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RECENT DEVELOPMENTS IN HERD IMPROVEMENT

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HERD IMPROVEMENT in New Zealand, in its widest sense, is concerned with improvements through the testing and culling of dairy herds, identification and use of high quality breeding stock, and measures to improve the feeding and management of dairy herds. It is carried out through the testing and artificial breeding services provided by the various herd improvement associations and co-operative artificial breeding societies, and by the New Zealand Dairy Board through its Artificial Breeding Centre and the extension, investigation, and sire survey and Merit Register work of its Herd Improvement Department.

At the twelfth annual conference of this Society in 1952, A. H. Ward, in his paper, "The Future of Herd Improvement in New Zealand", gave a comprehensive review of developments that were in progress, or which were contemplated, in these various facets of herd improvement, and it is not intended in this paper to cover all these aspects again. There will be ample scope for discussion if the paper is confined to the subjects of herd testing and dairy cattle breeding and implications of some other factors and research findings in herd improvement.

Herd Testing

It is appropriate that any discussion of herd improvement should commence with herd testing, as it has two extremely important functions to perform. First, by enabling the identification and culling of low producers, it provides the quickest and most direct means of improving herd quality; secondly, it provides the basic information without which no plan for herd improvement through breeding could possibly function.

In this latter connection, we have been fortunate in this country in having had men who have encouraged the widespread adoption of herd testing, introduced such schemes as the identification of grade calves, and brought into being a central organization to which all testing records are sent. This has enabled herd improvement measures to be operated on a wide base and with the fullest possible information, and has made possible investigations which have defined, even if they have

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not answered, many of the problems of the industry, while the progeny testing of bulls through sire survey has grown to the extent that over 3,000 bulls are now sire surveyed annually.

The continuance of this desirable state of affairs depends, however, on the importance placed by the individual dairy-farmer on the value of herd testing, as a herd improvement measure within his own herd. Herd testing must therefore always be considered basically from this point of view. It must also be placed in its proper perspective primarily as a means of culling low producers and providing information to assist with herd management.

There has been a tendency among farmers to consider that the use of artificial breeding removes the need for herd testing. However, as there is considerable variation in the production of daughters of all bulls, the culling of low producers will still remain as the primary means of herd improvement, whatever the breeding policy in the herd may be. Selection of the dams of replacement stock and the selection and proving of the herd sire, while effective on a long-term basis, are necessarily slow means of improving herd quality.

The value of herd testing will also depend on the use made of the information obtained. The farmer must be encouraged to look at his returns and consider their implications in so far as his herd and farm management policies are concerned. An interesting development here has been the introduction by one herd improvement association of a system of graphing each farmer's monthly averages against the average of the five highest producing herds in the same testing group. By seeking the answers to the questions thus raised, a farmer has taken the first step towards lifting the production of his herd.

From both the point of view of the farmer and national herd improvement plans, it is important that the information that herd testing supplies should give the best possible estimate of the real merit of each individual cow and that the cost of the service should be as cheap as is compatible with this requirement.

Therefore, although investigations have shown that the improvement in production taking place in tested herds is sufficient to provide a considerable margin over and above the cost of testing which is based on monthly samplings, a study is being made of the practicability of a system of testing based on alternate monthly milk weighings and samplings.

This question has previously been investigated at the Dairy Research Institute (1), where the records based on such a test were stated to be too inaccurate for practical use. However, as the use of testing records for culling purposes is a within-herd comparison, bi-monthly testing could still be satisfactory for this purpose, provided the ranking order of the cows and the repeatability of the records are not greatly affected.

Further, as the use of "absolute" production records in dairy cattle breeding work is tending to be replaced by systems based on contemporary comparisons under which, on a within-herd basis, uniform variation of production records from the true figure in one direction is relatively unimportant, these records could still be valuable for sire proving purposes, even though they are not accurate as an indication of the exact production of a cow.

In order to study the value of bi-monthly testing for culling and sire proving purposes, the records of 30 Jersey herds over a four-year period have been used. Rank correlation coefficients between the monthly and bi-monthly tests were calculated for each of the herds in all four seasons. Very little variation was found in these values, all of them being above 0.80 and approximately 90 per cent. of them being above 0.90.

Repeatability estimates were made for both the monthly and bi-monthly records of the 30 herds. Pooling the estimates for each herd, the overall figures for the 30 herds were:

Repeatability of "monthly" records	0.49
Repeatability of "bi-monthly" records	0.44

This small decline in repeatability, together with the high ranking correlation between productions calculated under the two systems, indicates that bi-monthly testing could be quite a satisfactory system for progeny testing and herd culling purposes. It would not, of course, be as suitable as "monthly" testing for farm management purposes, owing to the increased interval between successive tests, nor would it be suitable where "absolute" records are required. Provided there is a reasonable demand for such a test, it is hoped to be able to introduce it in the near future.

The other important aspect of herd testing is the question of its accuracy in giving the best possible estimate of the real merit of each individual cow. Obviously, if it fails in this regard, then herd testing and all the ancillary services built upon the use of herd testing records must also fail.

The factors influencing the production records of a cow can be broadly divided into two main categories—genetic, the inherent ability of the cow, and non-genetic, which would include such influences as incidence of disease, level of feeding, time of calving, and lactation length in so far as its non-inherited aspects are concerned. The value of the cow to a farmer will depend on both these categories—thus early calving cows are preferred to late calvers, cows of high genetic merit to cows of low genetic merit. When the records are used for breeding purposes, however, such as sire survey, interest in them is purely in the differences due to genetic causes. While it is known that within-herd comparisons will "iron out" many of the non-genetic factors influencing the records of a bull's daughters and other herd mates, so that worthwhile estimates of genetic differences can be made, it is considered desirable to examine the value and feasibility of correcting for some of the non-genetic effects influencing production records on a within-herd basis.

For example, the New Zealand Dairy Board is examining such questions as the correction of records to a standard lactation length and for time of calving, and whether improvement in the accuracy of progeny testing will result from this and/or the use of part lactation records. Finally, there is the question of whether a cow's production record is in fact the only measurement which should be made in determining her merit.

At the Ruakura Farmers' Conference Week in 1956 (2), Dr. L. R. Wallace pointed out, as a result of his work on intake measurements, that the amount of food eaten by a cow depends on her live weight, level of production, and rate of live-weight gain. A cow's efficiency as a producer of milk or butterfat will therefore depend not only on her level of production, but also on her live-weight. This has been confirmed by a survey (3) carried out by the Dairy Board, comparing production per acre on farms carrying Ayrshire, Friesian and Jersey cattle which showed that the light-weight Jersey breed had the highest carrying capacity and the highest butterfat production per acre. A practical means of estimating the efficiency of cows has been suggested by Dr. Wallace, using the formula:

$$\text{Efficiency} = \frac{\text{Production}}{(\text{Chest girth})^2}$$

As the dairy herds in this country normally contain cows of one breed only, and as the primary use of production records is for within-herd comparisons, there are two major questions which the Dairy Board would like to answer before determining whether live-weight estimations should become a routine practice in herd improvement. These are whether on a within-herd, within-breed, basis the differences in live-weight between animals of similar age, are of sufficient magnitude to make ranking on production alone an unsatisfactory means of comparing the relative merits of dairy cows, and whether ranking bulls on the productive ability of their daughters is in agreement with their ranking on the efficiency of their daughters. With a view to answering these questions, chest girth measurements have recently been taken in 70 herds. Selection of these herds has been made as far as possible from herds containing artificially bred cows, so that progeny testing aspects can be studied, while herds of mixed breeds as well as straight breed herds have been included. A limited amount of information on this question is already available as a result of taking chest girth measurements for two grade Jersey herds in November, 1955.

Using the method suggested by Dr. Wallace, an analysis of these data has in both herds given the following results: There was a high correlation (0.91) between production and efficiency, and culling on production would have improved average efficiency almost as much as culling on efficiency. In neither herd was there a significant correlation between chest girth and production (—0.22, +0.13). These results appear to be due to the fact that the variation in production within these herds was much greater than the variation in chest girth. The coefficients of variation were 15 per cent. for production and 3 per cent. for chest girth. If these results are substantiated by the more extensive investigation at present being carried out, it would appear that the herd improvement movement can continue to use production per cow as the practical index of efficiency for most of its work.

Sire Survey

The sire survey system of progeny testing dairy bulls was introduced some tweny years ago, as the result of the work of A. H. Ward, to replace the practice of basing the selection of herd sires almost entirely, as far as production was concerned, on single records for the dam. In conjunction with the Merit Cow Register, it was designed to estimate the breeding worth of dairy cattle, on the basis of production of an unselected sample of daughters for the sire, and a series of records for the dam.

These basic principles of dairy cattle breeding remain unaltered to this day, though increasing knowledge of the heritability and repeatability of dairy cow records, in other words, the influence of environmental effects in determining within- and between-herd production differences, has led to more precise estimates of the value of successive records of a cow and numbers of daughters of a sire, and has also, over the years, been responsible for a change in emphasis from absolute production records to methods which consider such records in relation to the environment in which they were made by one means or another. This change in emphasis can be seen quite clearly in the sire survey system, particularly in the setting of the merit sire standard, the aim of which has been to indicate a class of bulls which are likely to be above average in breeding ability, so that a hallmark should exist for use by breeders and farmers when selecting breeding stock.

It may be helpful if the changes that have taken place (4) are briefly reviewed. Sire surveys were originally taken out by the daughter-dam comparison method. The comparison took into account all available records for the daughters and dams, while merit sires were bulls which had daughter averages of approximately 350 lb. of fat or higher, or which showed sufficient improvement over the dams to be classified as of a 350 lb. standard. In 1946, two changes were made. The daughter-dam comparison was changed to a within-season one, to eliminate the effects of seasonal conditions, and a provision was made in the merit sire standard which resulted in bulls which lowered production substantially not qualifying as merit sires, even though they met the minimum daughter average requirement. The greater reliability of surveys based on larger numbers of daughters and lactations was recognized from the outset by issuing official surveys in three stages—Preliminary, Intermediate and Final (according to the number of daughters with one, two, or three lactations included in the survey), and in 1948 the merit sire standard was amended further by requiring a higher daughter average for bulls with Preliminary and Intermediate surveys.

The daughter-dam comparison method suffered, however, from the small number of comparisons possible on a within-season basis, and the consequent bias thus introduced. Accordingly, the daughter-mature cow comparison method was introduced in the 1949/50 season and the difference from expectancy figure was published with each survey.

The expectancy line from which this figure is calculated has been developed from the regression of daughter average on mature cow average, the formula being:

$$X = 0.74Y + 80$$

where X is the expected daughter average and Y the mature cow average. Under this technique, merit sire rating was given to those bulls whose daughter average reached the minimum standard and which were equal to or above expectancy. Provision was also made for bulls with lower daughter averages but high difference from expectancy figures to qualify as merit sires.

The daughter average requirement for merit sires has meant, as pointed out by Hancock at the 1952 meeting of this Society (5), that the proportion of bulls used in high-producing herds qualifying as merit has been very much greater than that in low-producing herds. This could be justified if a considerable difference existed in the average genetic quality of bulls in use in high- and low-producing herds.

Recent investigations have shown, however, that, while such a difference probably exists, it is not of very great magnitude and thus the merit sire standard has penalized bulls used in lower producing herds. It has also been shown (6) that, with the present expectancy line, which is biased so that more than half the bulls used in high-producing herds reach expectancy, the same bull will, in general, have the same difference from expectancy at all herd levels. It appears, therefore, that the difference from expectancy figure alone provides sufficient information on which to estimate a bull's breeding ability without taking the daughter average into further consideration.

Another aspect of sire survey which has concerned the Dairy Board for some time is the comparison between bulls with different numbers of daughters and lactations included in their surveys. The division of official surveys into Preliminary, Intermediate and Final, according to the number of lactations included, had some obvious anomalies due in the main to the emphasis placed on additional lactations per daughter, rather than additional daughters, once the minimum number of ten daughters had been reached.

Adjustment factors for numbers of daughters and lactations have therefore been calculated, which, when applied to the difference from expectancy figure, enable the performance of future daughters to be estimated. These adjustment factors emphasize, first, the value of an adequate number of daughters, and secondly, the value of additional lactations per daughter, in increasing the reliability of a progeny test. The effect of these adjustments is that a bull with a survey based on a small number of daughters and lactations will need to have a higher actual difference from expectancy figure to be rated as equal to a bull which has a survey based on larger numbers of daughters and lactations. Such adjustments will not, of course, necessarily be accurate for any individual bull, but, when applied to a group of bulls of a particular standard, have been shown to enable a good prediction to be made of the performance of future daughters (6). They will thus be of considerable value in selecting bulls for artificial breeding.

In view of these developments, it has been decided to amend the standard for merit sires, and in future this distinction will be given to those bulls which have surveys with an adjusted difference from expectancy figure of +10 or better. This will result in approximately 25 per cent. of all surveyed bulls qualifying as merit, the same proportion as under the previous standards, but fewer of these bulls will be those surveyed in the higher producing herds in the industry. This merit class represents the Board's present estimate of the top 25 per cent. of surveyed bulls. As a general statement, this will probably continue to be the case, although the "refinements" mentioned in the calculation of production records, together with a method of making a better assessment of age correction factors in individual herds, if possible, may enable some bulls to reach the standard which at present do not qualify. However, no major changes are anticipated, such as would be likely to alter significantly the group of bulls from which selection for artificial breeding purposes is made.

Artificial Breeding

Since 1951, when artificial breeding was placed on a commercial basis following the investigations and operational research carried out by the Ruakura Animal Research Station, there has been a rapid growth of this service. From the point of view of herd improvement through breeding, this development is of prime importance. As a result of this expansion, the stage is now being reached when the production records of a larger number of artificially bred daughters will soon be available. It is appropriate, therefore, that this paper should discuss the results so far achieved, and make some tentative predictions as to the future.

Up until the end of the 1955-56 season, production records are available for some 3,227 daughters of 20 proven bulls which have averaged 18 lb. above expectancy. This can be compared with the difference from expectancy figure of +22 for their original sire surveys after adjusting for daughter and lactation numbers. Sixteen bulls, originally purchased as yearlings, also have A.B. daughters with production records, and these daughters averaged 8 lb. above expectancy.

By the end of the 1958-59 dairying season, production records will be available for the artificially bred daughters of a further 42 sire surveyed bulls and approximately the same number of bulls originally purchased as yearlings.

These 42 "naturally proven" bulls have sire surveys which, after adjustment for daughter and lactation numbers, average approximately 30 lb. above expectancy. This should lead to an improvement of at least 20 lb. of fat per daughter for first generation A.B. heifers. This conclusion anticipates that progeny tests made under natural service conditions will continue to be of value in predicting a bull's performance under A.B. Henderson (7) and Robertson and Rendel (8), have pointed out that this has not been the case overseas. However, in this country the large size of the average herd, and the uniform within-herd feeding conditions, should enable sire surveys, when considered together with a careful assessment of the conditions on the farm concerned, to indicate bulls of above-average genetic ability with a fairly high degree of accuracy. The policy of selecting bulls for artificial breeding on their sire survey results is therefore being continued.

It is recognized, though, that the ultimate test of a bull's value for artificial breeding is an A.B. proof based on a large sample of daughters. Approximately 20 yearling bulls are therefore being purchased annually for proving through A.B., and while only 3 of the 110 bulls at present at the Centre have been proven on artificially bred daughters, this proportion should rise considerably in the near future.

The production results of artificially bred stock, besides supplying data for studies into various genetic problems, are also valuable as an illustration of the production gains which can be achieved through improved breeding, and the importance of breeding in raising the production level of the national dairy herd. Because recent investigations overseas have shown that only a small proportion of the difference in production between groups of high- and low-producing herds is due to genetic causes, there has been a tendency to interpret this as indicating that breeding is unimportant as a means of lifting dairy farm production. These findings, if substantiated in this country, should be interpreted as indicating the wide range in environmental conditions which exists between herds, and that this tends to mask genetic differences when comparisons are made between herd production levels. They also emphasize the need to consider a cow's production in relation to her environment, a condition which has always been stressed in herd improvement work in this country.

I cannot agree with any suggestion that considerable genetic differences do not exist between individual herds at any one time, although such differences will not necessarily persist over a long period.

The widespread adoption of herd testing under methods which give as accurate an indication as possible of the relative merits of individual cows, the use of these records for progeny testing purposes both within and ouside an artificial breeding scheme, and the full application of the results of such progeny testing through artificial breeding, will reduce genetic differences between herds and will, at the same time, result in an improvement of the production of the national dairy herd due to breeding.

References

(1) DAIRY RES. INST. (N.Z.) (1955): *27th Ann. Rep.*, p.26.

(2) WALLACE, L. R. (1956): *Proc. Ruakura Farmers' Conference Week* (1956), p.177.

(3) N.Z. DAIRY BD. (1954): *Ann. Rep.*

(4) N.Z. DAIRY BD.: *Sire Survey and Merit Register,* edns. 2-7.

(5) HANCOCK, J. (1952): *Proc. N.Z. Soc. Anim. Prod.*, *12*:16.

(6) N.Z. DAIRY BD. (1956): *Ann. Rep.*

(7) HENDERSON, C. R. (1956): *Proc. N.Z. Soc. Anim. Prod.*, *16*:69.

(8) ROBERTSON, A. and RENDEL, J. M. (1954): *J. Agr. Sci.*, *44*:184.

DISCUSSION

Q: : *Could Mr. Stichbury enlarge on his statement that "he could not agree that large genetic differences do not exist between herds"? How would he relate this statement to the results obtained at Ruakura from an experiment, designed to answer this very question, in which 40 daughters selected at random from 20 high-producing herds have been run together from birth onwards with 40 daughters from 20 low-producing herds? To date both groups of daughters have produced on average almost exactly the same amount of milk and butterfat.*

A: : We have evidence from an analysis of the quality of bulls bred by different studs that considerable genetic differences do exist between individual herds. The fact that only a small proportion of the difference in production between high- and low-producing herds has been shown to be due to genetic causes does not, to my mind, affect this. Two herds of the same production level could differ considerably in genetic merit and some low-producing herds would undoubtedly be superior genetically to the average high-producing herds. Ruakura's findings indicate that a herd's average is not a good index of its genetic quality but that does not necessarily mean that there are not considerable genetic differences between herds.

Mr. McArthur: : In New Zealand it has been found that a few herds at the top possess most of the valuable genes. By the use of sires from these herds in the process of grading up, I would expect the average genetic difference between herds to be reduced. By the more widespread use of such sires through artificial breeding, it is possible that these differences will still further be reduced. In spite of this, however, worthwhile increases in production can still be obtained through breeding.

Q: : *It has been suggested that, in the future, more attention could profitably be given to milk and solids-not-fat production rather than butterfat alone. Would Mr. Stichbury comment on this suggestion?*

A: : At present, when selecting for artificial breeding, the emphasis is on butterfat production because the great majority of dairy farmers are paid on this basis. However, bulls whose daughters are above average in butterfat production will also, on average, raise milk production as there is a positive genetic correlation between these two characteristics. Progress in raising milk production will, of course, be slower than would be the case if selection were made on milk production alone.

Q: : *Whether genetic differences between herds are large or small does not matter insofar as herd improvement is concerned. The main purpose in trying to determine the extent of these differences is to refine, perhaps even more, the expectancy index used in bull selection.*

Q: : *I would like to add one further point. If, in fact, these differences are small, it immediately highlights the need for improving environment as a means of lifting production per cow.*

A: : I would agree that improving the environment would lift the production of the national dairy herd. This is not always easy to achieve in practice, though, whereas improved breeding methods can be applied on any dairy farm. The use of proven bulls through artificial breeding has given worthwhile production increases in this country under widely different environmental conditions. While improvement through breeding is undoubtedly slow by comparison with improvement of the environment, it does have the advantages of requiring no physical effort, and of being independent of climatic factors.