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Selection Through the Herd Sire

MISS O. M. CASTLE, N.Z. Dairy Board.

For the past 14 years the Herd Recording Department of the New Zealand Dairy Board has been carrying out progeny tests (Sire Surveys as they are called in New Zealand) of dairy bulls, using records compiled by the Group Herd Testing Associations. The number of bulls surveyed annually has increased from 100 in 1937 to nearly 3000 in 1951.

Sire Survey work carried out over a number of years has provided basic information on a large sample of bulls, which is proving a valuable source of material for studying problems in dairy cattle breeding. Not the least of these problems is the relative importance of the various methods of selecting the herd sire.

Only those bulls used in herds testing fairly consistently can be surveyed and as these herds have a per cow average at least 40lb. butterfat above the level of the national herd, it is realised that surveyed bulls would be a better than average sample of all bulls in use in New Zealand. Within this sample, however, the bulls are unselected as they are automatically placed under survey as soon as they have sufficient daughters under test. A minimum of 6 daughters is required for a Preparatory Survey and 10 for an Official Survey.

There will not be time to discuss at length problems connected with the technique of progeny testing. These, together with measures taken to overcome them are discussed fully in the foreword to the various editions of the Board's Sire Survey and Merit Registers. A brief description of the present method of compiling surveys will, however, be necessary to ensure a clearer understanding of the terms used in discussing the results of the analyses.

Method of Compiling Sire Surveys.

Sire Survey in its present form is a measure of how the daughters of a bull compare in productive ability with the other cows in the herd. The daughter average is based on all available normal records of all daughters tested in the owner's herd—two and three-year-old records being corrected to a maturity basis.

The daughter average is compared with a mature cow average based on the records of cows aged 4 to 9 years in the owner's herd. The mature cow average is weighted according to the number of daughters tested each season, so that fluctuations in seasonal conditions are taken into account.

Expectancy Value.

Nearly 4000 bulls of the four main breeds have been surveyed on a daughter-mature cow comparison basis, and these represent sires used in herds under a wide range of environmental conditions. By tabulating these results according to the mature cow average for each survey it is possible to arrive at an average figure or an "expected" average for the daughters of a bull according to the production level of the herd in which he was used.

TABLE 1.

USE OF "EXPECTANCY" VALUE

	Mature Cow Average (lb. fat)	Daughter Average (lb. fat)	'Expectancy' Value (lb. fat)	Difference from 'Expectancy' (lb. fat)
Bull A	250	255	265	— 10
Bull B	300	310	302	+ 8
Bull C	350	360	339	+ 21
Bull D	400	390	376	+ 14

In Table I the results for four different sires are shown in order to illustrate the use of the "expectancy" value in interpreting the survey results. Bull A was used in a herd with a mature cow average of 250lb. fat. When results for all sires used in herds of this standard were analysed it was found that the average bull left daughters averaging 265lb. fat. This then is the "expectancy" value for herds of this production standard. As Bull A left daughters averaging 255lb. fat he is 10lb. fat below expectancy.

Similarly, the "expectancy" value for herds with a mature cow average of 400lb. fat is 376lb. fat so that Bull D, used in a 400lb. herd and leaving daughters averaging 390lb. fat is 14lb. fat above "expectancy." The use of "expectancy" values in interpreting survey results enables a correction to be made for differences in the environmental levels of the herds in which the sires were used and also takes into account the degree of selection practised by the average owner in each class. It is a most practical index as it indicates the degree to which a particular bull is inferior to or superior to the average bull used in herds of a similar production level. All advantages gained through the various methods of selection have in this paper been measured in terms of "Difference from Expectancy."

It has always been realised that any method of progeny testing will give results which may be misleading in individual cases, and consequently, it is the owner himself who should be in the best position to interpret results for his own bull. The limitations of the sire survey method and the difficulties of interpreting results for individual sires are not so apparent when results for a number of bulls of a particular class are being considered. Individual differences are cancelled out provided the sample is large enough. The variability of the material used in this study can be gauged from the fact that differences from expectancy for all bulls are distributed about a zero mean with a standard deviation of 28lb. fat (i.e. two-thirds of all bulls surveyed are within 28lb. of expectancy). Advantages gained through selection as measured by survey results are not very great so that it is essential that large samples of bulls be considered if significance is to be attached to the results.

The present study is based on an analysis of the results of approximately 3000 Jersey sires which have been surveyed on a daughter-mature cow comparison basis. These surveys were issued in 1950 or 1951 so that nearly all these bulls had daughters coming into the herd as 2 year olds in 1949 or 1950. The material used, therefore, represents a sample of the bulls used in tested herds in 1946 and 1947.

Selection Methods.

When the National Herd Improvement Plan was introduced in 1939, selection of the herd sire was based mainly on single records of production and/or type classification for the dam. Subsequently, investigational work demonstrated that single records were not a satisfactory basis for selection, and also that half the selection potential was being ignored through lack of information on the quality of the sire. (N.Z. Dairy Board, 1942).

The principle of a series of records behind the dam of the bull and the use of sire survey results for the sire of the bull have now largely replaced the previous method of selecting on single records of the dam.

A Lifetime Merit Register for older pedigree cows and an Intermediate Merit Register for younger cows was introduced in order to provide information on suitable breeding cows qualifying with a series of records. Names and details of all cows included in these Registers are published annually in the Board's Sire Survey and Merit Register together with the survey results for all sires under official survey. A merit sire class was also introduced to include sires whose daughters under official survey reached certain production standards. (The standards for these merit classes are set out in the Board's Sire Survey and Merit Registers).

Sons of "Merit" Parents.

A large number of sons of these merit cows and sires have now been surveyed and the analysis of their survey results is summarised in Table II.

TABLE II.

SURVEY RESULTS OF SONS OF "MERIT" PARENTS

	No. of Sons	Daughter Average (lb. fat)	Difference from "Expectancy" (lb. fat)
Sons of Elite L.M.R. cows (Av. 400lb. fat for 10 years)	115	343	+ 9
Sons of L.M.R. cows (not Elite (Av. 312lb. fat for 8 years)	344	329	+ 5
Sons of I.M.R. cows (Av. 400lb. fat for 3 years)	227	328	+ 5
Sons of "Merit" sires	580	329	+ 5
Sons of Merit Sires out of Elite L.M.R. dams	70	349	+ 12
Sons of Merit sires out of L.M.R. dams	155	333	+ 8
Sons of Merit sires out of I.M.R. dams	94	338	+ 12

The first three groups of sons are analysed according to the Merit classification of their dams. In analysing these groups the quality of the sires has not been taken into consideration. This will introduce a slight bias in favour of the merit cows as they would tend to be mated to better than average quality sires. This tendency is also apparent when sons of high quality sires are being studied. A higher proportion of their dams would be "Merit" cows.

The Production requirement for an Elite Lifetime Merit Register cow is virtually a 400lb. fat lactation average in 10 successive years.

The 115 sons of cows in this Register left daughters 9lb. fat above "expectancy."

There were 344 sons of L.M.R. cows not up to Elite standard and these sons were 5lb. fat above "expectancy." The standard for these L.M.R. cows will be referred to later.

The 227 sons of Intermediate Merit Register cows were also 5lb. fat above "expectancy." I.M.R. cows must produce at the level of approximately 400lb. fat in three successive lactations.

The next group are sons of Merit Sires. To reach Merit standard a sire must on Final survey have a daughter average of at least 350lb. fat and this average must be above "expectancy."

Of the 3000 bulls included in this study 580—nearly 20% were sons of Merit sires. These sons were 5lb. fat above "expectancy."

The next groups studied were sons, both of whose parents had reached Merit standard.

Of the 115 sons of Elite L.M.R. cows 70 or 60% were also sons of Merit sires—they left daughters 12lb. fat above "expectancy." The 155 or 45% of sons of L.M.R. cows which were also by Merit sires were 8lb. fat above "expectancy" and the 94 or 41% of sons of I.M.R. cows, also by Merit sires were 12lb. fat above "expectancy."

When the actual production standards for the Merit Registers were originally set, there were not sufficient sire survey results available to make a large scale check on advantages to be gained from selecting at various levels of lifetime productions. There has been some criticism of the L.M.R. standards, as a cow can qualify for this Register with a lactation average of only 312lb. fat (the actual requirement is a total of 2500lb. fat in eight successive years) whereas for the Intermediate and Elite Registers the requirement is equivalent to a 400lb. fat lactation average. Records for a sample of the L.M.R. dams included in Table II were analysed according to whether the dam would also qualify under I.M.R. standards. It was found that only 30% of the dams did not reach I.M.R. standards and that the sons of these dams were leaving daughters below "expectancy." It appears, therefore, that existing standards do permit the entry of a small percentage of cows which are not improvers from a breeding point of view. Consideration is therefore being given to the amalgamation of the I.M.R. and L.M.R. Registers into one Register of "Merit" cows with production standards similar to the I.M.R. standards.

This paper is not intended to be an account of the problems encountered by the Dairy Board in compiling its Merit Register, but these figures do illustrate the value of the Sire Survey results in providing a basis for comparing various methods of selection and in particular in checking production standards adopted for Merit Registers.

As more sire survey results become available it will be possible to make further sub-division according to various production standards and also to study more closely results for sons of cows not included in the Merit Registers.

Sons of Merit Cows according to Type Classification.

In examining methods of selecting the herd sire at present in use the type classification of the dams has not been overlooked. It has been possible up to the present to study only sons of Merit cows in this connection as their type classification is readily available for tabulation.

The analysis of all surveyed sires—not only sons of Merit cows—according to the type classification of the dam would provide a much more interesting study, as the results for Merit cows only are biased by the fact that a higher proportion of "V.H.C." cows would be entered in the Register than "H.C." or "C." cows. (Ward and Castle, 1948).

The results for sons of dams entered in the three Merit Registers according to the dam's type classification are shown in Table III.

TABLE III.
SONS OF "MERIT COWS.
SURVEY RESULTS ACCORDING TO TYPE CLASSIFICATION OF "MERIT" DAM."

	No. of Sons	Daughter Average (lb. fat)	Difference from "Expectancy" (lb. fat)
Sons of "V.H.C." Merit Cows	129	337	+ 7
Sons of "H.C." Merit cows	299	327	+ 5
Sons of "C." Merit Cows	81	328	+ 7
Sons of Unclassified Merit cows	60	337	+ 5
Sons of all Merit cows	569	331	+ 6

The sons of "C." Merit cows show the same improvement as the sons of "V.H.C." Merit cows, and the sons of unclassified cows the same improvement as sons of "H.C." cows. So that it does appear that provided the requisite butterfat standards are reached the type classification of the dam does not influence the production of her son's daughters.

Quality of Sons according to the Survey Result of the Sire.

Of the 3000 bulls in the sample surveyed, approximately 900 were in turn sons of surveyed sires. It has been possible, therefore, to study methods of selection based on the survey result of the sire in addition to those based on the production level of the dam. These sons were grouped first of all according to their sire's daughter average. The results of the four groups are shown in Table IV.

TABLE IV.
SONS OF SURVEYED SIRES ACCORDING TO SIRE'S DAUGHTER AVERAGE.

Sire's Survey Result	No. of Sons	Son's Survey Result	
		Daughter Average	Difference from Expectancy
		lb. fat	lb. fat
1. Daughter Average—Below 300lb. fat	94	302	— 10
2. Daughter Average—300-349lb. fat	261	311	— 2
3. Daughter Average—350-399lb. fat.	324	326	+ 3
4. Daughter Average—400lb. fat or more	220	339	+ 10
Total—all sons	899	322	+ 2

In the first group there were 94 sons whose sires had a daughter average of less than 300lb. fat—these sons were 10lb. fat below expectancy. The second group comprised 261 sons of sires with a daughter average between 300 and 349lb. fat—these sons were 2lb. fat below expectancy. The third group of sons, by sires with a daughter average of between 350 and 399lb. fat, were 3lb. fat above expectancy. The fourth group—sons of sires with a daughter average of 400lb. fat or more—were 10lb. fat above expectancy.

These groups were subdivided further in order to study the effect on the son's results, of including "difference from expectancy" as well as the "daughter average." in the selection index. The sires in each group were classified according to whether they were above or below expectancy.

The results for the sons in each of these sub-groups are shown in Table V.

TABLE V.

SONS OF SURVEYED SIRES ACCORDING TO SIRE'S DAUGHTER AVERAGE AND DIFFERENCE FROM EXPECTANCY.

SIRE'S SURVEY RESULT Daughter Average (lb. fat) plus or minus "Expectancy"	No. of Sons	SON'S SURVEY RESULT Daughter Average	 Difference from "Expectancy" (lb. fat)
1. Below 300—			
Below Expectancy	79	298	— 11
Above Expectancy	15	320	— 2
2. 300-349—			
Below Expectancy	113	308	— 5
Above Expectancy	148	314	0
3. 350-399—			
Below Expectancy	35	321	+ 1
Above Expectancy	289	327	+ 4
4. 400 or more—			
Below Expectancy	4	298	— 13
Above Expectancy	216	340	+ 10

From the results in the first two groups it would appear that "difference from expectancy" alone would not be adequate as a selection index for the sire, as sires above expectancy left sons just equal to, or below expectancy. Similarly, results in the last two groups demonstrate the inadequacy of the daughter average alone as a selection index, as "below expectancy" sires in these two groups left sons showing little or no improvement on expectancy. Where, however, the sire's survey result combined a high daughter average with an improvement on expectancy, the sons were above average—4lb. above in the third group and 10lb. above in the fourth group where the sire's daughter average was 400lb. fat or more.

The "above expectancy" sires in the 400lb. daughter average group were further sub-divided according to the amount by which they exceeded "expectancy." Sires in this group which were less than 30lb. above expectancy, left sons 3lb. fat above expectancy but the sires more than 30lb. fat above expectancy demonstrated clearly their superior breeding quality. The 152 sons of these sires were 13lb. fat above expectancy.

This improvement cannot, however, be attributed solely to the sire, as 50% of these sons were out of either I.M.R. or Elite L.M.R. cows. The sons in this group (i.e. sons with both parents of 400lb. fat merit standard) were 17lb. fat above "expectancy."

Analysis of Stud Results.

The marked superiority of the sons of the 400lb. fat bulls in the highest "expectancy" groups and the fact that half of them were also sons of 400lb. fat Merit cows would point to the existence of studs where several generations of successful breeding have resulted in a high concentration of Merit cows. The use of superior quality sires on these cows would enable these studs to supply a very much better than average sample of bulls to the industry.

It is appropriate, therefore, at this stage to analyse results for studs which are the source of a large proportion of the bulls used in New Zealand, and to study the variation in the quality of the bulls they are supplying. The results for studs with at least 15 bulls of their own breeding which have been surveyed in tested herds are summarised in Table VI.

TABLE VI.

QUALITY OF BULLS SUPPLIED TO THE INDUSTRY BY VARIOUS STUDS.

Stud	No. of Sires Surveyed	SURVEY RESULTS	
		Daughter Average (lb. fat)	Difference from "Expectancy" (lb. fat)
A	18	368	+ 29
B	18	334	+ 19
C	31	348	+ 17
D	18	343	+ 16
E	27	344	+ 10
F	31	336	+ 10
G	53	347	+ 9
H	33	331	+ 7
I	19	352	+ 5
J	15	348	+ 3
K	15	329	+ 3
L	28	331	+ 2
M	19	327	— 1
N	44	321	— 3
O	32	319	— 4
P	23	312	— 8
Q	18	313	— 8

The 17 studs included in this analysis have been arranged in descending order according to the survey results of the bulls they have bred. Differences from "Expectancy" range from 29lb. fat above for stud A, to 8lb. fat below for studs P and Q.

As was mentioned earlier in this paper, the sample of 3000 bulls included in this survey would be used in tested herds in 1946 and 1947. The results shown in this table would, therefore, be a measure of the quality of these studs prior to 1945.

It has not been possible to determine the present concentration of Merit stock in all these studs as a number have not tested under the Group system. But it is known that in Stud A there are over 90% of Merit cows.

Five of the studs in the top half of the table have tested consistently under the Group system and all have at the present time at least 40% of the cows in their herds of Merit standard.

These figures demonstrate a considerable variation in the quality of the studs supplying bulls to the industry but the results for the top four studs indicate that an improvement of 17lb. fat through improved methods of selection is not an impossible objective.

Results for A.I. Sires.

Before discussing the significance of the results of these studies into improved methods of selection it will be necessary to summarise results which have been obtained through the use of high quality merit sires by means of Artificial Insemination. These are results which could be secured in the larger herds without the use of A.I. if herd owners were prepared to keep their bulls in limited use until proven and to select a herd sire for intensive use on the basis of his own progeny test results. Only 3% per cent of all surveyed sires are 30lb. fat above "expectancy" and have a daughter average of 400lb. fat and approximately 40% of these sires would be lost to the industry by the time they were proven. It is obvious, therefore, that unless the influence of the existing high quality sires can be increased by their widespread use through A.I. there will be only a limited value in recommending the use of sons of these sires.

It is too early yet to obtain information on the quality of artificially bred sons, but production improvements actually being achieved with artificially bred daughters in commercial herds are quite substantial. The results for 10 different sires used at Ruakura are summarised in Table VII.

TABLE VII.

PRODUCTION OF A.I. BRED DAUGHTERS OF MERIT SIRES.

SIRE	No. of Daughters	Daughters Average (lb. fat)	Difference from Expectancy (lb. fat)
J.G.H.B.	269	356	+ 42
E.T.	187	349	+ 32
L.D.S.	55	342	+ 22
K.K.B.K.	44	335	+ 19
G.H.P.	30	337	+ 17
McL.	7	314	+ 15
M.O.L.	31	326	+ 8
A.P.	16	320	+ 6
G.A.	11	325	+ 5
L.G.L.	112	306	+ 4
Av. of 10 'Merit' Sires	762	341	+ 27

It is obvious that there has been a considerable variation in the quality of the sires used. J.G.H.B. has 269 A.I. bred daughters averaging 356lb. fat and is 42lb. fat above "expectancy." E.T. and L.D.S. are also showing a substantial improvement on "expectancy." With the exception of L.G.L. whose daughters are only 4lb. above expectancy, the poorer bulls have not ben used extensively. The overall improvement for the 762 daughters of these 10 sires is 27lb. fat. This then is a measure of the gain in average per cow production which would be secured by the average herd owner using an A.I. bull instead of his usual herd sire or the "average" sire.

Discussion

These investigations have indicated production improvements which could be expected from various methods of selection through the herd sire. An improvement of 17lb. fat has been demonstrated by selecting sons of sires with a 400lb. fat daughter average at least 30lb. fat above "expectancy," out of dams with a series of records at the 400lb. fat level.

As sires used in tested herds would be a better than average sample, the "expectancy" values against which improvements have been measured, would themselves be above the level for all sires in the industry. It is probably not too optimistic, therefore, to expect an improvement of at least 20lb. fat per cow in the national herd through the use of these sires.

It should be emphasised, however, that the improvements quoted in this paper, in terms of difference from "expectancy" are generation improvements. A generation improvement of 20lb. would be equivalent to an overall annual improvement of 4lb. fat as one-fifth of the national herd is replaced annually.

Future investigations may indicate a more satisfactory basis for assessing genotype and consequently a better basis for selecting herd sires. We may, at the moment, be neglecting quite a large reservoir of cows and bulls from which it would be safe to select sires, but until that has been discovered we should make the best use of the material available.

To provide all true dairy herds with at least one of these sires, 30,000 bulls would be required which would be replaced at the rate of approximately 6000 annually. To provide these 6000 bulls, at least 15,000 cows of the requisite 400lb. fat Merit standard would be needed and each of these would have to be mated to a high quality proven sire.

It is estimated that between 1500 and 2000 of the pedigree cows entered in the Merit Registers are still in the industry. With an increase in the number of pedigree cows under test and in the number of herds tested consistently this number could possibly be trebled in the next three or four years. The existing pedigree population will therefore be able to supply little more than one-third of the cows of the standard suggested for dams of future herd sires.

Production records for grade cows under consistent test reveal a potential source of large numbers of cows producing consistently at the 400lb. fat level. As pedigree bulls are used in 80% of the herds, under test, a number of these cows would have been top crossed with pedigree bulls for several generations. It would not be impossible, therefore, in the next few years, to build up a population of 15,000 cows of 400lb. fat merit standard.

The development of A.I. by enabling maximum use to be made of existing high quality sires has made the second half of the task at least possible although I realise that the problem of artificially inseminating 15,000 selected cows scattered through our main dairying areas should not be dismissed lightly.

Even if this select population of cows were mated naturally to carefully selected sires the improvement in the quality of the sons should be substantial.

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