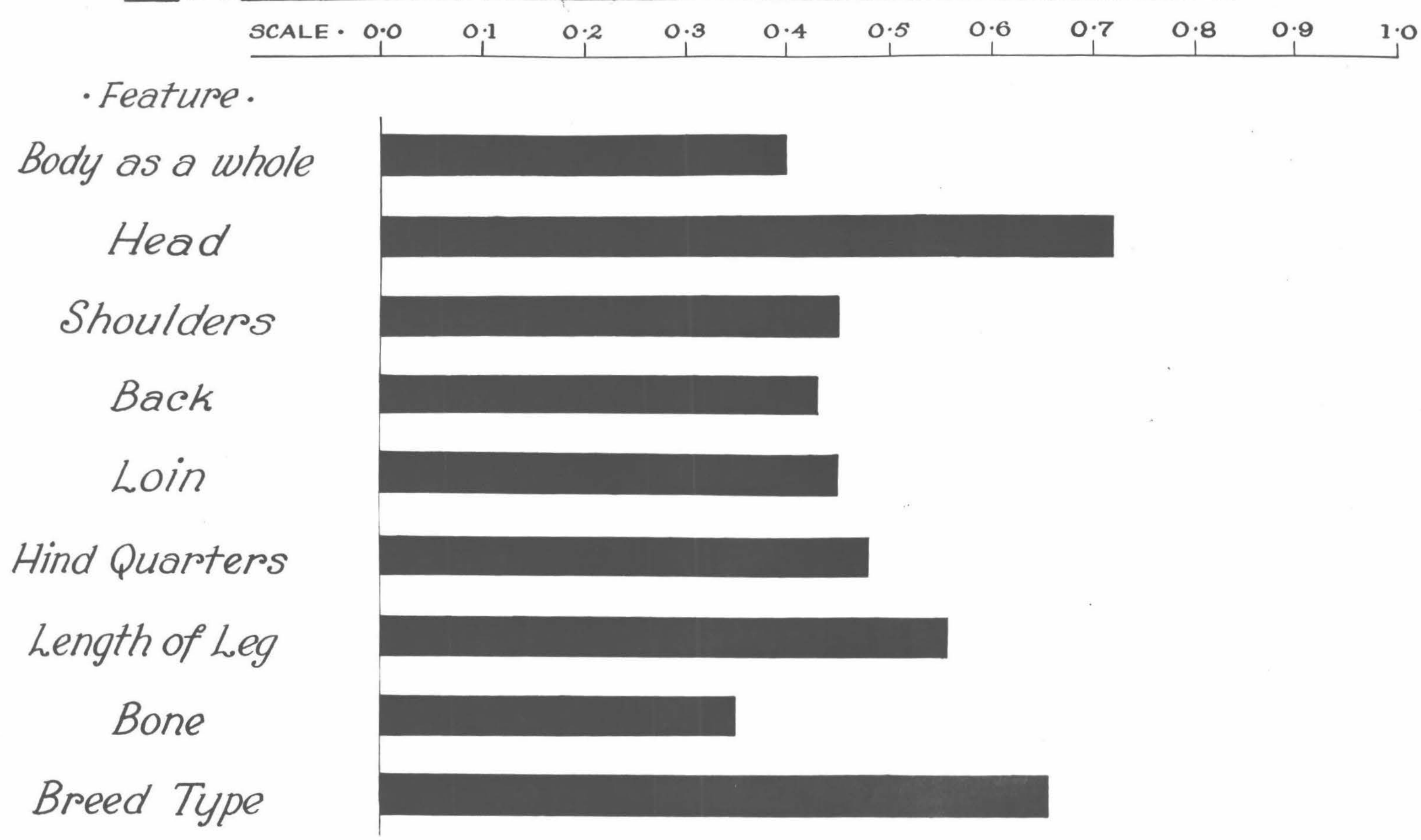
TABLE XXXVI. CORRELATION COEFFICIENTS BETWEEN LAMB AND HOGGET FLEECE CHARACTERISTICS.

Character		N	r	P.I.
Count		191	·48 xx	·12
Fleece Quality As A Whole		190	·37 xx	·07
Handle		189	·48 xx	·12
Lustre		189	·42 xx	·10
General Character Fore Quarter		189	·25 xx	·03
Side		189	·55 xx	·16
Hind Quarter		189	·57 xx	·18
Back		189	·02	·00

The Prediction index calculated according to Treloar (1939) is also given. The Prediction Index is a measure of the predictive value of the correlation coefficient and emphasises the fact that correlations may be high in value and statistically significant and yet be relatively low in value for predictive purposes. It is calculated from the formula. $P. I. = 1 - \sqrt{1-r^2}$

In all cases, except that of Back grading, the relationships between lamb and hogget fleece characters are statistically highly significant, but the prediction indices are generally low.. The poor relationship between the

Relationship Between Lamb and Hogget Body Conformation Characters



back wool grading for lamb and hogget can be explained in part by a fairly low level of repeatability for the estimation. In addition, it was found in the description of the lamb fleece that only very small differences could be detected in the quality and soundness of the back wool, whereas, in the hogget fleece, which had been subjected for a longer time to more adverse weather conditions, the tendency towards unsoundness and "mushiness" became apparent.

It is important also to note that this repeatability of characters in the subsequent fleece is in effect a method of determining heretability, for it shows approximately the amount of the differences in the fleece which are caused by permanent characteristics of the animal. These permanent characteristics will include the hereditary endowment of the animal, as well as any permanent features of the environment which are constant from year to year, and any action of the environment on the animal prior to the first description which has had a persistent effect. Thus, the correlation coefficients shown in Table XXXVI are likely to represent the upper limit of heritability for the characters concerned, and it can be seen by reference to Part V that they place these characters in approximately the same relative position as regards the importance of additive gene-effects.

(b) BODY CONFORMATION CHARACTERS.

The results of correlation analyses between the lamb and hogget conformational characters are given in Table XXXVI while the graphical presentation of the associations are shown in Figures XXXIII to XXXX.

TABLE XXXVII. CORRELATIONS BETWEEN LAMB AND HOGGET. CONFORMATION CHARACTERS.

Character	n	r	P	P.I.
Body As A Whole	190	·40	S.S.	·08
Head	189	·72	S.S.	·31
Shoulders	189	·45	S.S.	·11
Back	189	·43	S.S .	·10
Loin	189	·45	S.S.	·11
Hind Quarters	189	·46	S.S.	·12
Length of Leg	189	·56	S.S.	·17
Bone	189	·35	S.S.	·06
Breed Type	189	·66	S.S.	·26

The correlations for all characters are highly significant and in the case of Head grading, Breed Type and Legs are sufficiently high to have some predictive value.

Again, the general picture with regard to heritability is borne out by these results. From this aspect, the concept of earliness of development of the characters can again be mentioned. It is to be expected that the relationship between lamb and hogget will be greater for those characters which develop earliest and are hence less liable to be affected by environment. (e.g. Length of Leg, Head, Bone and Breed Type). On the other hand, gradings for later developing characters are correlated to a lower degree, because their period of maximum development occurs at a later time, and can be modified to a greater degree by the adverse effects of winter conditions which intervene between the lamb and the hogget evaluation. Hence, this data, and its relationship to heritability lends confirmatory evidence to the postulate advanced in Part V.

DISCUSSION.

The results presented for the relationship between lamb and hogget characteristics leave little doubt as to the close association between the estimations at the two ages. The predictive value of the correlations are in most cases low, and it is seen that generally early developing body characters yield the most information at the lamb stage as regards their probable future quality.

The correlations presented are, in fact, measures of the reliability of early selections. An examination indicates that a satisfactory job of selection could be done under certain circumstances. On the assumption that a large number of animals are available and that only a small percentage (say 30%) had to be rejected, then it would appear that serious mistakes in selection on the lamb fleece would be unlikely to occur when based on correlations of the above order of significance. It is improbable that the best animals would be culled but naturally some few of the poorer than average animals would be included. Overall, the effect of this on the average of the group would be very slight. The low predictive value of the correlations however has a marked effect when a few top animals have to be selected from a large number of possible candidates (as, for instance, in the selection of sires). Under these conditions, selection on the lamb characters is unlikely to be successful. The analyses indicate that the practice carried out by many hill country breeders of culling the worst of their ewe lambs is, in general, sound.

From the point of view of Progeny Testing, the low predictive values of the correlation coefficient do not, however, in the majority of cases, present a favourable picture. It has to be admitted that the sire evaluation is based on an average of a number of progeny, which allows of reduction in error, but at the same time, it must be remembered that, in the practical use of progeny testing, selection will be usually on the basis of selecting the top sire or top few sires from a number of candidates. Under these circumstances, the strong possibility exists that sire evaluation on the basis of lamb characters will be of doubtful utility.

Finally, the results indicate that Head Grading, Length of Leg, Breed Type, and Hindquarters, Fleece Character Grading may be used satisfactorily in predicting the hogget characters. However, it appears advisable that further studies be conducted along this line before final conclusions can be reached.

TABLE XXXVIII.

LAMBING DATA.

Group	Lambs Born dead or alive.	Lambs Born Dead.	Lambs Born Alive.	Lambs died within 24 hrs.	Lambs dead within-in 3 days.	Total.	Lambs dead after 3 days.	Lambs reared.
1	51	5	46	1	1	7	2	42
2	55	3	52	6	5	14	1	40
3	31	5	26	1	3	9	-	22
4	44	6	38	-	1	7	3	34
5	56	4	52	1	-	5	-	51
6	51	7	44	1	-	8	2	41
7	47	-	47	1	-	1	2	44
8	51	6	45	3	1	10	2	39
9	44	1	43	3	1	5	3	36
10	47	2	45	2	1	5	3	39
	477	39	438	19	13	71	18	388

PART VII. ANALYSES OF DIFFERENCES BETWEEN SIRES.

The groups of progeny sired by different rams were compared to determine whether differences existed in the ability of the rams to transmit various characters to their offspring. In this connection, no account has been taken of the dams of the offspring. The reason for this is two-fold. Firstly, as shown in Part V, the records of the dams were not, in many cases, correlated to the records of the offspring, and secondly, the ewes for each sire had been selected at random and thus allowed the assumption of nearly equal means and variances in each sire group of ewes. This eliminated the necessity for using covariance analysis to correct the groups to a common dam level.

It was also decided not to correct the data at this stage for the effects of multiple births, mainly because full data is not available for their calculation, and, moreover, their use would not be usual in a practical progeny testing programme at the present time.

The results have been analysed mainly by the simple analysis of variance technique, as described by Snedecor (1940), the variance being apportioned to differences between sire-groups and within sire-groups or error. Differences between means of sire groups were tested by the t test. The results have been discussed under the following headings.

I Lambing Data.

II Fleece Data.

III Carcase Slaughter Data.

IV Carcase Conformation Data.

- - - - - - - -

I LAMBING DATA.

The total number of lambs born (dead or alive), the total number born dead, the number dead within twentyfour hours, and the number dead within 3 days are given in table XXXVIII for each group. From this table it is seen that 8·2% of total lambs born were dead at birth, 4·0% died within 24 hours, of birth, and 2·7% between 1 and 3 days, giving a total of 16·9% death rate, from birth to three days. This figure seems alarmingly high, and to seek a possible explanation a more detailed table of results taking into account age of ewe, sex and birth rank, was made out.

TABLE XXXIX.

LAMBING DATA.

Group		Lambs born (Dead and Alive): Singles E	Singles R	Twins E	Twins R	Triplets E	Triplets R	Lambs dead at Birth or within 3 days: Singles E	Singles R	Twins E	Twins R	Triplets E	Triplets R
1	Total Born	8	4	11	7	4	2	6	3	1	5	-	-
	Dead	1	1	-	1	-	1	1	-	-	2	-	-
2	Total Born	-	5	13	23	-	-	6	2	5	1	-	-
	Dead	-	1.	5	4	-	-	3	1	1	-	-	-
3	Total Born	6	3	3	5	3	3	5	3	3	-	-	-
	Dead	2	-	-	2	2	1	1	1	-	-	-	-
4	Total Born	9	5	9	7	-	-	4	6	1	3	-	-
	Dead	1	1	2	2	-	-	-	-	-	1	-	-
5	Total Born	4	2	13	17	2	4	5	7	1	1	-	-
	Dead	-	-	2	-	-	1	-	2	-	-	-	-
6	Total Born	6	6	14	4	2	1	2	10	3	3	-	-
	Dead	2	1	2	-	-	-	-	1	-	2	-	-
7	Total Born	4	2	15	13	1	2	2	4	3	1	-	-
	Dead	-	-	-	-	-	-	-	1	-	-	-	-
8	Total Born	3	5	11	13	-	3	6	4	3	3	-	-
	Dead	-	-	1	2	-	2	2	-	1	2	-	-
9	Total Born	5	6	12	10	-	-	4	3	2	2	-	-
	Dead	1	1	1	-	-	-	-	1	-	1	-	-
10	Total Born	5	2	20	8	-	-	4	2	2	4	-	-
	Dead	1	1	2	-	-	-	-	-	-	1	-	-

From this Table XXXIX, it was found that of the total lambs born to two-tooth ewes, 18·2% of them died within the first three days, while only 13·9% of the lambs born to the 5½ year old ewes died within a similar period. Also the death rate was higher in the lambs born as singles, than among those born as twins (15·7% as against 14·4%) Consequently it appears that the high lamb mortality amongst the lambs of the two-tooth ewes has contributed in a large measure to this high overall mortality at birth. In addition, from a study of the lambing records, it is noticed that some 25% of the ewes had to be assisted at parturition in this season. No reason can be given for this feature.

An analysis of the total number of lambs dead either at birth or within three days (as shown in Table XXXVIII) by the χ^2 technique shows that there is a highly significant difference between sire groups (χ^2 = 15·61 $P < \cdot 01$) The two main contributions to this value of χ^2 are Sire Groups 2 and 7, with 14 and 1 lambs dead respectively. In these two groups the number of lambs born from two-tooth ewes is approximately the same (25% and 21% respectively) and the number of twins born in the two groups is also similar (76% - 68% respectively). This supports the conclusion that there is a real difference in survival between the offspring of the two rams.

(ii) DURATION OF LAMBING AND MEAN LAMBING DATE.

For the 1944 lambing season, the first lamb to be born was dropped on August 19th. This date was used as a base line to estimate the mean lambing dates for each group. The last lamb was born on October 14th giving a spread of lambing of 56 days. As mentioned previously, 62% of the total lambs were born in the first three weeks of lambing, and by the end of six weeks, 97% of the total had been dropped.

Mean lambing dates by groups and sexes are given in Table XL.

TABLE XL. MEAN DATES OF LAMBING. (DAYS)

Group	Ewes	Rams	Average
1	21·15	23·14	22·04
2	23·61	27·00	25·47
3	19·43	23·58	21·35
4	16·55	24·39	20·26
5	18·48	20·14	19·40
6	15·09	20·86	17·84
7	21·36	17·82	19·70
8	15·94	17·64	16·93
9	23·33	24·32	23·80
10	23·11	21·80	22·65
Average	20·03	21·94	20·96

Analyses of variance of lambing dates for the whole groups and for rams only are given below in Tables XLI and XLII

TABLE XLI. ANALYSIS OF VARIANCE OF LAMBING DATES. FOR EWES AND RAMS.

Source of Variation	d.f.	S.S.	M.S.	
Total	430	36212·33		
Between Sire Groups.	9	2278·34	253·15	F = 3·14
Within Sire Groups.	421	33933·99	80·60	S.S.

TABLE XLII ANALYSIS OF VARIANCE OF LAMBING DATE OF RAM LAMBS.

Source of Variation	d.f.	S.S.	M.S.	
Total	209	20355·32		
Between Sire Groups.	9	1949·99	216·67	F = 2·35
Within Sire Groups	200	18405·33	92·03	S.

There is a highly significant difference between the means of groups for lambing date as shown in Table XLI, Sire Group 2 being significantly later lambing than Groups 6 and 8. The difference between group means for lambing date of the ram lambs is significant between the 5 and 1% level. Again Group 2 is significantly later lambing than Groups 7 and 8. This difference of groups 7 and 8 assumes importance at a later section when discussing the age at killing of the wether lambs. This is in fact the sole reason for the analysis, for obviously no conclusion of significance from the viewpoint of sire differences in production can be drawn from the above analyses.

(iii) BIRTH WEIGHT.

The factors which affect birth weight of the lamb have been adequately discussed by Hammond (1932) Donald and McLean (1935) and Bonsma (1939). As stated in an earlier section lambs were weighed as soon as they were "dry" after birth. This tended to eliminate any error due to the weight of amniotic fluid, but a further source of error remained due to the amount of milk obtained by the lamb during that period. The experimental area was visited on the average 2 or 3 times per day for the purposes of recording the lambs born, except in the peak of lambing when more frequent visits were made. Thus some variation must exist as a result of the varying time available for the lamb to obtain milk from its dam. The assumption that in a reasonably large number of lambs, this source of error would be randomly distributed over the groups has to be made, and appears to be valid.

Bonsma (1939) summarises a number of factors affecting birth weights of lambs. Of these, the following were able to be considered in the analysis of variance: sex, birth rank, and sire differences, and the various interactions between them. The non-orthogonal distribution of the data made it necessary to modify the analysis of variance, and Yate's method of unweighted means was used (Snedecor & Cox, 1935). The analysis is given in Table XLIII.

TABLE XLIII. ANALYSIS OF VARIANCE OF LAMB BIRTH WEIGHTS.

Source	d.f.	S.S.	M.S.	Sign.
Subclasses	39	37.2748		
Sire Groups	9	6.0940	0.6771	N.S.
Sex	1	3.3062	3.3062	S.S.
Birth Rank	1	14.4721	14.4721	S.S.
Group, Sex	9	3.9814	0.4424	N.S.
Birth, Sex	1	0.0026	0.0026	N.S.
Group, Birth	9	5.6799	0.6311	N.S.
Group, Sex, Birth	9	3.7386	0.4154	N.S.
Error	369	-	0.3673	

TABLE XLIV. MEAN BIRTH WEIGHTS OF LAMBS. (lbs.)

Group.	Singles.		Twins.	
	E	R	E	R
1	11.04	11.23	9.82	10.29
2	9.92	12.20	9.42	10.81
3	10.87	10.76	8.90	9.62
4	11.41	11.54	9.36	9.86
5	9.18	9.39	9.28	10.03
6	10.22	11.69	8.75	8.75
7	12.42	10.33	9.58	10.43
8	9.38	11.24	9.53	10.17
9	10.31	11.63	9.89	10.43
10	10.87	11.20	8.90	8.95

TABLE XLVI. MEAN VALUES OF FLEECE CHARACTERS BY SIRE GROUPS.

Character	1	2	3	4	5	6	7	8	9	10
Fleece weight	5.89	5.64	5.84	5.89	5.70	5.89	5.70	5.39	5.21	6.08
Fleece Quality	8.00,	8.83	7.54	7.95	8.10	7.43	7.39	7.50	8.29	6.90
Staple Length	13.25	13.55	12.08	12.63	12.50	12.95	12.39	12.23	12.18	14.33
Count	7.83	7.98	9.15	9.32	9.60	8.84	8.56	8.40	9.28	7.71
Medullation (log (x + 1)	.8005	.5594	.9267	.8311	.9500	.7740	.9200	.8443	.8017	1.0413

FLOCK MEANS.

Fleece weight	5.74 lbs.
Fleece Quality	7.80 units.
Staple Length	12.89 cms.
Count	8.58 units.
Medullation	0.8497 (log (X + 1) value)

Mean birth weights by group, sex, and birth rank are given in Table XLIV (triplets were not considered, because of the small numbers available). As seen from the analysis, there was no significance between sires in birth weight of their lambs. Sex,differences and differences due to number at birth (birth rank), were both highly significant, a result which is in accord with numerous other writers (Hammond 1932, Donald and McLean, 1935, Bonsma 1939, Verges 1939).

The non-significance of differences between sire groups is important in view of the high correlation between weight at birth, and weight at later dates (Donald & McLean, 1935). This eliminates the necessity for correcting for birth weight when considering such factors as age at killing of the wether lambs.

II FLEECE CHARACTERS.

Analyses of variance between sire groups of ewe hoggets were carried out for those fleece characters that could be stated in numerical terms. The mean values for sire groups and for the flock as a whole are given in Table XLVI.

FLEECE WEIGHT.

The fleece weights of ewe hoggets were analysed to dtermine sire differences in regard to this character. The figures used are based on ten months growth of wool and because shearing dates were the same for all groups no correction was necessary for differences in dates of shearing. In addition no correction was made for count. The analysis of variance is presented in Table XLV.

TABLE XLV. ANALYSIS OF VARIANCE OF FLEECE WEIGHT.

Source	d.f.	S.S.	M.S.	Sign.
Total	182	148·37		
Between Sire Groups	9	10·97	1·219	F = 1·53
Within Sire Groups	173	137·40	0·794	N.S.

The data presented do not show any significant difference between sire groups in greasy fleece weight at the hogget stage. Reference to group means show that the differences are small.

FLEECE QUALITY AS A WHOLE.

Using the coding system as given in Section IV, for Fleece As A Whole, the analysis presented in Table XLVII was completed.

TABLE XLVII. ANALYSIS OF VARIANCE OF FLEECE AS A WHOLE.

Source	d.f.	S.S.	M.S.	Sign.
Total	185	476·24		
Between Sire Groups.	9	51·42	5·713	F = 2·36
Within Sire Groups.	176	424·82	2·414	S

The differences between group means are significant at the 5% level. On reference to the mean values, it is found that Group 10 is significantly lower in fleece quality than Groups 2, 5, and 9 at the 1% level, and Groups 1 and 4 at the 5% level. Group 2 is significantly higher than Groups 3, 6, 7, 8. (P ·01)

STAPLE LENGTH.

The length of staple as measured in centimetres on the side position shows highly significant differences between sire groups, (Table XLVIII)

TABLE XLVIII. ANALYSIS OF VARIANCE OF STAPLE LENGTH.

Source	d.f.	S.S	M.S.	Sign.
Total	183	632·60		
Between Sire Groups	9	86·64	9·627	F = 3·07
Within Sire Groups	174	545·96	3·138	S.S.

Group 3 is seen to be significantly shorter (P ·01) than Groups 1, 2 and 10 while Group 10 is significantly longer than all other groups except Group 2.

COUNT.

The numerical scale quoted in Section IV was used to evaluate sire differences in count, and the results are quoted in Table IL.

TABLE IL. ANALYSIS OF VARIANCE OF COUNT.

Source	d.f.	S.S.	M.S.	Sign.
Total	186	1224·45		
Between Sire Groups	9	197·53	21·948	F = 3·74
Within Sire Groups.	175	1026·92	5·868	S.S.

The differences between group means are highly significant as shown by the mean values. Group 10 had the strongest fleeces, while Group 9 was the finest. The differences between these two groups is, however, only of the order of one count interval. Where large differences in count occur it is very necessary that these differences be taken into account when comparing fleece weights of different sire groups. The complex interrelationship shown between count and fleece weight by McMahon (1942) indicates the necessity for and difficulty in making this allowance. Because of the small differences shown in count it is felt that this factor would have little effect on fleece weight. It must be remarked, however, that Group No. 10, which is strongest in count, shows the highest fleece weight, (although not significantly so). Hence material difference may be made in the order of merit in fleece weight if count is considered.

MEDULLATION.

Hairiness estimations of the fleece have been based on the Hindquarters Position No. 5 sample which Goot (1945) has shown to be strongly correlated with total hindquarter hairiness. For statistical analyses, the photo-electric indices have been transformed to logarithmic values by the use of the transformation log, (X+1), where X is equal to the photo-electric index - 2·18) The analysis is presented in Table L.

TABLE L. ANALYSIS OF VARIANCE OF MEDULLATION.

(log (X+1) values.)

Source	d.f.	S.S.	M.S.	Significance.
Total	180	17·7564		
Between Sire Groups	9	2·8594	0·3177	F = 3·65
Within Sire Groups	171	14·8970	0·0871	S.S.

The main contributors to this highly significant difference between means are Groups 2 and 10. Group 2 is significantly (P ·01) lower than all other groups in hairiness, while Group 10 is significantly higher than all other groups except Groups 3 and 7.

OTHER FLEECE CHARACTERS.

A summary of mean values, for other fleece characteristics is given in Table LI. It is seen that the variation in the mean values is not great and on testing the group differences for significance by technique it is found that generally the value of the probability is in the range of P = 0·20 to P = 0·10. The overall impression that can be gained from these mean values is that Group 2 is the best from the point of view of fleece quality and Group 10, the worst - an impression which is borne out by the analysis of the fleece as a whole grading, which shows the same trend.

TABLE LI. SUMMARY OF MEANS OF FLEECE CHARACTERS.

Character	1	2	3	4	5	6	7	8	9	10
Handle	4·21	4·22	4·46	3·95	3·95	4·57	4·00	4·20	4·22	4·21
Lustre	4·63	4·50	4·54	4·21	4·19	4·57	4·15	4·33	4·50	4·38
Colour	4·63	5·11	4·62	4·68	4·67	4·57	4·45	4·60	4·83	4·75
Character Side	4·38	4·28	4·08	4·16	4·29	4·00	3·90	4·00	4·28	4·41
(Hindquarter)	4·21	4·22	3·85	4·05	3·81	3·62	3·85	3·80	4·17	3·63
(Forequarter)	5·04	5·11	4·92	4·89	4·86	4·76	4·75	4·80	4·94	4·70
Back	4·50	4·50	4·38	4·74	4·62	4·43	4·25	4·53	4·72	4·50
Evenness	4·67	4·61	4·46	4·68	4·71	4·29	4·50	4·53	4·89	3·79

TABLE LII.

SUMMARY OF MEANS OF PROGENY TEST LAMB GROUPS FOR 1944-5. WETHERS.

Feature	1	2	3	4	5	6	7	8	9	10	Average
No. Killed	15	21	9	16	24	19	20	18	17	10	
Age	146.6	149.3	136.3	133.8	132.5	132.1	146.6	122.2	132.2	148.1	137.6
F	24.75	24.61	24.13	25.01	25.56	25.59	25.29	25.58	25.06	25.23	25.15
G	22.10	21.68	21.64	22.03	21.68	22.54	22.06	22.64	21.92	21.63	22.03
T	19.01	18.97	18.70	18.77	19.36	19.33	18.91	18.98	18.85	19.16	19.03
B.T. Carcase Total.	[1] 62.40	[4] 59.71	[2] 61.44	[5] 59.12	[7] 55.25	[10] 52.23	[6] 55.40	[3] 53.83	[8] 55.00	[3] 59.80	56.93
Wgt. Cannon Bone.	34.27	35.51	33.63	38.58	37.33	39.64	34.86	38.38	35.99	35.02	36.57
A	49.00	52.57	53.89	53.31	50.46	55.74	53.80	52.22	51.53	53.00	52.48
B	26.40	26.95	26.78	26.38	27.00	26.79	27.00	26.61	26.06	27.80	26.76
C	3.333	3.190	3.444	2.875	3.042	2.000	2.650	2.389	2.647	4.000	2.876
Length Cannon Bone	11.49	11.64	11.18	11.80	11.76	11.89	11.41	11.42	11.57	11.65	11.61
W.R.	22.42	22.50	22.21	22.14	21.80	21.35	22.43	21.97	21.74	21.78	22.03
W.F.	17.43	17.72	17.80	17.58	17.38	17.74	17.36	17.67	17.30	17.40	17.53
W. TH.	15.60	15.50	16.49	15.51	15.36	15.33	15.88	15.48	15.66	15.95	15.61
Th.	25.60	25.83	25.42	25.61	25.87	35.04	25.53	25.27	25.88	26.17	25.61
W.N.	8.51	8.78	8.91	8.86	8.72	8.50	8.91	8.88	8.85	8.50	8.75
R.	17.86	17.86	17.61	17.68	17.93	18.23	17.97	18.12	17.72	17.94	17.91
K.	55.60	56.86	56.28	56.73	56.71	56.45	56.72	58.68	57.52	56.80	56.88
L.	54.40	55.55	55.11	56.76	56.85	55.68	55.55	57.58	56.38	56.60	56.10
H.	27.80	28.86	28.56	28.78	28.83	28.25	28.48	29.09	29.00	29.38	28.59
P.	34.88	34.61	34.29	34.88	35.64	35.77	34.91	34.07	35.05	35.45	35.12
D.	3.067	2.190	5.000	2.875	2.917	2.053	2.600	2.278	2.941	2.800	2.740
X.	14.60	14.43	14.56	14.00	13.29	13.47	13.45	13.78	13.94	14.20	13.89
Y.	2.533	2.571	3.667	2.750	2.333	2.366	3.000	2.333	2.706	3.900	2.704
J.	8.80	7.43	7.44	6.69	7.79	5.05	6.35	6.06	7.35	8.200	7.03
Points for leg.	14.20	13.76	14.67	12.75	10.75	12.58	12.25	12.17	11.94	10.800	12.49
Points for Loin Fat.	16.07	15.05	15.56	14.94	15.00	11.00	13.50	12.83	14.24	17.60	14.34
Points for Eye Muscle.	6.40	6.76	6.56	6.75	6.83	6.79	6.90	6.50	5.94	7.60	6.69
Wght. Head.	3.053	3.200	3.022	3.106	3.133	3.326	3.120	3.144	2.982	3.170	3.134

III CARCASE DATA.

The mean values for the carcase measurements for the 1944-45 season are given in Table LII, according to sire groups. Analyses of variance were calculated for all these characters and are summarised below under their appropriate headings.

A. GENERAL DATA.

(a) Age at Slaughter.

The fundamental studies made on growth of meat-producing animals (Hammond 1932, Hirzel (1937) Verges 1939, McMeekan 1939) indicate that, for economic production, weight for age is of prime importance. The quick growing animal reaches a certain killing weight in less time than a slow growing one, and not only requires a smaller total maintenance food requirement, but under New Zealand conditions, fits in better with the seasonal nature of pasture production.

Since all the wether lambs were killed at approximately the same live weight, the age at slaughter is of considerable importance. The analysis is presented in Table LIII.

TABLE LIII. ANALYSIS OF VARIANCE OF AGE AT SLAUGHTER.

Source	d.f.	S.S.	M.S.	Sign.
Total	168	154,386·50		
Between Sire Groups	9	13,034·97	1448·33	F = 1·63
Within Sire Groups	159	141,351·53	889·00	N.S.

Despite the large differences shown between the means of sire groups they are non-significant, largely owing to the wide range shown within groups. Sire No. 8 has the lowest mean value of 122·2 days, while Sire No. 2. has the highest of 149·3 days. A possible explanation for the large difference can be seen by referring to Table XL where it is seen that Group 8 has the lowest mean lambing date, while Group No. 2 has the highest. This indicates that earlier born lambs reach killing weight at a younger age than lambs born later in the lambing season.

(b) COMMERCIAL GRADE.

The grading of the carcases, based mainly on conformation and finish, was strictly in accordance with the grading of North Island Export Lambs. Although the allotment of caraases to various grades is of little intrinsic

TABLE LIV. LAMB GRADING 1944-5.

Group	Down Cross.	Prime Cross.	Second	Total.
1	3	10	2	15
2	2	15	4	21
3	2	5	2	9
4	1	12	3	16
5	-	18	6	24
6	1	12	6	19
7	-	13	7	20
8	-	10	8	18
9	2	10	5	17
10	-	9	1	10
Total.	11	114	44	169

value in indicating real differences in composition in terms of muscle and bone (Walker and McMeekan 1944) it gives a useful indication of the suitability of the lamb for trade requirements, so much so, that Nichols (1945) has suggested it as an estimate to be used in measuring performance in progeny evaluation with sheep.

Because, with few exceptions, the lambs were within the 28-36 pound range, only three grades were used i.e.

Prime Down Crossbred.

Prime Crossbred.

Second Quality.

Table LIV shows the distribution of lambs within these grades according to sire groups.

No difference of any magnitude is shown between the sire groups on the basis of lamb grade. A chi-square analysis based on the numbers of Prime Crossbred and Seconds yielded a non-significant value (P = ·50 for 9 d.f.). The inclusion of the Down Crossbred figures, although giving a less reliable analysis because of small-expected subclass frequencies did not alter the non-significance of the results.

(c) CAMBRIDGE BLOCK TEST. (TOTAL POINTS.)

A more objective measure of carcase quality is furnished by the Cambridge Block Test. While, in part, it still entails a subjective evaluation of the fat cover over the leg region and an estimate of width and flatness of loin, every attempt has been made to increase its objectivity by using a score card for legs utilising the F and G measurements. The analysis of sire differences is presented in Table LV.

TABLE LV. ANALYSIS OF VARIANCE OF CARCASE TOTAL POINTS.

Source	d.f.	S.S.	M.S.	Sign.
Total	168	19,909·29		
Between Sire Groups	9	1,662·55	184·73	F = 1·61
Within Sire Groups	159	18,246·74	114·76	N.S.

The data do not show any significance between sire groups for carcase points, a fact which is in line with the results of Commercial Grading of the carcases. As can be also observed from Table LXII, the order of merit of

TABLE LVI. ANALYSES OF VARIANCE OF MEASUREMENTS OF LENGTH OF LEG.

Length of Cannon Bone.

Source	d.f.	S.S.	M.S.	Sign.
Total	168	33·19		
Between Sire Groups	9	6·11	·678	F = 3·98
Within Sire Groups	159	27·08	·170	S.S.

F. Measurement.

Total	168	187·59		
Between Sire Groups	9	29·71	3·301	F = 3·32
Within Sire Groups	159	157·88	·9929	S.S.

T. Measurement.

Total	168	416·43		
Between Sire Groups	9	7·49	·832	
Within Sire Groups	159	408·94	2·572	N.S.

R. Measurement.

Total	167	58·42		
Between Sire Groups	9	5·18	·576	F = 1·70
Within Sire Groups	159	53·24	·337	N.S.

P. Measurement.

Total	167	167·48		
Between Sire Groups	9	26·67	2·963	F = 3·32
Within Sire Groups	158	140·81	·891	S.S.

Block Test Points for Leg.

Total	168	2,391·21		
Between Sire Groups	9	231·08	25·675	F = 1·88
Within Sire Groups	159	2,160·13	13·585	N.S.

the sire groups is substantially the same for the two methods of evaluating carcase desirability. The mean values indicate that groups 1, 2 and 3 were highest for carcase points, and in view of the other carcase results reported later it would appear that these three rams bred the better type of lamb from the viewpoint of trade desirability.

B. LENGTH OF LEG MEASUREMENTS.

In the carcase data collected, a number of measurements indicate length of leg, either actual bone length or bone length as affected by the fat development of the carcase. Length of leg is an important consideration for; as has been shown by Hammond (1932) Palsson (1939) Verges (1939) using complete carcase dissection technique, short thick bones are associated with deep muscle covering, and that breed improvement for meat production has resulted in a shortening of bone. From the viewpoint of carcase suitability for trade purposes, the importance of leg length is shown by the fact that 30% of total Block Test carcase points are given for "blockiness" of leg. This factor is also taken into consideration in the present system of export grading of carcases.

Analyses of sire differences in leg length of the wether lambs are given in Table LVI and the mean values for each group is shown in Table LII. The measurements considered are length of cannon bone, F., T., R., P., and Block Test points for leg.

The cannon bone is one of the earliest maturing bones in the carcase (Hammond 1932) and is comparatively well developed at birth. Also the measurement of the length of cannon bone has every possibility of being accurate because in comparison with the measurements made on the carcase, it is made under relatively controlled and repeatable conditions. From these two points of view it is considered that cannon bone length should show differences between sires in leg length if they exist. The analysis of variance shows that there are differences between group means in cannon bone length. Referring to Tabl LII, it is seen that Group 3 is significantly shorter in cannon length than all other groups while Groups 7 and 8 are significantly shorter than Groups 4, 5, and 6.

The significance of the other leg length measurements varies. Measuremer F gives a useful picture of carcase conformation but is only partly a measure

TABLE LVII. ANALYSES OF VARIANCE OF WIDTH OF CARCASE MEASUREMENTS.

G. Measurement.

Source	d.f.	S.S.	M.S.	Sign.
Total	168	55·54		
Between Sire Groups	9	11·69	1·299	F = 4·71
Within Sire Groups	159	43·85	·276	S.S.

W.R. Measurement. (Width of Rib.)

Source	d.f.	S.S.	M.S.	Sign.
Total	168	121·89		
Between Sire Groups	9	22·79	2·532	F = 4·07
Within Sire Groups	159	99·10	·632	S.S.

W.F. Measurement. (Width of Forequarter)

Source	d.f.	S.S.	M.S.	Sign.
Total	168	88·56		
Between Sire Groups	9	4·99	·554	
Within Sire Groups	159	83·57	·525	N.S.

Th Measurement. (Depth of Thorax)

Source	d.f.	S.S.	M.S.	Sign.
Total	168	84·49		
Between Sire Groups	9	15·70	1·74	F = 4·01
Within Sire Groups	159	68·79	·433	S.S.

W Th Measurement. (Width Behind Shoulders)

Source	d.f.	S.S.	M.S.	Sign.
Total	168	109·59		
Between Sire Groups	9	14·38	1·598	F = 2·67
Within Sire Groups	159	95·21	·599	S.S.

W.N. Measurement. (Width of Neck)

Source	d.f.	S.S.	M.S.	Sign.
Total	168	81·66		
Between Sire Groups	9	4·06	·451	
Within Sire Groups	159	77·60	·488	N.S.

able for that breed.

By reference to Table LXII it can be seen that the various leg length measurements do in general place the rams in a similar order of merit but that there are considerable discrepancies. This is to be expected for the measurements differ in the degree to which they are affected by muscle and fat covering.

C. MEASUREMENTS OF CARCASE WIDTH.

In order to compare the different sire groups in regard to relative width of the carcases, the measurements for width of gigots, width of rib, width of forequarter, depth of thorax, width behind shoulders, and width of neck were considered and the analyses shown in Table LVII. Mean values for the sire groups are shown in Table LII.

From the analyses it is seen that there are highly significant differences between sire groups in width of gigots, a difference of approximately ·7 cms. between means being required for the 1% level. This shows that Group 10 is highly significantly lower in G measurement than Groups 6 and 8. The importance of the G measurement in carcase quality is shown by the highly significant correlation of 0·67 with total weight of muscle in the carcase. (Walker and McMeekan 1944).

A further interesting point of the analysis is the demonstration that both groups 6 and 8 are wider across the gigots than the other groups. These two rams were twins, and the marked similarity between their offspring is worthy of note, but cannot be interpreted further.

Incomparing width measurements across the ribs, significant sire group differences are again evident. Various Continental workers have studied the costal angle in lamb carcases and have demonstrated that more improved mutton breeds possess a small costal angle which results in a greater spring of rib. (Duerst 1931, Gartner, Heidenrich and Sprenger, 1930). It is likely, therefore, that this measurement indicates differences in the costal angle and of some importance in indicating desirable conformation in lambs.

A deep thorax is undesirable in the lamb carcase, for in general this is one of the cheapest cuts of the carcase. The analysis of variance shows highly significant differences between sire groups in this character, Groups 9 and 10 being the least desirable while Groups 6 and 8 show least depth of thorax.

TABLE LVIII. ANALYSES OF VARIANCE OF CARCASE LENGTH MEASURES.

Measurement K. (Length from Neck to Tail Head.)

Source	d.f.	S.S.	M.S.	Sign.
Total	168	580·08		
Between Sire Groups	9	98·54	10·95	F = 3·61
Within Sire Groups	159	481·54	3·029	S.S.

Measurement L. (Symphysis pubis to First Rib)

Total	168	582·03		
Between Sire Groups	9	131·81	14·64	F = 5·17
Within Sire Groups	159	450·22	2·83	S.S.

Measurement H. (Symphysis Pubis to Last Rib.)

Total	168	353·69		
Between Sire Groups	9	27·05	3·005	F = 1·46
Within Sire Groups	159	326·64	2·054	N.S.

The measurement of width behind the shoulders was expressly included because narrowness in this region is a common fault in the New Zealand Romney. Highly significant differences were obtained and it is notable that Sire No.6 which was markedly deficient in this respect, bred lambs which show the lowest value for these measurements. This indicates that the fault of narrowness behind the shoulders is strongly inherited.

The width of neck measurement is non-significant between sire groups. This measurement suffers considerably from lack of accuracy, because in many carcases, the fat covering over this region was torn off in butchering. Thus, little importance is attached to it.

D. MEASUREMENTS OF CARCASE LENGTH.

Since, from the butcher's viewpoint, as many cutlets as possible are required from the carcase, the longer the carcase is, the better. Also some of the most valuable muscles of the body run along each side of the vertebral column from pelvis to shoulder, again emphasising the necessity of length in the carcase. Increased length, however, is only advantageous when it is not followed by reduction in muscle thickness. As regards the desirability aspect of carcase conformation, it is probable that length of body is associated largely with longer length of leg bones, and hence reduced carcase suitability from the trade point of view. (Palsson, 1939).

The analyses of variance for length measurements is presented in Table LVIII and the mean values for sire groups in Table LII.

L - the length of body from symphysis pubis to the first rib is an accurate measure of body length, while K (from tailhead to base of neck) cannot be taken with the same degree of accuracy, but can be used as suitable confirmatory evidence for length L. The analyses show both to be highly significant, and by reference to Table LXII, the two measurements place the groups in a similar order of merit.

Measurement H, also an accurate measurement, measures the length of the hindquarters region of the carcase. The analysis shows it to be non-significant between sire groups indicating that the main differences in body length indicated by L and K measurements are due to differences in the length of the thoracic region of the carcase.

TABLE LIX. ANALYSES OF VARIANCE OF INTERNAL CARCASE MEASUREMENTS.

A. Measurement. Length of Eye Muscle.

Source	d.f.	S.S.	M.S.	Sign.
Total	168	2,164.18		
Between Sire Groups	9	564·58	62·73	F = 6·24
Within Sire Groups	159	1,599·60	10·06	S.S.

B. Measurement. Depth of Eye Muscle.

Total	168	781·06		
Between Sire Groups	9	27·22	3·02	
Within Sire Groups	159	753·84	4·74	N.S.

C. Measurement. Depth of Fat over B.

Total	168	304·39		
Between Sire Groups	9	42·18	4·69	F = 2·84
Within Sire Groups	159	262·21	1·65	S.S.

D. Measurement. Depth of Fat over Spinous Process.

Total	168	434·54		
Between Sire Groups	9	68·89	7·65	F = 3·32
Within Sire Groups	159	345·65	2·30	S.S.

X. Measurement. Width of Muscle in Rib Region.

Total	168	990·08		
Between Sire Groups	9	35·82	3·98	
Within Sire Groups	159	954·26	6·00	N.S.

Y. Measurement. Depth of Fat over X.

Total	168	247·21		
Between Sire Groups	9	33·16	3·683	F = 2·736
Within Sire Groups	159	214·05	1·346	S.S.

E. INTERNAL MEASUREMENTS.

The quality and development of the animal for meat purposes is most effectively estimated by cutting the carcase at the last rib and taking measurements to indicate the development in that region (Hammond 1936) The reliability of this statement is maintained by the fact that the main growth gradients in the body of the sheep all meet in the region of the lumbar and thoracic vertebrae. (Hammond 1932) Moreover, from the commercial point of view, the loin is the most valuable and high priced joint in the lamb carcase. Consequently, measurements which show the development in cross section of the longissimus dorsi in this region give valuable evidence not only of the relative muscular development of the animal, but also of the development of the commercially most important part of the carcase.

The analyses of variance for the various measurements made on the cross section surface of the carcase at the last rib are presented in Table LIX. Mean values for the above dimensions are presented in Table LII.

Considering first the muscle measurements, length of eye muscle "A" is shown to be highly significant between sire groups. Group No. 1 is significantly (P ·01) below all other groups with the exception of Groups 5 and 9, while Group 6 shows the greatest development in this character. Measurement A is an early developing characteristic and according to Walker and McMeekan (1944) is strongly correlated with total weight of muscle. Therefore, this significant difference between sire groups bears considerable importance from the viewpoint of carcase quality in terms of relative proportions of muscle, fat and bone.

With depth of eye muscle, measurement B, the analyses of variance indicates that no significant differences occur between groups. Depth of eye muscle, being a later developing characteristic than length of eye muscle is more closely related to the nutritional conditions than is measurement A, and consequently under the relatively uniform environmental conditions imposed in the experiment, it would be less likely to show differences between groups. The strong relationship shown by Walker & McMeekan (1944) between B and muscle : bone ratio indicates its importance in carcase quality.

Measurement X, the thickness of muscle layer over the ribs is also non-significant, between groups. In general, this measurement is less important than the A and B measurements.

In respect of the fat measurements, they are considered to be an indication of the finish and distribution of fat in the body. The measurements of thickness of fat in the loin region provides a satisfactory index of the degree of fatness of the carcass, because both the deposition of fat and the loin itself are late developing features, and as a result, any lack of finish will show up in this area. Lack of sufficient fat is asssociated with an unfinished appearance and is deterimental to the cooking and keeping qualities of the carcase. Too much fat is, however, disliked by the buying public, and is wasted. Hirzel (1936) has shown that fat cover over the eye muscle has an optimum value, and this feature is stressed in the Cambridge Block Test (McMeekan 1939).

The analyses show that in all the fat measurements there is a significant difference between sire groups. Reference to Table LII indicates that Groups 1, 2, 3 and 10 are higher in these measurements than the other groups. The Block Test points for Loin Fat based on measurement C (Depth of Fat over B) also supports the significance of the previous analyses. Assuming uniformity (as far as practicable) of environment, this fact indicates that there were real differences in the ability of the sires to transmit genetic potentiality for this important feature of fat cover to their offspring.

F. SUNDRY MEASUREMENTS

(a) Weight of Cannon Bone.

Many workers have indicated in sheep that the weight of cannon bone is a useful basis for comparing the relative development of the skeleton (e.g. Hammond 1932, Hirzel (1936 and Palsson (1938), Hammond (1932) suggested that the cannon bones, because they can be obtained without damaging the carcase and can be easily cleaned, would serve as a satisfactory index of total weight of bone in the carcase. Palsson (1938) found that the weight of left fore cannon bone, gave a correlation of + 0.9432. (P .01) with total weight of bone, a correlation which was quite as good as that found using an average of all four cannon bones. Hence, for lambs killed at a constant weight the weight of the left fore cannon bone gives a very accurate estimate of total weight of bone.

The analysis of variance is shown in Table LX.

BLE LXII

SUMMARY OF CARCASE ANALYSIS

Feature	1	2	3	4	5	6	7	8	9	10
Age	7	9	6	5	4	2	7	1	3	8
Grade	1	4	2	5	7	8	9	10	6	3
B.T. Carcase Total	1	4	2	5	7	10	6	9	8	3
F	3	2	1	4	8	10	7	9	5	6
T	7	5	1	2	10	9	4	6	3	8
R	4	4	1	2	5	9	7	8	3	6
P	4	3	2	4	8	9	5	1	6	7
Points for leg.	2	3	1	4	10	5	6	7	8	9
G	3	7	8	5	7	1	4	2	6	9
W.R	3	1	4	5	7	10	2	6	9	8
W.F	6	3	1	5	8	2	9	4	10	7
Th	6	7	3	5	8	1	4	2	9	10
W. Th.	5	7	1	6	9	10	3	8	4	2
W.N.	7	5	1	3	6	8	1	2	4	8
K.	1	8	2	6	5	3	4	10	9	7
L.	1	3	2	8	9	5	4	10	6	7
H.	1	7	4	5	6	2	3	9	8	10
A.	10	6	2	4	9	1	3	7	8	5
B.	7	3	5	8	2	4	2	6	9	1
C.	3	4	2	6	5	9	7	8	7	1
D.	2	9	1	5	3	10	7	8	4	6
X	1	3	2	5	10	8	9	7	6	4
Y.	7	6	2	4	9	8	3	9	5	1
J.	1	5	4	7	3	10	8	9	6	2
Points for Loin Fat	2	4	3	6	6	10	8	9	7	1
" " Eye Muscle	9	5	7	6	3	4	2	8	10	1
Length of Cannon Bone	4	6	1	9	8	10	2	3	5	7
Weight of Cannon Bone	2	5	1	9	7	10	3	8	6	4
Weight of Head	3	9	2	4	6	10	5	7	1	8
Total Points	113	147	74	152	194	198	144	193	181	159
Placing	2	4	1	5	9	10	3	8	7	6

TABLE LX. ANALYSIS OF VARIANCE OF WEIGHT OF LEFT FORE CANNON BONE

Source	d.f.	S.S.	M.S.	Sign.
Total	167	1,666.35		
Between Sire Groups	9	583.71	64.86	F = 9.47
Within Sire Groups	158	1,082.64	6.85	S.S.

Group differences are highly significant as would be expected with a range of 6.01 grams, between the smallest and largest mean. Group 6 is significantly (P .01) heavier in cannon bone weight than all other groups while Groups 3, 1 and 7 have low mean weights.

(b) WEIGHT OF HEAD

This weight was expressly taken for the purpose of ascertaining whether the particularly "heavy" type of head shown by Sire No.6 would be reflected in the offspring of this sire. The analyses is given in Table LXI.

TABLE LXI. ANALYSIS OF VARIANCE OF WEIGHT OF HEAD

Source	d.f	S.S	M.S.	Sign.
Total	168	7.20		
Between Sire Groups	9	1.42	0.1567	F = 4.31
Within Sire Groups	159	5.78	.0364	S.S.

Highly significant sire differences are shown and by reference to Table LII it is seen that this is due mainly to the high mean value of Group 6. This indicates that the heavy type of head shown by Sire No.6 is strongly inherited. Moreover, by comparison of cannon bone weight and head weight, it is also noticed that Sire No.6 had the heaviest cannon bone weight, which supports the conclusion that can be drawn as regards the total weight of bone in the carcase.

SUMMARY OF CARCASE ANALYSIS

In order to form an estimate of the relative merit of each sire group, they have been arranged in order of merit for the carcase measurements and the results presented in Table LXII. This method of summarising of necessarity gives equal weight to each of the characters considered. This table

TABLE LXIII. SUMMARY OF SELECTED CARCASE MEASUREMENTS

Feature	1	2	3	4	5	6	7	8	9	10
Block Test Total	1	4	2	5	7	10	6	9	8	3
F	3	2	1	4	8	10	7	9	5	6
G	3	77	8	5	7	1	4	2	6	9
L	1	3	2	8	9	5	4	10	5	7
A	10	6	2	4	9	1	3	7	8	5
C	3	4	2	6	5	9	7	8	7	1
Length of Cannon	4	6	1	9	8	10	2	3	5	7
Weight of Cannon	2	5	1	9	7	10	3	8	6	4
	27	37	19	50	60	56	36	56	51	42

TABLE LXIV. LAMB GRADING 1945-6

Group	Down Cross	Prime Cross	Second	Total
1	1	8	8	17
2	1	15	10	26
5	-	6	19	25
6	-	5	21	26
7	1	11	9	21
8	-	7	9	16
10	-	16	8	24
Total	3	68	84	155

also includes many measurements which indicate the same or similar qualities in the sire groups, and hence is intended largely as a demonstration of the degree to which these similar measurements place the groups in the same order. From this point of view, frequent references have been made to it in the text.

As a more reliable indication of the overall quality of the groups it was decided to select out those measurements and evaluations which are of principle importance in showing carcase quality and those measurements which were significant between groups. On this basis the measurements shown in Table LXIII were summarised. It is seen that the order of merit does not differ to any great degree between the two classifications.

Sire No. 3, on this overall appraisal, has produced the best quality carcase, followed by Sire No. 1 and then No. 7. The lowest quality groups are Groups No. 6, 8 and 9. It is interesting to note that the twin sires No. 6 and 8 both bred stock of consistently low merit.

1945-46 SEASON.

In the second season of the experiment, three rams were eliminated on account of age (Nos. 3, 4, and 9). Data was collected, however, on the remaining seven sire groups, and selected measurements have been analysed for sire differences.

LAMB GRADING.

Table LXIV shows the results of the commercial grading of the wether lamb carcases. A χ^2 analysis was conducted to determine whether the differences were significant. The value of 19·633 is highly significant ($P < \cdot 01$ for 6 d.f.) As in the previous year, rams 5, 6, and 8 show the lowest carcase quality.

This difference in carcase desirability is also supported by the highly significant difference shown in Block Test Carcase Total points as presented in Table LXV.

AGE AT SLAUGHTER.

The analysis of variance as presented in Table LXV indicate that no significant difference has been shown between groups in age at the time of slaughter. The fact that the placings of the sires according to the magnitude of the mean values, (as given in Table LXVI) does not bear any

TABLE LXV. ANALYSES OF VARIANCE OF CARCASE FEATURES. 1945-6.

Age at Slaughter.

Source	d.f.	S.S.	M.S.	Sign.
Total	153	330,801·42		
Between Sire Groups.	6	10,032.51	1672.09	
Within Sire Groups	147	320,768·91	2182.10	N.S.

Block Test Carcase Total Points.

Total	154	19,160·17		
Between Sire Groups	6	3,943·73	657·29	F = 6·39
Within Sire Groups	148	15,216·44	102·81	S.S.

F. Measurement. (Length of Leg.)

Total	154	146.93		
Between Sire Groups	6	36.23	6·04	F = 8·05
Within Sire Groups	148	110.70	0.75	S.S.

G Measurement. (Width of Gigots.)

Total	154	72.94		
Between Sire Groups	6	13.52	2.25	F = 5.63
Within Sire Groups	148	59.42	0.40	S.S.

T. Measurement. (Length of tibia-tarsal)

Total	154	51.35		
Between Sire Groups	6	9.70	1.62	F = 5.79
Within Sire Groups	148	41.65	0.28	S.S.

L Measurement. (Body Length.)

Total	154	408·44		
Between Sire Groups	6	84.53	14.09	F = 6.43
Within Sire Groups	148	323.91	2.19	S.S.

TABLE LXVI. SUMMARY OF AVERAGES OF PROGENY TEST LAMB GROUPS FOR 1945-46 WETHERS.

Feature	1	2	5	6	7	8	10	Average
No. killed	17	26	25	26	21	16	24	
Age	164.88	168.58	148.16	163.72	174.86	163.50	157.58	162.68
F	25.36	24.82	25.73	26.01	24.71	25.89	25.68	25.45
G	21.53	21.82	21.26	22.03	21.44	22.16	21.66	21.69
T	19.40	19.06	19.50	19.56	18.82	19.29	19.44	19.30
L	55.32	55.88	57.46	56.37	55.62	57.44	56.31	56.35
A	49.76	53.12	51.04	54.38	51.67	51.69	54.13	51.44
B	27.29	28.00	26.32	26.69	26.76	26.25	27.21	26.96
C	2.88	2.46	1.96	1.12	2.62	1.88	2.38	2.15
Wgt. of Cannon Bone	35.22	34.50	38.22	39.54	32.70	37.08	36.38	36.34
Lgt. of Cannon Bone	11.49	11.47	11.80	11.95	11.06	11.53	11.70	11.59
B.T. Carcase Total	55.88	55.04	44.24	42.62	54.19	47.44	49.58	49.56

TABLE LXVII SUMMARY OF CARCASE DATA. 1945-6

Measurement	1	2	5	6	7	8	10
Grade	4	2	6	7	3	5	1
Block Test Pts	1	2	6	7	3	5	4
Age	5	6	1	4	7	3	2
F.	3	2	5	7	1	6	4
G.	5	3	7	2	6	1	4
T.	4	2	6	7	1	3	5
L.	1	3	7	5	2	6	4
A.	7	3	6	1	5	4	2
B.	2	1	6	5	4	7	3
C.	1	3	5	7	2	6	4
Weight of Cannon	3	2	6	7	1	5	4
Length of Cannon	3	2	6	7	1	4	5

A. Measurement. (Length of Eye Muscle)

Source	d.f.	S.S.	M.S.	Sign.
Total	154	1804.17		
Between Sire Groups	6	370.62	61.77	F = 6.37
Within Sire Groups	148	1433.55	9.69	S.S.

B. Measurement (Depth of Eye Muscle)

Total	154	653.77		
Between Sire Groups	6	52.49	8.75	F = 2.16
Within Sire Groups	148	601.28	4.06	N.S

C. Measurement. (Depth of Fat)

Total	154	321.59		
Between Sire Groups	6	47.44	7.91	F = 4.28
Within Sire Groups	148	274.15	1.85	S.S

Weight of Cannon Bone.

Total	154	1854.65		
Between Sire Groups	6	754.39	125.40	16.83
Within Sire Groups	148	1102.26	7.45	S.S.

Length of Cannon Bone

Total	153	38.54		
Between Sire Groups	6	11.12	1.85	F = 9.74
Within Sire Groups	147	27.42	0.19	S.S.

noticeable relationship to the placings in the previous year, tends to bear out the previous conclusion that the differences in this character were due to other factors than the sire.

CARCASE MEASUREMENTS

Table LXV shows the analyses of variance for measurements F (length of leg) G. (width of gigots) T. (Length of tibia and tarsal) L.(length of body) A.(length of eye muscle) B. (depth of eye muscle) C.(depth of fat over B) and cannon bone length and weight. In general the significance of these analyses is in line with the previous year's results with one notable exception. In the second year, measurement T is significantly different ($P < .01$) between sire groups. The placing of the mean values for sire groups in order of merit, is in addition, the same for the two years. This result leads to the conclusion that, although the first year's analysis was non-significant at the conventional level of significance, the differences between sire groups is consistent and repeatable in a different year.

The repeatability of these sire differences in the two different years will be the subject of a separate enquiry.

TABLE LXIX. MEAN VALUES AND PLACINGS FOR BODY AS A WHOLE GRADING

1	2	3	4	5	6	7	8	9	10
8.36	8.28	8.33	8.68	8.23	8.05	8.26	8.00	8.89	8.00
3	5	4	2	7	8	6	9=	1	9=

IV. BODY DESCRIPTION DATA.

The body description data collected on the ewe hoggets has been anal-ysed for sire differences, and the results are presented in thissection. The subjective gradings on the ewe hoggets can be compared on a sire basis with the carcase measurements taken on the wether lambs although disparity in age and sex differences somewhat invalidate this comparison..

BODY AS A WHOLE GRADING.

Using the numerical values mentioned in Section IV for the grades, an analysis of varience was carried out and is given in Table LXVIII. Mean values for sire groups in this character are given in Table LXIX.

TABLES LXVIII. ANALYSIS OF VARIANCE OF BODY AS A WHOLE GRADING

Source	d.f.	S.S.	M.S	Sign.
Total	182	460.33		
Between Sire Groups	9	16.93	1.88	F = 1.36
Within Sire Groups	173	443.40	2.56	N.S.

The data fail to show any significant differences between groups in overall body conformation and it can be seen that the range in means is less than one unit or half-a-grade. This non-significance of Body as a Whole lines up with the non significance of the Block Test Carcase Total and Commercial Grade with the wether carcases. The order of merit of the groups as placed by the mean values, however, differs in the two cases. Little importance can be attached to this point, however, in view of the non-signif-icance of both analyses and the inadequacy of comparisons between the difference sexes at different ages in a character which is much affected by the environment.

OTHER CONFORMATION DATA

The mean values by sire groups for the remaining body conformation features as detailed in Section III C, are given in Table LXX.

HEAD GRADING.

The significance of group differences in this feature were tested by analysis. The highly significant value of 64.11 (P .001 for 18 degrees of freedom) indicates real differences between sire groups in head grading. This fact is in accord with the highly significant differences in this char-acter found in the lamb descriptions by means of the Discriminant Function

TABLE LXX. MEAN VALUES OF BODY CONFORMATION CHARACTERS.

Feature	1	2	3	4	5	6	7	8	9	10
Head	3.32	4.89	4.67	3.53	4.43	4.67	4.16	4.25	3.28	4.38
Shoulders	4.36	4.50	4.83	4.84	4.43	4.48	4.21	4.56	4.89	4.21
Back	4.80	4.50	4.58	4.89	4.43	4.90	4.63	4.81	5.17	4.41
Loin	4.80	4.78	4.33	5.05	4.52	4.76	4.84	4.50	5.00	4.79
Hindquarters	4.64	4.50	4.42	4.37	4.10	3.95	4.37	4.19	4.61	4.04
Legs	4.08	4.39	4.33	3.79	4.05	3.67	4.16	3.81	4.11	4.08
Bone	4.24	4.83	4.33	4.42	4.86	4.33	4.63	4.56	4.11	4.71
Breed type	3.48	4.67	4.58	3.63	4.14	4.33	4.16	4.25	3.61	4.21

TABLE LXXI SUMMARY OF RESULTS OF SIRE GROUPING

(Scale 1 - 10)

	1	2	3	4	5	6	7	8	9	10
Head Type	3	8	6	8	5	7	6	3	1	8
Length of Leg	6	8	6	6	6	2	6	3	3	6
Fleece Quality	7	7	5	8	3	5	3	3	4	2
Evenness	7	7	6	8	2	6	3	3	1	1
Placing	2=	1=	2=	1=	6	3	4	7	8	5

TABLE LXXII. COMPARISON OF ORDER OF MERIT OF SIRE GROUPS BY SIRE GROUPING AND BY INDIVIDUAL DESCRIPTION

Head Grading.

Method	1	2	3	4	5	6	7	8	9	10
Sire Grouping	5=	1=	3=	1=	4	2	3=	5=	6=	1=
Description	8	1	2=	7	3	2=	6	5	9	4
Length of Leg.										
Method										
Sire Grouping	2=	1	2=	2=	2=	4	2=	3=	3=	2=
Description	5=	1	2	9	6	8	3	7	4	5=
Fleece Quality										
Sire Grouping	2=	2=	3=	1	5=	3=	5=	5=	4	6
Description	4	1	6	5	3	8	9	7	2	10

TABLE LIX (Cont'd)

J. - Depth of Fat. (Rib Region)

Source	d.f.	S.S.	M.S.	Sign.
Total	168	1288·85		
Between Sire Groups	9	183·77	20·42	F = 2·94
Within Sire Groups	159	1105·08	6·95	S.S.

Block Test Points for Loin Fat.

Total	168	3936·06		
Between Sire Groups	9	458·09	50·90	F = 2·33
Within Sire Groups	159	3478·00	21·88	S.

Block Test Points for Eye Muscle.

Total	168	742·38		
Between Sire Groups	9	21·62	2·402	
Within Sire Groups	159	720·76	4·533	N.S.

Analysis. The order of merit of the sire groups too, is in agreement with that obtained at the lamb stage.

Groups 2, 3, and 6 are graded highest, while groups 1, 4 and 9 are considerably below average.

LENGTH OF LEG.

In view of the varying significance of length of leg measurement on the wether lambs, it was decided to test the significance of the estimate of leg length made upon the ewe hoggets. The analysis by χ^2 technique proved to be non-significant at conventional levels of significance. (χ^2 = 24·307 P = ·10 for 18 d.f.) The variation in mean values, as shown in Table LXX is, moreover, only slightly above half-a-grade. It is seen, however, that the order of the groups in leg length is substantially the same as that shown by the wether lambs with more accurate methods of measurement.

BREED TYPE.

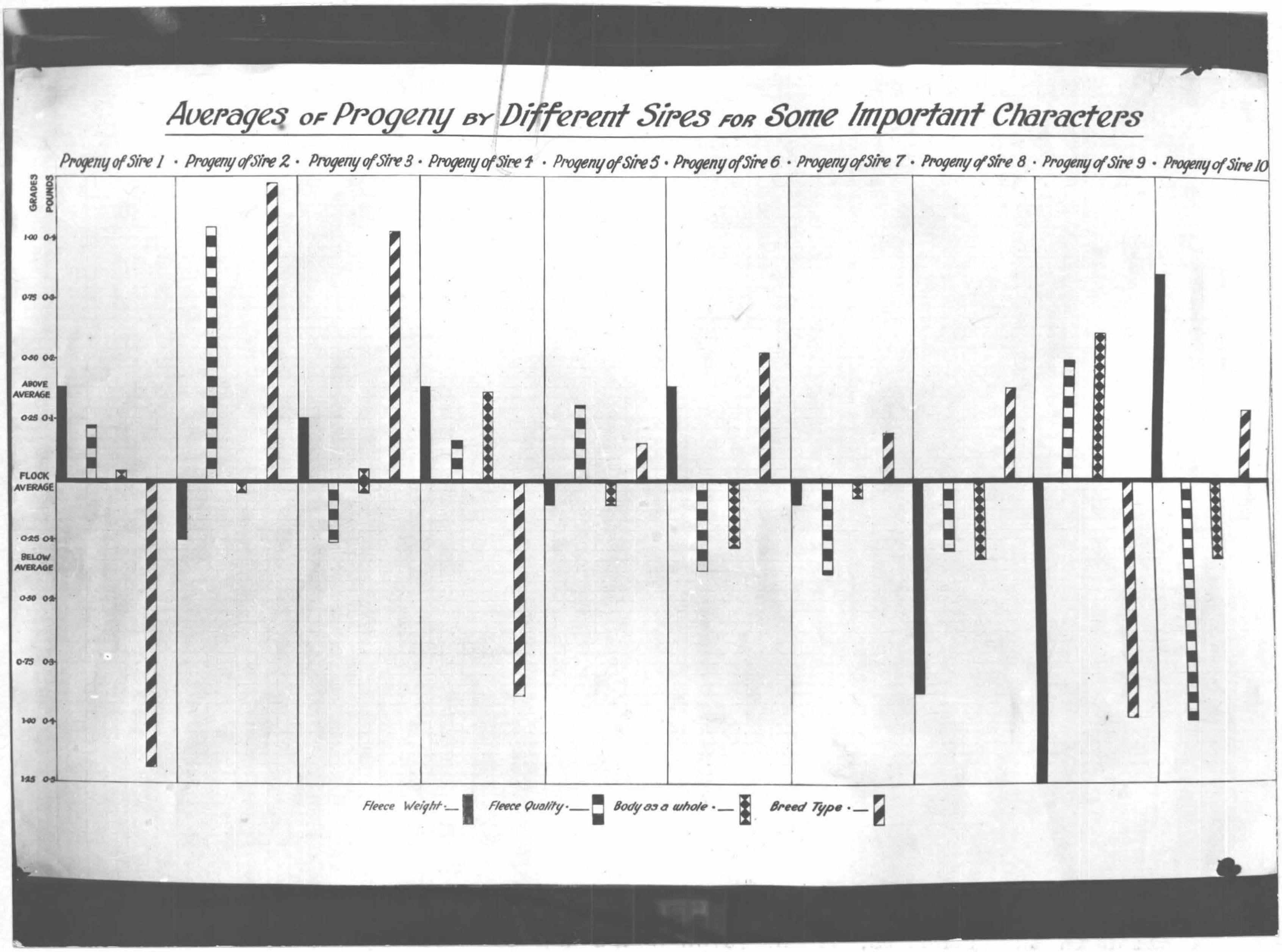
The χ^2 analysis of Breed Type grading yielded a value of 39·37 which is significant ($P < \cdot01$ for 18 d.f.). By reference to Table LXX it is seen that the values for Breed Type grading follow closely those of Head Type grading once again emphasising the important part that the head desirability plays in the estimate of Breed Type. Groups 2 and 3 excelled in this character while 1, 4 and 9 show very low values.

OTHER CHARACTERS.

The remaining estimates of Shoulders, Back, Loin and Hindquarters were analysed by χ^2 technique, but no significant differences were shown between the Groups in these characters. In general the probability for the values obtained was in the vicinity of ·20 to ·10. The variation exhibited in the means is, in addition small and the picture presented supports the non-significance found in the Body As A Whole grading.

V. SIRE GROUPING OF EWE HOGGETS.

Prior to hogget shearing, the ewe hoggets were grouped according to their sires, and a general survey of their quality was made by five judges working independently. Notes were then compared, and a final value was placed on each group, using a scale of points from 1 to 10. The features considered were.


Averages of Progeny by Different Sires for Some Important Characters
Progeny of Sire 1 · Progeny of Sire 2 · Progeny of Sire 3 · Progeny of Sire 4 · Progeny of Sire 5 · Progeny of Sire 6 · Progeny of Sire 7 · Progeny of Sire 8 · Progeny of Sire 9 · Progeny of Sire 10
GRADES
POUNDS
1·00 0·4
0·75 0·3
0·50 0·2
ABOVE AVERAGE
0·25 0·1
FLOCK AVERAGE
0·25 0·1
BELOW AVERAGE
0·50 0·2
0·75 0·3
1·00 0·4
1·25 0·5
Fleece Weight
Fleece Quality
Body as a whole
Breed Type

Quality of Head type.

Length of Leg.

Quality of Fleece.

Evenness of the Group.

The results of these estimations are presented in Table LXXI. A final placing in order of merit by summing the points for the individual items is also given. It is seen that Groups 2 and 4, are placed first, followed by Groups 1 and 3. Groups 8 and 9 are shown as the poorest in overall quality.

The intrinsic worth of the method of sire grouping in evaluating sire differences must be judged by the degree to which it agrees with the average values for sire groups derived from the individual descriptions of each animal in the group. A comparison between the order of rating according to merit by the two methods is given in Table LXXII.

For Head grading, it can be seen that Group 2 has been placed first by both methods, but serious disagreement is shown in Groups 4 and 10. The remainder of the groups are placed more or less in a similar order. It is notable that both methods place Group 9 as being lowest in merit.

A similar picture is shown in regard to Length of Leg estimate. Again the two methods show agreement in placing Group 2 as shortest in leg length, but there is a big discrepancy shown in the placing of Group 4.

Fleece quality as judged by the two methods shows variation between the estimates of a similar order. Group 4, again exhibits the widest divergence.

This consistent difference shown between the two methods in placing Group 4 requires some explanation. Reference to the crude data and to the score awarded under the heading of Evenness, indicates that this Sire Group was noticeably more even as a line than the offspring of the other sires. In the estimates of the Head Type, Length of Leg and Fleece Quality, therefore, it is probable that this property of evenness would tend to make the judges award higher marks to this group than were in fact warranted by the quality of the animals as individuals. The consideration of evenness of the progeny group as a whole is of considerable importance and should be taken into account in evaluation of a sire's get.

Summing up, it can be said that the method of sire grouping gives an evaluation Which is substantially correct, but it cannot draw as fine distinc-

TABLE LXXIII. SUMMARY OF FLEECE AND CONFORMATION RESULTS. (EWE HOGGETS)

Character	1	2	3	4	5	6	7	8	9	10
Fleece Weight	2	5	3	2	4	2	4	6	7	1
Fleece Quality.	4	1	6	5	3	8	9	7	2	10.
Body As A Whole.	3	5	4	2	7	8	6	9	1	9.
Breed Type.	10	1	2	8	7	3	6	4	9	5.
Total	19	12	15	17	21	21	25	26	19	25
Placing.	4	1	2	3	6=	6=	7=	8	5	7=

tions between groups of offspring as does the individual descriptions method. Agreement is usual in the first and last placings, but intermediate ones are often in disagreement. This is naturally to be expected, for there is considerable difficulty in making a general summation of a group of 20 - 25 animals. This fact is further emphasised by a comparison of the scores given to the groups in Table LXXI, It is seem that in many cases considerable difficulty has been encountered in drawing a distinction between quality in different groups, and consequently many groups have been placed equal. Sire grouping, however, can be of importance in evaluating the evenness of a sire's get, and this may be of some importance.

VI. SUMMARY OF SIRE DIFFERENCES IN THE EWE HOGGETS.

As a basis for comparing the relative merits of each sire as judged on the quality of its ewe hogget offspring, Table LXIII was drawn up, containing the order of merit of the sires in Fleece Weight, Fleece Quality, Body As A Whole and Breed Type. In the absence of any specific knowledge as their relative importance, the weighting for all factors is the same.

The table shows that Sire No. 2 can be ranked as the best sire, followed closely by Sire No's. 3 and 4. Sire Nos. 7, 8, and 10 are closely grouped as showing the poorest quality in these combined attributes. The differences between sires in the four features are shown in Figure

TABLE LXXIV. DIFFERENCES NECESSARY TO BE SIGNIFICANT (P = ·05) WITH VARIOUS NUMBERS OF OFFSPRING.

No. of Offspring	Fleece Weight	Fleece Quality	Body As A Whole
Standard Deviation	Pounds 0·90	½ Grades 1·54	½ Grades. 1·59
2	1·78	3·1	3·2
3	1·45	2·5	2·6
4	1·26	2·2	2·3
5	1·12	2·0	2·0
6	1·03	1·8	1·8
8	0·89	1·6	1·6
10	0·79	1·4	1·4
12	0·71	1·3	1·3
14	0·66	1·2	1·2
16	0·62	1·1	1·1
18	0·59	1·0	1·1
20	0·57	1·0	1·0
30	0·46	0·8	0·8

An analysis of the sex ratios of lambs [illegible] from groups of ewes by different sires.
See Table XXXIX in A. L. Reid's Thesis

Sire Group	Actual Sex Ratio		Expected Sex Ratio		χ^2	d. f.
	M	F	M	F		
1	13	23	18	18	2.77	1
2	28	13	20.5	20.5	5.49 *	1
3	11	12	11.5	11.5	0.043	1
4	12	18	15.0	15.0	1.20	1
5	23	19	21	21	0.38	1
6	11	22	16.5	16.5	3.67	1
7	17	20	18.5	18.5	0.24	1
8	21	14	17.5	17.5	1.4	1
9	16	17	16.5	16.5	0.03	1
10	10	25	17.5	17.5	6.43 *	1
Total	162	183	172.5	172.5	1.66	1

		d. f.
Total of individual χ^2 s.	= 21.653	10
χ^2 from totals	= 1.66	1
Interaction χ^2	= 19.993 *	9

PART VIII. THE NUMBER OF OFFSPRING REQUIRED FOR AN ADEQUATE PROGENY TEST.

The number of offspring required to test a sire is an extremely important problem in progeny testing, for, as Lush(1943) indicates, requiring too many offspring to prove a sire can actually lower the rate of progress by causing a smaller number of sires to be tested and therefore limiting selection among them on the basis of their progeny test. Hence, in order to be able to test the maximum number of sires, it is necessary to know the minimum number of offspring required without sacrificing the accuracy of the progeny test.

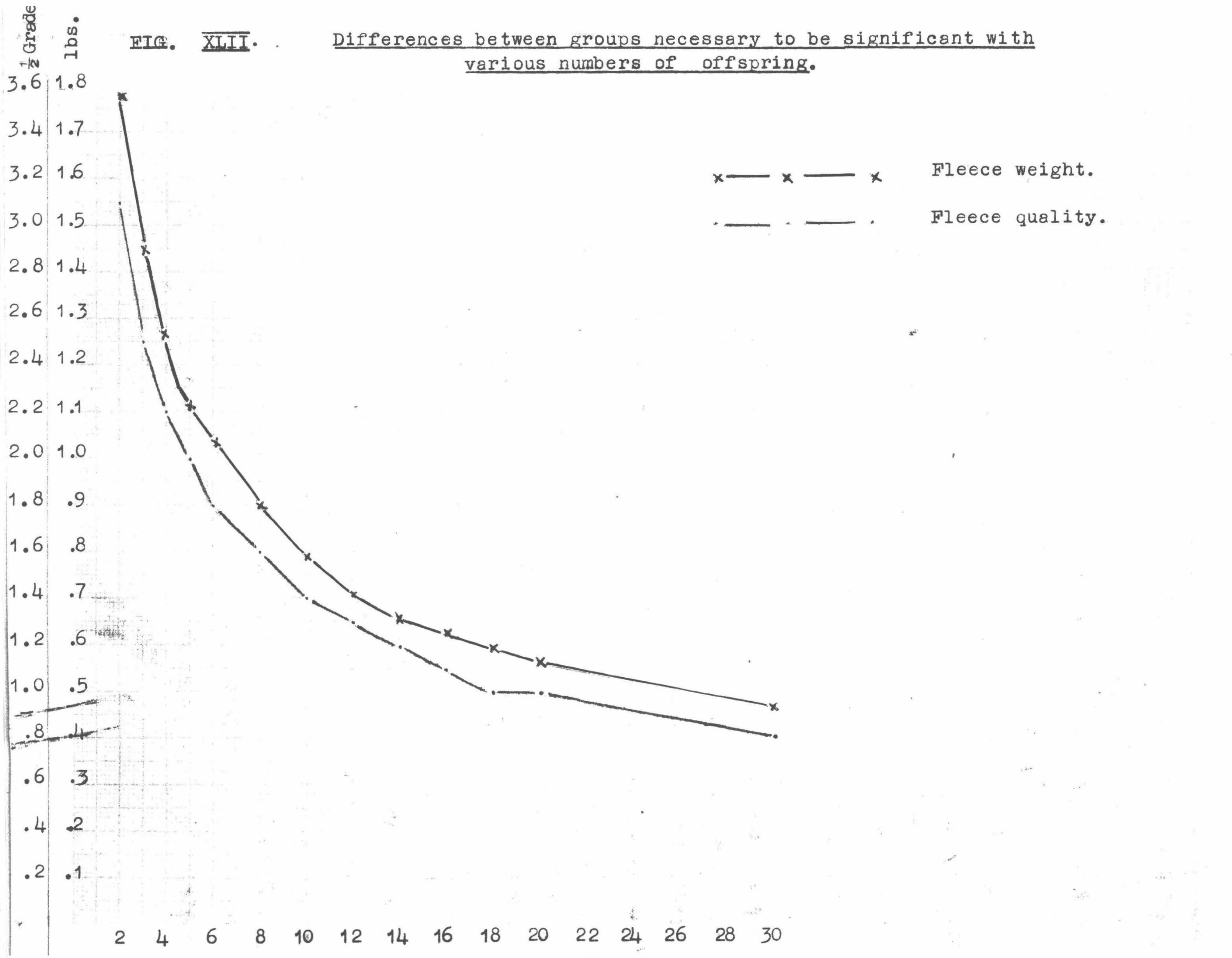
Considerable differences of opinion are found among writers on this aspect of progeny testing in sheep. In the New Zealand Romney Marsh, McMahon (1940) considered that seven offspring would be sufficient, but later (McMahon 1943) he gives a more accurate formulation of the problem showing the number of offspring required to establish the superiority of a ram leaving fleece weight and qualities of any given value above the average. Ensminger et al. (1943) also give a similar presentation based on their data for Shropshires and Southdowns.

An estimation of the number of offspring required to test a ram can be made from the standard deviation derived from the within-sire groups variance obtained in the analyses of variance in Part VII. The method used is that described by Hetzer and Brier (1939) and use was made of their tables. The results are presented in Table LXXIV, and graphed in Figure XLII.

These results are based on the assumption that equal numbers of offspring are present in the two sire groups being compared.

It is seen that considerable information is gained for each additional offspring up to 8 or 10. From this point the decrease in information for each extra offspring is rapid and little information is added beyond 14-15. Hence, it would appear from this data that this number of offspring would be sufficient in the practical application of progeny testing to supply a test of adequate accuracy.

FIG. XLII. Differences between groups necessary to be significant with various numbers of offspring.



SECTION VI. DISCUSSION AND APPLICATION OF RESULTS.

While the time is not ripe for a complete discussion of progeny testing in sheep, some conclusions can be drawn from the data presented in this report. They must, however, be evaluated with due regard to their tentative nature and be subjected to rigorous examination when data from subsequent years of the experiment are analysed. At the same time, they may serve some useful purpose in stimulating active interest in those most intimately concerned, both scientifically and economically, in the improvement of the sheep stock of New Zealand.

Problems of progeny testing and its application are, in part, problems of the wider field of sheep breeding. Their interrelation necessitates a simultaneous discussion of both, for progeny testing has no intrinsic value when seperated from its actual application in sheep breeding. Its proven ability to produce improvement in other forms of livestock must be reviewed in the light of the inherent limitations to progress in the betterment of sheep.

The factors that handicap progress in improvement of sheep may be briefly enumerated as:

(1) Lack of objective techniques for measuring productivity in wool and meat.

(2) The inadequacy of knowledge with regard to the inheritance of productivity in these features.

(3) The necessity for a knowledge of the variability of productive characters.

(4) The urgency for a consideration of questionable breed standards in relation to their significance from the viewpoint of the commercial aim of utility in sheep production.

The results detailed in this thesis have a bearing on certain of these difficulties.

With regard to the difficulties of measurement of fleece characters, nothing novel has been introduced. The repeatability of the eye and hand evaluation leaves much to be desired though it is the only available method which combines the advantages of speed of working with general applicability to the practice of fleece evaluation under commercial conditions. No information has yet been obtained on the maintaining of the standards for grading from year to year.

If improvement in a flock over time is to be evaluated then these standards must be kept the same in different years. But one feels that, despite a conscious effort in this direction, the tendency is to a very large degree to base the standard on the average of the flock for each particular year, a factor which invalidates year to year comparisons but does not effect intra-year comparisons. Photographic standards may help considerably in this respect, but they are only available for features such as the general Character gradings for the fleece.

In this connection, McPhee and Spencer (1936) have stated that subjective scoring procedure and its use in selective breeding and progeny testing has served only to maintain the average grade for each characteristic at a certain level. There is a lack of specific knowledge on this point but a priori considerations lead to the conclusion that, if the best sires, chosen on the basis of subjective fleece analysis of their offspring, are used in each year, some improvement should take place over time even though this improvement may only be indicated by general appraisal of the flock quality and not by the average score of the flock for different characters. Consequently, the need for precise methods of evaluation of wool quality which can be applied in practice is urgent. Progress in the solution of this problem is contingent upon basic research, intensive in application but broad in conception and embracing the efforts of the pure as well as the applied scientist. Results to date in the field of wool metrology indicate that the problem is not easy of solution, but solved it must be if the full fruits of breeding methods are to be obtained. In the meantime subjective evaluation of fleece characters is the only solution and the results show it to be sufficiently accurate to lead to considerable advances.

In addition, accurate and detailed information is required on the significance of wool characters from the point of view of manufacture, an aspect on which little information has yet been collected. This feature, and the interrelationships between wool characters, are both essential in formulating breeding programmes for wool improvement.

To the difficulties inherent in fleece analysis is added the complication of studying the productivity of the animal from the viewpoint of meat production. The quality and quantity of meat production can only be truly estimated after slaughter, a condition which naturally, does not allow of incorporation into breeding practice. Hence the relationship between the characters, as estimated on the live animal and then later on the carcase is important. Quantity of production can readily be assessed by means of live weight records taken at or adjusted to a constant age. The quality aspect of meat production presents greater difficulties. The subjective method of evaluation is again the most readily applicable and simplest system but, as shown in Part I, there is no greater precision achieved than in the case of fleece analysis. A preliminary investigation of measurements on the live animal, in a desire to introduce, greater objectivity, indicates that height at withers can be measured with a high degree of accuracy and moreover, has some real significance as a measure of leg length and some relationship to carcase quality. Its applicability, at the moment, is likely to be limited to experimental technique. From the breeder's point of view, the reasonably good correlation ($r = 0{\cdot}70$) between the subjective Body As A Whole grading and Commercial Carcase Grade justifies the subjective method of evaluation which is in common use.

In connection with those subjective evaluations, of fleece and carcase quality which have been based on the use of seven or fewer grades, the results presented in Part VII indicate that generally sire differences are non-significant at the accepted level of probability of chance occurrence. This non-significance may possibly be construed as indicating that these gradings are of little value in description work. It must be emphasised, however, that within the limited number of sires used, it is possible that only small differences in these features occur. Moreover, the breeder may be willing to, and usually has to, accept lower odds than nineteen to one that the differences are not due to chance. The probability in most of the χ^2 analyses ranges between 0·1 and 0·2, a level of probability which may be quite acceptable to the breeder but not rigorous enough for experimental purposes.

The inclusion of the detailed aspects of fleece and carcase qualities in description work has a disadvantage in that it tends to make the evaluation combersome for practical application. The writer maintains, however, that this detailed analysis serves a purpose in lending precision to the overall gradings for fleece and carcase, for it is the totality of these points which comprises quality. These overall gradings are the important ones in evaluation of the sire's breeding value, and every opportunity should be taken to increase their accuracy. Elimination of the finer details may be necessary under certain conditions but is done so to a great extent at the expense of precision in the overall quality gradings.

The second major problem of sheep breeding is the lack of knowledge of the inheritance of productive characters. The polygenic nature of inheritance and the strong environmental effect on these characters makes impossible an analysis of the number and kind of genetic factors at work. The analysis of the observed variation into its genetic and environmental components is the necessary compromise. The results presented in Part V are a contribution to the knowledge of the inheritance of productivity. Within the limits of similar environmental conditions, these figures give a basis for advocating the type of breeding programme that will best bring about improvement. They allow of a division of the features into two groups on the basis of their intensity of inheritance. Thus, Head type, Length of Leg, Breed Type, Bone quality, Count, Handle, Hairiness and Lustre may be classed as strongly inherited while Fleece Weight, Fleece Quality, Body As A Whole, Colour and Back wool character are grouped as weakly inherited. It has been emphasised by many writers, in particular, Dickerson & Hazel (1944) that selection on individual merit will bring about improvement most rapidly in strongly inherited characters, while the progeny test is indispensable for improvement of weakly inherited characters. The estimates of heritability are therefore of major importance in deciding what features of production will be considered in progeny testing. On this basis, then it may be said that the essential items to consider in a progeny test for New Zealand is available on the relative economic importance of fleece and carcase characters in sheep nor have any adequate studies been made of the interrelationships of fleece and carcase characters. Hazel (1943) has indicated the theoretical requirements for and the mode of construction of selection indices, but in the absence of specific information the best method is based on weighting all characters equally.

The above argument is based on the desirability of using a sire that is an "improver" in every character. This naturally may not be required by the breeder. He may be concentrating on one particular character, and then the best sire for his purpose will be the one which is outstanding in improving that one particular character with the added proviso that he maintains the standard in other characters. This provides a strong reason against the attempted use of a sire index based on the totality of the characters of the offspring and indicates the graphical method of showing the sire's value for each character considered as being the better method.

In practical breeding operations, a progeny test system as detailed in this report is impossible, not only in the technique but also in the complexity of the statistical procedure. This experimental approach however leads to the possibility of framing a practical technique which can be applied in commercial stud practice.

The essential features of any applied programme of progeny testing are:

(1) Individual identification of the ewe flock and of lambs at birth.

(2) Accurate knowledge of the sire of each offspring.

(3) Accurate collection of data and records.

In general these do not introduce any new factor into stud practice. The practical difficulties in the second requirement have been reviewed by Wheeler (1945) and suggestions have been submitted for overcoming them at mating time. The possibilities are:

(1) Segregating each ram with his ewes to separate paddocks. For this method to be applicable, many paddocks are required - a disadvantage that may be important in many cases.

(2) Raddling the ram and putting him out with a number of ewes until he has marked the requisite number required for a progeny test.

Then putting out another ram after the first has been withdrawn. This method is advantageous in that the number of paddocks required is reduced. Moreover this method has the effect of randomising, within limits, the ewes which are marked by each ram. The disadvantage is that there will be a difference in mean date of lambing for each sire - a factor which possibly has some importance.

At lambing time accurate records must be kept of the sire group to which each lamb belongs for future sire evaluation. In view of the low value of lamb characters in predicting those of the hogget it is evident that the description of wool features should be taken prior to hogget shearing, while fleece weight can be easily recorded at hogget shearing. The body description is taken subsequent to shearing after allowing some time to elapse for unevenness due to shearing to be smoothed out.

In order to make the individual descriptions be as unbiased as possible, the person doing the work should not know the sire of the particular animal being considered and hence the animals should be described in random order. Subsequent sire grouping appears to be definitely an advantage in allowing of an estimation of evenness of the sire's get and evaluation of any outstanding feature of the group.

Simple averages of the sire groups using numerical values for the estimations are all that is then necessary to place the sires in their order of merit while a flock average is advantageous in showing the relative positions of the sire groups in relation to the mean of the flock. For the sake of clarity these may be graphed, as shown in Figure XLI.

The amount of detail recorded in the fleece and body description must be largely a matter of the individual breeder's opinion within the limits of the necessity of recording weakly inherited characters. As emphasised earlier the added detail of the descriptions used in this experiment are claimed to increase the precision of the final quality ratings in fleece and carcase. Essential information in the fleece analysis is Count and the Fleece As A Whole grading, while General Character on Side, Forequarter and Hindquarter and Back grading aid in lending precision to the Fleece As A Whole grading.

For the carcase evaluation it would appear that Shoulders, Back, Loin and Hindquarters grading are necessary to supplement the Body as a Whole grade.

Obviously not all rams can be tested. As Goot (1946) has shown, the testing of 20% of rams as suggested by McMahon (1940) is impracticable under usual conditions because of the number of ewes required to test a ram. Hence a selection must be made of those animals which are to be used as candidates in the progeny testing scheme. This selection will have to be obviously based on individual merit with perhaps some attention to pedigree. The phenotype of the animal reflects its genotype most accurately in characters which are strongly inherited and consequently these characters should be used as the basis of selection. Such characters as Head type, Length of Leg, Breed Type, Bone quality, Hairiness, Count, Handle and Lustre of wool. The best animals for these features can then be put to progeny test on the basis of the weakly inherited characters - Fleece Weight, Fleece Quality and Carcase Quality.

Finally, it must be emphasised that progeny testing is not the panacea of all the ills besetting the sheep breeder. The undue optimism as to the startling improvements which it would produce that characterises the earlier thinking of progeny testing must now give place to a more sober and considered attitude. The difficulties inherent in sheep breeding itself are still involved in progeny testing, but, within these limitations, it offers the soundest and most accurate approach to sheep improvement. Whatever breeding plan is adopted, the method of progeny testing is essential in the identification of those animals with the "superior germ plasm" which is so obviously required for improvement.

BIBLIOGRAPHY.

Aitken, A.C., (1944) Determinants and Matrices. 3rd. Ed. Oliver & Boyd, 1943.

Austin, H.B., (1943) Merino, Past, Present and Probable. Graham Book Coy., 1943.

Arapov, P., (1934) Animal Breeding Abstracts, 2, P.318.

Barker, S.G., (1931) Wool Quality. Empire Wool Marketing, 1931.

Barton, R.A., (1946) Private communication.

Bonnier, G., (1936) Hereditas 22, P.145

Bonsma, F.N., (1939) Univ. Pretoria Pub. Agric. No. 48.

Briggs, H.M., (1939) Proc, Amer. Soc. An. Prod. P.161

Daniels, H.E.,(1942) Jr. Text. Inst., 33 T. 137

Davydov. S.G.,(1934) Animal Breeding Abstracts, 1935, P.32.

Donald, H.P. and McLean, J.W. (1935) N.Z. Jr. Sc. and Tech. 17, P.497.

Duerst, J.U., (1931) Grundlagen der Rinderzucht. (Abst)

Dickerson, G.E. and Hazel, L.N. (1944) Jr. Agric. Res. 69, P.459.

Dry, F.W., (1934) N.Z. Jr. Agric. 48, P.331.

——— (1930) Wool Record 37, P.97.

Dunlop, A.A., (1942) M. Agr. Sc. Thesis, C.A.C.

Edwards, J., (1932) Jr. Agric. Sc., 22, PP.811-837.

Ensminger, M.E., Phillips R.W., Schott, R.G., Parsons, C.H. (1943) Jr. An. Sc. 2 P.157.

Fisher, R.A., (1936) Annals Eugenics 7, pp 179-188, (Photostat)

——— (1938) (a) Statistical Methods for Research Workers, III Ed Oliver & Boyd.

——— (1938) (b) Annals Eugenics 8, pp 376-386 (Photostat)

——— (1940) Annals Eugenics 10, pp 422-429.

——— (1941) Statistical Methods for Research Workers, VIII Ed. Oliver & Boyd.

Frolich, G., (1933) Animal Breeding Abstracts 3, p.33.

Gartner, R, Heidenreich, C.H., and Sprenger, G., (1930) Zeitschrift Zuchtungskunder (Abst.)

Glembockii, J.L. (1939) Animal Breeding Abstracts 8, p.249.

Goodale, H.D., (1927) Amer. Nat., 61, pp 539-544.

Goot, H. (1945) (a) N.Z. Jr. Sc. Tech, 27 (1) p 45.

——— (1945) (b) N.Z. Jr. Sc. Tech, 27 (2) p 173.

——— (1946) Private communication.

Hagedoorn, A.L., (1939) Animal Breeding Crosby, Lockwood & Son, Ltd., 1939.

Haldane, J.B.S., (1945) Biometrika 33, pp 234-238 (Abst.)

Hammond, J., (1932) Growth and Development of Mutton Qualities in the Sheep. Oliver & Boyd, 1932.

____ (1936) Festschrift Prof. Duerst Bern.

Hardy, J.I., (1933) Text. Res., 3 pp 381-387.

____ (1935) Text. Res., 5 pp 184-190.

Hazel, L.N., (1943) Genetics 28, pp 476-490.

____ and Lush, J.L., (1942) Jr. Heredity 33, pp 393-399

____ and Terrill, C.E., (1945) (a) Jr. Am. Sc. 4, (4) p 331.

____ ____ (1945) (b) Jr. Am. Sc. 4. (4) p 341

____ (1946) Jr. Am. Sc. 5. (1) p 55.

Hetzer, H.O. and Brier, G.W., (1939) Proc. Am. Soc. An. Prod. p 157.

____ and Phillips, R.W., (1938) Proc. Am. Soc. An. Prod. p 141.

____ and Dickerson, G.E., and Zeller, J.H. (1944) Jr. Am. Sc. 3, (4) p 390.

Hill, J.A., (1921) Wyo, Agr. Exp. Stat. Bull. 127.

Hirzel, R., (1939) Onders. Jr. Vet. Sci. and An. Indus. 12 (2) pp 379-554

Hogben, L, (1933) Nature and Nurture, Allen and Unwin, Ltd., London.

Holomeizer, V., (1935) Animal Breeding Abstracts 3, p 384.

Hotelling, H. (1936) Biometrika 28, pp 321-377. (Photostat)

Kardymovic, F.I., (1937) Animal Breeding Abstracts 7, p 24.

____ and Viebe, A.P., (1937) Animal Breeding Abstracts 5, p 407.

Kelley, R.B., (1946) Principles and Methods of Animal Breeding.

Knap, B, and Nordskog, A.W., (1946) (a) Jr. An. Sc. 5, p 62.

____ (1946) (b) Jr. An. Sc. 5, p 194.

Lambert, W.V., Hardy, J.I., and Schott, R.G., (1938) Proc. Am. Soc. An. Prod, p 298.

Lamont, N., (1934) M. Agr. Sc. Thesis M.A.C.

Langlet, J., (1935) Animal Breeding Abstracts 3, p 388.

Lush, J.L., (1933) Jr. Dairy Sc. 16, pp 501-522.

____ (1935) (a) Jr. Dairy Sc. 18. p 1.

____ (1935) (b) Emp. Jr. Exp. Agr, 3, p 25.

____ (1936) Res. Bull. 204, Iowa State Agr. Exp. Sta.

____ (1938) quoted by Whately, J.A., (1941) Res. Item 22, Iowa.

Lush, J.L., (1940) Proc. Am. Soc. An. Prod. 1940, p 293.

____ (1943) Animal Breeding Plans, 2nd. Ed. Iowa. State College Press.

____ (1944) Jr. Dairy Sc. 27, - 937.

____ and Copeland, O.C., (1930) Jr. Agr. Res. 41,p- 37.

____ and Jones, J.M., (1923) Texas Agr. Exp. Stat. Bull. 311.

McMahon, P.R., (1937) Jr. Text. Inst. 28, T. 340.

____ (1940) (a) Proc. 9th Annual Meeting Sheep Farmers, Massey Agr. College.

____ (1940) (b) Proc. N.Z. Soc. An. Prod. p 44.

____ (1941) N.Z. Dept. Sc. and Indus. Res. Ann. Rep. 1941.

____ (1942) Proc. N.Z. Soc. An. Prod. p 61.

____ (1943) Proc. N.Z. Soc. An. Prod. p

____ (1946) Proc. N.Z. Soc. An. Prod.

McMeekan, C.P. (1939) Proc. 8th Annual Meeting Sheep Farmers, Massey Agr. College.

____ (1940) Jr. Agr. Sc. 30 p 276

McPhee, H.C., and Spencer, D.A., (1936) U.S.D.A. Year Book.

Maung, K., (1941) Annals Eugenics II (1) p 64.

____ (1942) Annals Eugenics 11 (3) p 189.

Moiseev, S.B. (1937) Animal Breeding Abstracts 7, p 21.

Morley, F., (1946) Private communication.

Nicholls, J.E., (1945) Livestock Improvement, Oliver & Boyd.

Palsson, H., (1939) Jr. Agr. Sc. 29, p 544

Panfilova, E.P. (1939) (a) Animal Breeding Abstracts 9, p 124.

____ (1939) (b) Animal Breeding Abstracts 9, p-318.

Pearson, K, (1940) Draper's Co. Research Memoirs (Abstract)

____ (1913) Biometrika 9, pp 116-139.

____ (1931) Tables for Biometricians, Oliver & Boyd.

Peren, G.S., Hudson, A.W., Morton A.C., and Yates, C.C. (1938) Massey Agr. College Bull. No. 9.

Peters, C.C. and Van Voorhis, W.R. (1940) Statistical Procedures and Their Mathematical Bases. McGraw-Hill Book Coy.

Phillips, R.W., and Dawson, C.M. (1936) Proc. Am. Soc. An. Prod. pp 93-99

____ , Krantz, E.B., and Lambert, W.V., (1938) Proc. Am. Soc. An. Prod. p 77.

Phillips, R.W., Schott, R.G., Lambert, W.V., and Brier, G.W., (1940) U.S.D.A. Circ. 580.

____ , and Stoehr, J.A., (1945) Jr. An. Sc. 4 (3) p 311.

Pohle, E.M., (1942) Jr. An. Sc. 1 p 229.

Pomanskii, E.A., (1939) Animal Breeding Abstracts 8, p 381.

Rasmussen, K., (1942) Sci. Agr. 23, p 104.

Rice, V.A., (1944) Jr. Dairy Sc. 27, p 921

Ritzman, E. G., (1917) Jr. Agr. Res. 11, p 612.

Roberts, J.A., Fraser, (1927) Jr. Text. Inst. 18, T. 48-54.

________, (1930) Jr. Text. Inst. 21, T 127-164.

Sannikov, M.I., (1939) Animal Breeding Abstracts, 8, p 251.

____ and Sarygina, E.A., (1939) Animal Breeding Abstracts, 8, p 251

Schutte, D.J., (1935) Onders. Jr. Vet. Sci. and An. Indus. 5, p 538.

Snedecor, G.W., (1940) Statistical Methods 3rd. Ed. Iowa State College Press, 1940.

____ and Cox, G.M., (1935) Res. Bull. No. 180.

Stanbury, G.R., and Daniels, H.E., (1937) Jr. Text. Inst. 28, T.188.

Stephens, F.B., and Barnicoat, C.R. (1936) Agricultural organisation in New Zealand. Melbourne Univ. Press.

Stonaker, H.H., and Lush, J.L., (1942) Jr. An. Sc. 1, p 99.

Terrill, C.E., (1939) Proc. Am. Soc. An. Prod. 1939, p333.

____ and Hazel, L.N., (1943) Jr. An. Sc. 2, pp 358-359 (Abstract)

Thomasset, L.F., (1938) Jr. Agr. Sc. 28, p 523.

Treloar, A.E., (1939) Elements of Statistical Reasoning. John Wiley and Sons.

Verges, J.B., (1939) Suffolk Sheep Soc. Year Book.

Walker, D.E., and McMeekan, C.P., (1944) N.Z. Jr. Sc. and Tech. 26, 2a, and 3a.

Waters, R., (1939) Proc. 8th Annual Meeting Sheep Farmers, Massey Agr. College.

Whately, J.A., (1941) Res. Item 22. Iowa.

Wheeler, A.L., (1945) Past. Rev. LV p 762.

Wildman A.B., and Daniels, H.E., (1937) Jr. Text. Inst. 28, T 202.

Winson, C.G., (1931) Jr. Text. Inst. 22, T 533-546

Winsor, C.P., and Clarke, G.L., (1940) Jr. Marine Res. 3, pp 1-34.

Winters, L.M., and Green, W.W., (1944) Jr. An. Sc. 3, (4) p 399.

Wright, S., (1932) Proc. Am. Soc. An. Prod., 1932, pp 71-78.

____ (1934) Annals Math. Stat. 5, p 161-215.

Wright, S., (1939) Proc. Am. Soc. An. Prod. 1939, pp 18-26.

Yapp, W.W., (1925) Proc. Am. Soc. An. Prod. pp 90-92.

Yule, G.U., and Kendall, M.G. (1937) Introduction to the Theory of Statistics, Griffin & Coy, Ltd.,

Zorn, W., Kruger, L., and Rauer, H., (1933) Animal Breeding Abstracts, 1 p.253.

A. L. Rae. 1946

Massey University Library

APPENDIX I

PROGENY TEST

CARCASE MEASUREMENTS AND BLOCK TEST

DATE ....

LAMB NO ....SEX ....SIRE NO .... GROUP NO ....

EWE NO ....NO. BORN .... NO. REARED .... BIRTH WGT ....

BIRTH DAY ....KILLING DATE .... AGE ....

CARCASE MEASUREMENTS

A. EXTERNAL.

F. ... ...

G. ... ...

W.R. ... ...

W.F. ... ...

W.TH. ... ...

TH. ... ...

W.N. ... ...

T. ... ...

R. ... ...

K. ... ...

L. ... ...

H. ... ...

P. ... ...

B. INTERNAL

A. ... ...

B. ... ...

C. ... ...

D. ... ...

X. ... ...

Y. ... ...

J. ... ...

NO. OF RIBS (L) (R)

MUSCLE COLOUR ... ...

WGT. OF LEFT FORE CANNON ...

LENGTH " " " ...

WGT. OF HIND QUARTER ... ...

" " FORE " ... ...

RATIO FQ/HQ ... ...

BLOCK TEST

	MAX. PTS	POINTS AWARDED
A. EXTERNAL POINTS		
(1) LEGS	30	
(2) FAT COVER	10	
(3) LOIN	10	
B. INTERNAL POINTS		
(4) DEPTH OF FAT ON LOIN	20	
(5) EYE MUSCLE	15	
(6) RIBS	10	
(7) COLOUR AND TEXTURE OF FLESH	5	
CARCASE TOTAL	100	
C. CARCASE WGT		
(COLD) .. LBS	100	
GRAND TOTAL	200	

REMARKS ....
....

A. L. Rae. 1946

APPENDIX I

PROGENY TEST

CARCASE MEASUREMENTS AND BLOCK TEST

DATE ....

LAMB NO ....SEX ....SIRE NO .... GROUP NO ....

EWE NO ....NO. BORN .... NO. REARED .... BIRTH WGT ....

BIRTH DAY ....KILLING DATE .... AGE ....

CARCASE MEASUREMENTS

A. EXTERNAL.

F. ... ...
G. ... ...
W.R. ... ...
W.F. ... ...
W.TH. ... ...
TH. ... ...
W.N. ... ...
T. ... ...
R. ... ...
K. ... ...
L. ... ...
H. ... ...
P. ... ...

B. INTERNAL

A. ... ...
B. ... ...
C. ... ...
D. ... ...
X. ... ...
Y. ... ...
J. ... ...

NO. OF RIBS (L) (R)

MUSCLE COLOUR ... ...

WGT. OF LEFT FORE CANNON ...

LENGTH " " " ...

WGT. OF HIND QUARTER ... ...

" " FORE " ... ...

RATIO FQ/HQ ... ...

BLOCK TEST

	MAX. PTS	POINTS AWARDED
A. EXTERNAL POINTS		
(1) LEGS	30	
(2) FAT COVER	10	
(3) LOIN	10	
B. INTERNAL POINTS		
(4) DEPTH OF FAT ON LOIN	20	
(5) EYE MUSCLE	15	
(6) RIBS	10	
(7) COLOUR AND TEXTURE OF FLESH	5	
CARCASE TOTAL	100	
C. CARCASE WGT		
(COLD) .. LBS	100	
GRAND TOTAL	200	

REMARKS ....
....

APPENDIX 11 CORRELATION TECHNIQUE FOR QUALITATIVE CHARACTERS.

DAM - DAUGHTER CORRELATION FOR FOREQUARTER FLEECE GRADING

	C	U	.	I	V	Total	%	Mean Deviation
U	1	4	2	1	0	8	4.26	-2.146
.	2	12	13	12	2	41	21.81	-1.071
I	5	13	45	32	10	105	55.85	+0.110
V	3	5	15	9	2	34	18.09	1.456
Total	11	34	75	54	14	188		
%	5.85	18.09	39.89	28.72	7.45			
Mean Deviation	2.010	1.065	.162	.812	1.901			

X	Y	XY	X	Y	F
-2.010	-2.146	4.3135	4.0401	4.6053	1
	-1.071	2.1527		1.1470	2
	+0.110	-.2211		0.0121	5
	+1.456	- 2.9266		2.1199	3
-1.065	-2.146	2.2855	1.1342		4
	-1.071	1.1406			12
	+0.110	-0.1172			13
	+1.456	-1.5506			5
-0.162	-2.146	0.3476	0.0262		2
	-1.071	0.1735			13
	+0.110	-0.0178			45
	+1.456	-0.2359			15
0.812	-2.146	- 1.7426	0.6593		1
	-1.071	-0.8697			12
	+0.110	0.0893			32
	+1.456	1.1823			9
1.901	-2.146	-4.0795	3.6138		0
	-1.071	-2.0360			2
	+0.110	0.2091			10
	+1.456	2.7679			2

ΣXY = 55.5239
\- 39.7524

= 15.7715

= 171.1643 187

= 157.2165 187

= . 9153 = .9567

= 8407 .9169

$$\frac{15.7715}{188 \times .9567 \times .9169}$$

= .0956

$$= \frac{.0956}{.9567 \times .9169}$$

= . 1090

APPENDIX III

CARCASE MEASUREMENTS ON

THE LIVE ANIMAL.

OBSERVER A.

Lamb No.	Ht.at Withers		Width of Loin		Width of Hdquarter		Width of Forequater	
	1	2	1	2	1	2	1	2
77	56.7	56.7	13.5	13.1	22.0	22.2	19.7	19.4
330	58.4	56.1	13.0	13.1	23.3	23.3	19.5	19.2
440	54.5	55.2	13.1	13.1	22.9	23.3	21.8	20.8
488	59.9	59.8	12.6	12.5	21.9	22.4	20.2	19.6
183	57.5	57.0	12.7	12.5	21.8	21.7	20.4	20.5
32	54.5	55.1	13.2	13.4	24.2	24.3	20.5	20.1
126	52.8	55.9	12.9	12.6	23.0	23.2	18.8	19.0
13	56.0	57.2	13.5	13.2	22.8	22.7	20.4	20.6
248	53.2	54.6	13.4	13.5	23.9	22.9	19.8	20.3
180	55.9	56.2	13.0	12.9	23.6	23.5	19.3	19.3
246	55.5	55.6	12.9	13.1	21.5	21.8	19.9	20.1
459	57.0	58.0	12.8	12.7	23.9	23.6	20.3	20.0
Lost Tag	59.0	59.0	12.8	13.0	21.6	21.7	19.5	19.6
448	59.5	59.5	12.2	12.7	21.9	22.2	19.3	19.2
250	51.9	51.4	12.8	12.8	24.2	24.5	20.4	20.5
115	55.4	55.8	13.3	13.1	22.5	22.2	19.5	19.7
268	56.7	57.6	12.3	12.3	20.9	20.6	19.7	19.3
451	58.4	58.4	12.9	12.6	22.9	21.5	19.5	19.5
199	55.9	56.6	13.2	13.1	23.9	23.6	20.4	20.2
444	55.0	55.2	13.2	13.3	23.0	23.4	20.4	19.9

OBSERVER B.

Lamb	Ht. at Withers		Width of Loin		Width of Hdqurts.		Width of Forequtrs	
No.	1	2	1	2	1	2	1	2
77	54.7	57.5	13.3	13.0	23.0	20.6	18.5	18.5
330	55.4	55.1	12.8	13.5	24.2	22.7	18.3	18.2
440	54.3	53.9	12.6	12.5	22.2	22.2	19.2	18.9
488	57.8	59.2	12.5	12.6	21.7	21.4	18.8	18.8
183	57.1	57.5	12.8	12.2	23.0	22.6	19.2	19.2
32	54.8	53.6	12.8	13.1	22.4	23.3	19.0	18.2
126	53.4	55.0	12.1	12.1	21.8	21.5	20.3	19.5
13	51.7	54.3	12.0	12.2	25.1	24.8	18.6	19.1
248	53.9	52.7	12.3	12.3	21.3	22.2	18.1	18.6
180	55.9	56.7	11.9	12.0	23.3	20.7	18.1	18.8
246	55.4	55.1	13.5	13.6	21.1	21.5	19.3	18.8
459	55.9	56.9	13.6	13.3	23.0	23.8	18.8	18.7
Lost Tag	58.0	59.4	13.2	13.0	23.3	21.2	18.7	19.2
448	59.5	59.5	12.6	12.8	21.0	22.5	20.5	19.3
250	51.2	55.2	13.1	13.0	24.5	23.4	18.9	19.2
115	58.4	56.3	12.7	12.5	23.2	22.5	18.0	19.0
268	57.0	56.9	12.0	12.5	22.9	21.6	18.9	18.4
451	57.5	57.4	13.2	13.1	21.3	22.2	20.4	19.8
199	56.8	56.8	13.6	12.5	22.9	23.3	19.4	19.2
444	57.0	56.9	12.6	13.0	23.0	21.7	18.9	18.5

OBSERVER C.

Lamb	Ht. at Withers		Width of Loin		Width of Hdqurts		Width of Frequrtrs	
No.	1	2	1	2	1	2	1	2
77	56.6	57.8	12.5	13.1	20.2	21.0	18.4	17.9
330	57.9	57.3	12.4	12.5	22.1	22.0	19.0	18.2
440	57.3	55.2	12.3	12.0	21.4	21.0	19.2	19.0
488	59.6	59.9	11.9	12.3	21.3	21.6	17.7	18.1
183	57.9	55.9	12.5	12.5	22.1	22.3	19.5	19.4
32	55.8	55.2	12.4	12.2	21.6	22.6	18.9	19.1
126	55.3	56.0	12.0	11.8	21.7	19.5	18.3	18.5
13	55.4	55.5	11.6	11.5	23.0	22.6	20.0	19.4
248	54.8	56.2	11.4	11.9	21.4	21.9	18.7	19.2
180	57.6	56.9	12.5	12.5	22.9	22.6	20.1	19.2
246	56.5	55.4	12.8	12.7	21.5	22.4	18.5	19.5
459	56.3	58.4	12.3	12.7	21.9	21.0	18.7	19.0
Lost Tag	58.1	58.9	12.2	12.4	20.9	22.4	19.3	19.0
448	58.3	59.2	11.5	11.5	20.5	20.2	19.0	18.7
250	53.3	53.9	12.2	12.1	22.7	22.0	19.5	19.2
115	57.9	55.8	11.0	11.3	22.0	20.5	19.0	18.5
268	57.2	57.8	12.0	11.9	20.4	20.2	18.8	18.4
451	58.0	58.5	13.0	12.5	23.0	22.0	19.0	18.3
199	56.6	57.5	11.5	12.0	23.1	22.5	20.0	19.2
444	55.4	57.5	12.5	11.3	22.5	21.0	19.4	18.7

APPENDIX IV

FLEECE DESCRIPTION OF EWE LAMBS - 1944

GROUP NO.1.

Lamb No.	Count	Handle	Lustre	Colour	Length	Gen. Chars	H.Q.	F.Q.	Back	Evenness	Fleece	Fleece Wt.
41	56	/	V	X	9	/	/	V	/	V	/+	3.2
42	54	.	/	V	8½	/	/	V	/	/	/	3.0
47	54	.	/	V	8½	/	/	V	.	/	/+	4.2
74	56	/	/	V	9	.	/	V	/	/	/	3.9
77	56	/	V	X	8½	V	V	X	/	V	V+	3.3
95	54	.	/	X	9	/	/	/	/	X	/	4.6
132	54	/	X	X	8	V	/	V	/	V	V	3.2
133	50/54	.	V	V	8½	V	/	V	.	/	V	3.2
154	54	.	/	V	9	V	/	X	/	V	V	3.5
182	50	.	/	V	9½	.	.	V	U	.	.+	4.2
211	54	/	/	X	10	/	.	V	/	/	/	4.5
215	54	/	X	X	8	V	/	X	/	/	V	3.2
227	56	.	/	X	8	.	/	/	/	/	/	4.2
267	48	.	/	V	10	.	.	V	V	/	.+	3.2
283	54	/	V	X	8	/	/	V	/	/	/	3.2
311	56	.	/	V	8	.	U	/	/	/	/	3.4
313	50	/	/	V	8	/	.	V	.	U	.	2.6
330	50	/	X	X	6½	/	/	V	/	/	/+	2.3
331	54	.	/	V	8½	.	.	V	/	V	.+	3.3
341	54	.	/	X	8½	/	/	V	V	/	/+	3.7
347	48	U	.	/	10	U	C	/	/	U	U	3.7
352	50	/	/	V	9½	/	.	V	/	.	/	4.0
360	50	/	X	X	9	V	V	V	V	X	V+	3.7
402	50	.	/	V	8	.	.	V	/	.	.	2.0
410	48	U	U	V	8½	U	C	/	/	U	U	3.1

GROUP NO. 2

Lamb No.	Count	Handle	Lust-re	Col-our	Len-gth	Gen. Char. S	H.Q.	F.Q.	Back	Even-ness	Fleece	Fleece Wt.
136	50	/	V	V	9	.	.	/	/	V	.+	3.5
192	56	.	/	V	8	/	/	V	.	/	/+	2.9
212	50	U	.	/	9	.	/	V	/	/	/	3.7
219	54	/	V	V	9	/	/	V	/	/	/+	3.0
228	56	/	/	X	7	/	/	V	/	/	/+	2.5
232	56	/	/	V	7	/	.	X	/	/	/	2.3
233	54	/	V	X	8½	V	.	V	/	.	.+	2.6
247	50	.	/	V	8½	/	.	X	/	.	/	3.7
279	54	/	V	V	8½	/	/	V	U	.	/+	3.1
290	54	/	V	X	7½	/	/	V	/	/	/+	2.4
300	54	/	/	X	8½	/	/	V	/	V	/+	3.9
301	54	U	/	V	9	.	.	.	/	/	.	3.5
336	56	.	/	X	7	/	/	X	/	V	/+	2.6
346	48	.	.	V	9½	.	.	/	/	/	.+	3.2
372	54	/	V	X	7½	/	/	V	/	V	/+	3.8
390	50	/	V	V	8½	V	/	V	/	V	V	3.1
391	54	/	/	V	8½	/	U	V	/	U	.+	2.8

GROUP NO. 3.

Lamb No.	Count	Handle	Lust-re	Col-our	Len-gth.	Gen. Char S	H.Q.	F.Q.	Back	Even-ness	Fleece	Fleece Wt.
50	54	.	/	V	9	/	/	V	/	/	/+	3.7
73	50	U	U	/	11	.	/	V	/	.	/	5.4
88	54	/	/	V	11	/	/	V	.	/	/+	3.7
105	54	U	.	/	8	.	.	V	.	.	.+	3.1
111	54	/	V	X	8	V	/	X	/	V	V+	3.0
186	54	/	V	X	8½	V	/	V	/	/	V	4.2
209	54	/	V	V	7½	V	/	V	/	/	V	4.0
222	50	U	.	V	9	.	.	/	/	/	.	3.3
237	56	/	V	V	7	/	/	V	/	V	/+	2.4
319	54	/	V	X	8½	/	/	V	/	V	/+	3.2
320	54	/	V	X	9	V	/	X	/	.	/	3.9
334	50	/	V	V	9	.	/	/	/	.	.+	3.8
359	54	/	X	X	8	V	/	V	/	V	V	3.2
435	50	.	U	V	4	.	.	/	/	/	/	-

GROUP NO.4.

Lamb No.	Count	Handle	Lust-re	Col-our	Len-gth	Gen. Char. S	H.Q.	F.Q.	Back	Even-ness	Fleece	Fleece
9	50	/	X	X	9	V	V	X	/	V	V+	4.2
14	56	.	.	.	8½	.	.	/	.	/	.	4.1
16	50	U	.	/	10	U	C	/	/	U	.	3.8
38	50	U	.	.	8	.	.	/	.	/	.+	4.0
58	50	U	.	/	10	.	U	/	U	.	.	3.6
59	50	.	.	/	11	.	.	.	.	/	.	3.5
71	50	.	.	V	10	.	.	/	/	/	.+	3.6
94	50	.	/	X	10½	.	.	V	.	/	.+	4.1
124	56	/	/	V	7½	.	/	/	/	V	/	2.8
137	56	/	/	X	8	/	/	V	/	V	/+	2.7
144	54	/	X	X	10	/	V	X	/	V	V+	4.3
170	56	/	/	X	8½	/	.	V	/	/	/	3.0
202	54	U	.	/	9	.	C	/	/	U	U+	3.3
240	50/48	.	/	/	9	/	.	V	.	.	.	4.0
275	54	.	/	X	8	/	/	V	/	/	/+	3.0
321	50	/	V	X	9	/	/	V	/	V	/+	3.2
335	50/54	/	V	V	8½	V	/	X	/	V	V	3.7
361	50	/	V	X	8	V	/	V	/	/	/+	3.9
362	56	V	/	V	7	V	.	V	V	/	/+	3.3

GROUP NO. 5

Lamb No.	Count	Handle	Lustre	Colour	Length	Gen. Char. S	H.Q.	F.Q.	Back	Evenness	Fleece	Fleece Wt.
2	56	U	U	/	9	.	.	V	U	.	.+	4.2
29	56	.	/	X	6½	/	/	V	/	V	/+	2.8
31	48/50	U	U	/	9	U	N	/	U	U	C	4.1
64	54	/	/	X	7½	V	/	X	.	/	V	3.1
75	54	/	X	X	8½	V	/	X	/	V	V	3.4
110	54/56	.	/	X	7	V	/	X	/	V	V+	3.5
113	54	/	/	V	9	.	.	V	.	/	.+	3.6
114	50	/	V	V	9	/	.	V	/	V	/+	3.3
117	50	U	U	/	8	.	C	V	U	U	.	3.1
143	50	U	.	V	8½	.	U	V	/	.	.	3.7
174	56	/	/	X	7½	/	/	V	/	V	/+	3.2
175	54	/	V	V	8½	/	/	V	/	/	/+	3.5
198	56	U	.	V	8	.	U	/	/	.	.	2.6
204	54/50	.	.	/	8½	U	C	V	/	U	U+	3.1
230	54	.	/	V	7½	.	U	V	/	.	.	4.2
252	50	U	.	/	8½	U	C	/	/	U	U+	3.3
255	50	/	X	X	8½	V	/	X	/	/	/	4.0
262	48	U	.	/	8½	U	N	/	/	C	C	3.4
266	56	.	/	X	6½	/	/	/	/	/	/	3.3
325	54	/	X	X	7½	V	V	X	/	V	V+	3.0
326	56	U	U	/	7½	U	U	V	.	U	U+	3.2
401	54	.	.	V	7½	.	.	V	/	.	.+	3.5
404	50	.	.	V	7	.	.	V	/	.	.+	2.9

GROUP NO. 6

Lamb No.	Count	Handle	Lust-re	Col-our	Len-gth	Gen. Char S	H.Q.	F.Q.	Back	Even-ness	Fleece	Fleece Wt.
1	50	/	/	X	10½	/	/	V	/	V	/+	5.0
23	50	.	/	V	9½	/	/	V	/	/	/+	4.5
46	54	/	X	X	9	V	V	X	/	X	V+	3.2
53	54	.	/	V	8	/	/	V	/	/	/+	2.9
56	54	/	X	X	9½	V	V	V	.	X	V	3.5
57	50	/	/	V	9	.	.	/	.	/	.+	3.0
60	54	/	/	V	8	V	V	X	/	V	V+	3.7
78	48	U	.	/	9½	U	C	/	.	U	U	3.2
79	56	/	/	V	8	/	.	V	.	.	.+	2.9
115	50	/	V	X	9	V	/	V	.	/	/+	4.2
122	50	.	/	V	9	/	.	V	.	/	/	3.0
126	54	/	V	V	7½	/	/	V	.	/	/	2.6
127	54	/	/	V	8½	/	/	V	.	V	/+	-
134	50	/	/	V	8	/	.	V	/	/	/	2.9
176	54	.	/	X	7½	/	/	V	/	/	/	3.2
178	50	U	.	/	8½	.	U	/	/	U	U+	2.4
179	54	U	/	.	8½	U	U	/	/	.	U	2.1
200	50	.	/	V	9	/	.	V	/	.	/	3.1
254	50	/	/	/	8	V	/	V	/	/	/+	3.0
259	50	.	V	V	7½	/	.	/	/	/	.+	3.0

GROUP NO. 7

Lamb No.	Count	Handle	Lust-re	Col-our	Len-gth	Gen. Char S	H.Q.	F.Q.	Back	Even-ness	Fleece	Fleece Wt
20	54	•	/	V	8	•	/	/	/	/	•+	3.8
22	50	/	V	X	9½	V	V	X	/	V	V+	5.5
33	50	U	U	/	10	U	U	/	U	•	U+	3.6
36	54	/	V	X	9	V	V	X	/	X	V+	3.3
43	54	•	/	V	9	/	/	X	/	V	/+	3.1
44	50	•	/	V	9½	/	•	V	/	/	/	3.7
67	54	/	/	/	9	•	U	/	/	•	•	3.8
160	54	/	X	/	9	V	/	X	/	V	V+	3.9
185	54	•	•	V	9½	•	•	V	/	•	•	4.1
196	48	U	•	/	11	U	C	U	/	C	U	4.6
217	56	•	•	V	8½	/	/	X	/	/	/+	3.7
239	50	•	/	V	8	•	•	/	/	/	•+	3.0
242	56	/	/	X	7½	/	/	V	/	/	/+	2.4
260	48	/	/	/	9	U	C	V	/	U	U	2.2
243	54	/	V	V	8½	/	/	V	/	V	/+	2.5
261	54	•	•	V	8½	•	•	U	/	•	•	2.7
294	56	•	/	X	6½	/	/	V	/	/	/+	2.8
339	50	U	U	/	8	•	U	/	•	•	•	2.7
387	50	/	/	V	8½	/	/	V	/	/	/	4.1
407	54	/	/	V	8½	/	/	X	/	/	/+	3.7
417	56	/	/	X	6	/	/	V	•	/	/+	2.1
418	54	/	V	X	6½	/	/	V	•	/	/+	2.5
419	56	/	/	X	6	/	/	V	/	/	/+	2.9

GROUP NO. 8

Lamb No.	Count	Handle	Lust-re	Col-our	Len-gth	Gen. Chars	H.Q.	F.Q.	Back	Even-ness	Fleece	Fleece Wt.
4	54	.	.	/	10	.	U	V	.	.	.	4.3
6	50	.	/	/	9	/	/	X	/	/	/+	3.7
39	54	/	/	V	10½	/	/	X	.	/	/+	3.3
72	46	U	U	/	11	U	N	/	.	C	C	3.8
81	54	/	/	/	9	/	/	V	.	V	/+	2.8
107	50	U	U	/	9½	C	C	/	.	C	U	3.0
149	54	/	/	V	8	/	/	V	.	/	/+	3.4
152	54	/	/	V	8	V	/	X	V	V	V	3.9
158	54	/	X	X	8	/	/	V	/	/	/+	2.7
159	50	V	V	V	8	/	.	V	.	.	.	2.8
162	50	.	.	V	10	.	U	/	/	.	.	3.6
184	50	/	/	V	7½	/	.	V	.	.	/	3.2
256	50	.	.	V	8	.	C	V	/	C	.	3.1
257	48	.	/	V	10½	.	.	/	/	.	.	4.4
355	54	.	V	X	8	/	.	V	/	.	/	3.6
382	50	U	.	V	8	.	U	/	/	U	U+	2.5

GROUP NO. 9

Lamb No.	Count	Handle	Lustre	Colour	Length	Gen. Char. S	H.Q.	F.Q.	Back	Evenness	Fleece	Fleece Wt.
55	54	/	/	V	7½	/	/	V	/	/	/+	2.5
101	56	/	V	X	8	/	/	V	.	/	/+	2.7
148	54	/	/	V	8½	/	/	V	/	/	/	3.0
168	54	/	/	X	8	/	/	/	/	V	/+	3.2
193	50	/	V	V	8	/	.	/	/	/	/	2.8
206	50	U	U	V	9	U	C	/	/	U	U	3.0
272	50	.	/	V	7½	/	/	V	/	/	/+	3.0
305	50	/	/	.	6	.	/	/	/	/	/	2.0
308	56	.	.	V	7	.	.	V	/	/	.+	3.0
314	54	/	/	V	8½	/	/	V	/	/	/+	3.2
315	54	/	.	V	8	/	/	V	/	/	/+	3.1
348	50	/	V	V	8	.	.	/	.	.	.	2.7
351	50	.	/	V	8	.	U	/	.	.	.	3.3
353	54	.	/	V	7	.	.	/	/	/	.+	2.6
357	54	/	V	X	7	/	/	V	/	V	/+	3.0
363	50	.	/	V	6	.	.	/	/	V	.+	2.8
379	50	.	.	V	6½	.	.	/	.	V	.+	3.7
406	54/6	.	/	V	6	/	.	V	/	.	/	2.4

GROUP NO.10

Lamb No.	Count	Handle	Lustre	Colour	Length	Gen. Chars	H.Q.	F.Q.	Back	Evenness	Fleece	Fleece Wt.
19	50	U	.	V	10½	.	U	.	/	.	U+	4.0
51	50/58	.	/	V	12	.	.	V	/	.	.+	3.5
65	48	.	/	V	10	/	U	V	.	U	.	3.3
87	50	U	/	V	9½	/	U	U	.	U	U+	3.2
91	50	.	/	V	10	/	.	/	U	U	.	3.4
93	48	U	.	/	9½	U	N	/	.	C	U	3.9
119	56	.	.	/	9½	/	/	X	/	/	/+	3.5
142	48/6	U	U	V	11½	C	C	/	.	C	C+	3.8
146	48	U	.	V	10½	U	U	/	/	U	U+	3.4
156	50	/	V	X	10	/	/	V	/	V	/+	2.5
157	54	.	/	V	9	.	.	/	/	X	.+	3.5
163	50	.	.	/	9	.	.	/	/	/	.	3.2
164	54	.	/	/	9	.	.	/	/	/	.+	3.2
281	50	/	/	V	9	.	C	/	/	U	U+	3.0
309	54	/	/	V	8½	/	.	V	/	.	/	3.2
310	50	.	/	V	8	/	/	V	.	/	/+	2.9
343	50	.	/	V	7½	/	.	/	/	.	.+	3.5
368	54	/	V	V	9	/	/	V	.	/	/+	4.0
374	50	/	V	X	8½	/	/	V	.	/	/+	3.3
413	50	.	.	/	9	.	.	/	/	.	.+	3.1
416	54	/	V	X	7½	V	/	V	/	/	/+	3.3
421	54	.	/	/	7	.	U	/	/	/	.	3.0
430	48	.	.	/	9	U	C	/	.	C	U	2.2
434	54	/	V	V	5½	/	.	/	.	/	.+	1.6

APPENDIX V

BODY CONFORMATION DESCRIPTION

EWE LAMBS 1944

GROUP NO. 1 .

Lamb No.	Head	Should	Back	Loin	H.Q.	Legs	Bone	Condition	Breed	Body as a whole
41	U	V	X	X	V	V	I	X	I	V
42	•	V	V	V	V	•	U	I	U	V
47	U	V	V	V	I	I	I	V	C	V
74	•	V	V	V	I	•	•	V	U	V
77	U	I	V	I	I	V	•	V	U	I
95	I	I	V	V	I	U	U	I	I	I
132	C	V	X	X	V	•	•	X	N	V
133	U	I	I	I	V	U	U	•	C	I
154	•	I	V	V	V	I	I	I	I	V
182	•	•	V	•	•	I	I	•	•	•
211	•	V	X	V	I	I	V	X	U	V
215	U	U	U	U	C	U	•	N	N	U
277	•	V	V	I	V	I	I	I	I	V
267	C	I	I	I	I	•	I	I	N	I
283	•	•	I	I	•	•	•	•	•	•
311	U	I	I	I	V	I	•	I	•	I
313	•	C	U	U	•	•	U	C	U	U
330	U	•	•	U	•	U	U	C	C	U
331	C	•	I	•	I	U	U	•	C	•
341	•	•	•	U	I	•	•	•	U	U
347	U	I	X	X	I	•	U	V	•	V
352	•	V	I	V	I	I	V	V	I	I
360	•	I	V	I	I	U	I	I	U	I
410	•	U	U	U	U	•	U	U	U	U

GROUP NO. 2.

Lamb No.	Head	Should	Back	Loin	H.Q.	Legs	Bone	Cond-ition	B.T.	Body.
136	V	I	V	V	I	.	.	I	I	I
192	V	.	I	I	I	I	.	U	I	I
212	V	I	I	I	I	.	U		I	I
219	I	V	V	I	I	V	.	I	V	I
228	.	.	I	I	I	.	.	I	.	I
232	.	.	I	.	I	I	.	.	U	.
233	I	I	I	I	I	I	I	.	V	I
247	X	V	X	X	X	V	I	X	V	X
279	I	U	U	U	U	.	U	C	U	U
290	I	V	V	I	V	V	I	.	I	V
300	I	C	C	C	C	U	U	C	U	C
301	I	I	I	I	I	.	.	I	I	I
336	.	U	U	U	.	.	U	U	U	U
346	.	.	.	.	V	I	I	U	.	I
372	U	C	U	U	C	I	.	U	U	C
390	V	I	V	V	V	V	.	I	V	V
391	X	U	I	I	V	V	I	I	I	I

GROUP NO. 3.

Lamb No.		Head	Should	Back	Loin	H.Q.	Leg	Bone	Condi-tion	B.T.	Body
50		I	V	I	I	I	•	I	•	I	I
73		I	X	X	V	V	V	I	V	I	V
88		X	X	X	V	X	V	•	V	X	X
105		U	I	V	V	V	•	U	V	•	V
111		V	I	I	I	V	V	•	I	I	I
209		X	V	V	I	V	I	I	V	V	V
222		•	I	V	I	V	V	V	I	I	V
237		I	I	I	I	V	I	I	V	I	I
319		U	C	C	U	U	•	U	C	C	C
320		I	V	I	•	I	I	I	I	I	I
334		•	V	V	V	V	I	•	V	•	V
359		I	I	I	I	I	I	I	I	I	I

GROUP NO. 4.

Lamb No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	Condition	B.T.	Body
9		I	I	I	I	I	•	•	I	•	I
14		•	V	V	V	V	I	I	I	•	V
16		•	•	V	I	I	I	I	I	•	I
38		•	I	V	I	•	•	I	I	U	I
58		U	V	V	I	•	U	U	•	U	X
59		I	•	•	I	I	•	U	•	I	•
71		U	V	I	I	V	•	•	I	Y	I
94		•	V	V	V	I	I	I	I	U	I
124		•	I	I	I	I	I	•	I	•	I
137		•	I	V	I	I	I	•	I	•	I
144		U	I	I	I	•	U	•	I	U	X
170		•	•	•	•	•	•	U	U	•	•
202		U	I	I	I	I	•	•	U	U	I
240		U	I	I	I	I	U	U	•	U	I
275		•	•	•	•	•	U	•	•	•	•
321		•	I	I	I	I	•	I	•	I	I
335		•	I	V	I	I	I	X	I	C	I
361		•	•	•	I	I	I	•	•	•	I
362		•	V	V	I	I	I	I	U	•	I

GROUP NO. 5.

Lamb No.		Head	Should.	Back	Loin	H.Q.	Legs	Bone	Condition	B.T.	Bon
2		I	V	V	I	I	I	I	I	I	I
29		•	•	•	•	U	•	•	C	C	•
31		•	I	I	•	I	•	•	•	U	I
64		U	U	U	U	•	•	I	U	U	U
75		V	V	V	V	I	•	•	I	V	V
110		V	I	I	I	I	I	•	I	V	V
113		•	I	V	V	I	U	•	U	•	I
114		I	I	I	I	I	•	•	•	I	I
117		I	C	C	C	U	U	•	C	•	C
143		•	I	I	I	I	I	I	I	I	I
174		•	•	I	•	I	I	•	•	I	•
175		V	•	I	I	I	V	V	U	X	V
148		I	•	•	•	•	I	I	U	I	•
204		I	•	•	•	I	I	I	U	•	•
113		I	V	X	X	V	V	V	X	U	V
252		I	I	I	I	V	I	I	V	U	I
255		V	I	I	•	•	I	I	•	I	I
262		U	C	U	U	U	•	I	C	U	U
266		•	•	•	U	•	I	I	U	C	U
325		I	•	I	I	I	•	I	I	I	I
326		I	U	•	U	•	•	•	U	•	U
401		I	V	V	V	I	•	I	I	•	V
404		I	•	•	•	I	I	I	•	I	I

GROUP NO. 6.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	Cond.	B.T.	Body
1		V	I	V	V	I	.	.	I	I	I
23		I	I	I	I	I	.	.	I	I	I
46		I	V	V	I	I	I	.	.	I	I
53		V	.	.	.	U	.	.	U	.	.
56		.	.	.	.	.	.	I	U	.	.
57		.	U	.	.	.	U	I	U	U	.
60		V	X	X	V	V	V	I	V	V	V
78		.	V	V	V	V	.	I	V	U	V
79		I	I	V	X	V	I	.	V	I	V
115		I	.	.	.	.	.	I	.	I	.
122		X	.	I	V	I	.	.	.	I	I
126		.	.	I	I	I	.	.	.	.	I
134		.	U	.	.	.	.	.	U	I	.
176		V	X	V	V	I	.	.	I	I	V
178		I	I	I	I	I	X	U	U	I	I
179		I	U	.	.	.	.	U	C	I	U
200		C	U	U	U	U	C	.	C	C	U
254		V	.	I	I	I	I	.	.	I	I
259		I	I	I	I	I	I	I	I	I	I

GROUP NO. 7.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	Cond.	B.T.	Body
20		I	I	I	I	I	I	I	I	I	I
22		V	I	•	•	I	I	I	•	I	I
33		•	I	I	V	V	I	I	I	U	I
36		•	U	•	•	•	•	U	•	I	•
43		•	•	I	I	I	•	I	I	I	I
44		•	I	V	V	V	I	I	I	•	V
67		•	I	I	•	I	I	I	U	U	I
160		I	I	V	I	I	I	I	I	V	I
185		I	•	I	I	V	V	I	•	I	I
196		I	•	I	I	I	•	•	I	U	I
217		V	I	I	V	V	I	I	•	V	I
239		•	U	U	U	I	I	I	C	•	V
242		V	•	•	•	I	I	U	U	I	•
243		I	U	•	•	I	I	U	U	•	•
260		U	I	I	I	V	V	•	•	I	I
261		U	I	I	I	I	I	•	I	•	I
294		•	•	•	•	U	I	•	I	•	•
339		I	I	I	I	I	I	•	•	I	I
387		•	I	•	•	I	U	U	U	•	•
407		I	V	V	V	I	I	•	I	I	V
417		I	•	•	•	•	•	•	U	•	•
418		•	I	I	•	I	I	•	U	I	I
419		V	V	V	V	V	I	•	I	V	V

GROUP NO. 8.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	Cond	B.T.	Body
4		•	I	I	I	I	I	•	I	•	I
6		•	•	I	I	I	I	I	•	•	I
39		•	I	V	V	I	U	U	I	•	I
72		V	I	I	I	I	I	•	I	I	I
81		•	C	U	U	C	•	C	C	C	C
107		I	I	I	I	I	•	I	•	U	I
149		I	V	V	V	V	I	•	I	I	V
152		V	I	V	I	•	•	•	U	V	I
158		U	U	U	U	U	•	•	C	U	U
159		•	•	I	•	•	•	•	U	U	•
162		U	I	I	I	I	•	•	I	U	I
184		•	•	I	I	•	•	I	U	I	•
256		•	I	I	I	C	U	U	U	C	U
257		•	I	I	I	U	•	U	•	C	•
355		I	V	V	V	I	I	I	I	I	I
382		I	I	I	I	I	I	•	•	•	•

GROUP NO. 9.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	Cond.	B.T.	Body.
55		U	V	V	I	I	•	•	I	U	I
101		•	I	I	I	I	•	•	•	•	I
148		U	V	I	I	I	I	•	I	U	I
167		•	I	V	I	V	•	•	I	•	I
168		U	I	I	I	I	•	•	I	U	I
193		•	I	I	•	U	•	U	U	•	•
206		I	•	I	I	V	I	•	I	•	I
272		•	I	V	V	V	I	•	V	U	V
305		U	U	U	C	I	•	•	C	•	U
308		U	V	V	V	I	I	•	V	•	V
314		•	•	I	I	I	•	•	•	I	I
315		U	•	I	I	•	U	•	•	U	•
348		U	U	•	•	I	I	•	C	U	•
351		•	V	V	V	I	I	U	V	•	I
353		C	•	•	U	U	•	I	I	N	U
357		U	I	I	I	I	•	•	•	U	I
363		•	I	I	I	V	I	•	I	U	I
379		•	I	I	I	I	•	•	•	•	I
406		U	U	U	U	•	•	U	U	U	U

GROUP NO. 10.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	Cond	B.T.	Body.
19		•	I	V	V	I	I	I	I	U	I
51		V	V	V	V	I	I	V	I	V	V
65		•	•	I	I	I	I	U	U	•	I
87		I	•	I	I	•	I	I	•	U	I
91		•	•	•	•	I	I	•	U	•	I
93		I	•	I	I	I	I	•	•	I	I
119		V	•	I	I	•	I	•	C	I	•
142		•	V	X	X	V	I	•	X	I	V
146		•	I	I	I	•	I	•	•	I	I
156		I	•	•	I	I	I	I	o	I	I
157		V	•	•	•	•	•	•	U	I	•
163		•	•	•	•	•	U	•	U	•	•
164		I	•	I	I	I	I	•	•	•	I
281		U	•	•	•	•	I	•	U	U	•
309		I	I	I	I	I	I	I	I	V	V
310		I	•	I	I	I	•	•	U	•	•
343		I	•	•	•	I	I	I	U	I	•
368		I	•	I	I	I	•	I	•	V	I
374		•	C	U	U	•	•	U	C	•	U
413		•	I	I	I	•	U	•	•	U	•
416		I	•	I	•	U	•	•	U	•	•
421		I	I	V	V	I	I	I	U	I	I
430		•	•	I	I	•	•	•	U	•	•
434		V	•	•	•	•	I	I	N	V	•

APPENDIX VI FLEECE DESCRIPTION OF EWE HOGGETS - 1945

GROUP NO. 1.

No.	Count	Handle	Lustre	Color	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight
41	50/2	U	•	I	13	I	I	I	I	V	I	5.6
42	56/8	I	V	I	15	I	I	I	•	I	I	5.5
47	50/48	I	I	•	11	•	U	I	I	•	•	5.0
74	48/50	U	U	•	13	U	U	•	U	U	U	3.9
77	52	I	V	V	13	I	I	V	I	I	I	6.4
95	48/50	I	I	I	13	I	•	V	I	I	I	6.1
132	48/50	•	I	I	15	I	I	I	I	I	I	6.0
133	48/50	•	•	•	14	I	I	V	I	I	I	7.1
154	50	I	I	I	13	I	•	I	I	I	I	6.8
182	48/50	I	•	•	13	•	•	I	I	I	I	6.0
211	48	U	•	I	13	•	•	•	U	I	•	8.0
215	50	I	V	V	12	I	I	I	I	I	I	3.3
227	48/50	I	I	I	14	•	•	•	•	I	•	7.1
267	48	•	•	•	14	•	I	I	•	I	•	5.5
283	48/50	•	•	•	13	I	•	I	•	•	•	5.8
311	48	•	I	•	13	•	•	•	•	I	•	6.0
313	48	I	I	•	13	•	•	I	•	•	•	5.0
330	48	I	I	I	13	I	•	V	I	•	I	5.9
331	48/50	•	I	•	13	•	•	V	I	I	I	5.6
341	50	U	I	I	11	•	•	•	I	I	•	6.4
347	46	C	U	•	15	C	U	I	•	U	C	7.5
352	48	•	•	•	12	•	•	I	•	I	•	6.0
360	50	I	V	B	14	V	I	V	I	I	V	5.9
402												5.5
410	46	U	U	•	15	•	•	I	I	•	•	5.4

GROUP NO. 2.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight
136	48	I	I	V	14	I	I	I	•	•	V	5.5
192	50	•	I	I	14	•	•	V	I	•	I	6.5
212	48	•	•	•	13	•	•	•	•	I	•	4.2
219	50/48	U	•	I	13	•	•	I	I	I	•	5.8
228	50	I	I	I	12	I	I	V	I	V	V	5.1
232	50	I	•	•	12	•	•	I	I	I	•	6.0
233	48	•	•	I	14	I	I	V	I	I	V	6.4
247	48	•	I	•	13	I	•	V	I	I	I	6.0
279	50	I	I	I	16	•	•	I	I	I	I	5.4
289	48	I	I	I	13	I	I	I	•	I	I	6.2
290	50	•	U	•	13	I	•	•	U	U	I	3.5
300	48/50	I	I	I	12	I	I	I	•	I	I	6.5
301	48	U	I	I	14	-	•	I	•	•	•	6.5
336	52	•	U	•	13	•	•	I	•	I	•	5.3
346	46/8	•	•	I	16	U	U	I	I	•	•	5.9
372	50	I	V	V	12	I	•	I	I	I	I	5.0
390	48	•	I	I	14	I	I	V	I	I	V	6.0
391	46	U	•	•	16	U	U	•	•	U	U	5.8

GROUP NO. 3.

No	Count	Handle	Lustre	Colour	Length	S	HQ	FQ	Back	Even-ness	Fleece	Fleece Weight
50	50	I	I	I	13	.	.	I	I	I	.	5.6
73	46/8	I	I	I	16	U	.	I	I	.	.	7.0
88	50	I	I	I	14	I	.	V	I	I	I	6.0
105	48/50	.	I	I	12	I	.	I	I	I	I	5.9
111	50	I	I	I	11	I	I	I	I	V	I	5.1
186	50	U	U	U	9	U	U	.	U	U	U	7.8
209	50	I	I	I	9	.	I	I	.	.	.	5.4
222	52	U	U	.	13	.	U	I	I	I	.	5.9
237	50/52	U	U	.	11	.	.	I	U	.	.	5.9
319	52	I	I	I	10	U	C	.	.	U	U	4.3
320	50	I	I	V	13	.	.	I	.	I	.	5.9
334	48/50	I	I	.	15	.	.	I	I	I	.	6.5
359	52	I	I	.	11	I	.	I	.	.	.	4.6

GROUP NO. 4.

No.	Count	Handle	Lustre	Colour	Length	S	HQ	FQ.	Back	Even-ness	Fleece	Fleece Weight
9	48/50	I	I	•	12	I	I	V	I	I	I	6.4
14	52	U	•	I	13	•	I	•	I	•	I	7.0
16	50/48	U	•	•	14	U	U	I	•	U	U	7.1
38	50	U	U	•	11	•	U	I	•	•	•	6.5
58	48	I	V	•	12	U	•	I	•	U	•	5.3
59	48	•	•	I	16	•	I	I	I	I	I	7.0
71	48	•	•	•	14	•	•	I	I	I	•	7.0
94	48/50	C	U	•	14	U	U	•	•	•	U	6.0
124	54	U	U	I	10	U	U	U	•	I	U	3.9
137	50	•	U	•	12	•	•	•	•	I	•	4.0
144	50	I	I	I	13	I	I	I	I	I	I	5.8
170	52	U	•	•	12	•	•	I	I	I	•	4.7
202	52	I	•	I	12	•	U	I	I	I	•	5.6
240	50	I	I	I	13	I	I	V	I	I	I	5.4
275	50	U	•	I	12	I	U	I	I	•	•	7.0
321	52	U	I	V	12	I	I	I	V	V	I	7.0
335	50/48	I	I	V	14	I	•	I	I	I	I	5.9
361	48	I	I	I	14	•	•	•	•	I	•	4.6
362	54	•	•	I	10	I	I	V	V	V	I	5.8

GROUP NO. 5.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight
2	50	•	•	I	12	•	•	I	I	I	I	6.5
29	54	•	•	I	10	•	I	I	•	•	•	4.3
31	48	•	U	•	12	•	U	I	I	I	•	6.4
64	48	I	I	I	13	I	I	I	I	I	I	6.5
75												
110	52/4	•	I	V	11	V	I	V	I	V	V	5.5
113	48	•	•	I	17	•	•	I	I	I	I	6.0
114	48/50	I	I	I	15	I	•	I	I	I	I	5.9
117	52	I	I	V	10	U	C	•	I	U	U	4.1
143	50	U	U	•	15	•	U	•	•	I	•	5.2
174	48	U	U	•	12	•	U	I	I	•	•	5.8
175	50/48	U	•	U	12	•	I	I	•	•	•	5.6
198	50	•	I	I	12	I	I	I	I	V	I	5.9
204	50	I	I	I	15	I	•	I	I	I	I	5.8
230	52	•	•	I	II	I	•	I	I	V	I	6.6
252	50	•	I	V	14	U	U	•	•	I	U	6.0
255	52/16	I	I	•	13	V	I	V	I	V	V	6.0
262	52	U	U	U	12	•	C	I	I	C	•	5.2
266	52/4	U	•	•	9	•	U	•	•	I	U	4.5
352	50.48	I	V	I	17	I	I	V	•	•	I	6.4
326	52	C	U	I	11	U	U	•	•	I	U	5.7
401	50	U	U	•	9	U	U	•	•	U	U	
404												

GROUP NO. 6.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight
1	48	.	.	I	14	.	.	I	.	.	.	7.5
23	48	U	.	I	14	U	U	.	.	.	U	6.8
46	48/50	I	I	I	13	I	I	V	I	I	I	6.2
53	52	I	.	.	11	.	U	I	I	I	.	5.3
56	50	I	I	I	13	.	U	.	.	I	.	5.9
57	48/50	I	I	I	13	U	U	.	.	.	U	5.0
60	50	I	.	.	14	.	U	I	I	.	.	6.1
78	50/48	.	.	I	11	U	C	.	.	U	U	-
79	50	I	I	.	9	.	U	I	I	I	.	5.0
115	50	I	I	I	13	I	.	I	I	I	I	5.9
122	48	I	I	I	14	.	.	I	I	.	.	6.0
126	50	.	.	U	13	U	U	I	U	U	U	5.3
127	48/50	I	.	U	17	.	.	.	.	.	.	-
134	48/50	I	.	.	12	I	I	I	I	I	I	5.0
176	52	.	I	I	9	I	.	I	I	V	I	5.2
178	48/50	.	U	.	14	.	.	I	I	I	.	5.8
179	50	.	.	.	13.	U	U	.	.	U	U	4.9
188	48/50	I	V	V	14	U	.	I	.	.	.	7.1
200	50	.	I	I	13	I	.	I	.	.	.	5.3
254	48/6	I	V	I	16	.	.	I	.	U	.	7.3
259	48/50	I	I	I	12	I	.	I	I	I	I	6.3

GROUP NO. 7.

No.	Count	Handle	Lustre	Colour	Length	S	HQ	FQ	Back	Even-ness	Fleece	Fleece Weight
20	52	U	U	•	11	•	•	•	•	I	•	5.3
22												
33	48/6	U	•	I	14	U	U	•	•	I	U	5.9
36	48/50	I	I	I	12	I	•	I	I	I	I	6.0
43	48	U	U	•	14	•	U	•	U	•	U	5.8
44	50	•	•	I	12	•	•	V	•	•	I	6.6
67	48	U	U	U	13	U	U	I	I	•	U	6.3
160	48	•	I	I	14	I	U	I	•	•	•	8.0
185	48/50	•	•	I	14	•	•	I	•	•	•	5.5
196	48/6	C	U	C	16	C	N	C	U	C	N	8.3
217												
239	50/2	I	•	I	13	U	•	•	•	I	U	6.6
242	48	I	I	I	12	I	I	I	•	I	I	5.6
243	48	•	•	•	14	•	I	I	•	•	•	6.0
260	48	I	I	I	9	U	•	•	•	•	•	3.8
261	50	•	•	•	10	U	I	I	•	•	U	4.7
294	52	U	I	I	12	I	•	V	I	V	I	5.9
339	48	I	V	I	12	•	•	•	I	I	•	4.9
387	50/48	I	I	I	12	I	•	V	I	I	I	–
407	52	U	•	•	12	•	I	V	I	V	I	6.0
417	52	•	U	•	10	•	•	I	I	•	•	5.6
418												
419	52	I	•	•	12	•	•	I	•	•	•	5.0

GROUP NO. 8.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight
4	50	I	I	I								2.9
6	52	•	•	I	13	•	•	I	I	I	•	4.6
39	46	•	I	V	14	•	•	I	I	V	•	7.0
72	46/8	U	•	I	14	U	U	•	I	•	U	6.2
81	50/48	I	I	I	12	U	•	•	•	I	•	4.5
107	48	U	•	•	12	•	•	I	I	•	•+	5.4
149												
152	50	I	U	I	10	U	U	U	•	I	U	4.7
158	50	I	I	I	11	•	•	I	I	I	•	5.0
159	50	I	I	I	14	I	I	I	I	I	I	5.5
162	50	•	I	•	12	I	•	V	•	•	I	5.6
184	52	•	U	•	10	I	I	V	I	V	I	6.7
256	48/50	U	I	•	12	•	U	I	•	•	•	4.9
257	48/50	•	U	U	12	•	U	I	I	•	•	7.2
355	48/50	I	I	I	9	U	U	1	•	U	U	5.3
382	48/50	•	•	•	14	I	•	I	•	•	•	

GROUP NO. 9.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight
55	52	.	U	I	11	.	.	I	.	I	.	5.1
148	52	.	U	I	13	.	.	I	I	.	.	4.4
167								I				
101	48	.	.	.	15	.	.	I	I	I	.	5.0
168	50	.	I	I	13	.	.	I	I	I	.	5.6
193	48	I	I	I	15	.	.	I	.	I	.	4.7
206	52	U	U	.	11	.	.	.	I	I	.	6.1
272	50	.	I	I	14	I	U	V	I	I	I	5.4
305	50	I	V	X	10	V	I	V	I	I	V	4.5
308	54	U	U	I	15	.	U	I	I	I	.	5.5
314	50	I	I	.	13	.	.	I	I	I	.	5.6
315	50	I	I	I	10	.	.	I	.	I	.	4.9
348	50	I	V	I	12	I	I	I	I	I	I	6.1
351	48	U	.	I	14	.	.	I	I	I	.	6.1
353	52	I	.	.	9	.	.	I	.	I	.	3.3
357	50	I	.	I	13	.	I	I	I	I	I	5.5
363	50/48	.	I	V	10	.	U	.	I	.	.	4.0
379	46/8	U	I	I	11	.	.	.	.	I	.	6.5
406	52	I	V	.	11	I	I	I	I	I	I	5.5

GROUP NO. 10,

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece weight
19	48	I	.	I	16	.	U	I	I	.	.	7.3
51	48	.	.	I	15	.	U	I	I	U	.	5.0
65	48/6	.	I	I	16	.	U	.	.	.	U	6.5
87	48/50	I	I	V	14	.	U	V	.	U	.	5.6
91	48	I	V	V	14	I	I	I	.	I	U	6.0
93	48	U	Y	I	14	.	.	.	I	.	.	5.6
119	52	I	I	I	12	I	.	V	I	I	I	5.6
142	48	U	U	.	16	U	U	I	.	U	U	5.7
146	48/6	U	.	.	15	.	.	I	I	.	.	5.8
156	48	I	V	V	15	I	I	I	I	I	U	5.9
157	50	U	U	.	13	.	I	I	I	.	U	6.9
163	48	.	.	I	16	.	.	.	I	I	.	6.2
164	48/6	C	U	.	17	U	.	.	.	.	.	6.5
281	48	U	.	.	14	.	.	.	I	.	U	5.8
309	48/50	I	.	I	14	I	U	I	I	.	.	6.2
310	50	I	I	.	13	I	.	V	.	.	I	5.8
343	50	.	I	.	11	I	I	U	I	I	U	6.0
368	48	I	I	I	15	I	I	I	.	.	I	5.5
374	50	.	I	I	13	I	.	V	.	.	I	5.2
413	48	I	U	U	14	I	.	V	I	I	I	8.2
416	50	I	.	.	12	.	.	I	U	.	.	6.9
421	50	U	.	I	11	I	I	V	I	I	I	6.0
430	46/8	I	I	V	19	.	.	I	I	.	C	6.0
434	50	I	V	I	14	V	I	V	U	I	V	3.9

APPENDIX V11

BODY CONFORMATION DESCRIPTION

EWE HOGGETS 1945

GROUP NO. 1.

No.	Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body
41	U	V	V	V	X	I	•	•	V
42	•	I	X	V	V	I	I	•	V
47	U	I	I	I	I	U	•	U	I
74	C	•	•	I	•	•	•	U	•
77	•	•	I	I	I	V	I	•	I
95	•	I	I	I	I	•	I	•	I
132	U	I	I	I	•	U	U	U	X
133	U	I	X	X	V	U	U	U	V
154	U	I	I	V	•	•	I	U	I
182	•	•	•	•	I	•	I	•	X
211	U	I	I	I	V	U	I	U	I
215	C	U	U	C	C	•	U	U	U
227	I	V	V	V	V	I	I	I	V
267	C	•	I	I	I	I	I	U	I
283	•	•	I	•	C	U	•	U	U
311	C	U	U	U	•	•	•	C	U
313	•	U	•	I	V	I	I	I	I
330	U	I	I	I	•	U	U	U	X
331	U	U	•	•	•	U	•	U	•
341	•	I	I	I	•	•	•	•	I
347	U	•	•	I	U	U	U	U	U
352	U	U	U	•	•	I	I	U	U
360	•	V	V	I	V	•	I	•	I
402	I	•	I	I	I	I	•	•	I
410	U	U	•	U	•	I	•	•	•

GROUP NO. 2.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body.
136.		V	I	I	I	V	I	.	I	I
192		V	-	.	.	I	I	I	I	X
212		V	I	I	V	I	.	I	I	I
219		I	V	I	V	I	I	I	V	I
228		.	I	V	V	I	.	.	.	I
232		.	V	V	V	V	I	I	I	V
233		.	.	U	.	U	.	I	I	U
247		V	I	V	V	I	I	I	V	V
279		I	U	.	.	.	.	I	U	.
289		.	V	I	I	I	I	U	I	I
290		I	I	I	I	I	V	I	I	I
300		.	U	U	U	U	.	.	U	U
301		.	I	I	I	.	.	I	.	I
336		.	.	.	.	.	.	I	.	.
346		I	.	.	I	.	.	I	I	X
372		.	U	.	.	U	.	I	.	U
390		V	.	.	.	I	I	I	V	X
391		V	.	U	-	.	.	I	I	.

GROUP NO. 3.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body
50		•	•	•	•	•	•	U	•	•
73		I	V	V	V	I	I	I	I	V
88		V	I	V	•	•	•	I	V	I
105		U	I	I	I	V	I	•	U	I
111		V	•	•	•	•	•	I	I	X
209		X	•	U	U	U	•	U	V	U
222		I	I	I	I	I	I	I	I	I
237		•	I	•	•	I	•	I	•	X
319		U	•	U	U	U	U	U	U	U
320		I	I	I	I	I	-	I	I	I
334		•	V	I	I	I	•	I	•	I
359		I	I	I	•	•	V	•	I	X

GROUP NO. 4.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body
9		•	I	I	I	•	•	•	•	X
14		U	V	I	V	I	•	I	•	I
16		•	V	V	V	I	•	•	•	I
38		U	•	•	•	U	C	•	U	U
58		•	I	I	I	•	U	I	•	I
59		I	•	I	I	•	•	I	I	X
71		U	•	•	•	V	U	•	U	X
94		U	I	I	V	•	•	I	U	I
124		•	I	I	I	•	•	I	•	I
137		•	V	I	V	V	I	I	I	V
144		U	I	I	I	•	U	•	•	I
170		•	I	V	V	I	I	I	•	V
202		•	•	•	•	•	•	•	•	•
240		C	I	I	I	•	U	U	U	•
275		U	•	•	I	•	U	U	U	X
321		•	V	V	V	I	•	I	•	V
335		•	I	I	•	I	•	I	C	I
361		U	U	•	•	U	I	I	U	U
362		U	I	I	I	•	•	•	U	I

GROUP NO. 5.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body.
2		.	.	.	.	.	I	I	.	X
29		I	V	V	I	I	.	I	V	I
31		.	I	I	.	.	.	I	.	.
64		.	.	.	.	U	U	I	.	.
75										
110		V	I	I	V	.	.	I	V	I
113		.	.	.	.	.	.	I	.	.
114		.	I	.	I	.	.	I	.	I
117		I	.	.	U	U	.	I	I	U
143		U	I	I	I	.	.	.	U	.
174		U	I	I	I	.	.	I	U	I
175		V	.	I	.	I	V	I	V	V
198		I	I	I	I	V	I	I	I	I
204		I	.	.	I	I	.	I	I	I
230		.	.	I	I	.	U	I	U	I
252		.	I	I	I	I	.	I	.	I
255		I	.	.	.	U	.	.	I	.
262		U	U	U	.	U	.	I	U	.
266		.	U	U	.	U	.	.	U	U
325		I	I	I	I	I	.	I	I	I
326		I	.	.	.	.	U	I	.	.
401		I	I	.	I	.	.	I	.	X

GROUP NO. 6.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body.
1		I	I	I	I	.	.	I	I	I
23		I	I	I	I	.	.	I	I	I
46		I	I	I	I	I	.	.	I	I
53		V	I	I	V	U	.	I	I	I
56		.	.	I	I	U	U	I	.	.
57		.	.	I	.	.	.	.	.	.
60		V	I	I	I	V	I	I	V	I
78		.	.	I	I	.	.	U	U	.
79		I	V	V	I	I	I	U	I	I
115		.	u	u	.	C	U	U	U	U
122		V	.	I	I	.	U	I	I	.
126		.	U	.	I	U	U	.	.	U
127		I	.	.	U	U	I	I	I	.
134		.	.	I	I	.	U	I	.	.
176		V	I	V	I	.	C	.	I	I
178		.	I	I	I	I	.	.	.	I
179		.	.	.	.	.	.	U	.	.
188		.	I	X	V	C	U	I	.	I
200		C	I	I	.	U	C	I	C	.
254		I	.	I	I	I	U	.	.	.
259		V	I	.	.	I	I	I	I	I

GROUP NO. 7.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body.
20		I	I	I	I	I	I	I	I	I
33		U	U	•	I	I	U	I	U	•
36		U	•	I	I	I	•	I	•	I
43		•	U	•	I	•	U	•	•	•
44		•	•	I	V	V	I	•	•	I
67		•	•	V	V	I	I	I	•	I
160		I	V	V	I	V	•	I	I	V
185										
196		I	I	I	V	•	I	I	•	I
217										
239		•	•	•	•	•	•	I	•	•
242		I	I	I	I	I	I	I	I	I
243		•	•	•	•	•	•	V	•	•
260		U	•	•	•	•	•	•	U	•
261		C	•	•	•	•	•	•	U	•
294		I	I	I	I	•	I	I	I	I
339		U	•	•	I	•	•	•	U	•
387		•	•	•	I	U	U	I	•	•
407		I	V	•	•	U	•	I	•	•
417		I	•	•	•	•	•	I	I	•
418										
419		V	I	V	I	•	•	I	V	I

GROUP NO. 8.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body.
4		.	.	.	.	U	.	.	.	.
6		.	V	V	I	I	U	I	.	I
39		.	I	V	I	I	.	.	.	I
72		I	.	.	.	U	.	I	I	.
81		.	.	I	.	.	.	.	.	.
107		.	.	.	.	.	.	I	.	.
149		.	V	V	X	I	.	I	I	V
152		V	.	.	.	.	U	I	V	.
158		.	.	.	.	.	.	.	.	.
159		I	V	V	I	I	U	I	I	I
162		.	.	.	.	.	.	U	.	.
184		U	.	I	I	I	I	I	U	I
256		I	.	.	.	U	U	.	.	.
257		.	I	I	.	.	.	I	U	.
355		.	I	I	I	I	I	I	I	I
382		.	.	I	.	.	U	I	.	.

GROUP NO. 9.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body.
55		U	V	I	I	.	U	U	U	.
148		C	I	I	I	I	.	I	U	I
101		U	I	V	V	I	.	U	.	I
168		U	V	V	V	I	.	U	U	I
193		.	U	U	C	U	.	.	U	U
206		.	I	I	I	I	.	I	.	I
272		I	V	X	X	I	I	I	I	V
305		U	U	.	U	.	.	.	U	U
308		.	V	V	V	V	I	I	I	V
314		U	V	I	I	I	I	I	.	I
315		U	V	V	V	I	.	I	V	V
348		.	V	V	I	I	.	I	.	I
351		.	I	V	V	I	.	U	.	I
353		U	I	I	I	.	I	.	U	.
357		C	.	I	I	.	U	U	U	.
363		C	U	U	C	U	.	.	U	U
379		U	.	V	X	V	.	.	.	V
406		.	.	.	.	.	.	.	.	.

GROUP NO. 10.

No.		Head	Should	Back	Loin	H.Q.	Legs	Bone	B.T.	Body.
19		.	I	I	.	I	.	I	.	I
51		V	I	I	I	.	V	I	V	I
65		I	.	V	V	I	I	I	I	V
87		I	U	.	.	.	.	I	.	.
91		.	.	.	I	.	I	I	.	.
93		I	U	.	.	.	.	I	I	.
119		I	U	U	U	.	.	I	I	U
142		U	V	I	I	.	.	.	U	I
146		I	.	.	.	U	I	I	I	.
156		.	.	U	.	.	.	I	.	.
157		V	.	.	.	.	.	I	I	.
163		.	I	I	I	.	U	.	.	.
164		I	U	.	.	.	I	I	I	.
281		U	I	V	V	I	I	I	U	I
309		.	I	I	I	I	.	I	.	I
310		.	I	I	.	.	U	I	.	.
343		I	.	.	I	I	V	I	V	I
368		I	I	I	I	I	I	.	I	I
374		.	U	U	.	U	U	I	.	U
413		.	V	I	I	I	U	.	.	I
416		U	.	.	.	U	U	.	U	.
421		I	.	I	I	.	.	I	I	I
430		U	.	I	I	U	U	.	U	.
434		.	U	U	.	C	C	.	N	U

APPENDIX V111

FLEECE DESCRIPTION

5½ yr. OLD EWES.

GROUP NO.1.

No.		Count	Handle	Lustre	Colour	Lgth	S	HQ.	FQ.	Back	Evenness	Fleece	Fleece Wgt.
1		46/4	U	.	.	19	U	.	U	U	.	U	11.6
2		44	I	V	V	20	U	.	.	I	U	.	12.2
4		46	.	I	I	19	U	U	U	U	.	U	12.5
5		46	.	I	I	17	.	U	U	U	U	U	10.3
6		48	U	U	I	15	.	.	.	I	I	.	9.8
7		48	.	.	I	18	.	U	U	.	.	U	
8		48/46	.	I	V	19	.	U	.	I	U	.	12.5
10		48	U	.	I	18	.	.	I	I	I	.	10.6
11		44	U	I	V	21	.	.	.	I	.	.	12.2
12		48	I	I	V	19	I	I	I	V	V	I	9.7
13		48/6	.	.	.	15	U	.	.	.	I	U	9.0
14		50	.	.	I	16	I	.	.	.	.	.	8.7
15		46	U	C	U	17	C	C	.	U	C	U	10.4
16		50/48	I	.	I	16	.	.	.	I	I	.	9.2
17		46	U	I	I	15	U	C	C	U	C	C	16.8
19		44	U	C	U	17	U	U	U	.	U	U	9.2
20		50	.	U	.	16	.	.	I	I	V	I	10.2
21		48	U	I	V	16	.	.	.	I	I	.	10.1
22		48/46	.	.	I	18	.	U	U	U	.	U	10.1
23		46	.	I	I	18	I	I	.	.	.	.	9.6
25		48	.	.	V	16	I	.	I	.	I	.	9.3

GROUP NO. 2.

No.	Count	Handle	Lustre	Color	Length	S	HQ.	Fq.	Back	Even-ness	Fleece	Fleece Wgt.
27	52	U	U	I	13	.	.	I	I	V	.	7.8
28	46/8	I	.	.	18	.	U	U	.	U	U	12.0
29	48	.	.	.	19	.	I	U	.	I	.	9.6
30	44	U	.	.	21	.	I	.	U	C	.	13.8
31	46	.	U	.	17	C	C	C	C	U	C	10.1
32	44/6	U	.	.	20	U	C	C	.	.	U	10.9
34	48	.	C	U	17	U	C	U	U	U	C	9.5
35	40/4	U	U	.	18	C	N	C	U	C	C	12.0
37	46	U	U	I	18	.	.	I	I	.	.	10.8
38	48	.	.	I	16	.	.	I	I	.	.	9.8
39	46	I	I	I	18	U	U	U	.	.	U	9.7
40	48	.	U	.	19	.	.	I	.	.	.	11.4
41	46/8	I	U	U	17	U	U	C	I	U	U	10.C
42	48	.	.	V	17	.	.	.	I	.	.	11.9
43	48	.	.	.	17	.	.	I	.	.	.	12.9
44	48	.	.	.	15	.	.	I	.	I	.	9.5
45	50	I	.	I	13	I	U	I	U	U	.	8.0
46	44	I	I	I	20	U	C	U	C	U	C	11.6
47	48	.	U	.	18	.	.	.	U	I	.	10.5
48	48	I	I	I	16	I	I	I	V	V	I	9.2
49	50	U	U	I	15	U	U	.	U	I	U	10.3
50	46	.	.	I	17	U	U	U	I	U	U	9.3

GROUP NO. 3.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight.
52	48	.	.	I	17	U	U	.	I	U	U	9.8
54	48	I	V	V	16	.	.	.	I	.	.	9.0
55	48	U	U	.	16	.	.	.	I	I	.	10.5
57	48	U	.	I	17	.	.	I	.	.	.	-
58	48	I	I	I	13	.	.	.	I	.	.	8.2
59	44/40	I	I	.	19	I	.	.	.	U	.	11.5
60	48	I	V	I	18	I	I	I	I	V	I	11.8
61	46	I	I	I	18	I	I	I	I	V	I	11.0
62	46	.	I	V	20	.	.	.	.	U	.	12.0
66	48	I	V	V	20	I	I	.	U	U	.	10.8
74	46	.	I	V	16	.	.	.	.	I	.	11.2

GROUP NO. 4.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	Fq.	Back	Evenness	Fleece	Fleece Weight.
76	48	U	.	.	19	.	U	.	I	U	.	9.9
77	48	V	X	X	19	I	.	.	V	I	I	12.2
78	48	U	.	.	17	U	U	U	I	.	U	11.5
79	48	I	I	I	16	I	I	V	V	I	I	9.3
80	44	U	I	I	13	U	U	U	.	I	U	8.7
82	46	U	U	.	19	U	U	U	U	C	U	11.9
83	46	U	.	.	17	U	U	.	U	U	U	10.6
84	48/6	.	.	I	19	.	.	.	.	I	.	8.1
85	50	V	V	V	15	I	I	I	I	V	I	9.7
86	50	.	U	.	15	.	.	.	.	I	.	9.1
87	50	U	U	V	14	.	.	.	I	V	.	8.3
89	46	I	V	I	16	.	U	U	.	U	U	12.4
91	48/6	.	.	.	15	.	U	.	.	.	.	12.0
92	48	I	I	I	16	.	.	.	U	.	.	12.4
93	46/4	.	I	.	16	.	I	.	I	I	.	14.8
95	46/8	.	.	.	17	.	.	.	I	I	.	11.0
96	50	U	C	I	15	U	U	.	U	C	U	8.1
97	44	U	C	C	20	C	U	U	C	C	C	11.7
98	46	I	I	V	19	I	I	I	I	U	.	13.9
100	48	U	.	I	15	.	.	.	I	I	.	7.7

GROUP NO. 5.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight
101	44/6	.	I	U	18	I	.	I	U	U	.	12.4
102	46/4	.	U	I	14	U	U	U	C	U	C	9.1
103	48	I	I	V	17	I	I	.	V	I	I	12.5
104	44/6	.	I	I	15	.	U	U	I	.	.	12.8
105	48/6	U	U	.	17	.	.	.	.	I	.	12.1
106	46	I	I	I	16	.	C	U	I	U	U	8.1
107	48/50	.	I	V	17	.	I	I	I	V	I	10.0
108	48	I	I	V	18	.	.	.	U	.	.	9.2
109	48	.	I	V	17	I	I	I	I	V	I	11.2
110	48/50	.	I	V	17	.	I	I	V	V	I	12.6
111	48/6	I	V	V	17	.	.	.	I	U	.	12.4
112	48	U	U	.	14	.	.	.	U	I	.	10.3
113	48	I	I	V	18	I	I	I	I	I	I	10.5
114	48	I	V	V	20	I	I	I	.	I	I	11.7
115	48	U	.	I	16	.	I	I	I	I	I	9.9
116	46	V	X	V	19	V	I	I	I	I	I	9.8
117	46	.	I	.	21	I	.	.	U	I	.	14.1
118	48	.	.	.	17	.	.	.	I	.	.	10.2
119	46	U	.	.	15	.	.	.	.	I	.	11.5
120	48	U	U	.	17	.	.	I	.	.	.	12.4
123	44	U	.	I	16	C	C	C	.	I	C	10.0
124	46	I	V	V	19	.	.	.	I	I	.	13.7

GROUP NO. 6.

No.	Count	Handle	Lustre	Colour	Length	S	H.Q.	F.Q.	Back	Even-ness	Fleece	Fleece Weight
126	48	I	I	.	16	.	.	.	I	.	.	11.3
129	46	.	.	I	17	.	U	U	I	.	.	10.8
130	46	.	I	I	13	U	U	.	I	.	U	8.8
131	46	.	.	1	14	U	U	I	.	U	U	7.8
132	48	I	I	I	15	.	U	.	I	.	.	11.9
133	46	U	I	I	19	I	I	.	.	I	.	12.2
134	46	.	I	V	18	.	.	.	V	I	.	12.3
136	46	I	I	I	19	U	.	.	.	.	.	9.2
137	46	I	I	V	16	.	.	.	I	.	.	9.3
138	48	.	.	I	16	U	.	.	I	.	.	11.9
140	44	.	.	U	16	U	U	C	.	C	C	9.6
141	44	.	I	I	18	I	I	I	V	V	I	13.5
142	48	.	.	I	16	.	U	U	U	.	U	9.6
143	48	I	I	V	16	.	.	.	V	U	.	12.6
144	44	I	.	.	18	.	.	.	I	.	.	8.5
146	46	U	.	I	18	.	.	.	I	.	.	11.3
148	46	I	V	V	19	I	.	.	.	C	.	12.1
149	44	I	V	I	18	I	.	.	I	I	.	10.2
150	46	.	.	I	18	.	.	.	I	I	.	8.8

GROUP NO. 7.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight
151	44	U	.	C	17	U	U	C	.	U	C	11.2
152	48	.	U	.	17	U	U	U	V	I	U	13.5
154	48	I	I	V	19	.	.	.	I	.	.	11.1
155	50	U	U	V	13	.	I	I	.	I	.	8.0
156	44	U	.	C	21	C	C	C	U	C	C	12.8
157	46	I	V	V	19	I	I	I	I	I	I	11.0
158	44	.	I	I	19	.	U	U	I	C	U	12.7
159	46	.	U	C	20	U	U	U	.	.	U	4.9
163	48	I	.	.	20	U	U	U	.	U	U	10.6
164	44	I	I	I	19	.	.	.	U	.	.	9.8
165	48	.	I	.	17	.	I	I	U	V	.	10.3
168	50	.	.	I	17	.	U	U	I	I	U	10.8
169	46	I	.	I	16	.	.	I	I	.	.	8.8
170	46	I	I	I	16	U	U	U	I	I	U	11.7
171	46	.	I	V	16	I	.	.	.	U	.	12.0
172	48	I	V	X	18	I	I	V	V	V	I	10.0
173	50	.	U	I	17	U	U	U	U	.	U	9.0
174	44	U	U	U	17	U	C	C	.	C	C	13.7
175	46	I	.	I	16	I	C	U	.	U	U	10.2

GROUP NO. 8.

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight
177	46	•	•	I	18	U	U	U	U	C	U	11.8
178	46	•	I	I	20	•	I	•	U	•	•	13.0
179	50/48	I	I	•	16	•	•	I	•	I	•	8.6
180	50/48	I	•	I	19	•	I	I	V	I	•	11.3
181	44	U	•	•	20	•	I	•	I	U	•	11.8
182	46	U	U	C	16	U	U	U	U	C	U	9.5
183	46	•	I	•	18	•	U	U	•	•	U	13.6
184	48/50	I	I	X	19	I	I	I	V	I	I	9.8
185	46	U	U	I	19	C	C	U	U	C	C	11.9
187	48	U	U	U	15	U	U	•	•	•	U	8.4
188	48	U	C	C	-	C	•	•	•	U	U	9.6
189	47	I	I	I	14	•	•	•	I	I	•	9.0
190	44	U	•	•	18	U	U	•	I	C	U	11.3
191	44	•	•	U	16	•	U	U	•	•	U	12.4
192	46/4	I	I	I	17	•	I	•	•	U	•	11.5
194	48	•	I	I	17	I	V	I	I	V	I	9.3
195	48	•	•	I	16	•	U	•	U	U	U	9.7
196	50	U	•	V	19	•	I	I	I	V	I	12.1
197	46	U	I	I	16	•	•	•	I	•	•	11.5
198	46/8	•	I	•	17	•	•	•	•	I	•	15.7
199	50/48	U	U	•	17	•	•	•	I	I	•	10.4
200	46	•	I	I	19	•	•	U	U	C	U	13.1

GROUP NO. 9

No.	Count	Handle	Lustre	Colour	Length	S	HQ.	FQ.	Back	Even-ness	Fleece	Fleece Weight.
202	46/8	.	I	V	21	I	.	I	I	.	.	13.5
203	46	U	I	I	18	.	U	.	.	.	.	11.8
205	48	.	I	I	16	.	U	U	I	.	U	9.8
206	46	I	I	I	18	I	.	.	V	.	.	8.8
207	50/48	U	U	U	16	U	.	.	U	U	U	10.4
208	48/50	U	U	.	18	.	.	I	.	U	.	12.3
209	46	U	.	I	15	U	U	.	.	.	U	9.4
210	48	I	I	V	17	.	I	I	.	.	.	12.6
211	48/46	U	U	.	19	.	.	.	.	.	.	7.1
212	50/48	U	.	I	13	.	U	I	.	I	.	8.9
213	46/4	U	U	.	18	U	U	.	.	U	U	10.0
216	44	U	.	.	19	.	C	C	I	U	U	13.8
217	50	.	U	.	14	.	U	.	I	.	.	8.6
218	46	I	I	V	19	I	.	.	.	.	.	9.5
219	46	I	I	I	16	.	.	I	I	.	.	11.6
220	50	U	U	U	15	U	U	.	.	I	U	10.0
221	48	I	.	I	17	I	.	I	.	I	I	10.2
222	46	.	.	U	16	.	.	.	.	I	.	11.6
223	46/8	I	V	V	16	I	I	V	.	I	I	7.7
224	46	I	V	V	18	V	I	V	I	V	V	12.2

GROUP NO. 10.

No.	Count	Handle	Lustre	Colour	Length	S	H.Q.	FQ.	Back	Even-ness	Fleece	Fleece Weight.
227	48/50	U	U	V	16	U	U	U	.	I	U	9.0
229	46/8	I	I	I	14	U	U	U	I	U	U	6.5
231	46	I	I	I	17	I	I	I	I	I	I	10.8
232	46	.	.	I	21	.	U	.	I	I	.	13.1
233	44/6	.	V	V	20	I	I	.	I	.	.	11.6
234	46	U	.	I	17	.	U	I	.	U	.	11.4
235	46	I	I	I	14	.	U	U	V	.	.	8.6
236	46/8	U	.	I	18	.	U	I	U	C	.	11.4
237	48	I	I	V	18	.	.	.	I	V	I	13.3
238	46	.	.	.	18	.	.	.	.	.	.	13.4
242	48/50	.	.	.	17	.	.	.	.	I	.	12.5
243	44	.	I	.	20	.	.	.	.	.	.	11.0
244	46	.	I	I	16	.	U	C	I	U	U	11.4
245	46	.	.	.	19	U	.	U	I	U	U	9.1
246	48	.	.	I	17	.	.	I	.	.	.	11.7
248	46	.	I	I	16	I	.	.	I	I	I	12.0
249	48	.	.	.	16	I	.	.	.	.	?	10.3
250	46/48	U	U	C	20	C	U	C	U	C	C	12.3

APPENDIX IX — FLEECE DESCRIPTION - 2½ YR. OLD EWES

GROUP NO. I.

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ.	FQ.	BACK	EVEN-NESS	FLEECE	FLEECE WGT.
N 78		46	.	I	V	22	I	I	I	.	I	I	12.7
N 83		48	.	.	.	17	.	.	.	.	.	.	7.8
N 86		48	I	V	V	20	I	V	I	I	V	V	11.6
N 96		46	.	.	.	19	V	V	C	C	C	C	10.3
N 108		46	I	I	I	20	I	I	I	I	V	I	10.8
N 130		48/6	I	V	V	21	I	V	I	I	V	I	12.4
N 146		50/48	.	.	.	17	.	.	I	I	I	.	12.5
N 147		48	I	I	V	20	.	.	I	I	.	.	11.3
N 224		48	U	U	.	21	U	U	.	I	.	U	10.1
N 323		46	.	I	I	20	.	U	U	.	.	U	11.7
N 387		48	I	V	I	21	I	I	.	V	I	I	10.6
N 389		48/50	I	I	V	19	I	.	I	I	I	I	10.9

GROUP NO. 2.

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ	FQ	BACK	EVEN-NESS	FLEECE	FLEECE WGT.
N 4		46/8	.	.	I	20	.	.	.	.	.	.	10.9
N 28		48	I	I	.	21	U	I	.	U	U	.	12.1
N 32		46	I	I	I	20	I	I	.	I	I	I	14.0
N 47		50	.	.	I	19	.	.	.	I	I	.	11.3
N 51		46/4	U	I	I	22	.	.	.	U	U	U	7.0
N 186		50/48	I	V	V	20	I	I	I	V	V	I	12.1
N 192		50	I	I	V	16	I	I	V	U	.	I	10.5
N 288		50	I	V	V	18	V	I	V	U	V	I	9.2
N 320		48	.	.	I	23	I	I	I	.	I	I	12.7
N 349		48	I	.	.	19	U	U	.	.	U	U	12.9

GROUP NO. 3.

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ	FQ	BACK	EVEN-NESS	FLEECE	FLEEC WGT.
N 104		46	U	.	.	19	U	.	.	.	U	.	12.6
N 136		48/50	.	.	I	17	.	.	.	.	.	.	12.0
N 200		48/6	.	U	I	18	U	.	.	.	.	.	9.3
N 205		48	.	.	C	17	U	.	.	U	.	.	10.3
N 221		46	.	.	I	22	.	.	.	.	U	.	12.7
N 275		48	U	C	C	17	U	.	.	.	.	U	12.5
N 386		46	I	V	V	21	V	V	I	V	I	I	11.2
N 400		46	I	I	I	18	I	I	.	.	I	I	12.5

GROUP NO. 4.

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ	FQ	BACK	EVEN-NESS	FLEECE	FLEEC WGT.
N 20		46	I	I	I	26	I	V	I	I	I	I	13.7
N 34		46/4	.	I	I	18	.	.	.	I	I	.	11.7
N 40		48	.	.	.	21	U	C	C	.	U	C	13.5
N 58		46	.	.	.	22	.	U	U	I	.	U	12.5
N 89		46	I	V	V	21	I	I	V	V	V	I	11.2
N 155		48/50	.	I	V	18	V	V	V	V	X	V	12.5
N 165		50	U	U	V	17	.	I	I	I	I	I	12.3
N 182		46	.	.	.	20	.	.	I	I	I	I	13.5
N 197		48	I	V	V	19	I	I	I	I	V	I	12.9
N 213		48	I	I	I	21	I	I	I	.	I	.	9.1
N 283		46/8	U	U	I	18	U	U	U	I	U	U	10.6
N 308		48	.	.	V	19	I	.	U	C	C	U	11.8

GROUP NO. 5.

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ	FQ	BACK	EVEN-NESS	FLEECE	FLEEC WGT.
N 1		48	.	I	I	18	U	.	U	.	.	.	11.7
N 3		50	U	U	V	17	.	.	I	V	I	.	10.6
N 23		48	.	.	.	19	.	.	I	.	.	.	12.3
N 56		48	I	I	U	19	I	I	V	.	I	I	12.6
N 75		48	I	I	I	21	I	I	.	U	U	.	12.8
N 114		48/50	.	.	.	17	:	.	I	.	I	.	12.0
N 252		48/50	.	I	.	20	.	I	.	I	I	.	12.5
N 262		48/6	.	.	I	23	.	.	U	I	U	.	13.5
N 362		48	.	.	.	21	.	.	.	V	I	.	11.7
N 396		48	.	.	I	19	.	.	I	I	I	I	10.0

GROUP NO. 6.

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ	FQ	BACK	EVEN-NESS	FLEECE	FLEEC WGT.
N 18		48/50	I	.	V	21	I	.	I	I	.	I	13.1
N 39		48/6	U	U	I	19	:	I	.	U	U	U	10.0
N 57		48	I	I	.	21	I	V	V	I	V	I	11.6
N 133		46	.	I	.	22	.	.	.	U	U	.	13.1
N 139		46	I	V	V	21	.	I	.	.	.	.	11.9
N 152		50	I	.	V	18	I	I	V	I	I	I	11.0
N 196		48	.	I	V	18	I	I	.	.	I	I	11.8
N 236		46/8	.	I	I	22	I	I	.	U	.	I	10.8
N 316		50	.	.	V	20	I	I	V	U	I	I	9.5
N 321		50/48	I	I	V	18	.	I	I	V	I	I	10.8
N 350		48	I	I	I	19	I	I	I	I	V	I	10.1
N 356		46/4	U	C	C	18	U	.	.	.	.	U	13.0
N 392		46	.	I	I	22	I	.	I	.	I	.	15.5
N 395		48	I	I	I	21	I	I	I	V	V	I	10.0

GROUP NO. 7.

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ	FQ	BACK	EVEN-NESS	FLEECE	FLEECE WGT.
N 44		50/48	I	I	I	19	I	I	V	.	I	I	11.6
N 99		48	I	I	V	18	I	I	I	.	.	.	12.7
N 125		48	.	.	I	19	I	.	.	.	.	.	11.5
N 242		50/48	.	I	I	17	.	I	I	I	I	I	9.0
N 274		48	.	I	V	21	I	V	I	V	V	I	11.7
N 276		48	I	I	I	22	.	.	I	C	U	.	10.1
N 371		50	U	C	U	19	U	U	.	.	.	U	8.2

GROUP NO. 8

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ	FQ	BACK	EVEN-NESS	FLEECE	FLEECE WGT.
N 22		48	I	I	V	18	.	.	.	I	.	.	11.0
N 106		48/50	U	U	.	20	.	I	.	I	I	.	9.9
N 138		50/48	I	I	V	18	I	V	V	.	.	I	10.4
N 148		46	I	.	I	20	U	U	U	.	U	U	11.5
N 156		48	U	.	I	18	I	.	.	.	.	.	12.5
N 194		50	U	U	I	18	.	.	.	.	.	.	12.5
N 249		46/4	U	.	.	21	.	I	U	U	U	.	14.3
N 310		46/4	.	I	.	22	..	U	U	.	U	U	13.4
N 332		48	.	U	U	21	U	.	.	U	U	.	13.9
N 335		48/50	I	.	I	18	.	.	U	I	.	.	11.6
N 348		48	.	I	I	22	I	V	V	I	V	I	10.0
N 367		48	.	.	I	18	.	.	I	I	V	.	11.4
N 393		50	I	V	X	20	I	I	.	.	.	.	13.2

GROUP NO. 9

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ	FQ	BACK	EVEN-NESS	FLEECE	FLEECE WGT.
N 29		48	I	I	V	20	I	I	I	I	I	I	10.9
N 117		48	.	.	I	19	U	C	C	.	U	C	12.1
N 177		48/6	I	V	X	19	I	I	I	I	I	I	12.0
N 198		48/50	I	V	X	21	V	X	V	I	I	V	12.6
N 204		48/6	V	V	V	23	V	V	I	V	V	V	13.1
N 318		50/48	U	C	U	16	U	C	U	C	.	U	8.5
N 342		48/6	U	.	I	22	.	.	.	I	I	.	11.7
N 361		46/4	.	I	I	23	I	.	.	.	I	.	11.6

GROUP NO. 10

NO.		COUNT	HANDLE	LUSTRE	COLOUR	LENGTH	S	HQ	FQ	BACK	EVEN-NESS	FLEECE	FLEECE WGT.
N 121		48/6	U	U	.	19	U	U	U	I	U	U	13.1
N 131		50	I	I	V	19	.	.	U	U	U	U	11.8
N 173		50/48	U	U	.	18	.	I	V	.	.	I	9.3
N 212		48	.	.	I	20	.	I	.	.	.	.	12.8
N 325		48	I	V	I	20	I	I	I	I	I	I	15.0
N 334		48/6	I	V	V	22	I	I	I	.	.	I	11.7
N 336		48	I	I	I	18	.	.	I	.	I	.	11.1
N 374		50/48	.	.	I	17	.	.	.	.	V	.	10.9

APPENDIX X. BODY CONFORMATION DESCRIPTION

5½ YR. OLD EWES.

GROUP NO. I.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
1.		X	I	I	I	U	I	I	I	.
2.		.	I	I	I	I	.	I	.	I
4.		U	I	I	I	.	I	I	.	I
5.		.	V	V	X	V	V	I	V	V
6.		I	I	I	V	V	V	I	I	I
7.		.	I	V	I	I	I	.	I	I
8.		.	V	V	V	V	I	V	V	V
10.		.	I	I	I	I	I	.	.	I
11.		I	V	V	V	V	V	I	.	I
12.		.	I	V	I	I	I	I	I	I
13.		.	I	I	I	I	.	U	.	I
14.		.	.	.	.	.	I	.	.	.
15.		I	V	V	V	V	V	.	V	V
16.		I	V	V	V	V	I	.	V	V
17.		.	.	.	.	.	.	.	.	.
19.		.	.	.	.	.	V	.	.	.
20.		.	V	V	I	V	.	.	I	V
21.		U	I	I	.	.	.	.	U	.
22.		U	.	.	.	.	I	.	.	.
23.		U	.	.	.	.	.	U	U	.
25.		.	I	I	I	.	I	U	I	I

GROUP NO. 2.

NO.		HEAD	SHOULD.	BACK	LOIN	H. Q.	LEGS	BONE	B. T.	BODY
27		C	U	.	.	U	I	U	U	U
28		U	I	I	I	I	.	.	.	I
29		.	.	.	U	.	.	I	.	.
30		.	.	.	.	.	.	.	.	.
31		.	U	.	.	.	.	.	.	.
32		I	I	V	V	I	V	V	V	I
34		U	U	.	.	.	I	.	U	.
35		U	.	I	V	I	.	.	U	I
37		U	.	I	I	I	U	I	U	.
38		C	I	I	.	C	.	C	C	.
39		V	V	V	X	X	I	I	I	.V
40		.	I	I	I	I	I	I	I	I
41		I	I	I	I	I	X	I	U	I
42		I	I	V	V	V	V	.	V	V
43		.	I	I	I	I	.	I	I	I
44		.	.	U	U	U	.	U	U	U
45		I	I	I	I	I	V	V	I	I
46		N	U	.	.	.	.	.	C	.
47		I	V	V	X	V	I	I	V	V
48		.	.	.	.	.	.	.	.	.
49		U	X	X	X	X	V	V	I	X
50		.	.	.	I	.	.	.	.	.

GROUP NO. 3.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
52		.	V	V	I	I	.	U	.	I
54		.	.	.	.	.	I	U	.	.
55		C	.	.	.	.	C	C	C	.
57		I	I	I	I	I	I	I	I	I
58		I	I	I	I	I	I	I	I	I
59		U	I	I	.	U	U	U	U	.
60		U	I	I	I	.	U	.	U	I
61		I	I	I	V	I	I	I	I	I
62		.	I	I	I	I	I	I	I	I
66		I	V	V	I	V	V	.	V	V
74		.	.	.	.	.	.	.	.	.

GROUP NO. 4.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
76		.	I	I	I	I	I	U	I	I
77		.	I	V	V	V	I	I	V	V
78		.	I	I	.	I	I	I	V	I
79		U	V	I	I	I	I	.	.	I
80		.	.	I	I	.	I	.	.	.
82		I	I	I	I	I	V	.	I	I
83		.	U	U	U	.	.	.	U	U
84		U	.	.	I	I	.	.	U	.
85		I	I	V	I	I	V	V	V	I
86		.	.	.	.	I	.	.	.	.
87		.	.	I	I	.	.	.	.	.
89		I	X	X	V	V	V	.	I	V
91		.	.	.	I	.	.	.	.	.
92		U	I	I	V	V	I	V	V	I
93		.	.	.	.	.	I	I	.	.
95		.	I	V	V	V	I	I	V	V
96		.	V	V	V	I	I	.	I	I
97		I	I	I	I	I	I	I	I	I
98		U	V	V	I	V	I	I	I	V
100		.	V	V	V	V	I	.	V	V

GROUP NO. 5.

NO.		HEAD	SHOULD.	BACK	LOIN	H. Q.	LEGS	BONE	B. T.	BODY
101		U	I	I	I	I	I	.	.	I
102		.	.	.	I	I	V	U	.	.
103		I	I	V	V	V	I	.	I	I
104		I	I	I	I	I	I	I	I	I
105		I	V	V	V	V	I	V	V	V
106		C	U	U	.	.	I	.	C	U
107		.	V	V	V	I	I	.	V	V
108		I	I	V	V	V	I	.	I	I
109		.	I	I	I	V	I	C	.	I
110		I	.	.	.	.	.	U	U	.
111		I	I	.	.	I	I	.	I	.
112		.	V	V	.	I	V	I	I	I
113		.	V	V	V	V	I	.	I	V
114		.	I	I	I	I	I	I	I	I
115		U	V	V	V	V	I	U	I	V
116		C	.	U	.	U	U	U	C	U
117		.	I	V	I	V	I	I	I	I
118		U	V	I	V	.	I	.	I	I
119		.	.	.	I	I	I	U	.	.
120		V	I	I	I	I	V	.	V	I
123										
124		.	.	.	.	U	.	.	U	U

GROUP NO. 6.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
126		.	I	V	V	V	.	V	I	I
129		I	X	X	X	X	V	V	V	X
130		U	.	U	U	.	.	I	U	U
131		U	U	U	U	U	I	U	U	U
132		.	I	.	.	.	.	U	U	U
133		.	V	V	V	V	I	I	V	V
134		U	.	.	.	.	I	I	.	.
136		.	.	.	.	U	I	U	U	U
137		.	V	V	V	V	V	I	V	V
138										
140		I	.	.	.	.	.	.	.	.
141		U	V	V	I	I	.	U	.	I
142		.	VV	V	V	V	V	.	I	V
143		I	V	V	V	I	V	I	I	I
144		U	U	U	.	U	U	U	C	U
146		I	I	V	V	V	I	V	V	V
148		I	.	.	.	.	I	.	.	.
149		.	I	I	I	I	V	I	V	I
150		.	.	.	U	.	.	U	U	U

GROUP NO. 7.

NO.		HEAD	SHOULD.	BACK	LOIN	H. Q.	LEGS	BONE	B. T.	BODY
151		U	.	U	U	U	.	U	U	U
152		.	I	V	V	I	.	.	.	I
154		C	U	U	.	U	U	.	C	U
155		.	I	I	I	I	I	.	I	I
156		.	.	U	U	U	.	.	U	U
157		.	.	I	I	.	.	.	.	.
158		U	.	.	.	U	.	U	U	U
159		.	.	I	I	.	I	I	.	.
163		.	.	.	.	V	I	.	I	I
164		C	I	I	I	I	.	X	U	I
165		U	V	V	V	I	I	.	.	V
168		I	V	V	V	I	V	.	V	V
169		.	U	U	.	.	.	.	U	U
170		.	.	U	U	.	V	.	U	U
171		U	I	V	V	V	I	I	I	I
172		I	X	V	V	V	V	I	V	V
173		.	C	.	U	.	.	U	U	U
174		.	U	U	.	.	.	I	.	U
175		.	.	I	I	I	I	.	.	.

GROUP NO. 8.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
177		.	.	I	I	I	I	.	I	I
178		I	I	I	I	I	I	I	I	I
179		U	.	I	I	I	I	.	.	I
180		I	I	I	I	I	I	I	I	I
181		.	.	I	I	I	I	I	I	I
182		U	I	I	.	..	.	I	U	.
183		.	V	V	V	I	.	I	.	I
184		U	.	.	.	.	.	U	.	.
185		I	.	I	.	I	I	.	I	.
187		.	.	I	.	I	I	.	.	.
188		U	V	V	V	I	V	I	V	V
189		.	I	I	I	I	I	I	I	I
190		V	I	.	I	I	I	I	I	I
191		.	.	I	I	I	I	.	I	I
192		I	V	V	V	I	I	.	I	I
194		I	.	.	.	.	V	.	I	.
195		.	I	I	I	.	.	.	U	.
196		.	V	X	V	I	I	I	V	V
197		.	X	X	V	V	I	I	V	V
198		V	V	V	V	V	I	I	V	V
199		.	.	.	I	I	I	I	I	.
200		I	V	V	V	V	V	I	V	V

GROUP NO. 9.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
202		.	V	V	I	I	V	I	I	I
203		.	I	I	I	I	.	U	I	I
205		U	V	V	V	I	.	I	.	I
206		.	.	.	.	.	I	.	.	.
207		C	.	.	.	.	.	U	C	.
208		.	I	V	V	I	.	U	.	I
209		U	I	.	I	I	.	I	.	.
210		.	I	I	I	V	.	.	I	I
211		.	X	X	X	V	V	.	V	X
212		.	I	I	I	I	I	.	I	I
213		.	I	I	I	I	I	I	I	I
216		.	V	V	V	I	V	.	I	I
217		U	.	.	.	.	.	.	.	.
218		V	I	V	I	I	V	.	V	I
219		.	.	U	U	.	V	.	.	U
220		U	U	U	U	.	.	U	U	U
221		U	V	I	V	I	I	.	I	I
222										
223										
224		.	.	I	I	I	I	.	I	.

GROUP NO. 10

NO.		HEAD	SHOULD	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
227		.	.	.	.	.	I	U	.	:
229		.	.	.	U	.	.	I	U	.
231		I	V	V	V	V	I	I	V	V
232		I	I	.	.	I	I	I	I	.
233		U	I	I	I	.	I	.	.	.
234		.	I	I	I	I	I	U	I	I
235		I	X	X	V	X	I	V	V	X
236		I	V	V	V	I	I	I	V	V
237		I	I	I	V	V	I	I	I	I
238		.	I	V	V	I	I	I	I	I
242		I	.	I	I	I	I	.	I	.
243		.	U	U	.	.	.	.	U	U
244		.	.	.	.	U	.	I	.	.
245		I	.	.	.	I	I	.	I	.
246		.	I	I	I	I	I	I	I	I
248		.	I	I	I	I	I	I	I	I
249		U	.	I	.	I	I	I	.	.
250		.	I	V	V	I	I	.	.	I

APPENDIX XI

BODY CONFORMATION

DESCRIPTION - 2½ YR. OLD EWES.

GROUP NO. I.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 78		.	V	V	V	V	.	V	.	V
N 83		U	U	U	.	U	I	.	U	U
N 86		U	V	V	V	V	V	I	.	V
N 96		I	U	U	U	.	V	.	U	U
N 108		I	I	I	I	.	I	I	I	.
N 130		.	V	I	I	I	I	I	I	I
N 146		I	I	I	I	I	.	I	.	I
N 147		U	I	I	I	.	.	.	U	I
N 224		I	I	V	V	V	V	I	V	V
N 323		.	.	.	.	.	I	I	.	.
N 387		.	I	I	I	I	V	.	.	I
N 389		.	I	I	.	I	.	I	I	I

GROUP NO. 2.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 4		I	I	I	I	I	I	I	V	I
N 28		C	I	I	I	I	I	I	U	I
N 32		V	V	X	V	V	I	I	V	V
N 47		I	I	V	V	I	I	.	V	I
N 51		I	I	V	V	I	V	I	V	I
N 186		U	U	U	U	U	I	I	C	U
N 192		U	I	I	I	I	.	.	.	I
N 288		.	I	.	.	U	.	I	C	.
N 320		U	I	.	U	I	I	.	U	.
N 349		.	V	V	I	I	I	I	.	I

GROUP NO. 3.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 104		I	.	I	I	.	I	I	.	.
N 136		X	I	I	I	I	V	I	V	I
N 200		I	I	I	I	I	I	I	I	I
N 205		U	.	.	I	.	.	.	C	.
N 221		.	I	I	.	.	.	I	.	.
N 275		.	U	U	U	C	I	.	N	U
N 386		I	I	I	.	I	X	.	.	I
N 400		I	I	I	I	V	I	I	V	I

GROUP NO. 4.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 20		.	.	.	.	I	I	.	.	.
N 34		U	V	V	V	.	.	I	U	I
N 40		.	I	I	I	I	.	I	.	I
N 58		U	.	.	I	I	I	I	.	.
N 89		I	V	V	V	V	I	I	I	V
N 154		.	.	.	I	I	.	I	U	.
N 165		I	I	I	I	V	V	.	.	I
N 182		.	.	.	.	.	V	.	.	.
N 197		.	I	V	I	I	I	I	.	I
N 213		I	V	V	V	I	V	I	I	V
N 283		.	U	U	.	U	U	.	N	U
N 308		I	.	.	.	.	I	.	.	.

GROUP NO. 5.

NO.	HEAD	SHOULD	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 1	U	V	V	V	V	I	.	.	V
N 3	I	.	.	.	.	.	.	.	.
N 23	U	I	I	I	I	V	I	C	I
N 56	.	I	I	I	I	I	.	.	I
N 75	.	I	I	I	I	V	.	.	I
N 114	.	I	V	V	I	.	.	.	I
N 252	I	V	V	I	I	I	I	.	I
N 262	U	I	I	V	.	I	I	N	I
N 362	.	.	.	.	.	I	.	.	.
N 396	U	I	I	I	U	.	I	U	.

GROUP NO. 6.

NO.	HEAD	SHOULD	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 18	I	V	V	V	I	I	I	I	I
N 39	.	.	.	.	U	.	I	.	U
N 57	I	I	I	.	I	V	.	.	.
N 133	I	I	I	I	I	I	I	I	I
N 139	I	X	X	X	V	I	I	V	X
N 152	.	V	V	I	I	I	.	I	I
N 196	.	I	I	I	U	.	I	U	.
N 236	I	I	I	I	V	V	.	.	I
N 316	U	V	V	V	V	V	U	U	V
N 321	I	V	V	V	V	I	I	I	V
N 350	I	.	.	I	I	I	.	I	.
N 356	.	I	I	I	.	I	I	.	.
N 392	.	I	I	V	I	I	I	.	I
N 395	.	I	V	V	I	I	I	.	I

GROUP NO. 7.

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 44		N	.	.	.	.	.	I	N	.
N 99		.	V	V	V	.	I	V	.	I
N 125		I	I	I	.	I	I	I	.	I
N 242		I	V	V	V	V	I	I	I	V
N 274		I	.	.	I	.	I	I	.	.
N 276		.	V	V	V	V	I	I	I	V
N 371		.	I	V	V	V	V	I	.	V

GROUP NO. 8

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 22		I	I	V	V	I	V	I	.	I
N 106		U	.	.	.	U	.	I	U	.
N 138		.	I	I	I	V	I	I	I	I
N 148		.	.	I	.	.	V	I	U	.
N 156		V	.	.	.	I	X	I	V	.
N 194		.	I	I	V	V	I	I	I	I
N 249		I	I	I	V	I	V	I	I	I
N 310		I	I	V	V	V	X	I	V	V
N 332		.	V	V	V	V	I	I	I	V
N 335		I	I	I	I	I	V	I	I	I
N 348		U	.	.	U	I	V	.	U	.
N 367		I	I	I	.	I	V	.	I	I
N 393		V	V	V	V	V	V	I	V	V

GROUP NO. 9

NO.		HEAD	SHOULD.	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 29		.	I	I	I	I	I	I	I	I
N 117		I	V	V	V	V	V	I	V	V
N 177		I	I	V	V	I	I	I	I	I
N 198		.	I	I	I	.	U	I	.	I
N 204		I	I	I	.	.	I	I	.	.
N 318		.	.	.	.	U	.	.	U	U
N 342		U	.	.	.	.	.	I	.	.
N 361		.	.	.	I	.	.	I	.	.

GROUP NO. 10

NO.		HEAD	SHOULD	BACK	LOIN	H.Q.	LEGS	BONE	B.T.	BODY
N 121		I	I	.	.	I	.	I	.	.
N 131		I	I	V	V	I	.	.	I	I
N 173		.	U	.	.	.	I	.	U	.
N 212		.	I	I	I	I	.	I	.	I
N 325		I	V	V	V	V	V	V	V	V
N 334		.	I	V	V	I	.	U	.	I
N 336		U	U	.	U	.	V	.	U	U
N 374		I	I	V	V	V	I	I	I	V

APPENDIX XII CARCASE MEASUREMENTS DATA

- WETHER LAMBS 1944.

GROUP NO. 1.

Lamb No.	Age	Grade	F	G	T	B.T. Carcase Total	Wgt. Cannon Bone	A	B	C	Length Cannon Bone
34	92	D2	22.6	22.4	18.4	82	33.1	50	32	4	10.9
99	125	D2	24.9	22.4	18.7	73	31.4	44	28	4	11.0
153	129	P2	24.5	21.3	19.8	54	37.3	57	27	2	11.4
400	158	P2	24.6	21.7	19.2	66	33.2	50	25	5	11.1
70	154	P2	26.0	22.8	19.2	51	35.7	53	26	2	12.0
287	181	2nd	24.9	22.0	19.0	62	31.4	48	25	4	11.9
364	144	P2	26.8	22.0	19.4	35	38.8	49	23	1	12.0
288	181	D2	24.0	22.5	18.7	66	33.5	50	26	3	11.7
76	141	P2	23.6	21.7	18.3	75	30.3	46	27	5	10.8
342	128	P2	24.6	21.6	19.2	61	34.8	48	25	3	11.3
344	127	P2	24.3	22.1	18.3	69	38.5	51	25	4	11.4
365	125	P2	25.7	22.2	19.2	62	35.3	48	26	4	11.4
221	134	P2	25.5	22.0	19.7	65	34.8	47	27	4	12.1
226	190	P2	24.2	22.6	18.8	73	33.0	46	29	4	11.4
225	190	2nd	25.2	22.2	19.2	42	33.0	48	25	1	11.9

GROUP NO. 2.

Lamb No.	Age	Grade	F	G	T	B.T. Carcase Total	Wgt Cannon Bone	A	B	C	Length Cannon Bone
229	126	P2	24.8	21.3	19.0	45	38.1	52	26	1	12.0
250	125	2nd	26.5	21.6	19.8	45	39.6	52	27	1	11.7
383	99	D2	22.9	21.0	18.1	71	33.5	55	31	3	11.3
386	113	P2	26.3	22.1	20.0	65	39.3	55	30	3	12.2
411	100	D2	22.5	23.3	18.5	78	33.5	57	31	7	11.4
235	119	P2	24.3	22.6	18.6	70	39.4	60	30	3	11.6
377	167	2nd	24.3	22.2	18.7	59	32.8	52	26	3	11.5
213	180	2nd	23.7	21.7	19.9	51	38.5	53	27	2	11.6
220	171	P2	24.0	21.0	19.1	59	36.1	52	24	3	11.7
130	178	P2	25.0	21.3	18.6	55	32.5	52	24	3	11.6
135	163	P2	24.5	21.6	19.1	53	35.6	52	24	2	12.2
428	134	P2	24.2	21.7	18.3	69	33.0	54	27	4	11.1
191	160	P2	25.6	21.6	18.9	38	31.8	50	22	1	11.2
234	146	P2	24.6	22.5	18.9	64	35.5	56	29	3	11.8
337	147	P2	23.5	22.0	18.3	62		52	27	4	11.4
323	148	2nd	26.5	21.5	19.3	48	39.3	50	25	3	12.0
369	123	P2	24.0	22.1	18.5	71	34.0	51	28	4	11.2
299	186	P2	24.1	22.9	19.1	70	34.7	55	28	3	11.6
298	186	P2	24.0	22.3	19.2	59	35.2	49	25	3	12.0
422	167	P2	24.9	21.5	19.1	61	34.0	51	26	4	11.9
278	198	P2	24.7	21.8	19.4	61	33.8	44	29	7	11.4

GROUP NO. 3.

Lamb No.	Age	Grade	F	G	T	B.T. Carcase Total	Wgt Cannon Bone	A	B	C	Length Cannon.
104	132	P2	24.0	21.3	18.4	67	31.5	55	27	4	11.1
106	125	2nd	24.3	21.5	18.8	56	36.4	54	27	2	11.6
329	106	P2	23.9	20.8	18.2	66	33.3	52	24	5	10.5
433	147	P2	23.5	21.8	19.1	70	34.1	55	27	7	11.3
236	146	P2	23.9	22.2	18.0	64	31.8	49	25	3	10.7
249	145	P2	25.6	21.7	19.5	53	36.2	54	28	2	11.7
186	142	D2	22.9	21.5	18.6	74	34.7	57	30	4	11.1
318	148	2nd	26.0	21.7	19.2	39	31.2	55	25	2	11.2
306	136	D2	23.1	22.3	18.5	64	33.5	54	28	2	11.4

GROUP NO. 4.

Lamb No.	Age	Grade	F	G	T	B.T. Carcase Total	Weight Common Bone	A	B	C	Length Cannon
10	113	2nd	23.8	21.3	17.8	60	38.0	55	26	2	11.3
123	131	P2	24.0	22.4	19.0	72	34.8	50	27	5	11.1
203	120	D2	24.2	22.6	18.2	65	38.9	51	29	3	12.1
258	124	P2	24.8	21.6	19.0	60	38.4	56	24	3	11.8
423	101	P2	24.5	22.3	19.2	64	40.9	55	28	3	11.6
322	154	P2	25.1	22.0	19.0	58	37.5	51	25	3	11.9
169	148	P2	24.6	21.5	16.1	54	39.0	52	29	2	12.1
384	133	P2	26.7	22.0	19.0	55	39.8	53	27	3	12.1
139	150	P2	24.6	22.6	18.4	54	36.5	54	26	3	11.5
426	129	P2	24.3	21.5	18.9	63	34.4	52	26	5	11.5
425	129	2nd	25.5	21.5	19.0	43	38.5	57	22	1	12.1
125	145	P2	24.9	21.7	18.2	53	37.9	52	28	2	11.7
420	111	P2	25.3	21.9	18.9	56	40.3	55	24	3	11.7
15	149	2nd	26.6	22.1	19.3	47	42.5	50	26	2	12.1
424	110	P2	26.0	22.5	19.5	53	42.4	55	26	2	12.5
138	194	P2	25.3	23.0	18.9	69	37.5	55	29	4	11.7

GROUP NO. 5.

Lamb No.	Age	Grade	F	G	T	B.T. Carcase Total	Wgt Cannon Bone	A	B	C	Length Canon
3	114	P2	24.4	21.3	19.6	56	37.3	55	29	2	11.6
12	93	P2	26.7	21.8	19.4	60	41.1	52	29	4	11.7
24	131	P2	25.6	22.3	19.6	60	36.9	49	27	3	12.1
25	131	2nd	26.2	22.4	19.3	53	37.4	52	27	2	12.4
30	129	P2	26.0	22.5	19.5	56	38.3	52	27	2	12.4
61	120	2nd	28.0	21.3	21.7	26	44.4	52	24	1	12.6
62	134	2nd	25.8	22.0	19.8	56	38.8	50	29	2	12.7
173	98	P2	24.1	21.2	18.9	65	35.7	48	28	3	11.3
216	119	P2	25.6	22.0	19.7	58	35.8	51	26	6	11.9
223	126	2nd	25.1	21.9	19.1	49	38.8	51	29	1	12.1
338	97	P2	26.5	22.4	19.9	60	36.7	52	29	3	11.2
409	94	P2	25.6	21.7	18.9	56	39.2	51	27	3	10.9
429	154	P2	26.5	22.5	20.0	55	37.1	52	25	3	11.8
251	158	P2	25.9	22.1	19.3	51	26.6	47	25	3	11.7
291	143	P2	24.5	22.2	18.4	59	37.5	51	26	3	11.8
172	148	P2	24.3	22.0	18.7	68	35.0	46	27	5	11.5
199	147	2nd	26.3	21.6	19.7	39	34.3	55	25	2	11.3
118	139	2nd	25.5	22.3	19.3	50	37.0	49	25	3	11.6
294	137	P2	24.6	21.7	19.1	55	38.1	51	29	3	12.3
180	142	P2	26.0	21.7	19.3	35	39.2	48	26	5	11.9
28	163	P2	24.5	22.0	18.4	47	34.3	50	27	1	11.5
109	146	P2	25.6	21.7	19.4	63	37.8	54	30	4	11.9
394	120	P2	24.9	21.7	18.8	69	31.3	46	27	5	11.0
63	198	P2	26.2	22	18.8	52	37	47	25	4	12.5

GROUP NO. 6.

Lamb No	Age	Grade	F	G	T	B.T. Carcase Total	Wgt Cannon Bone	A	B	C	Length Cannon
8	67	P2	25.3	22.8	19.2	58	46	61	27	2	11.8
96	102	2nd	25.5	21.6	18.5	42	42.7	53	27	1	11.6
145	100	P2	24.0	21.6	18.9	60	39.8	57	30	2	11.5
147	122	P2	24.9	22.2	19.3	59	39.2	57	30	2	11.7
171	121	P2	25.9	23.5	18.9	64	40.5	56	28	2	11.2
189	127	2nd	25.6	22.1	19.4	44	36.6	56	27	1	11.4
408	108	P2	24.5	22.6	19.4	63	40.8	55	26	3	11.8
316	169	2nd	27.5	22.5	20.7	26	35.8	60	23	1	12.3
121	164	P2	25.5	22.9	19.3	26	35.7	58	26	2	11.7
140	150	P2	25.5	23.3	18.8	58	36.2	57	27	1	11.6
303	142	P2	24.6	22.7	19.3	57	35.3	50	27	4	12.0
253	151	P2	25.2	23.8	18.6	57	38.1	55	27	2	12.1
302	136	2nd	29.0	22.5	20.8	22	45.4	55	23	1	12.9
207	141	2nd	25.5	21.7	19.5	43	40.3	55	28	1	12.6
432	105	P2	25.0	22.8	19.3	61	41.3	58	28	2	11.5
201	135	P2	26.9	22.2	20.1	47	40.3	52	25	2	13.0
45	149	P2	24.5	22.7	18.3	66	35.3	52	29	3	11.2
269	131	2nd	26.1	22.6	19.2	53	44.0	57	26	3	12.1
224	190	P2	25.2	23.1	19.8	62	40.3	55	25	3	12.0

GROUP NO. 7.

Lamb No.	Age	Grade	F	G	T	B.T. Carcase Total	Wgt. Cannon Bone	A	B	C	Length.
161	129	P2	26.0	22.1	19.6	56	36.2	55	24	3	11.7
293	116	P2	24.2	22.1	18.3	64	35.6	58	30	2	11.1
392	99	P2	23.5	23.1	18.8	65	37.7	60	26	3	11.2
11	113	2nd	25.1	21.4	19.1	56	35.6	54	30	2	11.8
32	99	P2	24.8	21.9	19.1	64	35.0	57	29	4	11.0
35	129	P2	26.1	22.3	19.2	52	34.3	57	28	2	11.2
68	127	2nd	26.1	23.2	19.1	53	36.2	48	25	2	11.4
89	102	P2	23.8	22.2	18.2	65	33.9	54	28	2	10.6
128	124	2nd	27.9	23.2	20.1	43	40.1	56	27	2	12.1
129	124	2nd	26.6	22.7	19.6	50	37.4	56	29	2	12.1
195	181	2nd	24.9	21.8	19.2	53	35.0	56	28	2	11.5
214	146	P2	24.3	21.5	17.3	73	32.3	54	29	5	11.2
218	146	P2	26.2	22.0	19.3	51	33.8	54	26	3	11.9
83	160	P2	24.1	21.3	17.3	62	32.0	52	27	4	11.1
333	134	2nd	25.4	21.7	18.5	38	35.7	56	24	1	11.4
194	141	2nd	25.9	21.5	19.0	37	34.9	49	23	1	11.3
82	197	P2	24.7	21.9	18.9	57	32.3	55	28	2	11.2
295	197	P2	24.8	21.7	18.9	46	34.3	52	27	1	11.5
340	232	P2	26.7	22.2	19.5	60	32.8	46	27	5	11.6
238	237	P2	24.7	21.4	19.1	63	32.1	47	25	5	11.2

GROUP NO. 8.

Lamb No.	Age	Grade	F	G	T	B.T. Carcase Total	Wgt Cannon Bone	A	B	C	Cannon Bone
5	137	2nd	25.0	22.0	18.0	51	37.0	51	27	2	11.2
7	99	P2	25.8	22.5	19.1	61	39.5	51	29	3	11.5
21	128	2nd	25.2	22.8	19.4	50	39.5	58	23	2	11.4
37	136	2nd	35.5	21.8	18.9	46	38.0	54	27	1	11.6
40	122	2nd	25.5	22.7	19.3	52	36.5	55	28	2	11.5
48	128	P2	24.7	22.4	18.5	66	31.3	53	28	4	10.8
69	90	P2	25.2	22.4	19.2	62	42.1	54	29	2	11.7
150	97	P2	24.5	22.2	18.3	66	38.8	51	27	4	10.9
165	92	2nd	26.8	22.0	19.4	49	42.8	51	26	2	11.8
208	120	P2	25.9	23.5	19.0	47	42.6	55	28	1	12.1
241	95	P2	26.1	22.9	19.5	60	37.3	48	25	3	11.6
354	81	P2	25.6	22.3	18.9	63	38.3	52	28	3	10.9
388	99	P2	24.5	22.1	18.9	68	39.6	48	29	3	11.4
183	148	2nd	25.7	22.4	18.4	40	36.1	50	23	1	11.3
381	140	2nd	27.5	21.7	19.7	34	41.9	54	26	1	12.0
108	159	P2	24.7	22.5	18.8	68	35.5	52	26	5	11.1
80	147	2nd	26.3	22.2	19.1	37	37.5	55	24	1	11.3
271	187	P2	26.0	21.7	19.2	49	36.5	48	26	3	11.5

GROUP NO. 9.

Lamb No.	Age	Grade	F	G	T	B.T Carcase Total	Wgt Cannon Bone	A	B	C	Cannon Bone Length
155	99	P2	25.0	22.6	18.7	55	38.4	52	29	2	12.0
54	127	2nd	26.6	22.3	19.4	38	40.0	53	27	1	11.8
349	112	D2	24.5	22.6	19.0	71	41.1	51	29	4	12.2
356	118	P2	24.9	21.5	18.9	61	38.1	53	27	3	11.8
102	132	2nd	26.5	21.3	19.5	42	36.5	51	24	2	11.8
103	132	P2	25.9	21.8	19.6	49	35.2	48	23	2	11.6
112	87	P2	24.8	21.8	18.9	61	39.7	55	36	3	11.7
307	136	P2	24.1	21.7	18.3	26	33.0	56.	26	3	11.0
245	152	P2	23.3	21.7	18.3	59	31.9	51	23	3	11.3
205	135	P2	25.2	22.2	19.2	65	35.2	53	30	5	12.1
415	120	P2	24.9	21.4	18.5	61	32.8	51	26	4	11.2
187	141	2nd	25.3	22.6	18.6	42	38.1	54	25	1	12.0
286	131	P2	24.8	22.2	18.2	41	35.2	52	26	2	11.3
412	170	2nd	26.1	20.6	18.9	38	35.3	49	23	2	11.4
414	181	2nd	26.0	22.1	19.0	48	34.3	45	22	3	11.3
405	185	D2	24.1	22.3	19.0	72	31.2	45	27	5	11.3
345	89	P2	24.0	22.0	18.5	68	36.6	57	30	2	10.9

GROUP NO. 10.

Lamb No.	Age	Grade	F	G	T	B.T. Carcase Total	Wgt Cannon Bone	A	B	C	Length Cannon
17	90	P2	24.0	21.3	19.4	70	37.5	55	30	5	12.0
26	107	P2	25.3	21.9	18.6	67	40.0	57	30	4	11.6
86	132	P2	24.7	21.2	18.8	58	32.5	51	30	2	10.9
431	152	P2	24.3	22.1	18.7	67	32.3	51	28	3	11.2
97	152	P2	26.0	21.7	19.0	59	36.2	55	28	4	11.7
66	154	P2	24.9	22.0	19.1	65	34.0	53	29	5	11.9
396	120	P2	25.2	21.9	19.6	61	35.5	61	25	4	11.7
98	146	P2	26.1	21.2	19.5	62	34.4	55	32	3	11.7
27	201	P2	25.3	22.4	19.5	57	34.3	52	26	3	11.9
373	227	2nd	26.5	19.6	19.4	32	33.5	40	20	7	11.9

APPENDIX XII (CONT'D.)　　　　CARCASE MEASUREMENT DATA

GROUP NO. I

NO	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
34	21.8	18.5	16.7	25.3	9.0	17.4	55.0	57.0	28	34.0	7	17	3	14	22	19
99	22.5	18.3	16.0	24.3	9.7	17.8	55.0	54.5	27.5	34.5	4	19	2	12	15	19
153	20.7	18.1	15.3	25.7	8.4	18.2	55.0	52.0	28.0	35.5	1	13	2	5	12	12
400	22.1	18.1	16.7	25.9	9.1	17.9	57.0	53.5	27.0	34.7	4	14	2	10	14	20
70	22.7	16.3	14.8	25.5	7.7	17.6	52.5	52.5	25.5	35.5	1	12	1	3	12	12
287	24.0	17.5	16.5	26.3	8.4	17.8	54.0	53.5	29.0	34.3	4	13	4	11	13	19
364	22.1	16.7	15.5	25.3	8.6	18.9	56.0	54.0	29.0	36.6	2	10	3	8	7	5
288	23.1	17.5	16.2	26.7	8.3	17.8	54.5	52.0	27.0	35.0	2	12	3	11	18	17
76	22.7	17.6	16.4	25.3	8.4	17.4	56.0	54.5	27.0	33.7	4	20	3	10	17	20
342	22.5	17.0	14.5	25.4	7.8	17.6	56.0	53.0	26.5	34.7	1	15	1	6	13	17
344	22.2	17.7	14.8	26.4	8.3	17.8	56.5	56.0	28.5	33.6	3	17	3	9	16	19
365	22.2	17.0	14.7	25.5	8.8	18.3	56.5	57.5	27.5	35.5	3	12	5	10	12	19
221	23.3	16.7	14.1	24.9	8.7	18.5	54.5	55.0	28.0	35.6	4	17	2	8	11	19
226	23.2	17.7	16.6	25.5	8.2	17.3	56.0	54.5	28.5	34.8	5	16	1	10	18	19
225	21.2	16.7	15.2	26.0	8.3	17.6	59.5	56.5	30.0	35.2	1	12	3	5	13	5

NO	EYE Musc.	THYROID WEIGHT	WGT. HEAD	NO BORN	NO REAR.	AGE OF EWE	SHOULD	FQ CON.	BACK	LEGS	BONE	LOIN	LOIN CON.
34	12	1.7	2.9	1	1	5 yr.	V	5	V	V	I	V	14
99	8	2.9	3.2	2	1	5 yr.	V	5	V	I	U	X	5
153	7	5.6	3.1	3	2	5 yr.	.	4	.	.	I	.	4
400	5	2.0	2.8	1	1	2 th.	V	4	.	.	I	.	4
70	6	2.9	3.2	1	1	2 th.	.	4	I	I	I	I	3
287	5	3.5	2.9	2	2	5 yr.	V	4	V	I	.	I	3
304	3	5.6	3.1	2	2	5 yr.	.	4	I	.	I	.	3
288	6	3.7	3.0	2	2	5 yr.	.	5	.	.	.	U	4
76	7	1.9	2.8	2	2	5 yr.	V	4	.	V	.	I	5
342	5	3.1	3.4	2	2	5 yr.	I	4	I	.	U	I	4
344	5	2.0	3.3	1	1	5 yr.	I	4	I	.	.	V	4
365	6	5.4	3.1	2	2	5 yr.	.	3	.	.	U	.	3
221	7	2.6	3.0	1	1	5 yr.	.	4	.	.	.	.	4
226	9	3.9	3.0	2	2	2 th.	I	4	V	.	U	I	4
225	5	3.3	3.0	2	2	2 th.	.	3	U	.	U	U	3

GROUP NO. 2.

NO	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
229	22.7	17.7	15.4	25.7	8.9	18.4	59.0	57.0	29.5	35.3	2	11	2	5	11	5
250	21.3	17.5	14.7	26.1	9.2	18.7	58.5	56.0	27.0	36.0	2	17	1	3	7	5
383	23.0	19.4	16.9	25.4	9.9	17.1	52.5	54.5	27.5	33.2	4	17	5	13	17	15
386	21.1	18.2	15.4	25.6	8.6	18.5	57.5	55.5	28.0	36.4	2	16	3	8	9	17
411	23.0	18.6	17.0	25.1	9.3	17.5	56.5	57.0	28.0	33.8	3	17	6	16	22	17
235	22.9	18.6	15.5	26.2	10.2	17.8	58.0	57.0	28.5	34.5	2	17	3	5	17	17
377	22.5	16.9	14.8	25.4	9.0	17.5	56.5	53.0	28.0	34.1	3	12	3	7	16	17
213	24.2	17.4	15.5	25.5	7.9	18.3	56.5	55.5	28.5	36.0	2	15	3	6	10	12
220	22.3	17.6	16.1	25.5	8.9	17.8	59.5	56.5	29.5	34.2	1	15	3	8	13	17
130	22.6	17.0	14.6	26.7	9.2	18.0	56.5	55.0	29.5	34.3	2	14	1	6	11	17
135	21.8	17.9	15.5	26.7	8.5	17.9	56.5	55.0	26.5	35.1	1	15	1	5	13	12
428	22.9	17.1	15.5	25.9	8.6	17.5	56.0	55.0	27.0	34.2	2	17	3	11	15	19
191	22.0	17.0	14.4	24.3	7.8	18.5	55.0	56.5	29.0	34.8	1	13	1	3	10	5
234	22.9	17.5	15.3	26.1	8.0	17.6	53.0	54.0	29.0	35.3	2	13	3	6	16	17
337	21.7	18.1	15.1	25.7	8.9	17.2	56.5	53.5	31.5	34.3	2	10	2	10	18	19
323	21.3	16.7	15.0	26.1	8.7	18.7	56.0	55.5	31.5	36.1	1	14	3	8	6	17
369	22.1	18.2	15.3	25.1	8.0	17.5	57.5	53.5	29.0	33.9	2	15	3	8	17	19
299	22.8	17.8	16.3	27.2	9.4	17.7	58.5	58.0	31.0	35.2	4	17	3	7	19	17
298	22.6	17.2	15.5	26.1	7.3	17.5	58.0	57.0	30.5	35.2	3	12	1	4	17	17
422	23.3	18.7	16.5	25.6	8.8	17.5	59.0	56.0	29.0	35.2	2	13	2	8	12	19
278	23.6	17.1	15.3	26.4	9.4	17.8	57.0	55.5	28.0	34.0	3	13	2	9	13	16

NO	EYE MUSC.	THYROID Wgt.	HEAD WGT.	NO BORN	NO REAR.	AGE OF EWE	SHOULD.	FQ CON.	BACK	LEGS	BONE	LOIN	LOIN CON.
229	6	4.1	3.3	2	2	5 yr.	.	4	.	.	.	.	4
250	7	2.8	3.5	1	1	2 th.	.	3	.	.	.	.	3
383	9	2.9	2.9	1	1	5 yr.	X	5	X	V	I	V	5
386	10	8.6	3.1	2	1	5 yr.	I	4	V	.	I	V	5
411	9	3.7	3.1	1	1	5 yr.	X	5	I	I	I	X	5
235	10	2.1	3.5	2	2	5 yr.	I	4	I	I	I	I	4
377	6	3.9	3.2	2	1	5 yr.	.	3	U	.	.	U	2
213	7	5.0	3.2	2	2	5 yr.	I	3	I	.	.	I	3
220	4	3.7	3.1	2	1	5 yr.	I	4	I	:	.	.	4
130	4	9.2	3.3	2	1	5 yr.	.	3	.	.	I	I	4
135	4	5.1	3.3	2	2	5 yr.	I	4	.	.	U	.	3
428	7	1.8	3.3	2	1	5 yr.	I	4	I	I	.	I	4
191	2	1.8	2.9	2	2	5 yr.	.	4	.	I	.	.	3
234	9	2.8	3.4	2	2	5 yr.	V	4	V	I	.	I	3
337	7	1.2	3.2	2	2	5 yr.	I	4	I	I	I	I	4
323	5	-	3.1	1	1	5 yr.	.	3	.	U	.	.	2
369	8	5.6	3.3	2	1	5 yr.	V	4	I	V	.	I	4
299	8	3.9	3.1	2	2	5 yr.	I	4	I	I	.	.	4
298	5	1.9	3.1	2	2	5 yr.	U	3	U	.	.	.	3
422	6	7.3	3.2	1	1	5 yr.	I	4	I	I	.	.	4
278	9	[illegible]	3.1	2	2	5 yr.	.	4	.	I	.	.	4

GROUP NO. 3.

NO.	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
104	21.8	16.9	16.3	25.7	9.3	17.2	55	54.0	28.0	33.5	6	15	4	7	14	19
106	21.1	17.4	16.2	25.7	9.0	18.4	60.0	56.5	31.0	34.0	3	15	4	6	14	12
329	21.2	17.7	15.8	26.1	10.3	17.6	57.0	55.0	28.5	34.0	5	17	3	10	13	20
433	24.4	18.6	18.2	26.2	8.5	17.6	60.5	60.0	30.5	34.7	10	18	6	12	17	17
236	23.2	18.0	16.4	24.5	8.9	17.2	52.0	54.5	27.0	33.4	4	15	2	7	17	17
249	21.5	17.5	16.3	26.0	8.9	17.9	54.0	55.0	30.0	35.5	2	13	3	5	10	12
186	21.4	18.5	16.0	24.5	7.8	17.1	57.0	53.5	26.5	34.0	7	16	4	10	18	19
318	22.7	16.5	15.6	25.7	8.3	18.5	57.0	55.0	28.0	36.1	2	9	5	5	9	12
306	22.6	19.1	17.6	24.4	9.2	17.0	54.0	52.5	27.5	33.4	6	13	2	5	20	12

NO.	EYE MUSC.	THYROID WGT.	HEAD WGT.	NO BORN	NO REAR.	AGE OF EWE	SHOULD	FQ CON.	BACK	LEGS	BONE	LOIN	LOIN CON.
104	7	2.7	3.0	3	2	5 yr.	I	3	.	I	.	I	4
106	7	2.3	2.7	3	1	5 yr.	I	3	I	.	.	.	4
329	4	3.6	2.8	1	1	5 yr.	I	4	.	I	I	.	4
433	5	2.9	3.1	I	I	5 yr.	V	4	.	.	.	.	4
236	5	2.3	3.1	2	2	5 yr.	I	5	I	I	I	I	4
249	8	3.1	3.1	1	1	5 yr.	I	4	I	.	I	I	4
186	10	4.9	3.0	1	1	2 th.	I	5	I	I	.	I	5
318	5	3.9	3.3	2	1	5 yr.	.	3	.	I	I	.	2
306	8	3.1	3.1	1	1	2 th.	V	5	I	I	.	I	5

GROUP NO. 4.

NO.	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
10	22.1	17.4	15.3	24.8	8.9	17.2	56.1	56.7	29.5	33.1	3	16	2	6	15	12
123	22.4	18.5	16.4	25.0	8.4	17.6	56.0	54.5	28.5	34.2	5	15	3	9	18	20
203	23.3	18.5	16.7	25.9	10.2	17.2	57.0	58.0	29.5	34.0	7	15	3	8	18	15
258	20.8	17.5	15.2	26.3	9.1	17.8	56.5	58.5	29.5	34.7	2	16	3	7	12	17
423	21.2	18.0	14.7	27.0	9.0	17.2	59.0	58.5	30.0	35.3	3	14	3	8	16	15
322	22.9	17.2	16.3	24.8	8.5	17.7	56.0	56.5	29.0	34.5	2	12	2	6	13	17
169	21.7	17.6	15.5	26.2	8.0	17.2	55.0	54.5	29.0	34.5	2	12	2	5	13	12
384	21.3	17.5	15.2	26.6	8.7	18.3	57.0	57.5	30.0	37.2	2	18	3	13	7	17
139	21.7	16.8	15.2	24.9	8.5	17.1	55.5	56.5	28.5	35.0	2	15	3	5	10	17
426	22.0	16.9	15.7	25.1	8.5	17.1	57.0	56.0	30.5	34.0	4	14	5	8	14	20
425	22.5	16.7	15.0	25.8	8.4	17.9	58.0	58.0	23.0	35.5	1	10	3	5	10	5
125	21.1	17.7	16.1	24.5	9.0	17.7	60.0	58.0	30.5	34.7	2	14	2	6	12	12
420	23.2	17.9	15.0	25.9	9.3	18.3	56.5	56.5	28.5	34.3	3	13	2	5	12	17
15	22.2	17.2	14.7	25.3	9.3	18.2	54.5	56.0	28.5	35.8	3	12	1	3	8	12
424	23.7	18.5	15.9	25.7	8.5	18.7	55.0	57.0	27.5	35.9	2	13	4	5	11	12
138	22.1	17.4	15.3	25.9	9.4	17.6	58.5	55.5	28.5	35.3	3	15	3	8	15	19

NO.	EYE MUSC.	THYROID WGT.	WGT. HEAD	NO. BORN	NO. REAR.	AGE OF EWE	SHOLD.	FQ. CON.	BACK	LEGS	BONE	LOIN	LOIN CON.
10	6	1.5	3.0	1	1	2 th	I	4	I	I	I	V	4
123	7	3.2	3.1	1	1	2 th	I	4	.	I	.	V	4
203	7	3.8	3.3	1	1	5 yr.	V	5	V	I	.	V	5
258	4	2.9	3.1	1	1	5 yr.	.	4	.	.	.	.	4
423	6	3.5	3.1	1	1	5 yr.	.	4	.	.	.	I	4
322	5	3.6	3.1	2	2	5 yr.	.	4	.	.	.	.	4
169	9	3.5	3.1	2	2	5 yr.	I	4	I	.	.	I	4
384	7	3.2	3.2	1	1	5 yr.	.	4	.	.	.	.	4
139	6	2.1	3.0	2	2	2 th	I	4	I	.	.	.	4
426	6	2.8	3.1	2	2	5 yr.	U	3	.	I	.	.	3
425	12	3.2	3.1	2	2	5 yr.	U	3	U	U	.	U	3
125	8	2.1	2.9	2	2	5 yr.	I	4	.	.	.	.	3
420	4	3.6	3.0	1	1	2 th	V	4	I	I	.	I	4
15	6	2.0	3.3	1	1	2 th	.	3	.	.	.	U	3
424	6	2.6	3.1	1	1	2 th	I	5	I	I	.	I	4
138	9	3.1	3.2	2	2	2 th	I	4	I	.	.	.	4

GROUP NO. 5.

NO	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
3	20.5	17.5	15.7	25.5	9.0		57.5	56.5	28.0	35.3	4	11	2	9	13	12
12	22.4	18.4	16.0	26.5	8.5	18.0	54.5	56.5	27.3	36.3	5	18	3	12	7	18
24	22.7	17.0	15.5	25.4	8.6	18.1	58.0	60.0	30.5	35.6	2	15	3	6	12	17
25	21.4	16.9	14.2	26.5	8.9	18.0	59.0	58.0	29.5	35.3	2	14	1	6	10	12
30	21.8	18.0	15.7	25.8	8.3	18.1	57.5	56.5	28.5	35.8	2	18	2	9	11	12
61	21.8	16.4	15.1	25.8	8.5	18.9	57.5	58.0	28.5	37.6	2	8	1	4	1	5
62	22.7	18.1	15.6	25.7	8.1	18.6	59.0	58.0	29.5	35.8	5	14	2	6	11	12
173	21.6	18.1	15.4	26.1	10.3	17.6	57.5	58.0	29.0	34.2	4	15	2	9	13	17
216	22.5	18.2	16.3	25.6	10.0	17.9	56.0	54.5	27.5	35.8	4	14	4	12	11	18
223	22.0	18.3	15.7	24.9	7.9	18.3	57.0	54.5	28.0	35.0	1	12	2	7	12	5
338	21.3	18.2	15.7	25.7	10.8	18.3	60.5	58.5	28.5	36.7	3	17	3	10	9	15
409	21.8	17.6	15.2	25.1	8.3	18.2	58.0	60.0	30.0	35.3	4	13	2	5	10	17
429	21.5	17.0	14.8	26.9	8.4	18.3	56.5	57.0	27.5	36.4	3	14	3	8	10	17
251	22.6	16.5	15.7	26.3	8.6	18.0	55.5	57.0	29.0	35.6	2	10	2	8	10	17
291	21.3	17.8	14.6	25.3	7.5	16.6	53.5	53.5	28.5	35.1	1	13	3	7	15	17
172	21.4	17.4	15.3	26.0	9.3	17.3	55.0	55.0	29.5	24.7	4	13	3	9	15	20
199	21.8	16.3	15.1	26.5	8.2	18.5	54.0	55.5	29.5	36.8	2	10	1	4	7	12
118	21.6	17.1	15.1	26.1	8.8	17.6	53.5	57.5	29.0	36.0	3	12	1	5	9	17
292	21.3	17.6	16.0	26.1	9.1	18.0	58.0	56.5	27.5	35.4	3	15	2	8	13	17
180	20.8	17.0	13.9	25.2	7.7	17.0	59.0	58.5	30.5	36.4	4	11	2	6	9	20
28	21.9	17.3	16.7	25.7	8.2	17.0	56.5	55.5	31.5	34.4	1	14	4	14	15	5
109	21.6	16.3	14.6	25.7	8.3	18.2	57.0	57.5	28.0	36.0	2	14	1	4	11	19
394	22.3	17.1	14.7	25.7	9.4	17.5	54.0	56.5	28.0	34.3	4	14	4	11	15	20
63	22.7	17.1	16.0	26.7	8.6	18.4	56.5	55.5	28.5	35.5	3	10	3	8	9	19

NO	EYE MUSC.	THYROID WGT.	HEAD WGT.	NO BORN	NO. REAR.	AGE OF EWE	SHOULD.	FQ CON.	BACK	LEGS	BONE	LOIN	LOIN FAT
3	9	2.5	2.9	2	2	5 yr.	I	4	.	.	.	.	4
12	7	4.3	3.0	2	1	5 yr.	.	4	.	.	I	.	4
24	7	3.3	3.1	2	2	5 yr.	.	3	.	I	.	.	4
25	7	4.1	3.3	2	2	5 yr.	U	3	U	U	.	U	3
30	7	2.9	3.2	2	2	5 yr.	.	3	.	.	.	.	4
61	4	4.0	3.3	2	2	5 yr.	U	3	C	C	U	U	3
62	9	2.4	3.2	2	2	5 yr.	.	3	.	.	.	.	3
173	8	3.9	3.1	3	1	5 yr.	.	4	.	.	.	V	5
216	6	3.8	2.8	1	1	5 yr.	V	4	.	.	.	V	4
223	9	3.1	3.1	1	1	2 th	.	4	.	.	.	.	4
338	7	2.8	3.1	1	2	5 yr.	.	4	U	.	U	.	4
409	7	2.5	3.4	1	1	2 th	.	4	.	.	I	I	4
429	5	2.9	3.1	1	1	2 th	U	3	.	U	U	.	3
251	5	2.6	3.3	2	2	5 yr	.	4	.	I	.	U	3
291	6	2.9	3.1	1	1	2 th	I	4	I	I	.	I	4
172	7	3.9	3.0	3	1	5 yr.	.	4	.	.	.	.	4
199	5	2.7	3.2	2	2	2 th.	U	3	U	.	.	U	2
118	5	2.6	3.6	3	2	5 yr.	U	3	U	.	.	U	3
292	9	1.9	2.9	1	1	2 th	I	4	.	.	.	V	5
180	6	3.3	3.4	2	1	5 yr	U	3	.	.	.	U	3
28	7	3.4	3.0	2	2	5 yr	I	4	I	V	I	I	3
109	10	3.4	3.2	2	2	5 yr	.	4	.	.	.	U	3
394	7	7.8	2.8	2	2	5 yr.	I	4	I	I	U	I	5
63	5	3.4	3.1	2	2	5 yr	.	4	.	.	.	.	4

GROUP NO. 6.

NO.	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
8	22.3	18.8	15.9	24.8	8.4	18.1	56.5	55.8	28.1	34.9	3	16	2	3	15	12
96	20.2	17.6	14.3	24.3	9.5	17.8	56.0	57.5	27.0	35.1	1	11	2	3	10	5
145	20.7	19.0	16.3	24.1	9.6	18.0	56.5	55.7	27.2	35.0	3	15	2	7	11	12
147	22.0	19.4	16.1	24.3	9.6	18.0	54.5	55.5	28.5	36.0	2	16	3	8	14	12
171	22.0	18.0	15.8	24.3	10.0	18.5	58.0	56.0	28.5	35.5	2	17	2	4	15	12
189	20.0	18.0	14.8	24.7	8.3	18.3	57.0	57.5	28.5	36.2	1	13	2	3	11	5
408	21.5	18.5	16.3	26.1	9.3	18.3	55.0	54.0	27.5	34.6	3	11	3	7	17	17
316	21.4	17.0	15.6	25.7	6.7	19.3	59.5	57.0	29.5	37.2	1	12	1	3	6	1
121	22.1	16.9	15.0	25.9	8.3	18.5	56.0	56.5	28.0	35.2	2	14	5	5	14	12
140	22.6	17.5	15.1	26.0	7.7	17.5	55.0	51.5	25.5	36.0	1	12	4	5	16	5
303	21.5	17.3	15.9	25.1	8.9	18.1	53.5	56.0	30.0	35.7	3	17	2	6	17	19
253	21.2	17.7	15.2	25.1	9.1	17.9	55.5	54.0	31.5	35.7	2	15	1	7	15	12
302	21.1	16.5	14.3	25.1	7.4	18.9	57.0	58.0	28.5	38.5	1	8	1	2	1	5
207	20.9	17.3	15.1	24.0	8.2	18.2	55.0	55.5	27.5	35.6	1	14	1	4	10	5
432	21.4	18.0	15.3	25.3	8.9	17.8	58.0	56.0	28.5	35.5	2	15	2	5	16	12
201	20.6	17.2	15.4	25.8	7.7	19.0	58.0	54.0	27.0	36.6	3	13	3	6	7	12
45	21.4	17.4	15.1	24.8	8.7	16.5	56.0	56.5	29.0	34.1	3	11	3	7	17	17
269	21.1	17.1	13.8	25.1	7.8	18.8	58.5	56.0	29.0	36.0	1	11	1	3	11	17
224	21.7	17.8	15.9	25.3	7.4	18.8	57.0	55.0	27.5	36.2	4	15	5	8	16	17

NO.	EYE MUSC.	THYROID WGT.	HEAD WGT.	NO. BORN	NO REAR.	AGE OF EWE	SHOULD.	FQ CON.	BACK	LEGS	BONE	LOIN	LOIN CON.
8	7	-	3.1	1	1	5 yr.	I	3	I	.	V	I	3
96	7	3.1	3.4	1	1	5 yr.	.	3	.	I	I	U	3
145	10	2.6	3.7	1	1	2 th	V	4	I	.	.	V	4
147	10	3.8	3.5	1	1	5 yr.	V	4	I	C	.	V	4
171	8	3.2	3.5	1	1	2 th	I	4	.	I	I	V	4
189	7	2.0	3.4	2	1	2 th.	U	3	U	I	I	U	3
408	6	4.7	3.3	1	1	2 th.	I	5	I	I	I	V	5
316	3	8.6	3.5	1	1	2 th.	C	3	U	U	U	.	2
121	6	10.6	3.3	2	2	5 yr.	.	3	.	.	.	.	3
140	7	1.9	3.2	1	1	2 th.	.	4	I	.	I	.	4
303	7	4.7	3.3	1	1	5 yr.	I	4	I	.	I	.	4
253	7	3.6	3.2	2	2	5 yr.	.	4	.	I	I	.	3
302	3	2.6	3.4	1	1	5 yr.	U	3	.	C	.	C	3
207	8	2.8	3.2	1	1	2 th	.	3	I	U	.	.	3
432	8	1.6	3.3	1	1	2 th	I	4	.	.	V	I	3
201	5	4.9	3.2	2	2	5 yr.	U	4	U	C	U	U	4
45	9	3.1	3.0	2	2	5 yr.	I	4	I	I	.	I	4
269	6	2.9	3.3	1	1	2 th	U	3	U	.	.	U	3
224	5	3.7	3.4	1	1	2 th	.	4	.	U	U	.	4

GROUP NO. 7.

NO.	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
161	21.6	16.7	15.4	25.2	8.7	18.8	58.0	56.5	29.0	36.0	2	14	3	4	10	17
293	23.9	17.8	16.3	25.8	9.8	17.9	55.5	55.5	28.5	34.1	3	15	3	5	15	12
392	22.3	18.8	16.6	26.2	9.1	18.0	56.0	55.5	28.5	34.5	3	14	3	5	22	15
11	21.9	17.3	15.8	24.4	8.3	17.8	55.3	55.5	26.5	35.3	4	13	2	5	11	12
32	21.9	18.7	16.3	25.2	9.0	18.0	57.0	56.4	28.6	34.5	3	14	3	6	13	19
35	22.8	17.6	16.4	25.5	9.6	18.4	58.0	57.0	28.0	35.5	1	15	3	5	10	12
68	24.2	16.9	15.5	23.9	10.0	18.3	55.0	53.5	27.0	34.6	2	15	2	2	13	12
89	22.4	17.2	15.2	25.1	8.1	17.0	56.0	56.5	27.0	33.8	3	15	2	6	18	12
128	21.5	17.0	15.5	26.6	8.9	19.6	58.5	59.0	31.5	36.7	2	9	2	4	7	12
129	20.5	16.0	15.1	25.4	9.2	18.8	59.0	58.0	28.5	35.8	2	12	3	6	10	12
195	23.3	17.1	15.5	26.3	8.5	18.1	57.5	55.0	29.5	34.7	2	11	2	7	13	12
214	22.8	17.9	16.8	24.2	8.3	16.1	53.0	52.0	28.0	32.9	9	19	3	12	14	20
218	21.7	16.3	15.4	25.7	8.4	17.8	57.0	55.5	28.5	35.7	1	10	5	6	9	17
83	22.2	17.1	15.5	25.5	9.2	16.4	54.0	54.0	28.5	33.5	2	12	5	8	14	19
333	22.3	16.8	14.7	25.3	8.6	17.5	57.0	55.5	28.0	35.2	1	11	1	3	11	5
194	22.3	16.5	15.5	25.9	8.2	17.7	59.5	56.0	27.5	35.0	1	14	3	7	8	5
82	22.9	18.0	15.7	25.3	9.6	17.6	56.0	55.0	30.5	34.6	2	13	5	5	14	12
295	23.2	18.2	16.8	26.4	9.5	18.5	55.5	55.0	28.0	34.6	1	12	3	7	13	5
340	22.2	17.9	17.4	25.6	8.6	18.9	58.5	54.0	28.0	35.9	4	14	4	10	8	20
238	22.7	17.4	16.3	27.0	8.5	18.2	58.0	55.5	30.0	35.3	4	17	3	14	12	20

NO	EYE MUSC.	THYROID WGT.	HEAD WGT.	NO BORN	NO REAR.	AGE OF EWE	SHOULD.	FQ CON.	BACK	LEGS	BONE	LOIN	LOIN CON.
161	4	3.0	2.9	2	2	5 yr.	.	4	.	.	.	.	4
293	10	3.1	3.2	1	1	5 yr.	.	4	.	I	.	.	4
392	4	3.8	3.4	1	1	2 th	.	4	I	.	.	V	5
11	10	2.6	2.8	1	1	5 yr.	I	3	I	I	.	I	3
32	9	2.8	3.1	2	2	5 yr.	I	4	I	I	I	I	4
35	8	6.7	2.9	2	2	5 yr.	.	4	.	.	U	I	4
68	5	4.2	3.2	2	2	5 yr.	U	3	C	.	.	.	3
89	8	3.2	2.8	2	1	5 yr.	V	4	I	V	I	V	4
128	7	3.9	3.0	2	2	5 yr.	U	3	U	C	.	U	3
129	9	3.1	3.0	2	2	5 yr.	U	3	.	U	.	.	3
195	8	5.7	3.2	3	2	5 yr.	.	3	.	.	.	.	3
214	9	6.2	3.0	1	1	2 th	I	5	I	I	I	I	4
218	6	2.9	3.4	2	2	5 yr.	.	4	.	U	.	.	3
83	7	8.0	3.3	2	2	5 yr.	V	4	I	I	.	I	4
333	4	5.6	3.3	2	1	5 yr.	.	3	U	.	.	.	3
194	3	3.9	3.5	3	2	5 yr.	.	2	.	U	.	U	3
82	8	11.8	3.1	2	2	5 yr.	U	4	U	I	.	U	3
295	7		3.3	2	2	2 th	I	4	I	I	I	I	4
340	7		3.0	2	2	5 yr.	.	4	.	.	.	.	4
238	5		3.0	2	1	5 yr.	.	4	.	.	.	.	3

GROUP NO. 8

NO.	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
5	22.2	17.5	16.0	24.1	9.5	17.6	58.0	57.5	35.0	33.8	2	10	2	5	13	12
7	22.7	19.0	16.4	26.3	9.2	18.3	59.5	59.5	26.5	35.5	4	18	3	11	12	15
21	21.2	17.3	15.2	24.0	7.5	18.4	61.5	59.5	29.0	35.7	2	13	2	3	15	12
37	20.9	17.1	15.0	25.6	9.3	18.3	60.5	58.5	28.5	35.6	1	14	3	5	11	5
40	20.8	17.2	14.7	25.1	8.4	18.3	59.5	59.0	32.0	35.6	3	10	3	4	14	12
48	23.5	18.0	16.4	25.7	9.6	17.5	55.5	55.0	27.0	34.6	3	11	3	7	15	19
69	22.0	18.0	15.8	25.5	8.3	18.8	57.0	59.0	28.0	34.8	3	15	2	6	13	17
150	22.5	18.4	16.3	25.7	10.3	17.5	57.0	55.5	27.6	34.5	2	16	2	7	15	19
165	21.0	17.7	15.1	25.1	9.0	18.7	63.0	59.9	29.5	35.9	3	15	2	4	7	12
208	22.1	18.4	16.2	25.6	9.6	18.7	60.0	57.0	28.0	34.3	1	11	2	4	15	5
241	21.0	17.8	14.7	23.7	7.8	17.9	60.0	60.0	30.1		3	14	3	7	12	17
354	23.5	19.2	16.6	24.7	10.3	17.3	56.8	57.0	27.5	34.8	2	17	1	9	12	17
388	21.9	17.9	16.0	25.6	9.7	18.0	59.0	57.0	27.5	35.0	3	18	3	9	15	17
183	20.9	15.7	13.8	25.5	7.6	17.9	57.0	53.0	28.0	20.9	1	15	1	5	12	5
381	21.3	16.1	13.9	25.0	7.9	19.0	58.5	57.0	31.0	38.0	1	15	1	2	4	5
108	23.5	17.5	15.0	25.9	9.0	17.7	57.0	57.0	29.0	35.2	2	15	4	10	16	20
80	21.7	17.1	15.2	25.6	8.0	18.0	58.5	56.5	28.5	35.8	1	11	2	5	9	5
271	22.8	18.2	16.4	26.1	8.8	18.3	58.0	58.5	31.0	35.2	4	10	3	6	9	17

NO	EYE MUSC.	THYROID WGT.	HEAD WGT.	NO BORN	NO REAR.	AGE OF EWE	SHOLD.	FQ CON.	BACK	LEGS	BONE	LOIN	LOIN CON.
5	7	5.0	3.5	1	1	5 yr.	.	4	.	I	I	.	3
7	7	4.0	3.2	1	1	5 yr.	I	4	I	U	.	V	4
21	3	2.7	3.3	1	1	2 th	U	3	C	.	.	C	3
37	7	2.7	3.2	1	1	2 th	.	2	.	.	.	U	3
40	8	3.1	3.3	2	2	5 yr	U	3	U	C	U	.	3
48	8	3.0	2.7	2	1	5 yr	I	4	I	.	U	I	5
69	9	7.9	3.1	1	1	5 yr.	.	4	.	U	I	I	3
150	7	5.6	3.3	2	1	5 yr.	V	4	I	V	X	I	3
165	6	125.0	3.3	3	1	5 yr.	.	3	.	C	C	.	3
208	8	3.2	3.3	2	1	2 th	.	4	.	.	I	U	4
241	5	2.2	2.2	1	1	5 yr	.	4	.	.	.	.	3
354	8	34.2	2.9	1	1	2 th	V	4	I	I	I	I	4
388	9	5.3	3.3	1	1	5 yr	I	4	I	I	I	.	4
183	3	2.7	3.2	2	2	5 yr	U	3	U	.	.	U	2
381	6	3.2	3.0	2	2	5 yr	I	3	C	.	I	U	3
108	6	3.1	3.4	2	2	5 yr	I	4	I	I	I	I	3
80	4	2.1	3.1	2	2	5 yr	.	3	.	.	.	U	3
271	6	3.7	3.3	2	1	5 yr	I	4	I	U	.	.	3

GROUP NO. 9

NO	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
155	22.0	17.5	16.1	25.7	8.8	17.7	55.8	57.0	27.0	34.6	3	15	2	8	11	12
54	21.3	17.3	15.5	25.9	9.0	18.9	59.0	59.5	29.0	37.0	1	12	1	3	9	5
349	21.3	18.6	17.2	26.1	8.6	18.3	56.0	56.0	29.5	34.7	4	14	3	10	17	19
356	22.1	17.6	16.0	25.8	8.7	17.9	57.0	54.0	27.0	35.0	3	15	3	9	12	17
102	20.2	16.2	14.5	26.6	7.9	18.6	57.0	55.5	29.0	36.7	2	11	2	4	6	12
103	21.6	16.4	14.7	26.3	8.6	18.3	57.0	55.5	30.0	36.2	2	12	2	9	9	12
112	21.2	17.4	16.1	25.7	9.0	17.9	59.0	58.5	29.5	34.8	4	14	3	9	13	17
307	22.0	16.5	14.1	25.9	9.0	16.2	57.5	56.0	27.5	34.2	3	15	2	7	15	17
245	21.6	17.7	16.6	26.1	9.1	17.3	55.5	54.0	31.0	33.7	1	12	2	10	18	17
205	22.1	18.3	15.9	26.1	9.0	18.2	58.5	55.5	27.5	35.6	4	13	4	7	13	17
415	21.6	16.9	15.5	24.6	8.8	17.1	57.5	56.5	28.0	34.7	2	17	3	7	11	19
187	21.5	16.6	14.0	25.5	8.6	17.7	59.5	58.5	28.5	35.1	1	13	1	2	14	5
286	21.8	17.5	16.1	24.7	7.8	17.0	57.0	55.5	29.5	34.3	4	11	3	5	7	12
412	21.7	16.4	15.5	26.7	9.3	17.3	58.0	57.5	31.0	35.3	1	12	5	10	5	12
414	23.3	16.8	16.0	26.2	10.2	18.2	58.5	58.0	31.5	35.0	1	13	3	7	10	17
405	22.7	18.0	16.7	26.2	9.5	17.2	57.0	54.0	29.0	34.7	9	16	4	10	17	20
345	21.5	18.4	15.7	25.9	8.6	17.5	58.0	57.0	28.5	34.3	5	22	2	8	16	12

NO.	EYE MUSC.	THYROID WGT.	HEAD WGT.	NO BORN	NO REAR.	AGE OF EWE	SHOULD.	FQ CON.	BACK	LEGS	BONE	LOIN	LOIN CON.
155	9	2.1	3.0	1	1	5 yr.	V	4	I	I	.	I	4
54	7	3.2	2.8	2	2	5 yr	.	3	.	U	.	.	3
349	9	6.1	2.7	2	1	5 yr	V	5	I	.	.	I	5
356	7	2.7	3.1	2	2	5 yr	I	4	I	I	.	I	3
102	4	2.7	3.0	2	2	5 yr	.	3	.	.	.	.	3
103	3	2.7	2.9	1	1	5 yr	.	3	.	.	U	.	4
112	6	2.7	2.8	1	1	5 yr	.	4	.	.	.	.	3
307	6	3.0	3.0	2	2	5 yr	.	3	.	I	I	I	4
245	3	8.6	3.0	2	1	5 yr	.	4	I	I	.	I	3
205	10	3.6	2.8	2	2	5 yr	.	4	.	.	C	U	4
415	6	3.4	2.9	2	2	5 yr	I	4	.	I	.	I	4
187	5	3.5	3.1	1	1	2 th	U	3	U	.	.	U	3
286	6	3.6	3.0	1	1	2 th	I	4	I	.	.	I	5
412	3	2.7	2.9	1	1	5 yr	U	3	U	.	U	U	2
414	2		3.3	2	2	5 yr	.	3	I	.	.	.	3
405	5		3.1	2	2	5 yr	I	5	I	I	.	.	5
345	10	4.2	3.3	1	1	5 yr	V	4	I	.	.	V	5

GROUP NO. 10

NO	WR	WF	WTH	TH	WN	R	K	L	H	P	D	X	Y	J	LEGS	LOIN FAT
17	22.5	18.6	18.1	26.0	8.8	17.8	55.0	55.0	28.0	35.4	6	16	3	12	14	20
26	22.1	17.3	15.9	26.0	8.5	18.1	57.5	60.0	28.8	35.1	3	15	3	9	12	19
86	20.7	16.5	14.6	24.9	8.1	17.9	57.5	56.5	29.0	34.7	3	15	9	7	12	12
431	21.2	17.7	15.9	25.7	9.3	17.5	56.5	57.5	29.0	34.6	2	16	2	10	16	17
97	22.3	17.2	16.0	26.7	7.8	17.4	56.0	53.5	28.5	36.0	3	15	3	8	8	19
66	21.5	17.6	16.7	26.5	8.9	17.5	54.5	54.0	29.5	36.1	4	12	3	9	13	20
396	22.7	17.7	14.6	26.9	8.8	18.3	56.0	61.5	31.0	35.5	3	14	4	7	12	19
98	21.3	16.9	15.0	26.8	7.8	18.4	59.0	56.0	28.5	36.2	3	15	4	7	7	17
27	22.3	17.8	16.3	26.6	8.6	18.1	57.0	56.5	29.5	35.6	1	13	3	5	13	17
373	21.2	16.7	16.4	25.6	8.4	18.4	59.0	55.5	32.	35.3	0	11	5	8	1	16

NO.	EYE MUSC.	THYROID WGT.	HEAD WGT.	NO BORN	NO REAR.	AGE OF EWE	SHOULD.	FQ CON.	BACK	LEGS	BONE	LOIN	LOIN CON.
17	8	4.9	2.9	1	1	5 yr	V	4	V	I	.	V	5
26	10	2.5	3.1	1	1	2 th	.	3	U	U	.	I	3
86	10	3.9	3.2	2	2	5 yr	U	3	U	.	.	U	3
431	8	4.5	3.1	2	2	2 th	.	4	.	I	.	I	4
97	8	3.0	3.5	2	2	5 yr	U	4	.	.	I	.	3
66	9	3.6	3.0	2	2	5 yr	I	4	I	.	.	V	5
396	5	3.9	3.1	2	2	5 yr	C	3	.	.	U	I	4
98	12	2.3	3.1	2	2	5 yr	.	4	.	.	.	.	4
27	6	4.7	3.4	1	1	2 th	.	4	.	.	.	.	4
373	0		3.3	2	1	5 yr	.	2	.	U	.	U	2

APPENDIX XIII

CARCASE MEASUREMENT DATA.

Group No. 2.

WETHER LAMBS 1945.

Lamb No.	Age.	Grade.	F.	G.	T.	L.	A.	B.	C.	Weight Common Bone.	Length Common Bone.	B.T. Carcase Total.
9.	115	P2	25.2	21.7	18.9	54.0	55	31	1	39.6	11.5	46.
79	102	2nd	25.2	22.2	18.7	57.0	57	27	2	37.1	11.4	53
A114	103	P8	23.7	22.6	18.8	59.0	60	33	1	40.3	11.5	54
123	101	P2	23.8	21.9	17.3	54.5	57	27	2	32.1	10.2	57
233	116	2nd	24.5	21.3	18.8	57.0	50	30	2	33.1	11.4	60
362	115	2nd	24.9	20.8	19.3	57.5	53	26	1	37.2	11.7	43
447	102	D2	22.9	21.7	18.2	53.0	53	30	8	32.0	10.5	72
154	139	P2	24.8	21.8	19.5	55.0	51	32	5	34.4	11.9	68
217	152	2nd	24.9	22.1	19.2	55.0	60	27	1	34.0	11.1	50
203	166	2nd	26.9	21.2	20.2	58.5	52	27	1	34.6	11.8	35
37	165	2nd	25.3	21.9	19.4	54.0	53	26	2	31.7	11.3	51
A109	159	2nd	25.4	22.0	19.5	56.0	55	28	1	34.5	11.8	41
285	165	2nd	26.1	21.4	19.5	56.0	52	27	2	34.5	11.9	42
324	164	P2	24.7	21.3	19.1	57.0	55	26	4	36.0	12.0	62
383	204	P2	24.9	21.5	19.2	56.5	51	29	2	35.9	12.4	56
262	206	P2	24.8	22.7	19.7	55.0	53	30	2	36.7	11.8	64
318	205	P2	24.6	22.2	19.5	57.0	52	30	3	36.2	11.8	60
114	209	P2	25.2	21.7	19.2	54.0	50	26	2	35.5	11.5	53
91	189	2nd	24.5	21.6	18.5	55.0	51	25	1	31.2	11.3	48
199	186	P2	24.8	21.4	18.7	57.0	54	28	4	34.7	11.4	63
115	188	P2	26.0	21.3	19.5	57.0	52	29	1	34.6	11.7	42
13	200	P2	25.3	21.9	19.4	55.5	50	25	2	34.3	11.5	50
32	194	P2	23.9	21.9	18.4	55.5	52	27	1	33.5	11.6	53
325	247	P2	24.3	22.1	18.8	56.0	52	28	5	30.6	11.0	70
317	247	P2	24.8	22.6	19.5	54.0	52	29	5	32.5	11.6	73
409	244	2nd	24.0	22.4	18.7	57.0	49	25	3	30.2	10.7	65

Group No. 5.

Lamb No.	Age.	Grade	F.	G.	T.	L.	A.	B.	C.	Weight Carcase Bone.	Length Carcase Bone.	B.T. Carcase Total.
21	109	2nd	25.2	20.0	18.8	56.5	47	27	2	38.8	11.4	38
49	104	P2	24.8	20.5	18.5	58.5	46	29	6	40.4	11.1	64
387	96	P2	25.5	22.1	18.8	59.0	52	25	4	43.3	12.5	55
132	118	2nd	24.8	20.7	18.8	55.0	50	27	2	35.8	11.0	49
290	137	2nd	25.1	21.9	19.4	60.0	51	27	1	37.6	11.4	43
385	121	2nd	26.9	21.3	19.9	57.0	54	26	1	40.7	12.5	30
112	110	2nd	24.1	20.9	19.1	55.0	53	27	3	36.8	11.4	62
384	135	2nd	26.3	21.6	19.7	59.0	56	26	1	38.3	11.7	31
105	140	2nd	25.0	21.2	19.3	57.0	55	27	1	35.5	11.8	39
104	140	2nd	24.9	21.4	19.3	58.0	53	29	2	35.9	11.9	53
39	123	2nd	26.0	19.6	19.5	58.0	48	26	2	39.0	11.8	37
24	147	2nd	25.4	21.0	19.7	57.0	53	27	1	35.2	11.5	39
467	100	2nd	25.5	20.8	19.6	56.5	55	26	1	40.7	12.0	41
20	134	2nd	26.6	21.3	20.2	56.5	52	26	2	40.5	12.0	44
340	136	2nd	26.2	21.7	19.9	58.0	54	27	1	40.2	12.0	38
436	113	2nd	26.5	22.1	20.2	57.5	51	22	2	44.5	12.5	42
253	165	2nd	26.5	21.2	19.3	57.0	49	30	1	37.9	12.1	43
261	165	P2	26.5	21.2	19.9	57.0	47	27	2	38.0	12.5	43
146	167	P2	25.8	21.3	19.2	57.5	50	24	3	35.2	11.6	48
300	164	2nd	26.0	21.0	20.2	57.5	51	26	2	39.3	11.8	42
291	172	2nd	26.7	21.8	19.8	58.0	50	24	1	39.1	11.5	34
235	206	2nd	25.8	21.4	19.4	57.0	46	25	1	34.8	11.2	42
114	204	2nd	26.6	22.4	20.3	58.0	54	26	1	39.7	12.6	35
104	251	P2	25.7	21.2	19.8	58.0	53	28	4	35.9	12.0	61
332	247	P2	24.9	21.8	18.8	58.0	46	24	2	32.5	11.2	53

Group No. 1.

Lamb No.	Age.	Grade	F.	G.	T.	L.	A.	B.	C.	Weight Carcase Bone.	Length Carcase Bone.	B.T. Carcase Total.	
338	108	P8	24.6	21.8	19.0	56.0	56	30	5	36.2	11.5	71	
I.R.G.E. 113	Not recorded.	2nd	27.0	21.7	20.2	55.0	56	27	2	39.7	11.7	43	
215	138	P2	25.7	21.3	19.8	56.0	48	29	4	35.8	11.9	55	
103	119	2nd	23.9	21.2	18.3	55.5	49	28	2	32.5	11.0	57	
57	121	P2	24.8	21.7	18.7	54.0	49	26	2	33.9	11.2	52	
497	95	D2	23.2	21.6	18.7	53.0	53	31	4	34.6	11.1	76	
389	162	P2	24.9	21.0	19.0	55.0	51	26	4	32.8	11.2	60	
277	172	2nd	27.2	22.6	20.5	58.5	51	28	2	39.0	11.9	52	
305	205	2nd	35.7	21.8	19.8	56.0	50	26	1	38.1	11.8	43	
337	205	P2	24.1	21.6	18.7	55.0	48	26	4	31.7	11.3	64	
218	186	P2	26.1	21.1	19.8	53.0	45	27	3	33.9	11.3	53	
248	185	P2	26.0	21.6	19.7	55.5	48	28	3	35.7	11.6	60	
183	186	2nd	26.0	20.5	19.8	57.0	48	27	1	35.4	11.4	41	
440	172	2nd	25.5	21.6	19.7	55.0	49	25	2	34.3	11.5	52	
307	247	2nd	24.6	21.7	19.4	56.0	51	27	3	38.6	11.9	62	
98	252	P2.	25.0	21.9	19.3	55.0	48	28	5	32.9	11.2	65	
133	250	2nd	26.8	21.3	19.4	55.0	46	25	2	33.7	11.9	44	Bad with Arthritis.

Group No. 10.

Lamb No.	Age.	Grade.	F.	G.	T.	L.	A.	B.	C.	Weight Carcase Bone.	Length Carcase Bone	B.T. Carcase Total.
321	97	2nd	25.5	21.2	19.3	57.5	55	30	3	42.2	11.5	56
377	96	P2	25.0	21.9	18.1	57.0	52	24	2	36.7	11.4	50
258	116	P2	25.2	21.8	19.2	55.5	55	29	3	32.8	11.0	63
271	137	2nd	26.8	21.6	20.3	59.0	58	27	1	39.5	12.5	38
120	140	2nd	25.1	20.9	18.7	56.0	55	29	1	33.2	11.1	40
434	129	2nd	25.6	22.0	19.6	57.0	56	28	0	38.8	11.6	33
498	128	P2	26.1	21.3	19.8	58.0	55	30	3	40.3	12.4	53
274	151	P2	25.6	20.7	19.1	55.0	53	25	5	35.9		50
68	154	P2	23.7	21.3	18.2	53.5	47	29	5	32.8	11.0	49
53	157	2nd	26.1	21.8	20.0	57.5	62	27	1	40.7	12.2	39
46	171	P2	26.1	20.3	19.6	54.0	55	25	3	37.1	12.3	46
403	162	P2	24.1	22.5	19.4	56.0	57	30	2	36.0	11.8	63
191	166	P2	24.9	21.8	18.9	57.0	51	22	3	32.7	10.9	55
7	186	P2	26.0	22.3	19.6	58.0	52	26	4	37.6	11.6	59
94	169	P2	25.4	21.9	19.3	56.0	55	27	2	38.1	11.7	51
315	164	P2	26.0	21.9	19.8	54.5	58	28	1	37.7	12.3	44
225	165	P2	25.6	20.9	19.3	58.0	55	28	2	34.1	10.9	47
168	174	2nd	26.5	22.2	20.3	57.5	55	30	1	39.5	12.1	46
167	174	P2	25.5	22.2	19.5	54.5	58	29	2	34.0	11.4	56
444	171	P2	24.3	22.0	18.9	56.5	50	27	2	35.7	11.7	56
451	171	P2	26.9	21.5	20.1	56.0	52	27	2	35.0	12.1	46
488	166	2nd	26.9	22.6	20.3	57.0	53	24	2	37.6	12.7	45
77	190	P2	26.7	21.2	19.6	55.5	48	27	2	33.1	11.2	49
241	248	2nd	26.6	22.0	19.6	55.0	52	25	5	32.1	11.7	56

Group No. 6.

Lamb No.	Age	Grade	F.	G.	T.	L.	A.	B.	C.	Weight Carcase Bone.	Length Carcase Bone.	B.T. Carcase Total.
90	102	2nd	25.8	21.0	18.8	58.0	56	29	1	38.0	11.7	36
96	113	P8	25.9	23.1	20.3	59.5	56	33	2	42.0	12.4	58
406	106	2nd	26.5	22.2	19.5	58.5	65	31	1	41.5	12.2	38
60	142	2nd	26.3	20.8	19.4	59.0	54	26	1	41.9	11.8	31
357	114	P2	24.9	21.8	19.3	55.0	59	30	2	39.1	11.7	59
328	136	2nd	26.2	21.5	19.5	59.0	52	25	1	38.6	12.0	35
I.R.G.E. 101	Not recorded.	2nd	26.8	22.3	19,8	56.0	58	27	1	41.9	12.0	36
397	148	2nd	24.9	21.5	19.2	57.0	52	26	1	37.2	11.2	44
219	152	2nd	25.1	22.2	19.6	55.0	53	28	2	35.1	11.6	55
177	153	2nd	27.6	21.6	20.1	56.0	53	25	0	41.5	11.9	27
171	153	2nd	26.5	22.3	20.0	57.0	55	26	1	42.5	12.2	42
487	146	2nd	26.2	21.9	19.2	57.5	51	26	1	42.3	12.0	43
462	149	2nd	27.2	21.6	19.8	55.0	59	26	1	44.0	12.8	31
485	153	2nd	26.5	22.4	20.6	54.0	53	29	1	39.5	12.3	45
364	170	2nd	27.9	21.2	20.3	55.0	55	28	0	40.3	12.8	28
425	165	2nd	26.8	22.3	19.9	55.0	55	27	1	43.5	12.2	43
59	177	2nd	26.3	22.3	19.9	56.0	50	22	2	38.1	12.0	46
441	159	2nd	25.3	22.9	18.7	58.0	59	27	1	39.6	11.8	44
306	205	2nd	25.1	22.3	18.6	55.5	55	24	1	40.0	11.8	45
276	206	2nd	26.0	22.6	19.4	55.0	56	27	1	39.9	11.9	40
460	190	P2.	24.7	22.3	19.2	57.0	48	26	1	37.8	11.5	54
365	204	P2	25.0	21.8	19.9	56.5	51	26	2	38.5	12.2	56
448	171	2nd	27.0	21.6	19.8	58.0	53	25	1	41.2	11.7	34
459	171	P2	24.3	22.3	19.5	55.0	51	27	1	35.1	11.9	50
27	258	2nd	25.3	22.3	18.8	54.0	52	24	1	32.1	10.9	44
135	250	2nd	26.1	22.8	19.4	54.0	53	24	1	36.9	12.1	44

Group No. 7.

Lamb No.	Age	Grade.	F.	G.	T.	L.	A.	B.	C.	Weight Carcase Bone.	Length Carcase Bone.	S.T. Carcase Total
67	103	P2	25.8	21.3	19.0	56.5	52	27	1	36.6	11.0	44
174	100	P2	24.2	22.0	19.2	54.5	53	29	2	32.9	11.0	53
269	109	2nd	26.0	21.6	19.5	56.5	57	29	1	36.8	11.8	44
342	97	P2	24.8	20.5	18.5	55.0	53	27	4	32.9	10.6	56
192	138	2nd	25.3	21.7	18.8	57.0	53	24	0	34.0	11.0	30
353	135	2nd	26.0	21.1	19.7	57.0	52	26	1	33.3	11.0	36
369	135	2nd	24.0	22.3	18.5	57.0	52	26	1	38.6	11.2	48
3	144	2nd	24.7	21.0	18.7	59.0	57	23	1	34.5	11.1	37
2	187	P2	24.0	20.5	18.4	56.5	52	29	3	29.1	10.8	62
193	166	P2	23.5	21.1	17.6	55.0	50	25	2	30.0	10.5	57
22	183	P2	24.9	22.6	18.7	55.0	52	27	2	34.1	11.1	59
381	170	P2	24.2	22.4	18.4	58.0	52	28	4	31.8	10.8	73
268	185	2nd	25.7	21.5	19.1	56.0	48	27	2	33.6	11.8	52
250	185	D2	23.0	21.5	18.1	54.5	50	30	4	31.4	10.6	77
246	185	2nd	25.0	19.9	19.2	57.0	53	25	1	33.0	11.3	37
380	246	P2	23.9	20.8	18.6	54.0	48	27	7	27.7	11.0	62
478	230	P2	25.1	21.2	19.2	55.0	47	26	5	30.0	11.3	60
251	248	P2	23.9	22.5	18.8	54.5	50	27	4	31.5	11.2	73
470	232	2nd	25.4	21.7	19.0	55.0	55	30	3	35.4	11.5	59
354	246	P2	23.3	21.2	18.6	52.0	49	25	5	27.5	10.3	70
264	248	P2	26.2	21.9	19.6	53.0	50	25	2	31.9	11.4	49

Group No.8.

Lamb No.	Age	Grade.	F.	G.	T.	L.	A.	B.	C.	Weight Carcase Bone.	Length Carcase Bone.	B.T. Carcase Total
I.N.C.E.												
106	107	P2	26.2	22.1	19.8	58.0	54	28	2	39.1	11.9	50
112	101	2nd	26.0	22.4	19.2	60.0	52	27	1	37.1	11.6	42
161	100	2nd	26.0	21.5	18.8	58.0	54	25	0	40.6	11.4	27
326	108	2nd	25.3	22.0	19.3	58.0	49	25	1	38.1	11.4	43
40	105	2nd	25.8	22.3	19.0	57.5	56	27	2	41.6	11.6	51
463	100	2nd	25.2	21.5	19.2	55.0	56	29	4	34.3	11.7	56
181	166	2nd	26.0	22.1	19.1	58.0	49	27	3	35.9	11.5	51
359	163	P2	25.9	22.8	19.0	58.0	57	26	3	39.8	11.3	61
392	169	2nd	27.0	22.3	19.9	60.0	51	25	0	39.2	11.4	32
81	210	2nd	25.8	22.0	19.6	55.0	51	25	1	37.8	11.5	39
273	206	P2	25.2	21.2	19.3	58.0	48	24	2	37.0	11.4	46
180	186	2nd	26.4	21.3	19.6	55.5	49	24	1	36.0	11.9	33
330	184	P2	26.3	21.4	19.7	57.5	53	30	1	35.8	11.9	47
465	232	P2	26.0	21.9	19.2	58.0	50	26	2	34.0	11.3	50
490	229	P2	25.5	25.5	10.0	55.0	50	26	3	35.7	11.6	72
143	250	P2	25.6	22.3	19.0	57.5	48	26	4	31.3	11.0	59

APPENDIX XIV

LENGTH OF TIBIA.

In seeking some explanation of the irregularity exhibited in the T (length of tibia and tarsus) measurement, the following measurements were made on some dissected tibia bones from lamb carcases:

A - The maximum length of the bone.

B - From the most prominent (highest) point of the tubercle on the proximal end of the tibia to the end point of A.

T - length of tibia and tarsus from the tubercle on the proximal end of the tibia to the anterior edge of the distal end of the tarsal - as measured on the carcase prior to dissection.

The relationships $\frac{B}{A}$, $\frac{B}{T}$ and $\frac{A}{T}$ have been calculated and are presented with the crude data below.

GRADE -Y (SECOND QUALITY - UP TO 36 LBS.)

Lamb No.	A.	B.	T	$\frac{A}{T}$	$\frac{B}{T}$	$\frac{B}{A}$
1	16.9	15.3	18.6	.9086	.8226	.9053
2	19.2	17.1	20.8	.9231	.8221	.8906
3	18.4	16.4	19.7	.9340	.8325	.8913
4	17.6	15.9	19.6	.8980	.8112	.9034
9	17.4	15.4	19.8	.8788	.7778	.8851
10	17.0	15.2	18.5	.9189	.8216	.8941

GRADE - PRIME CROSSBRED 2 (UP TO 36 LBS.)

Lamb No.	A.	B.	T	$\frac{A}{T}$	$\frac{B}{T}$	$\frac{B}{A}$
2	17.0	15.4	18.8	.9043	.8191	.9059
3	16.5	14.7	17.8	.9270	.8258	.8909
5	16.2	14.4	17.7	.9153	.8136	.8889
7	17.3	15.6	18.8	.9202	.8298	.9017
8	16.0	14.1	17.5	.9143	.8057	.8813
9	16.6	14.9	17.8	.9326	.8371	.8976

GRADE - PRIME DOWN CROSS (UP TO 36 LBS.)

Lamb No.	A.	B.	T	$\frac{A}{T}$	$\frac{B}{T}$	$\frac{B}{A}$
4	16.4	14.7	18.0	.9111	.8167	.8963
5	15.2	13.6	16.8	.9048	.8095	.8947
6	16.5	14.8	18.0	.9167	.8222	.8970
7	16.7	14.9	18.2	.9176	.8187	.8922
9	16.2	14.3	17.2	.9419	.8314	.8827
10	16.4	14.7	18.2	.9011	.8077	.8963

The relationships show some considerable variation. In particular, the ratio of A to T shows that there is not a constant relationship between the measurement as taken on the carcase and the actual length of the tibia. This can in part be due to the inconstancy of the ratio of A to B which indicates some variation in the highest point of the tubercle in relation to the total length of bone. Though derived from very scanty data, these considerations appear to throw some doubt on the accuracy and validity of the T measurement in indicating length of tibia.