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MASSEY AGRICULTURAL COLLEGE
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A STUDY OF THE ROMNEY FAT LAMB EWE, WITH PARTICULAR REFERENCE TO MILK SECRETION AND ITS EFFECT ON FAT LAMB PRODUCTION.

Thesis submitted by " 392 "

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for the

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PREFACE.

The data obtained in the course of the investigation herin reported, were collected by the author , or under the supervision of Dr. C.R. Barnicoat or the author.

The writer is responsible for the analysis and interpretation of the material, and for the discussion of the results.

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GENERAL INTRODUCTION:

One of the distinguishing characteristics of mammals, is the dependance of the young, during early post-natal life, on nourishment secreted by the mammary gland of the mother. Hence milk secretion is of fundamental importance in all our farm animals with the exception of poultry. The essential attributes of milk (viz., high water content and liquid state, high digestibility, high protein content of excellent biological value, high calcium and phosphorus and the presence of most of the necessary vitamins) are specially suited to the needs of young rapidly growing animals.

In dairy cattle extensive study has been made of milk-producing ability and conscious effort made to improve this by breeding, and nutrition. Comparison of the characteristics of modern dairy cattle (highly developed milking qualities but inferior meat carcasses) and of beef cattle (early-maturing and good carcass quality but often poor milk yield) clearly indicate the extent of improvement from the wild form and the variation in productive efficiency of different types.

Valuable work on the milk-producing ability of other species, and its relationship to the welfare of the young has been carried out by Bonsma and Oosthuizen (1) and Donald (7) with Sows; and Ritzman (30), Fuller and Kleinhanz (10), Neidig and Iddings (24), Bonsma (2,3), 30a, Pierce (27,28) with ewes of non-milking breeds, and by several workers with specialised milking sheep, Scheingraber (31), Muhlberg (23), Maule (17).

These workers have shown that there is a close relationship between the mothering ability of the dam and the early post-natal expression of the hereditary potentialities of the young. Research with laboratory animals has strengthened this thesis (McDowell (18) and Enzmann (9)). McDowell has shown that the growth-curve of suckling mice is similar to the parabolic prenatal growth curve only when the milk supply is adequate. If this concept is fundamental, the indication is that the potential growth of the suckling is often not attained - a fact of some significance in live-stock production.

It is generally recognised that the relative rate of growth is more rapid in the early stages of the individual's life when "growth impulse" is strongest, and that the nutrition during this period may profoundly influence subsequent growth and development.

Hammond (15) and co-workers have suggested the permanency of the effects of periods of undernutrition, when they are applied during early life. Thus twins grow less rapidly than singles during the first month in consequence of having to share the milk supply, and although some of the difference is made up later when other food is consumed, the twin tends to be permanently retarded in its rate of growth. McMeekan (19) has demonstrated the influence of such periods of undernutrition on differential development of the growing pig.

Consequently, efficient live-stock production is largely dependant on rapid (and hence efficient) growth in the young animal, and this in turn is chiefly dependant on the milk production of the dam. This is of particular significance in fat-lamb raising, where feeding of concentrate supplements to lambs is not usually practised.

Analyses of milk of various species (and breeds within species) have shown considerable differences in composition.

Species.	Fat %.	SNF %. *
Sow	7.0	12.0
Ewe	5.0 - 7.0	11.0
Cow	4.0 - 5.0	9.0
Mare	1.0 - 1.5	8.0

It is also evident that these differences are related, in a general way, to the shape and slope of the growth curve of the suckling. Piglets double their birth weight in about one week, lambs in about three weeks and calves in about seven - eight weeks. A practical consideration arises when hand-rearing young animals on milk from other species, cow's milk being too rich for foals and too poor for piglets.

It is uncertain whether variations in milk composition within a breed are important. While some regard qualitative effects as unimportant, most authorities consider that composition has a certain limited influence on rate of growth of sucklings. Some workers (15) consider protein to be more significant biologically than fat, and others that total solids is the most important consideration. The general concensus of opinion, however, seems to point to the energy content of the milk as being the most vital concept (Gaines 11)), apart from yield.

More importance must, however, be attached to quantitative data, as an estimate of yield is more readily obtained than an estimate of any of the constituents, under practicalconditions.

* Morris, Morrison and various others.

Generalised observations in practice indicate considerable breed differences in milk yield. The Merino (improved for wool) and the Southdown (improved for carcass quality) are regarded as inferior in milking ability to intermediate or dual-purpose types (Romney and crossbred) (2).

In the New Zealand fat-lamb industry, during the war years 1939-44, between ten and twelve million lambs were killed annually, most of these being exported. Many of the fat lambs produced for export come from more or less specialised fat-lamb farms. The endeavour on this farm is to produce per acre, the maximum weight of fat lamb of the best quality, in the shortest time. In practice this objective involves the production of lambs fat from the mother.

The ability of the ewe is of vital economic importance on the specialist fat lamb farm as other sources of income are merely subsidiary. Our fat-lamb industry is essentially based on the use of crossbred ewes* culled from hill-country flocks, in which they have become less valuable for breeding flock replacements and growing wool than for selling as potential fat-lamb ewes. These five- and six-year old ewes are brought from

* In the North Island such ewes are virtually purebred Romneys having been graded up for many generations by Romney sires from a Merino-Lincoln base. In the South Island, crossbred ewes are mainly of the fine-woolled type, mostly Corriedales and half breds, although the Romney crossbreds are also employed.

comparaitvely hard grazing on to good quality pastures or arable farms and there mated with Southdown, or other early maturing "Down" rams. In this way the milking quality of the crossbred, (Bonsma (2)) is combined with the carcass quality of the Southdown.

The individual milk-producing ability of such ewes is unknown, but the fact that they have survived three or four lambings in a relatively poor environment, helps to insure reasonable performance in this respect. Experience has demonstrated that such ewes respond well to the improved nutrition and better management of intensive farming.

It is probable that under present conditions the maintenance of a high level of nutrition is the most vital concern of the specialist fat lamb farmer - particularly since milk yield is so intimately dependent on feed supply and since present knowledge does not permit the identification of good or poor milking strains of sheep.

Nevertheless the primary dependence of milking capacity upon inheritance makes the development of methods of improving this character in the sheep of great importance. A primary prerequisite is the investigation of methods of recording milk yield. While the present study is of the laboratory type in this regard, it is hoped that it may be of some assistance in an eventual solution of the problem.

To the stud breeder also, the milk-producing ability of his stock is of first rate importance as much success depends on producing well developed healthy animals for sale. It is generally recognised that much selection potential is expended on economically unimportant points, whereas little attention is

paid to the milking ability of the ewes. In fact it is not unreasonable to suggest that the practice of supplementing the lamb from an early stage with concentrates or other specially nutritious foods may even tend to mask poor milking capacity and so lead to the perpetuation of low yielding strains. It is under the stimulating environmental conditions of the stud farm that the higher milking strains can be best located.

The fat-lamb raiser must also consider milk yield in relation to the carcass quality of his produce.

The general opinion among farmers and research workers is that rapid growth to slaughter produces the best fat-lamb carcass. Certainly the most rapid growth under normal commercial conditions is the most economical growth, but we know little about the effect of small differences in rate of growth on carcass quality at the varying ages at which export lambs are killed.

The differential growth gradient concept advanced by Hammond (15) in sheep, and McMeekan with pigs (19) is well expressed by the latter (21).

> "It is well established that the characters upon which the value of any meat animal depends are fundamentally the result of differential growth and development changes occurring within the body. Differences in rate, order and extent of development of particular parts and particular tissues are responsible for the differences in form in anatomical, histological and chemical composition, and in

> structure of animals of different weights, breeds and even of different species. Furthermore, hereditary and environmental influences produce their effects upon the animal's body by controlling and modifying differentially the growth gradient mechanism."

It would appear, therefore, that there are good grounds for believing that studies of milking capacity in sheep are worthy of attention. Accordingly the experiments herein reported have been carried out. In particular they have been designed to provide information on the following points:

(1) Basic data on the milking ability of North Island Romney type ewes.

(2) The composition of their milk.

(3) The relationship between the milk yield of the ewe and the welfare of the lamb.

(4) The possibility of using the rate of growth of the lamb, as an index to the milking ability of the ewe, in breeding and selection work.

(5) The application of present techniques to more extensive field investigations and group comparisons.

II. MATERIAL AND METHODS.

(a) EWES:

The material available consisted of 42 mature ewes which were entering their fifth lambing season and 50 two-year old ewes purchased immediately prior to mating. These two groups were from the same flock originally and may be regarded as reasonably uniform samples from the same population, as the history of the flock showed consistent use of rams from the one stud for many years.

The area on which the ewes remained throughout, consisted of 20 one-acre paddocks, predominantly perennial rye (Lolium perenne) and white clover (Trifolium repens). Annual topdressing with superphosphate and lime had been carried out for several years previously. The soil is heavy clay which tends to be very wet in spring and the area (Kairanga) is notorious for footrot in sheep. The two age groups were divided equally into two mobs of mixed ages, one Southdown ram being employed in each. As each group was shifted daily a ten-day rotation was practised and the aim throughout was to keep the pastures 2-3 inches in height with the aid of cattle.

The rams were raddled frequently on the brisket, a different colour being used on each, and the colours changed fortnightly. As the ewes were moved between 8.0 - 9.0 a.m. each day, the rams were also alternated between mobs. This procedure enabled the date of tupping, the gestation period and the efficiency of the sire to be known.

One ram (No.62) proved of poor fertility and many of the ewes coloured by him returned to service. Tupping began on the 26th March and ram 62 was replaced on 26th April.

As the ewes were tupped, their eartag numbers (and also that of the ram concerned) were read and a raddle mark made on their sides. This facilitated the identification of ewes tupped each day, as it was only necessary to catch those ewes which were coloured on the rump but not marked on the side. Powdered raddle mixed with castor oil proved better than raddle alone for marking the rams.

Live weights of the ewes were recorded monthly for the first three months and thereafter fortnightly until the first ewes lambed. From then on all the ewes were weighed when milking took place.

The ewes lambing each day were separated from the mob and isolated for three days when the lambs were weighed and tagged. To simplify the experiment all ewes reared one lamb only, and consequently one member of each set of twins was either fostered or killed.

(b) LAMBS:

"Birth weight" throughout this paper refers to the weight at 3 days, as it is obviously impracticable under New Zealand farming conditions to be present when each ewe lambs - even with the small numbers dealt with in the present experiment. In order to investigate the relationship of three-day weight with "cleaned" birth weight, and to test its reliability as an estimate of weight at birth, newly dropped lambs were weighed whenever possible and these weights compared with the three-day weights. Donald and

McLean (6) and Hammond (15) both imply that a weight recorded at 2-3 days is useful and reasonably accurate.

The live weights used in plotting the growth curves were those obtained for the "empty" weighing at the early morning milking and thus compare with the final weight recorded immediately prior to slaughter.

Individual weights at 10-day intervals were obtained by plotting and smoothing the graphs of observed data. Periodical averages for each group were obtained - (a) by averaging the individual figures from the smoothed graph, and (b) by tabulating and averaging the observed data in 10-day periods. The resulting averages obtained by these two methods agreed very closely. The "smoothed average" figures are presented in the text.

(c) MILK YIELDS:

For convenience in determining the milk yields, temporary yards were erected. The lamb-holding pen, the three "milking" pens and the weighing pen were all covered by a canvas sheet, enabling work to be carried on despite rain.

The milk yields were determined over a 24-hour period, using the same technique as other workers (2). The young were weighed before and after suckling and the difference - or the milk consumed by the lamb - regarded as the yield of the ewe. The sum of the differences over a 24-hour period, using 4-5 weighings was taken as the daily milk production for the period. Thus, it is comparable with the New Zealand Group Herd Testing technique in measuring dairy cow yields, in that total periodical yields, and fat yields are estimated from one day's observations. Sampling

errors are magnified according to the length of the period between sampling.

Bonsma (2), Pierce (27(28) and others have used this method with sheep of non-milk breeds, Donald (7), Bonsma and Oosthuizen (1) with sows and various workers with rabbits, mice and guinea-pigs. It is also recognised as a reliable method of estimating the milk yield of lactating women.

In the present experiment the ewes and lambs were separated about 11.0 a.m., the ewes returning to pasture. From 2.30 p.m. on the same day and 10.30 a.m. the following day, four or five weighings were carried out, one at 5.30 a.m. being utilised for milk sampling. This time was chosen because the ewes had accumulated sufficient milk overnight to allow an adequate sample to be taken, and because when still young the lambs often found it difficult to consume all the milk accumulated.

To facilitate identification a number was rubbed on the back of each lamb with dark raddle, and a tag with the corresponding number attached to the wool at the base of the neck of the ewe. For holding the lambs a reinforced canvas sling was found to be the most satisfactory. Steelyards weighing 100 lb. in $\frac{1}{2}$ oz. proved rapid and accurate. As a routine measure for the first four or five weeks of each lactation, the udder of each ewe was handled and any milk remaining after the lamb had finished was withdrawn and measured.

Each ewe was brought in for the first determination following the tagging and weighing of the lamb. Thus in the main, the first observations were made on or between the third and tenth day of each lactation. Milk yield estimations were carried out

at approximately weekly intervals from 1/9/44 to 6/10/44 and then at fourteen day intervals until 19/12/44. The yields of a small number of ewes still suckling lambs were recorded in mid-January, 1945. The majority of the records are fairly complete for 100 days. Where a record was incomplete, the gaps were filled in by interpolation of the graph and from average ratios between the missing period and the remainder of the total yield obtained from the complete records. Several records were discarded because lactation curves could not reasonably be interpolated from the data available. Lactations which were obviously abnormal because of disease were not included.

To determine the milk yield at any given stage of lactation, the observed yields were plotted on graph paper. The curve was then carefully smoothed and readings taken at ten-day intervals.

Two alternative methods were used for the analysis of the milk yield data, and the resulting figures compared with those obtained from the smoothed curves. In one method, the readings were taken from the plotted graphs at ten-day intervals before smoothing. In the other method, the observed data were tabulated in ten-day periods (the identity of the individual records thus being lost), and all observations falling within each period were averaged. This method cannot be used where the data is required for statistical analysis and is best used for larger numbers.

Readings were taken from carefully smoothed graphs, at the mid-point of each period, e.g. the readings in this case were taken at 5, 15, 25 days. By this means much of the error arising from the slope of the lactation curve is avoided. The

somewhat arbitrary method of smoothing the plotted curves, is considered to be justified as:

(1) Any particular estimation may be higher or lower than the true milk yield of the ewe at the time -

(a) if she is nervous or upset, or

(b) if the lamb is unsettled

(c) day to day variation as observed in dairy cows,

may give a false estimation of the average daily yield for the period.

(2) The theoretical lactation curve is smooth rather than a series of straight lines joining a number of points.

(d) MILK COMPOSITION:

Most of the ewes in the yield determinations were also utilised for sampling - the few that were excluded being nervous or abnormal because of disease.

From the initiation of the experiment standardised technique was aimed at. The milk produced by each ewe was sampled at regular intervals and at a specified time during the 24-hour period. The time adopted was the early morning milking after the 12-hour night spell, the ewes then having sufficient milk accumulated to enable an adequate sample to be taken for analysis.

To obtain a representative sample of the whole of each ewe's milk was a problem. The difficulty in obtaining milk by hand is that the ewes of non-milking breeds, being unaccustomed to hand-milking, will not readily let down their milk when handled by humans. Apparently they require their own lambs to initiate the "letting down" processes.

Several ways of sampling were considered. One method is that of aliquot samples. From previous yields of the

ewe the probable yield for the milking concerned is estimated and a specified proportion of this is taken from one quarter. This method appears unsuitable for large numbers of ewes, and may be erroneous in that the rise in fat percentage as milking proceeds may be rather variable (Whittleston (37)). In addition, the previously mentioned day to day variation would be likely to render any analysis obtained on this basis rather unreliable. Complete hand-milking, likewise, would be unreliable, as there is some variation in the proportion of their potential yields which the ewes will release with hand-milking (10).

It was thought that by allowing the lamb to suckle one quarter only, a representative sample could be obtained from the other quarter. This method was tried and proved satisfactory once the operator became used to manipulating the small teats and holding the ewe still. In many cases the second quarter could be milked while the lamb was still suckling, the ewe then being quite contented. Most of the ewes soon became used to this handling and the quarter could often be emptied out in as little time as required by the lamb.

In view of the large variation in fat percentage in milk from individual ewes, and the uncertainty of the method of sampling from one quarter, detailed investigation of the qualitative aspects of the effect of milk on the lamb, were thought to be unwarranted.

The data available, however, (Fat % and S.N.F.%) were tabulated in ten-day periods and the figures falling within each period for the two age groups, were averaged and plotted as curves, on a similar basis to the milk yield curves.

(Note: The solids-not-fat analyses were corrected to a fat-free basis by the factor $\frac{S \times 100}{100 - F}$

Where S = Solids-not-fat %
F = Fat %

In the text "C/SNF" refers to this figure).

The rise in fat content during milking was investigated in a number of ewes, by milking into a two-ounce container, each consecutive sample being tested for fat. In these cases the lamb was allowed to suckle a second time and the second quarter was again stripped in case further milk had accumulated in the cistern.

In this investigation 400 samples were analysed for fat (Gerber) and for total solids over a period of 4 months, and at each milking, composites were made up of equal samples from all the ewes tested, the two age groups being kept separate. Further analyses were then carried out, viz. Protein, Ash, Calcium, (CaO), and Phosphorus (P_2O5).

(e) CARCASS QUALITY:

All the lambs in this work were slaughtered on reaching marketable weights, that is between 63 and 70 lb. live-weight. In all cases the "empty" live weight (after a fast of 16-20 hours) is taken as the final weight on the growth curve.

Each carcass was subjected to a comprehensive study which included objective internal and external measurements of many parts, and eye judgments by an experienced grader of such items as finish, fullness of loin and shape of leg. In addition, a grading comparable to that used in the North Island industry, was carried out. A commonly used score or block-test was used to evaluate carcass suitability (The Cambridge Block Test), and various items such as cannon weight per unit length $\left(\frac{W}{L}\right)$ related to post natal variants.