Prices for beef have been rising in relation to those for other pastoral products. This has caused a surge of interest in beef production in recent years, accompanied by many changes including the introduction of new breeds from Europe and Australia, and by the more extensive use of cattle bred in dairy herds.

Established beef farmers, and those commencing beef production, are eagerly seeking ways to improve their efficiency.

The Management Committee of the Society was concerned that the methods of beef cattle improvement through breeding and selection had not been clearly enough established for New Zealand conditions, and consequently they could not be well enough known to advisers and farmers.

It was decided to set up a study group of experts in various aspects of this subject to produce recommendations for subsequent publication. This work resulted in the Society's Occasional Publication No. 1, Beef Cattle Improvement through Performance Recording and Selection.

The main objective having been achieved by publication of the booklet, it was considered desirable to present a further report to the annual Conference of the Society. This was to permit discussion of the recommendations and to highlight areas where it was considered knowledge was lacking and further work should receive high priority.

A member of the Study Group, Dr R. L. Baker, was invited to present a summary along these lines to the annual Conference, and this summary follows.

H. J. CLIFFORD
Convener of Study Group

BEEF CATTLE IMPROVEMENT THROUGH PERFORMANCE RECORDING AND SELECTION*

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SUMMARY

Performance recording is recommended as the essential base on which a New Zealand beef herd improvement structure should be built. "Weight-for-age" is considered to be the best selection criterion rather than growth rate over a fixed period of time. Artificial breeding (A.B.) is the only way to make widespread use of an outstanding sire and is thus a desirable feature of any worthwhile national beef cattle improvement programme. Progeny testing of bulls for selection purposes is justified only when a highly rated performance tested bull is to be used widely through A.B. The various aspects of a national beef cattle improvement plan should be co-ordinated and supervised by a body repre-

*A summary of the main findings and recommendations of a Study Group of the N.Z. Society of Animal Production.

sentative of beef producers, and this could be integrated with the national dairy herd improvement services.

The areas where further information was required were discussed under the following headings: Selection objectives; effectiveness of selection; performance recording and assessment of genetic value; central test stations and group breeding schemes; artificial breeding; early mating; weaning age; optimum structure for genetic improvement of the beef cattle industry; other improvement methods; overseas developments; national plan for beef cattle improvement.

STUDY GROUP OPERATIONS AND FINDINGS

This report summarizes the main findings of the Society's published booklet (N.Z.S.A.P., 1972), and considers in a little more detail the areas where it appeared further information was required.

The method of operation of the Study Group involved the preparation of four background papers, circulated among all participants. A one-day workshop used these papers as a basis for discussion to reach agreement on recommendations. Appendix 1 lists the papers prepared, their authors and a full list of participants in the Study Group.

The booklet prepared by the Study Group consists of eight sections which may be summarized as follows:

(1) The rate of improvement through selective breeding depends on the choice of the most important characters and the ability to measure them accurately; the heritability; the variability; the generation interval; and the selection differential.

(2) Performance recording is the essential base on which a beef cattle herd improvement structure should be built.

(3) Selection objectives are discussed in relation to the productivity of the breeding cow and to post-weaning performance. On the one hand, reproductive performance (number of calves weaned per cow mated) is the trait of the highest economic value in the beef herd, but it has a low heritability. On the other hand, post-weaning growth rate is the trait of highest economic importance in slaughter cattle. Growth rate is reasonably heritable and selection should be directed principally towards this trait.

(4) The method of performance recording within herds is outlined. "Weight-for-age" is suggested as the best selection criterion.

(5) The advantages and disadvantages of central performance test stations are discussed. It is emphasized that central per-

formance testing must be an extension of within-herd (on-farm) performance recording and not a substitute for it. Central performance testing permits comparisons between animals in different herds. It is especially useful for herds which are too small (30 cows or fewer) for effective on-farm performance comparison. These tests are carried out in standard supervised conditions and thus avoid any preferential treatment of animals. They also serve an important extension function. A disadvantage of these tests is that the number of within-herd comparisons on a farm is reduced by the number of animals placed in a central test. Moreover, unless the animals enter the central test at, or soon after, birth, then the pre-test environment may mask the true genetic ranking. An extensive set of recommendations for carrying out a central test is provided. To avoid the effect of pre-test environment on true genetic rankings, it was suggested that animals should start the test at birth. Since this is unlikely to be acceptable at this time to most New Zealand farmers, it was recommended that animals go on test as early as possible after weighing at about 200 days of age and stay on test for about 300 to 350 days. It was noted that this recommendation would have to be modified by putting bulls on test earlier or leaving them on test for a shorter time if mating of bulls as yearlings was practised.

(6) The merits and disadvantages of progeny testing are considered. On the one hand, progeny testing provides a more accurate measure of a bull's breeding value than does his own performance and allows the measurement of characters which cannot be measured in the bull himself, such as calving difficulty and carcass composition and quality. On the other hand, comparatively few bulls can be progeny tested; such testing is expensive and also increases the generation interval, thus decreasing the rate of genetic improvement per year. The main value of progeny testing beef bulls is when an accurate comparative performance test has not been carried out, or when consideration is being given to using a bull widely through artificial breeding (A.B.). Requirements for an effective progeny test are given.

(7) Group breeding schemes are discussed. As a general rule, small herds on their own can make only a limited contribution to genetic improvement because of limited scope for culling and selection. The main value of group breeding schemes is considered to be where performance recording is not being used very widely. Faster progress can be made by bringing apparently superior cows from a number of herds into one nucleus where recording can be concentrated and A.B. can be

used. The progress from selection in the nucleus herd is shared with the contributing herds through distribution of the sires (or semen from them) bred in the nucleus herd.

(8) Attention is given to co-ordination of beef cattle improvement methods. It is recommended that one organization should control and supervise beef cattle recording in general, performance and progeny testing of bulls in particular, and selection and use of bulls in a national A.B. scheme. The case is made for greater use of A.B. in the beef cattle industry. It is realized that there are practical problems of mating beef cows by A.B. But the potential genetic gains are substantial enough to urge beef breeders to try to overcome these problems. It is emphasized that, if A.B. is to play an important role, then widespread performance recording on the farm and progeny testing of bulls are essential prerequisites.

It is suggested that a national beef cattle improvement authority should include representatives of beef producers, and that the services provided should be integrated with the national dairy herd improvement services for the most cost-effective way of providing for cattle improvement as a whole.

AREAS WHERE FURTHER INFORMATION AND STUDY ARE REQUIRED

Selection Objectives

It was pointed out that different traits vary in their economic importance between breeding females and slaughter stock. But the difference between economically important traits and useful selection objectives was not clearly stated. Given the present industry structure, where the same sires are used to produce both replacement females and surplus stock for slaughter, a unified selection goal would seem essential for maximum selection improvement. On present evidence, greatest gain in total productivity will result from selection on "weight for age" at some suitable time subsequent to weaning. Separate selection criteria in specialized sire and dam lines were not considered warranted at this time, but may have a place in the future as A.B. becomes more widely adopted in beef herds.

Optimum cow size elicited sustained discussion with considerable difference of opinion and the need for further work on this subject under New Zealand grasslands conditions. In their paper Rae and Barton reviewed the recent Irish studies (McClintock and Cunningham, 1973; Cunningham and McClintock, 1973) on the relative importance of beef and dairy traits in a dual-purpose population in which A.B. is used.

This is an area which could assume importance in New Zealand if the interest in use of Friesian bulls for beef, as well as milk production, continues.

Effectiveness of Selection

This subject was not specifically covered but the main factors involved were considered by Carter and Baker to be:

(1) More appropriate specification of objectives with proper allowance for economic value.

(2) More accurate identification of genetic merit, for example, through better environmental corrections, resulting in higher effective heritabilities.

(3) Development of improved selection criteria, including optimum combination of available performance information.

(4) Higher selection intensities, particularly for sires.

(5) Application of progeny testing for final selection of sires for A.B. use.

Performance Recording and Assessment of Genetic Value

Discussion was given to alternative methods of age-correcting liveweights, namely, according to an individual's own recorded daily gain, the average daily gain of his group, or regression of weight on age. The first method, that at present applied in the N.Z. Beef Recording Scheme (recently incorporated into the N.Z. Dairy Board), was considered to be satisfactory but futher investigation was needed.

The importance of accurate adjustments for age of dam and other factors in improving the assessment of genetic merit from liveweight data was rightly emphasized. The present multiplicative factors as used by the N.Z. Beef Recording Scheme involve adjustments of 15, 10 and 5% for calves out of cows aged 2 years, 3 years and 4 years old relative to those from older, mature cows. It was generally agreed that there was need for these age of dam adjustments to be re-evaluated on New Zealand data. The opinion was expressed that additive corrections may be more appropriate than multiplicative factors.

Consideration was given to the need for control or surveillance of on-farm performance recording to ensure its effective operation. It was recognized that the value of such

recording depended greatly on the extent to which animals being compared on the farm were, in fact, given similar feeding and management. Although a system of check-testing as adopted in dairy herds might be devised, it was felt that education of the user offers the best long-term assurance of successful operation.

The question of genotype-environment interactions received some discussion, particularly in relation to effective selection. Pending further study, it was felt by Carter and Baker that sound choice of breeding stock at present should be based on performance under the appropriate environment.

Central Test Stations and Group Breeding Schemes

Methods of conducting a central performance test are detailed in the booklet. Several members of the Study Group considered that the emphasis on Central Test Stations and Group Breeding Schemes was out of proportion to the genetic improvement likely to accrue relative to on-farm performance recording. But because of the interest in Central Test Stations in New Zealand it was felt that a standard set of recommendations was necessary.

Artificial Breeding

Members of the Study Group were unanimous in their advocacy of A.B. as one of the most powerful tools in future beef herd improvement. It seems unfortunate, therefore, that this important subject was included in the section on "Co-ordination of Beef Improvement Methods". It could have been given more prominence by expanding it into a separate section.

The principal genetic value of A.B. lies in the increased intensity of selection of sires. A.B. can also greatly increase the scope and efficiency of "planned matings" of the top proven bulls to the best cows available, designed to generate sons with superior performance pedigree for subsequent selection on performance or progeny tests.

Two main applications of A.B. were considered. Widespread use of superior proven bulls in commercial herds would promote greatest improvement in the industry as a whole, but many practical difficulties remain to be overcome. The development of synchronization of oestrus in beef cattle would do much to overcome these difficulties. In the meantime, useful progress should be possible if multiplying herds used semen from outstanding sires to generate "run" bulls for the industry.

Early Mating

Reducing the generation interval by mating and culling breeding stock at the earliest practicable age can substantially increase the rate of genetic improvement. The average generation interval in the beef cattle industry is about 5 years which could be reduced through yearling mating to 3 years. The advantage of selection and mating at 14 to 15 months of age was mentioned in this booklet but not given the emphasis some people thought it deserved. The relative genetic rankings of bulls at 14 and 20 months of age, and the effect of yearling mating as heifers on lifetime reproductive performance was questioned. However, research information is beginning to accumulate in New Zealand designed to answer these questions. It is hoped that the results from these studies could persuade more New Zealand farmers to adopt the practice of yearling selection and mating.

Weaning Age

It was generally agreed that there were both good genetic and management reasons for reducing the average weaning age currently practised in New Zealand, of about 8 to 9 months, to 6 months or younger. For a performance test on the farm or at a central test station to provide a true measure of genetic ranking, the effect of pre-test environment must be minimized, and this will be assisted by reducing the weaning age. The magnitude of the possible pre-test environment effect was well illustrated by Everitt (1972). The post-natal pre-test environment effect would be completely eliminated if calves were put on test at birth and all raised on the same rations. Since this is not likely to be acceptable to most New Zealand farmers, it was recommended that the average weaning age be reduced to 5 to 6 months of age or earlier. Early weaning is especially desirable in promoting more accurate selection for growth potential where mating at 14 months of age is practised.

Double conversion involved in milk as a feed for calves is energetically inefficient (McDonald, 1957). Thus, there could well be situations in the beef industry where the early weaning of calves or creep feeding may be more efficient procedures than attempting to increase milk production of the cow.

Regardless of age at weaning, there is considerable evidence that calf liveweight at about 3 months provides a better measure of dam's milk production than at later ages. Therefore, calf weights taken earlier than present normal weaning age (even if weaning occurs at a later date) are likely to be more useful in culling poor milking cows.

Optimum Structure for Genetic Improvement of the Beef Cattle Industry

This subject was not discussed in detail, but as A.B. gains more prominence in the beef cattle industry then it could become increasingly important. For optimum genetic improvement some of the questions which must be answered for New Zealand conditions are: the optimum size of performance tests; the desirability of starting from birth; the optimum intensity of selection for progeny testing; the optimum size of the progeny groups of A.B. bulls; the optimum selection intensity of A.B. sires of the progeny tested bulls; the optimum proportion of cows to be inseminated with young unproven bulls; the minimum size of herds for effective on-farm performance testing and the optimum size of nucleus herds and the structure of herds in group breeding schemes; and many other related questions. The answers to these questions depend on estimates of genetic parameters such as heritabilities, repeatabilities and genetic correlations. These are not well known for New Zealand conditions and some members of the Study Group considered that research work should be directed towards obtaining estimates of such genetic parameters. The contrary view was expressed that necessary population parameters are well enough known within limits, so that simulation analyses could be undertaken to evaluate alternative breeding schemes based on a range of relevant parameters, and incorporating cost factors.

Other Improvement Methods

Although not strictly within the terms of reference of the Study Group, this subject was considered to have a vital bearing on improvement through breeding, and received some discussion. Crossing with, or grading up to, a superior breed, constitutes a comparatively simple, rapid, and effective means of improvement. Very limited New Zealand data are available on the performance characteristics of the present pure breeds or of the many new breeds being imported. Studies are under way to resolve the problems associated with profitable exploitation of breed differences through breed change or through crossbreeding systems. Results from these studies must be integrated with any National Beef Improvement Programme.

Overseas Developments

It is instructive to consider this Study Group's findings in relation to similar recent undertakings in Britain and the U.S.A.

In Britain, a Scientific Study Group on beef cattle improvement was convened by the Meat and Livestock Commission (M.L.C., 1971). Some of its more pertinent recommendations were that selection within breeds should be based on performance testing and that bulls for performance testing should be brought to central stations as early as possible and fed a single "complete" diet over a fixed weight range. The primary selection criterion recommended was feed conversion efficiency.

In the U.S.A., the Beef Improvement Federation (B.I.F., 1971) has adopted guidelines for a national sire evaluation programme as recommended by a Technical Committee. Emphasis in this programme has been placed on encouragement of herd performance testing, and on final selection of replacement bulls for A.B. use based on a progeny test comparison, within co-operating herds, against existing proven "reference" sires.

This Study Group strongly supported the principles underlying these recommendations, namely, that primary emphasis in beef cattle improvement should be on performance testing. It did not envisage a place in New Zealand for wide-scale use of progeny testing as proposed by the B.I.F. at this time. This situation may change if A.B. is more widely adopted. It considered that there was need for more information on the relationship between feed conversion efficiency and growth rate in cattle under New Zealand pastoral conditions but believed that selection on feed conversion efficiency was impracticable at this time.

National Plan for Beef Cattle Improvement

The need for a co-ordinated Livestock Authority was clearly specified in the New Zealand Institute of Agricultural Science beef project (N.Z.I.A.S., 1970). The discussion paper by Everitt, Hight and Stichbury considers in some detail the composition and duties of such an authority. It was generally agreed that traditional methods of stud breeding in the beef cattle industry based on pedigree and eye appraisal are failing to meet modern requirements. A National Livestock Improvement Authority is required to encourage selection based on sound genetic principles as recommended here and provide the recording, testing and A.B. facilities needed if advantage is to be taken of current knowledge in this field.

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APPENDIX I

Papers

(a) Selection objectives and methods of measuring merit in beef cattle (A. L. Rae and R. A. Barton).
(b) Breeding for increased productivity of beef cattle (A. H. Carter and R. L. Baker).
(c) Detailed programme of performance and progeny testing (D. C. Dalton, A. M. Nicol and R. L. Baker).
(d) National plan for beef production improvement through breeding and selection (G. C. Everitt, G. K. Hight and J. W. Stichbury).

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