

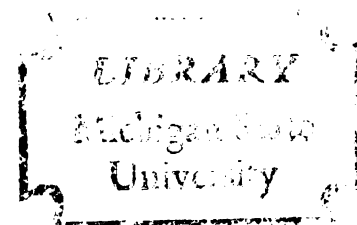
WEIGHTING COMPONENTS OF TYPE IN
CLASSIFYING HOLSTEINS

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THESIS



ABSTRACT

WEIGHTING COMPONENTS OF TYPE IN CLASSIFYING HOLSTEINS

by George W. Atkeson

The relationship between body conformation (type) and milk production of the dairy animal has been of interest to breeders for generations. Mitchell et al. (1961), Johnson and Fourt (1960), Carter et al. (1965) and others have presented the phenotypic and genetic correlations between the components of type, and for type score and production. One aspect of type that has been studied little is the relationship between scores of the component parts and the overall classification. Also the weights necessary to relate production most closely to the components of type have not been studied.

The two objectives of this study were:

1. To examine the agreement between the emphasis specified by the score card for it's components in measuring final type score and that actually applied by the official classifiers.
2. To measure the emphasis on the components of type to maximize the correlation between final score and production.

The Holstein-Friesian Association of America supplied the type classification data. Nine classifiers officially classified 12,890 registered Holstein cows in 96 herds in Michigan from 1963 through 1966. Production data were obtained from the Michigan Dairy Herd Improvement Association and were 305 day, 2X, mature equivalent records.

A least-squares analysis was used to determine the emphasis assigned to the components of type by classifiers predicting total score. Two models used eight components of type and four components. The multiple correlation coefficient of components with type score were $R = 0.95$ for either model. The emphasis on each component of type was expressed by the standard partial regression coefficient as a fraction of the sum of all coefficients for comparison with the Holstein score card.

The use of the four major components of the score card are just as useful for prediction of final score as all eight components. Classifiers are assigning less emphasis to dairy character and body capacity than specified by the score card. In relating type classification to production, dairy character for the prediction of production would be about as useful as all components of the score card.

WEIGHTING COMPONENTS OF TYPE IN
CLASSIFYING HOLSTEINS

By

George W. Atkeson

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INTRODUCTION

The relationship between body conformation (type) and milk producing ability of the dairy animal has interested breeders for generations. According to Gowen (1926) the problems relating conformation in dairy cattle fall into two general classes: (1) the influence of inheritance on conformation and productivity, and (2) the relation of conformation to productivity of the individual cow.

Copeland (1938) notes that the importance of conformation was recognized early by breeders on the Island of Jersey where the first score card or scale of points was developed in 1834. The five major dairy breed associations of the United States in America, having an appreciation for the value of type, adopted similar evaluation by score card. There have been several changes in the score card. In fact, the score card of today combines ideals of the breeder and showman of the past (Gowen, 1921).

The original concepts of type considered the animal as a whole, but over the years type became more and more regarded as composed of parts, each with a definite function. As the interest in type progressed, it became more evident that the component parts were correlated and that the conformation of one part of the individual might indicate the

purpose of another. Combined efforts of the breed associations through the P.D.C.A. (Purebred Dairy Cattle Association) in recent years developed a unified score card for the major breeds of dairy cattle. This score card unifies the weights given to the individual parts of type for all major dairy breeds, each developing their own card differing from the others in breed characteristics. The actual classification for the specific breeds does, however, differ in relative emphasis assigned to the specific components of type. The score card only suggests the emphasis. In some breeds the numerical values of components are totaled for the final numerical score. Other breeds use major and minor components of type. The minor values express most of their respective major component. The major components are then totaled for the final evaluation, or the final score is broken down into the final components. Originally type rating was only a letter designation, but for less coarseness of scale a combination of both numerical and letter grade is presently used by all breed organizations. Interest in the component parts of type has resulted in several recent studies of the genetic and phenotypic correlations of the different components of type and the development of selection indexes for multiple traits to aid breeders in their breeding programs. Type rating in dairy cattle breeding is primarily to aid selection of desired body conformation.

One aspect of type that has been studied little is the relationship between scores of the component parts and the overall classification. Perhaps due to variation among individual cows and the difficulty of combining components that make up final evaluation, official classifiers may not be following the P.D.C.A. score card. Weights necessary to relate production most closely to the components of type have not been studied. These questions suggested the two primary objectives of this investigation.

1. To examine the agreement between the emphasis specified by the score card for it's components in measuring final type score and that actually applied by the official classifiers.
2. To measure the emphasis on the components of type to maximize the correlation between final score and production.

REVIEW OF LITERATURE

Dairy Type

Type, or conformation, in modern dairy cattle is the form or structure of an animal which allows for the most efficient performance of a specific function (Rennie, 1962). The major function of dairy cattle is to produce milk economically.

Perhaps before one can say what emphasis should be placed on type in a breeding program, it becomes necessary to determine the value of type to the various kinds of dairy-men. To do this each dairyman must consider (Rennie, 1962) the importance of the following factors:

1. Relation between type and production.
2. Merchandising of sale value of type.
3. Utility value of type in the day-to-day milking operation.
4. Esthetic value of type.

Because breed improvement programs of various purebred associations have stressed the merits of good type, the general type of the dairy animal has received considerable attention by members of associations. What constitutes type and its most important elements may vary between breeds and regions, and judges within the same breed and region.

But, according to Johansson (1961) there is general agreement upon a definition of the standard or ideal type of the cow and bull of a certain breed, and the individual animals are judged on their similarity to or deviation from this standard.

Development of Type Classification

Early interest in a formal manner in the physical characteristics of dairy cattle developed on the Channel Islands of Guernsey & Jersey according to Porter et al. (1965). The scale of points directed attention to production traits as well as to points of conformation that were thought to be closely related to production and structural soundness. With these ideas John Jacob in 1830 published his interpretation of points for judging with a total score of 20. Several changes and additions to this means of evaluation resulted as the idea and use was accepted by different breeds. Bayley et al. (1961) explain that the idea of the score card for evaluation was first developed in the United States by the Guernsey breed in 1887, and the other breeds followed with their own similar systems.

The five dairy breed associations in 1940 formed the Purebred Dairy Cattle Association with the purpose of a unified effort to promote purebred dairy cattle and to work out uniform programs that concerned all of the breeds. Henderson and Reeves (1954) indicate that the adoption of a unified

dairy cattle score card for all breeds was one of the major aims of the association. This score card unifies the scale of points and description with the exception of certain characteristics specific for each breed. Prescott et al. (1930) note that the Holstein-Friesian Association of America first started a program of type classification for their members in 1928.

The basis for improvement in breed type is centered around ideas promoted by breed associations reflecting the desires of individual members. Each breed association has adopted true type models of the cow and bull. The purpose of a true type model is to set a standard that can be used to aid in evaluation for breeding and judging. Harrison et al. (1940) explain that the score card provides a definite basis for comparing cows with the standard of perfection established by the true type models of the breed associations.

The various breed associations use the general outline of the P.D.C.A. score card in the development of their own score cards. As Johansson (1961) indicates, the purpose of the subdivisions of the score card is to ascertain and record to what extent the animals are free from defects in either body conformation or udder development that might impair their value. Each breed specifies the actual emphasis for the different components a little differently.

The actual type classification is performed by an official judge employed by the association. Breeders desiring classification must request classification in advance of scheduled dates, and normally the breeder cannot specify the classification date or classifier. During scheduled classifications all milking cows in normal body condition must be evaluated by the classifier.

The recently accepted (January 1967) Holstein-Friesian cow score card divides 100 points into four major components. These components are:

General Appearance	30 points
Dairy Character	20 points
Body Capacity	20 points
Mammary System	<u>30</u> points
	100 points

The use of the score card by the official breed classifier enables the breeder and the classifier to have a common understanding of the important factors in evaluation of type. In general, the final score is summarized by word or letter rating. The relation of numerical final score and rating for the Holstein is:

EX = Excellent	90 points or above
VG = Very Good	85 to 89 points
GP = Good Plus	80 to 84 points
G = Good	75 to 79 points
F = Fair	65 to 74 points
P = Poor	Below 65 points

All classification information is recorded by the association and used in sire evaluation and other ways to

understand and promote the excellence of the breed. In some dairy breeds the classification score can be raised and lowered. However, the Holstein association permits only raises in ratings. Most breed associations have procedures to recognize animals qualifying repeatedly for the upper classification grade (EX). The Holstein association indicates cows classified excellently be, E 1, E 2, etc. to show the number of times classified excellent.

In classification, the points assigned by the score card are not always used to arrive at the final decision. The degree of deviation from the ideal must be given careful consideration. That is, the cow score card allows 10 points to feet and legs. However, if an individual is very poor in feet and legs, considerable deviation in this part of the 30 points of general appearance might occur in evaluation.

Carter and Rennie (1965) indicated that general appearance is receiving undue emphasis in comparison with the other components in the dairy cow score card. They feel that this has probably resulted from the whole conformation being considered in general appearance. General appearance should be redefined in the original sense as set out by the score card or replaced by the components that it really describes. Even in the early 1930's less emphasis was being given to general appearance.

According to Trimberger (1958) the adoption of the unified score card has done a great deal to correct the

problem of comparing in the show ring the different types of cattle that are found in different parts of the country. McGilliard and Lush (1956) point out that even though the use of show ring standards is important to the breed and members as a means of breed promotion, one must be conscious of different standards of appraisal. Not only are show cattle a highly selected group, but condition, fitting, etc. receive more attention in the show ring than in type classification.

Variations Among Classifiers

The purebred breeder depends on the official breed classifier and breed fieldmen for guidance in selection for type in his breeding program. Variations among classifiers and between ratings on the same cow classified more than one time often cause considerable controversy and confusion among breeders.

The final score for Holstein females that were rated at yearly intervals by different classifiers are moderately repeatable, and Johnson and Lush (1942) reported a correlation of 0.34. Hyatt and Tyler (1948) indicated that ratings of the same cow classified by the same inspector for an average of 5 times over 4.5 years resulted in repeatabilities for three different inspectors of 0.73, 0.82, and 0.62. Benson et al. (1951) reported correlations between final rating given at each classification by two classifiers were 0.56 for the same classifier at different times, 0.61 to 0.76

for different classifiers at the same time, and 0.48 for different classifiers at different times. Their work indicated the corresponding correlations for heifers which were also classified twice yearly by two classifiers were 0.28, 0.54 to 0.81, and 0.20.

The change in type could be an unconscious change that the classifier makes in his ideal, or as Touchberry and Tabler (1951) point out, the change in appearance of the cow from one time to the next may be the major cause of changes in overall type ratings. Changes in type rating of the same cow classified at different times could come from uncertain ideals, changing ideals, changes of classifiers with differing ideals, and changes in the cow. Touchberry and Tabler's (1951) results showed a repeatability of 0.55 for ratings given the same cow by different classifiers. The intrabreed correlation between ratings of cows made by the same man on different dates was 0.49; that for different men on the same date was 0.62; and for different men on different dates the correlation was 0.37, agreeing quite closely with Benson et al. (1951).

Classifiers must consider the age of the animal being classified because of the different physical characteristics developing at various ages. Harvey et al. (1953) found, for Jersey and Holstein heifers classified at intervals of six months to about 24 months of age, an intrabreed correlation of 0.40 between ratings of heifers made by the

same classifier on different dates, of 0.64 when different classifiers rated the heifers at the same time, and 0.37 for different classifiers working at different times. The studies of Touchberry and Tabler (1951) and Harvey et al. (1953) suggest that classifiers adjust to changes in age uniformly. The agreement between the results of Touchberry and Tabler (1951) with cows and those of Harvey et al. (1953) with heifers is summarized with two additional studies, Benson et al. (1951) and McGilliard and Lush (1956) in Table 1. McGilliard and Lush (1956) agree with the work of Touchberry and Tabler (1951) and Harvey et al. (1953) that judges had almost identical general levels. This perhaps could be a result of the training schools which most breed associations now hold for classifiers.

Table 1. Correlations between final scores at different times of classification

	Benson et al. (1951) Cows	Touchberry & Tabler (1951) Cows	Harvey et al. (1953) Heifers	McGilliard & Lush (1956) Cows
Same classifier at different times	0.56	0.40	0.40	0.41
Different classi- fier rating at the same time	0.61- 0.76	0.62	0.64	0.58
Different classi- fier rating at different times	0.48	0.37	0.37	0.32

The results of Hyatt and Tyler (1948) indicated a tendency for the inspectors to raise their ratings as cows advance in age. Perhaps the natural tendency is for the inspector to rate the animal lower at early age if there is any doubt in his mind, knowing that the individual can be raised at a subsequent reclassification and, for Holsteins, is never officially lowered in classification. Hyatt and Tyler (1948) further explain that the average classification score moves up by age groups. However, a point often overlooked is that selection for preferable type may be responsible for the change in average score as age advances. Their results indicated that the change in type rating due to advancement in age is not large. Wilcox et al. (1959) indicated that classifiers of cows 5 years and older were more lenient than they should have been and suggested that adjustments in type were made just because individuals were "nice old cows."

The New York study of Specht et al. (1967) indicated herds accounted for 10 per cent, sires 5 per cent to 8 per cent, and classifiers 2 per cent to 6 per cent of the variance in final score. The range of scores assigned to 2-year olds was 76.5 to 79.1. They felt that classifiers agreed best on overall type score, dairy character, rear udder and rump. A wider difference of opinion existed among classifiers for general appearance, body capacity, and feet and legs.

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Effects of cows, judges, and years and their interactions were of interest to McGilliard and Lush (1956) and their results were in general in agreement with the work of Touchberry and Tabler (1951) and Harvey et al. (1953). Table 2 summarizes the work of Touchberry and Tabler (1951), Harvey et al. (1953), and McGilliard and Lush (1956).

Table 2. Variances for cow, year, and judge of three related studies

Source	Range of Variance (%)	Reported By*
Cows**	10 - 55	3
Year	3 - 11	3
Judges	0	3
	0	1
	0	2
Cows X Judges	3	3
	3 - 11	1
	0 - 4	2
Cows X Years**	12 - 31	3
	21 - 42	1
	16 - 27	2
Judges X Year**	5	3
	0	1
	0 - 2	2
Error	23 - 52	3
	15 - 17	1
	28	2

*1 = Touchberry and Tabler (1951); 2 = Harvey et al. (1953); and 3 = McGilliard and Lush (1956).

**Significant at 0.01.

McGilliard and Lush (1956) divided their data into groups according to whether the classification was before or after the animal had calved for the first time. The significant interaction of cow by year indicated a real change in an individual cow's appearance apart from the general change in appearance of all cows. The judge by year interaction measured the extent to which the classifications of a judge in a given year were genuinely higher or lower than his average ratings in other years after the amount all judges changed was accounted for.

A factor that often presents a problem to the classifier is the stage of lactation of the individual being classified. Hyatt and Tyler (1948) reported that the difference in this aspect of classification are small but statistically significant when scores from either the early or the last part of the lactation are compared with those from the middle segment of the lactation. A little higher rating is obtained when animals are classified shortly before or after freshening rather than in the middle part of the lactation.

Freeman and Dunbar (1955), Carter et al. (1961), and others have examined the correlations for individual components of type and final score. The actual weights assigned to components of type for determining final score has not been reported in any detail.

Type and Production

The importance of body conformation or "type" and of production has frequently been the center of discussion for those interested in the improvement of the dairy animal. Freeman and Dunbar (1955) consider that overall type is made up of various components and it is possible that scores on certain of the components could be of value as additional information in the selection of overall type conformation and/or production. Copeland (1941) believes that too many breeders feel that good type is important only for the breeder of registered cattle, but if type is not appreciated by the average dairyman milking cows, perhaps it is not useful to any breeder. Some breeders have maintained that a close relationship exists between the conformation of a cow and her ability to produce milk while others have claimed no association, and still others more or less are in the middle.

A small positive phenotypic correlation between overall type and milk and fat production has been found in various breeds by Copeland (1938), (1941), Rennie (1951), and Tyler and Hyatt (1948). Curtis and Rennie (1951) point out that recent studies by Brieve et al. (1958), Johnson and Fourt (1960) and Mitchell et al. (1961) have shown that various components of overall type have low but positive correlations with production ranging from 0.1 to 0.3.

Various studies have indicated an association between type and production by the genetic and phenotypic

correlations between the components of type and type score or production. However, the weighted values for the components of type in expressing the type score or production have not been examined to any extent.

Rennie (1951) mentions that for many years body conformation has been used by dairy cattle breeders as an aid to production records in the selection of breeding stock. Type has also been used as one of the bases of selection of heifers before production records are available. The emphasis placed on type in a breeding program varies greatly among breeders. But the importance of type in a selection program where the primary goal is to improve genetic ability for a production trait will depend upon heritabilities of type and production and on genetic correlations between these traits. From the scientist to the man with only a limited appreciation for the aspects involved, each has his own concept of the importance of type and production and their relationship. Therefore, breeders actually differ in the use of knowledge available and the individual desires of each. The application and the importance of type and production are not at all concerned with only purebred cattle but involve the entire dairy cattle population.

Copeland (1941) concluded that culling and selection practices make higher classified cows appear to be superior in production. This probably results from culling in herds

after classifications were made, and cows rated "Fair" and "Good" were often disposed of shortly after or before they were classified, and their production records were not completed. Due to this practice, the "Excellent" cows tend to have more production records and undoubtedly better management. More recent and complete data presented by Curtis and Rennie (1961) in Table 3 also suggests that the better type cows on the average tend to be the higher producers and to have completed more records than do those in the lower classifications.

Table 3. Distribution by overall type rating of cows with one or more production records and the average production of the cows in each type grade

Overall Type Rating	No.of Cows	Percent of Cows	Milk (#)	Fat (#)	Test (%)	Percentage of All Classified Cows with Pro- duction Records
Excellent	130	3.98	9,334	512	5.51	86.7
Very Good	1,183	36.18	8,434	460	5.48	81.5
Good Plus	1,364	41.71	8,024	437	5.48	73.2
Good	538	16.45	7,654	418	5.49	61.6
Fair	55	1.68	7,594	402	5.37	45.1
Averages	3,270		8,156	445	5.48	73.3

Source: Curtis and Rennie (1961).

Copeland (1941) indicated that such results as reported by Curtis and Rennie (1961) would tend to give the wrong impression about the importance of type and it's related importance to production. He illustrates that selecting cows of higher classification will not positively insure higher production as compared to selecting cows of lower classification. He further suggests that the range in production within each classification group exceeds the difference between the various groups and that the relationship between classification ratings and production is not significant.

Lush (1945) says that all the characteristics to which one pays attention do not deserve equal importance. He feels when selecting for several characteristics, one runs the risk of paying too much attention to something which is really of minor importance, stressing that increasing the emphasis on one trait automatically reduces the opportunity for culling on something else. A selection index will assign the emphasis to the desired traits in proportion to their heritability, their economic importance, and the genetic correlation between traits. Heritability is the fraction of the parents' superiority that is received by the offspring, and one should select for the traits that have higher heritabilities and are of economic importance. What the breeder actually sees in phenotypic expression both in production and type can affect the decision that he will

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make in selection of future breeding stock. Such factors as, death loss, reproductive problems, etc. will tend to reduce the intensity of selection.

Selection for Both Type and Production

If both type and production are desired in a breeding program, then selection for one will not markedly improve the other (Lush, 1945). Thus, improvement in both production and type requires selection for both. Stone et al. (1955) agree with this concept from similar results with Canadian Holsteins. They feel that, in general, type and production are compatible and that most breeders are correct in continuing to select for both. Considering that there is a rather high genetic correlation between dairy character and production in the Holstein breed, Bayley et al. (1961) suggest that instead of considering the trait as a substitute for production records in estimating genetic merit for production, one might consider its value as a supplement to production records.

Curtis and Rennie (1961) computed the regression coefficients to give a practical value to the change in production for a single lactation which might be expected with each change of one grade in type rating. Table 4 shows the intra-sire, intra-herd regression of milk and fat production on type ratings. Curtis and Rennie (1961) assumed that most good dairymen feed and care for their higher producers and

Table 4. Regression of production on type components
(3,270 observations)

Type Component	Regression	
	Milk (#)	Fat (#)
Overall rating	408	24
Head and neck	362	20
Depth and width of chest	248	17
Body capacity	340	19
Back and loin	221	14
Rump and tail setting	233	15
Breed and dairy character	425	25
Legs, pasterns and feet	333	21
Fore udder	197	13
Rear udder	492	27
Teats	414	23

Source: Curtis and Rennie (1961).

superior type cows somewhat better than their poorer cows. Consequently, the regression presented may be biased upward from the regression based on the entire breed.

Harvey and Lush (1952) indicated that selection on the basis of type alone should no doubt automatically bring about some genetic improvement in production. However, selection on type alone would require about 6 to 10 generations to obtain the improvement that selection on the basis of production would obtain in only one generation.

Butcher et al. (1962) indicated that the progress expected in production of milk fat when one selects for any one of the components of type or final type rating is

approximately 1/50 times as much as selection based on one production record.

Bayley et al. (1961) indicated that if the ratio of milk to type is 3:1 in the selection index, it would impair the progress in improving milk production about 5 per cent for Holsteins. This actually means that if breeders use 3:1 as a basis for their relative emphasis on milk production and type, they will make very little progress in improving overall type. Certainly the breeders who noticeably improve the type of their cattle are giving more emphasis to type than this.

Each breeder needs to evaluate his breeding program and decide just how important type is to his overall goal. Just how much emphasis can a breeder give type without seriously reducing the progress in improving production is a question that all breeders must ask themselves. Bayley et al. (1961) further explain that if one does try to progress in type, it would be necessary to allow one type grade at least as much importance as 1,500 lb of milk, as shown in Figure 1.

Figure 2 (Bayley et al., 1961) shows that progress for milk yield with the relation of importance (3:1) would be 14 per cent less than if type were not considered at all. If type is given as much importance as 2,500 lb of milk, progress toward higher milk yield would be reduced by 28 per cent. This is almost the same as giving variation in type equal importance to the variation in production.

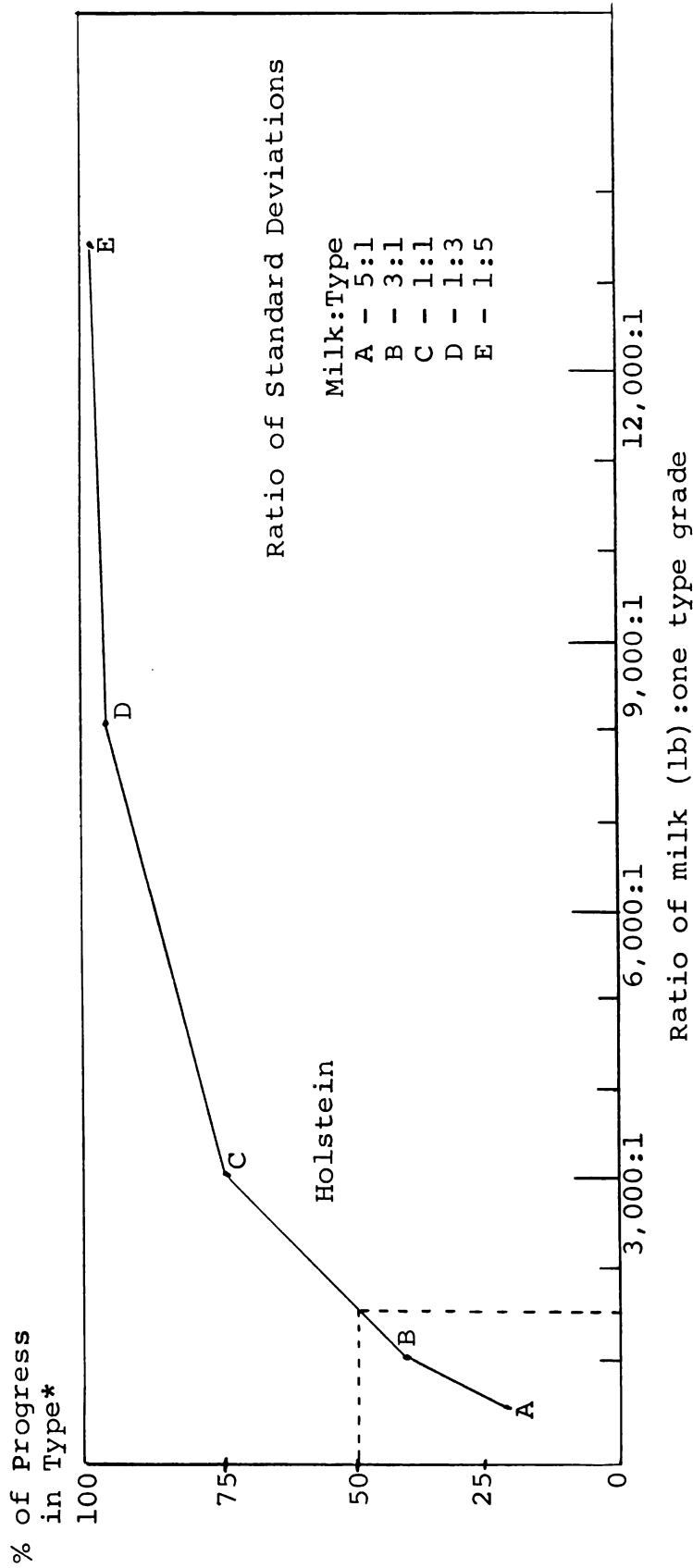


Figure 1. Progress that may be expected in improving type when selecting for both milk production and type, Bayley et al. (1961).

*per cent progress represents that fraction of the progress expected when selecting for both milk and type as compared to selection for type without any consideration given to milk production.

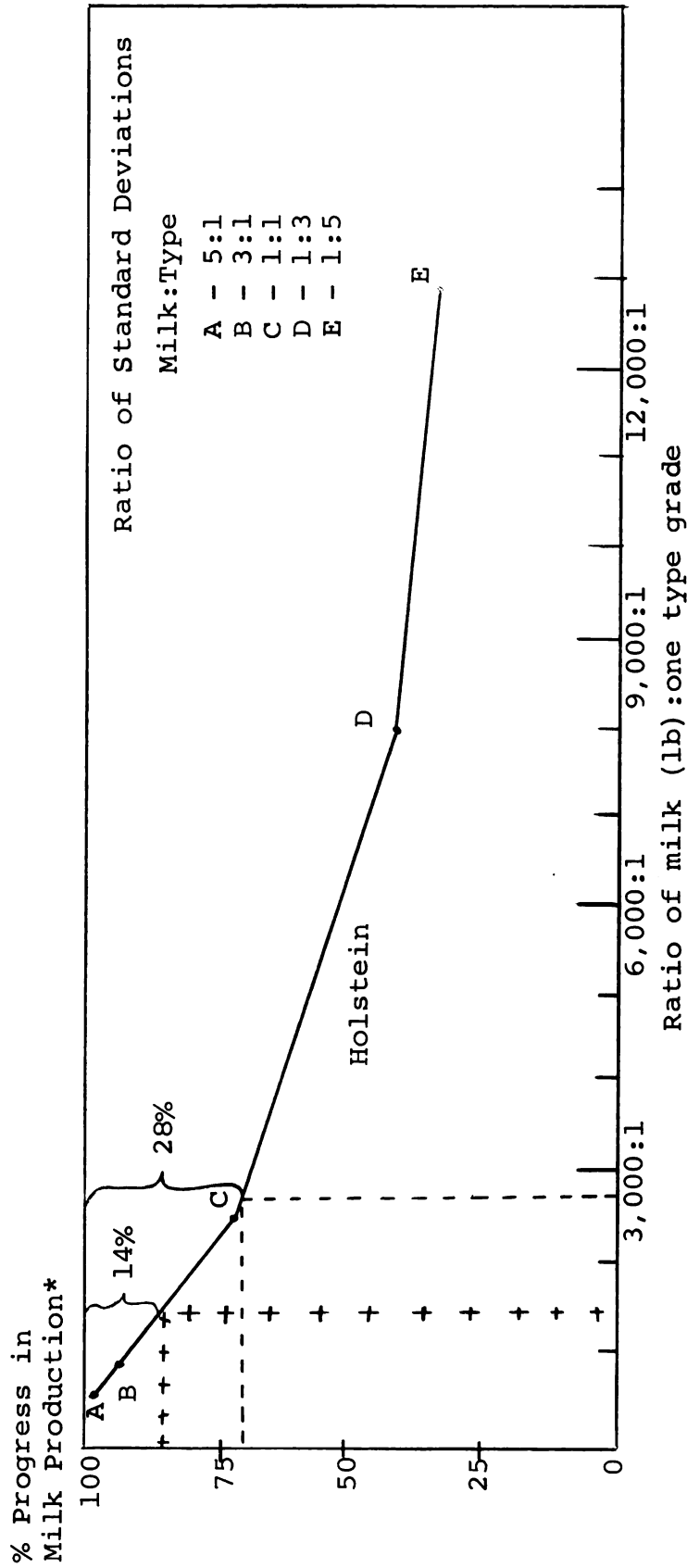


Figure 2. Progress that may be expected in improving milk production when selecting for both milk production and type, Bayley et al. (1961).

*Per cent progress represents that fraction of the progress expected when selecting for both milk and type as compared to selection for milk production without any consideration to type.

Overall Significance

Profitable milk production is the main reason for the dairy cow's existence, and other factors of individual breeder interest such as type, reproduction, color markings, etc. are considered second only to production in breed importance. Wilson (1952) points out that type standards are only satisfactory if the basic requirements conform to those qualities which are associated with a long lifetime of profitable production. From a practical standpoint type would be important only to the extent that it might interfere with the owner's ability to make the proper decision whether a cow should stay or leave the herd because of low production (Harvey and Lush, 1952). As Lush (1945) points out, the real damage is done by paying attention to the "fancy points" in selection. Namely, that the more attention given to them, the weaker the selection must be for the utility purposes which after all are the more important factors. In the average breeding herd the involuntary losses reduce the actual selection intensity that the breeder can practice which has a direct bearing on the rate of progress obtained.

The future might suggest to some breeders that because of the changing concepts of dairying, such as more confinement for the cows, larger herds, group feeding and housing, parlor milking, and attempt to secure higher energy intake per cow, the ideal dairy cow standards may change.

MATERIALS

Records of type were supplied by the Holstein-Friesian Association of America. Nine classifiers officially classified 12,898 registered Holstein cows in 96 herds in Michigan from 1963 through 1966. The number of observations used was 12,647. As indicated in Table 5, 12,898 observations were received from the Holstein association. In processing from card to magnetic tape 8 records were lost, resulting in 12,890 observations for the preliminary analysis.

Each of the eight classifiers worked in the state in two or more years during the time studied. Only one classifier worked all four years, classifying 2,125 individuals. The fewest observations recorded by any classifier was 374 during two years. Table 5 gives the number of classifications by classifier and year.

All information recorded by the classifier on official Holstein classification forms was used in this investigation. This information relates the evaluation of eight components of type for each individual cow. The score card records the major four and minor four components of type.

Table 5. Number of cows scored by year and classifier

Classifier	1963		1964		1965		1966		Total		% of Observations
	Herds	Cows	Herds	Cows	Herds	Cows	Herds	Cows	Herds	Cows	
1	4	100	23	1,033	..	..	..	..	27	1,133	9
2	25	643	..	..	..	..	21	922	46	1,565	12
3	14	693	4	111	25	787	14	534	57	2,125	16
4	14	474	24	1,022	5	132	..	..	43	1,628	13
5	20	1,542	8	257	..	..	..	..	28	1,799	14
6	18	622	..	..	..	..	..	..	18	622	5
7	..	..	1	42	11	332	..	..	12	374	3
8	..	..	36	1,957	1	21	..	..	37	1,978	15
9	..	..	..	..	8	246	10	1,428	18	1,674	13
Totals	95	4,074	96	4,422	50	1,518	45	2,884	286	12,898	100

The following events are normal for the general group classification program, in which the classifier will visit several farms in a given area during a specific time.

1. All cows of milking age in a herd must be classified. Some of these could be young cows receiving their first classification, could involve older cows eligible for classification but not previously scored, and Canadian cows scored for the first time in the American association.
2. Some previously classified cows will warrant reclassification and raising of their score and individual component evaluation.
3. Other individuals will receive the same evaluation as previously assigned and classification will be unchanged.
4. The breeder can request a new evaluation of the components of type if he does not agree that the individual cow should remain as previously scored.
5. Classifiers have the authority to consider any individual out of normal body condition at the time of classification.
6. Breeders have the right to cancel the registration papers on any individual during classification.

The production data were obtained from records of the Michigan Dairy Herd Improvement Association. Milk

production records were expressed as 305 day, 2X, mature equivalent records.

Combining the type and production data with specific restrictions resulted in 6,097 observations of which 1,456 were used for prediction of production by type components.

For ease in presentation the abbreviations will be:

Constant	C
Milk Production	MP
Final Score	FS
General Appearance	G
Dairy Character	D
Body Capacity	B
Mammary System	M
Fore Udder	FU
Rear Udder	RU
Feet and Legs	FL
Rump	R

METHODS AND RESULTS

Type

In addition to the normal numerical final score (85) of an individual cow, the final rating (VG) and individual components of type, commonly called the breakdowns, were assigned a coded value for ease in evaluation. As an example, final rating (4) and eight breakdowns, 4, 4, 3, 4, 2, 4, 4, 3. Codes used in this investigation are: Excellent = 5; Very Good = 4; Good Plus = 3; Good = 2; Fair = 1; and Poor = 0. These codes are similar to those used by Carter et al. (1965b), Specht et al. (1967), and many others. The mean type score of all females in this study was 81.2. Carter et al. (1965b) reported a mean score of 78.5 and Specht et al. (1967) 78.7.

Type data were further categorized into two major groups with several subdivisions, as shown in Table 6. Percentages for the 12,647 type observations were distributed as: 39 per cent first classifications, 16 per cent reclassified and raised, and 45 per cent classified and unchanged. A summary of these various divisions and percentages is presented in Tables 6 and 7.

To determine the simple correlations between the different components of type and final score, and the relative

Table 6. Grouping of classifications by sequence, character, and age

Total observations	12,647	
A. First observation of investigation . . .	7,856	62%
1. First classification . . .	4,905	62%
a. Cows 3 yrs (36 mos)		
b. Cows 3-5 yrs (37-60 mos)		
c. Cows 5+ yrs (61+ mos)		
2. Reclassified and raised . .	860	11%
3. Classification unchanged. .	2,090	27%
B. 2nd & 3rd observations of investigation	4,763	38%
1. Second classification after initial	3,387	71%
Code 2 . . .	885	26%
Code 3 . . .	2,502	74%
2. Remaining classifications	1,376	29%
Code 2 . . .	296	22%
Code 3 . . .	1,080	78%
	100%	100%
C. Classification unchanged		
3. Classifications unchanged	5,673	

Table 7. Number of first classifications by age and classifier (A.1)

Classifier	<36 mos.	%	37-60 mos.	%	61+ mos.	%
1	209	9	191	8	13	4
2	266	12	290	12	36	10
3	244	11	350	15	73	20
4	364	16	416	18	76	21
5	288	14	346	15	72	20
6	117	5	112	5	44	12
7	64	3	41	2	7	2
8	370	17	292	13	18	5
9	<u>288</u>	<u>13</u>	<u>291</u>	<u>12</u>	<u>24</u>	<u>6</u>
Total	2,210	100	2,332	100	363	100
Per cent of Total	45		48		7	

contribution of these components, least-squares was selected as the analysis. Of particular interest in this analysis was the weighted contributions as expressed by the standard partial regression coefficients (beta weights). The beta weights measure in standard units how final score would vary per unit change in general appearance if the other components were all held constant. Preliminary tests, using the 12,890 observations with no restrictions or special designations, were made on the eight components of type in ten different combinations to determine which combination of components predict type score most accurately. The multiple correlation coefficients, expressed numerically in Figure 3, indicate that using all eight components of type in contrast to only the major four components (general appearance, dairy character, body capacity, and mammary system) measure the contribution of each component in a linear manner to determine final score, and these two procedures are essentially equal in prediction.

The new descriptive type classification program of the Holstein-Friesian Association uses the scores of the four major components of type to form the final score. The design of this investigation is to use both the new method of only the major four components, and the old procedure of all eight components for determination of final score. The means and standard deviations for the 12,890 observations are presented in Table 8.

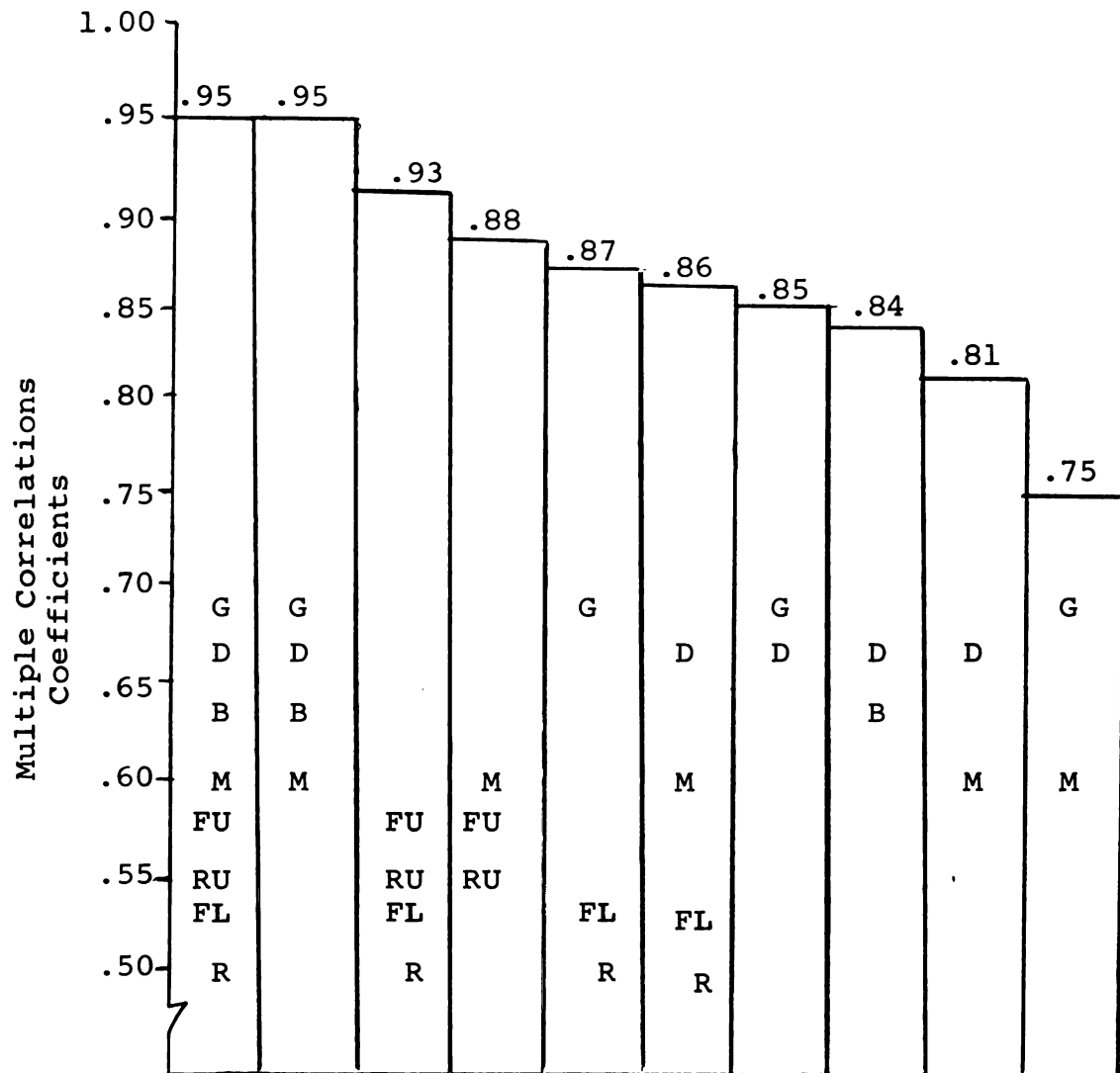


Figure 3. Correlation between ten combinations of type and final score.

Table 8. Means and standard deviations of type scores for 12,890 cows

Source	Means	Standard Deviations
Type Code	2.89	0.78
Type Score	81.23	3.58
General Appearance	2.73	0.90
Dairy Character	3.69	0.62
Body Capacity	3.51	0.71
Mammary System	2.77	0.84
Fore Udder	2.68	0.88
Rear Udder	2.94	0.89
Feet and Legs	2.46	0.79
Rump	2.92	0.99

The correlations between type score and each of the eight components of type are in Table 9.

The correlation of type score with general appearance is largest (0.86) and with dairy character and feet and legs the smallest (0.57).

Data used for this study are representative of the method of evaluation by the eight components of type in which the resulting type score is not the sum of these specific components. As an example, the score card assigns

Table 9. Correlations between type score and eight components of type (12,890 observations)

Compo- nents	FS	G	D	B	M	FU	RU	FL	R
G	0.86								
D	0.57	0.44							
B	0.65	0.58	0.37						
M	0.78	0.58	0.39	0.39					
FU	0.67	0.50	0.31	0.36	0.79				
RU	0.74	0.57	0.39	0.38	0.84	0.61			
FL	0.57	0.64	0.30	0.39	0.41	0.35	0.41		
R	0.63	0.68	0.31	0.42	0.45	0.40	0.43	0.37	

30 points for mammary system with 13 points for fore udder (6) and rear udder (7). The remaining 17 points for mammary system (10 for udder symmetry, 5 for teats, and 2 for mammary veins) are not recorded but are taken into account to determine the score for mammary system. Similarly 30 points are assigned for general appearance with less than 20 points for subdivisions of feet and legs (10) and rump (<10). Rump includes also the remaining points of general appearance not recorded which include the breed characteristics, shoulder blades, back, thurls, tail head and tail. In contrast, the new type evaluation procedure which consider only the major four components which will sum to 100 points.

The dependability of the minor components to express the proper emphasis in depicting the major components they help to describe, is of interest by either method of evaluation. Table 10 expresses the regression of general appearance (30) on the two minor components, feet and legs (10) and rump (<10). The R (multiple correlation coefficient) of 0.79 indicates the accuracy with which these two minor components contribute to the prediction of general appearance. R^2 of 0.63 measures the per cent of variation accounted for by these two components. One must realize that other factors equivalent to >10 points are not considered in this evaluation and that R^2 suggests that feet and legs and rump are expressing approximately 2/3 of the importance for general appearance.

Table 10. The regression of general appearance scores on scores for feet and legs and for rump (12,890 observations)

Compo- nents	Regres. Coef.	Std. Errors of Coef.	Beta Weight (% of Total)	Required Weight in %	Diff. in %
C	0.15	0.02	..	..	..
FL	0.50	0.01	0.47	0.50	-0.03
R	0.46	0.01	0.53	<0.50	+0.03

Table 10 indicates that the two minor components of general appearance are receiving proper weights according to score card importance.

The recorded components of mammary system (30) fore udder (6) and rear udder (7) represent 43 per cent of the 30 points, or 17 points are not recorded but are considered in the general evaluation. Table 11 indicates the regression of mammary system on fore and rear udder. The R of 0.91 indicates a high degree of accuracy with which these two components predict mammary system. R^2 is 0.83, and this value indicates that these two minor components of mammary system are receiving approximately double the weight suggested (43 per cent), thus indicating that other components of mammary system are not given enough emphasis by score card standards.

Table 11. The regression of mammary system scores on scores for fore udder and for rear udder (12,890 observations)

Compo- nents	Regres. Coef.	Std. Errors of Coef.	Beta Weights (% of Total)	Required Weight in %	Diff. in %
C	0.04	0.01	..	..	..
FU	0.42	0.00	0.43	0.46	-0.03
RU	0.54	0.00	0.57	0.54	+0.03

For the model with all eight components of type for evaluation of final score, Table 12 indicates the relative importance given to each of the eight components of type by all classifiers. The R^2 deletes indicate the percent of total variation accounted for when each specific component is not used to predict type score. The R^2 deletes in Table 12 for the minor components of type indicate that very little explanation of variation in type score would be lost if the minor components were not included, suggesting the Holstein Association's recent change to the major four components is justifiable.

In Table 12 the full model of all eight components expresses the standardized beta weights as percent of the total. The components of general appearance and mammary system require summation to obtain the appropriate values. General appearance would sum to 39 per cent and mammary system to 35 per cent.

If the nine classifiers had used the new method of only the four major components of type in evaluation, their emphasis is expressed by the beta weights as a per cent of the total in Table 12. The classifiers in general assign more weight to general appearance and mammary system than is specified by the score card.

Table 12. Regression of type score on scores of eight and four components of type

	Compo- nents	Regres. Coef.	Std. Errors of Coef.	Beta Weights	Beta Weights (% of Total)	Std. Errors of Betas	R ² Deletes
For all observations: 12,890							
R ² = 0.91 R = 0.96	C	64.83	0.07	..	..	..	..
	G	1.63	0.02	0.404	33	0.005	0.861
	D	0.87	0.02	0.150	12	0.003	0.891
	B	0.88	0.02	0.173	14	0.003	0.889
	M	1.02	0.03	0.250	20	0.006	0.898
	FU	0.31	0.02	0.077	6	0.004	0.906
	RU	0.45	0.02	0.112	9	0.005	0.905
	FL	0.07	0.02	0.015	2	0.003	0.908
	R	0.18	0.01	0.050	4	0.004	0.907
R ² = 0.90 R = 0.95	C	65.14	0.07	..	..	..	..
	G	1.84	0.02	0.458	39	0.004	0.861
	D	0.90	0.02	0.154	13	0.003	0.891
	B	0.92	0.02	0.180	15	0.003	0.889
	M	1.64	0.01	0.387	33	0.003	0.898
Cows less than 3 years. A.1: 2,210 observations							
R ² = 0.76 R = 0.87	C	64.76	0.26	..	..	..	..
	G	1.63	0.07	0.382	32	0.017	0.861
	D	0.81	0.07	0.138	11	0.012	0.891
	B	0.97	0.07	0.185	15	0.012	0.889
	M	0.96	0.10	0.220	18	0.022	0.898
	FU	0.42	0.07	0.100	8	0.016	0.906
	RU	0.45	0.08	0.109	9	0.018	0.905
	FL	-0.07	0.06	-0.016	1	0.013	0.908
	R	0.23	0.05	0.062	5	0.013	0.907

Table 12--Continued

Components		Regres. Coef.	Std. Errors of Coef.	Beta Weights	Beta Weights (% of Total)	Std. Errors of Betas
$R^2 = 0.76$	C	65.05	0.25	..	..	..
$R = 0.86$	G	1.80	0.06	0.423	37	0.014
	D	0.85	0.07	0.143	13	0.012
	B	1.00	0.07	0.191	17	0.013
	M	1.64	0.05	0.376	33	0.013
Cows 3 to 5 years. A.1: 2,332 observations						
$R^2 = 0.88$	C	64.94	0.18	..	..	..
$R = 0.94$	G	1.73	0.05	0.438	35	0.012
	D	0.82	0.05	0.141	11	0.008
	B	0.84	0.04	0.174	14	0.009
	M	0.90	0.07	0.213	17	0.016
	FU	0.34	0.04	0.086	7	0.011
	RU	0.61	0.05	0.157	13	0.013
	FL	-0.01	0.04	-0.003	00	0.009
	R	0.13	0.03	0.038	3	0.009
$R^2 = 0.87$	C	65.15	0.18	..	..	..
$R = 0.93$	G	1.87	0.04	0.474	39	0.010
	D	0.87	0.05	0.150	12	0.008
	B	0.89	0.04	0.184	15	0.009
	M	1.66	0.04	0.393	33	0.009

Table 12--Continued

Components		Regres. Coef.	Std. Errors of Coef.	Beta Weights	Beta Weights (% of Total)	Std. Errors of Betas
Cows 5+ years. A.1: 363 observations						
$R^2 = 0.90$ $R = 0.95$	C	64.76	0.50	..	..	..
	G	1.80	0.13	0.423	34	0.030
	D	0.71	0.12	0.109	9	0.019
	B	0.95	0.10	0.189	15	0.020
	M	1.34	0.18	0.340	27	0.045
	FU	0.16	0.12	0.040	3	0.030
	RU	0.25	0.14	0.064	5	0.035
	FL	0.17	0.10	0.038	3	0.022
	R	0.12	0.08	0.033	3	0.022
$R^2 = 0.90$ $R = 0.95$	C	65.12	0.48	..	..	..
	G	2.01	0.10	0.471	39	0.024
	D	0.71	0.12	0.109	9	0.019
	B	0.97	0.10	0.193	16	0.020
	M	1.67	0.08	0.423	35	0.021

Practical application of the regression coefficients from Table 13 can be illustrated by an example. If the designation for the four major components of type are E,E,+,+ we could arrive at the numerical score by multiplying the appropriate regression coefficients by their respective coded values, and the sum of these values would equal the classification score of 86.5. In contrast using all eight components for a cow with the breakdown: E,E,+,+,V,+,V,+, would result in the score 86.3. The scores indicate that there is essentially no difference in the final score.

Table 13. The regression of type score on scores of the major four components of type (12,890 observations)

Compo- nents	Regres. Coef.	Std. Errors of Coef.	Beta Weights (% of Total)	Required Weight in %	Diff. in %
C	65.14	0.07	..	..	..
G	1.84	0.02	0.39	0.30	+0.09
D	0.90	0.02	0.13	0.20	-0.07
B	0.92	0.02	0.15	0.20	-0.05
M	0.64	0.02	0.33	0.30	+0.03

According to Specht et al. (1967) with 13,719 observations from 1950 to 1963 on first classification type scores, the greatest variation and lowest scores occurred for individuals classified the first time. Table 14 indicates close agreement between this study and Specht et al. (1967) and both indicate that the highest scores and the smallest amount of variation occur in dairy character and body capacity. General appearance, mammary system, fore udder, and rear udder show essentially the same variation while rump varied most.

Table 14. Means and standard deviations comparison of this study and Specht et al. (1967)

Compo- nents	Means		Standard Deviations	
	This Study*	Specht et al.**	This Study	Specht et al.
TS	79.16	78.72	3.31	3.31
G	2.30	2.18	0.78	0.81
D	3.39	3.35	0.56	0.60
B	3.21	3.10	0.63	0.63
M	2.39	2.38	0.76	0.79
FU	2.33	2.40	0.78	0.84
RU	2.56	2.53	0.81	0.82
FL	2.21	2.05	0.72	0.72
R	2.43	2.33	0.90	0.93

*This study represents cows <3 yrs old: 2,210 observations.

**Specht et al. (1967) first classification type scores from 1961 to 1963: 12,170 observations. These data were recoded for comparison.

The numerical score for this study of 79.16 for individuals less than three years of age agrees closely with the work of Specht et al. (1967) with 78.72 for individuals two years of age. He further reported mean scores for type, including "checking" of previously classified animals, of 79.92, 80.52, 81.72 for 4, 5, and 6 year old and older animals, respectively. These scores are similar with the scores in Table 15.

Table 15. Classification scores and multiple correlation coefficients

Group	Type Score	R for 8 Components	R for 4 Components	Number
First obs. and first class. cows 3 yr	79.16	.87	.86	2,210
First obs. and first class. cows 3-5 yr	80.07	.88	.93	2,330
First obs. and first class. cows 5+ yr	81.41	.95	.95	363
Second class.	82.36	.97	.97	885
Remaining class.	83.91	.97	.96	296
Reclass. and raised	83.20	.97	.97	859
Classification unchanged	81.94	.97	.97	5,673

Mitchell et al. (1961) and Johnson and Fourt (1959) presented phenotypic and genetic correlations between type ratings in Holstein and Brown Swiss cattle, respectively. Mitchell et al. (1961) studied the same breed as this investigation, and similarity of phenotypic correlations of the two studies are related in Table 16.

From the medium producing herds reported by Mitchell et al. (1961) beta weights were computed using the major four components of type. Table 17 indicates the weights for the Mitchell et al. (1961) study as contrasted to this investigation.

Table 16. Phenotypic correlations between type score and major four components for this study and Mitchell et al. (1961)

Components	FS	G	D	B	M
G	0.86* (0.78) **				
D	0.57 (0.39)	0.44 (0.31)			
B	0.65 (0.48)	0.58 (0.50)	0.37 (0.19)		
M	0.78 (0.81)	0.58 (0.56)	0.39 (0.32)	0.39 (0.30)	

*Values for this study: 12,890 observations.

** () values for Mitchell et al. (1961) - medium producing herds: 3,991 observations.

Table 17. Beta weights expressed as per cent of total for two independent studies depicting type score by major four components

Components	Source	
	Mitchell et al. (1961)*	This Study**
G	37	39
D	8	13
B	9	15
M	47	33

*Mitchell et al. (1961) - medium producing herds: 3,991 observations.

**This study: 12,890 observations.

The significance of the difference between score card weights and the weights actually given by the classifiers, was tested using "Student's" t statistic. The weight given to a particular component of type by the classifiers was calculated as the ratio of the standardized partial regression coefficient for the component to the sum of all coefficients. Computational procedures for obtaining the variance of this ratio (Kendall and Stewart, 1961) are shown in the Appendix. The calculations were for the group of cows less than three years of age which were classified for the first time primarily because for them no bias enters as a result of the rule that allows scores to be raised on

reclassification but not lowered. Perhaps the effects of management and environmental factors are smallest for this group because of age.

When all eight components of type were included in the regression, the score card specifies a weight of 0.200 for dairy character. The weight actually assigned was 0.117, the difference -0.083 representing the lack of emphasis on dairy character. This difference was statistically significant at alpha 0.01 Type 1 error level. Similar procedure for body capacity used formula (A) in Appendix. Calculation of t values for general appearance and mammary system used formula (B) in Appendix. Table 18 indicates that when the evaluation was based on all eight components, all hypotheses were rejected and the components are not receiving the proper weights according to the score card.

When the evaluation of the weights concerned only the major four components, conclusions differ slightly. The second part of Table 18 compares weights and tests the differences by formulas (A) and (B) of the Appendix with adjustments for the number of components. The scores that classifiers give to body capacity and mammary system were not statistically different from the score card. But, values for general appearance were too large and dairy character too small; these differences were statistically significant.

Table 18. Agreement of weights assigned to eight and four components with score card specifications

Component	Calculated Value	Score Card Value	Diff.
<u>Eight components of type</u> (2,210 observations)			
General Appearance	.36	.30	.06**
Dairy Character	.12	.20	-.08**
Body Capacity	.16	.20	-.04**
Mammary System	.36	.30	.06**
<u>Major four components</u> (2,210 observations)			
General Appearance	.37	.30	.07**
Dairy Character	.13	.20	-.07**
Body Capacity	.17	.20	-.03
Mammary System	.33	.30	.03

**Probability (Type 1 Error) $\leq$ 0.01.

Production

With production of importance in dairy cattle, the relationship between type score and production is of interest to breeders desiring both traits. Using data with type and production information combined per individual cow, least-squares analysis was used to evaluate the relationship between type score and production. To compare the classification score with production records in progress at the time of classification was the objective of interest. To meet this condition the only records used were those initiated within twelve months preceeding the date of classification. These restrictions reduced the number of observations to 6,097 which was approximately half the number used in the previous analysis.

The first classification records (1,456) were selected for analysis. The distribution of this combined data is indicated in Table 19.

Multiple regression was used with production being the dependent variable and type the independent variable. The solution gives the weights that should be assigned if one was trying to predict production with the score card.

The beta weights in Table 20 indicate the emphasis assigned to the components of type. Regardless of the model used for evaluation, or the variation in age and mean production levels, the largest beta weight is dairy character.

Table 19. Data used in analysis of type and production data

A.1 (First classification)	1,456	24%
mean production = 14,955		
Cows 3 yr	444 30%	
mean production = 15,188		
Cows 3-5 yr	868 60%	
mean production = 14,955		
Cows 5+ yr	144 10%	
mean production = 14,232		
2 (Reclassified and raised)	1,132	19%
3 (Classification unchanged)	<u>3,509</u>	<u>57%</u>
Total observations	6,097	100%

The correlations between production and type in Table 21 is largest between dairy character and milk production. In contrast to Table 9 the correlation for dairy character is the smallest when the interest is related to type score.

The correlation for a single trait, dairy character and production is 0.36, while the correlation between all components and production is 0.37.

Table 20 implies that there is a tendency to give less weight to dairy character with increased age. It appears that with older cows dairy character is still the major type component, but smaller in magnitude. The emphasis on general appearance in the older cows has increased with age.

Table 20. Prediction of milk production with eight and four components of type

Components		Regres. Coef.	Std. Errors of Coef.	Beta Weights	Beta Weights (% of Total)	Std. Errors of Betas
<u>A.1--All ages: 1,456 observations</u>						
<u>Mean Production = 14,955 lbs</u>						
$R^2 = 0.15$	C	8,666.48	529.22	..	..	..
$R = 0.38$	G	-273.07	149.44	-0.074	11	0.041
	D	2,041.13	137.50	0.400	57	0.027
	B	155.32	122.29	0.036	5	0.028
	M	59.75	202.72	0.016	2	0.056
	FU	-356.54	132.69	-0.100	14	0.037
	RU	5.43	150.76	0.002	00	0.045
	FL	119.04	110.79	0.032	4	0.029
	R	-147.00	99.09	-0.047	7	0.032
$R^2 = 0.14$	C	8,509.66	515.52	..	..	..
$R = 0.37$	G	-325.16	116.39	-0.089	15	0.032
	D	2,036.36	137.53	0.400	69	0.027
	B	148.07	121.88	0.034	6	0.028
	M	-208.02	102.40	-0.057	10	0.028

Table 20--Continued

Components		Regres. Coef.	Std. Errors of Coef.	Beta Weights	Beta Weights (% of Total)	Std. Errors of Betas
A.1--Cows <3 yr: 444 observations						
Mean production = 15,188 lbs						
R ² = 0.23 R = 0.48	C	6,708.74	935.18	..	..	..
	G	-160.36	306.32	-0.039	5	0.075
	D	2,433.76	234.61	0.048	59	0.046
	B	389.56	225.26	0.084	10	0.048
	M	29.45	363.81	0.007	1	0.091
	FU	-380.51	232.70	-0.010	12	0.061
	RU	70.53	280.33	0.019	2	0.077
	FL	149.70	207.36	0.036	5	0.050
	R	-151.14	196.06	-0.046	6	0.060
R ² = 0.23 R = 0.48	C	6,593.98	893.95	..	..	..
	G	-221.81	223.30	-0.054	8	0.055
	D	2,455.44	231.59	0.482	72	0.045
	B	390.93	224.62	0.084	13	0.048
	M	-208.15	193.44	-0.052	8	0.048

Table 20--Continued

Components		Regres. Coef.	Std. Errors of Coef.	Beta Weights	Beta Weights (% of Total)	Std. Errors of Betas
A.1--Cows 3 to 5 yrs: 868 observations						
Mean production = 14,955 lbs						
R ² = 0.15	C	8,304.75	694.31	..	..	..
R = 0.38	G	-316.65	178.88	-0.090	12	0.051
	D	2,000.79	179.03	0.392	51	0.035
	B	192.41	151.69	0.046	6	0.036
	M	122.12	256.06	0.034	4	0.072
	FU	-378.16	170.50	-0.109	14	0.049
	RU	-81.51	186.14	-0.025	3	0.057
	FL	225.94	135.00	0.063	8	0.038
	R	-33.61	122.36	-0.011	1	0.040
R ² = 0.14	C	8,265.65	676.15	..	..	..
R = 0.37	G	-253.51	140.86	-0.072	13	0.040
	D	2,002.31	178.70	0.393	68	0.035
	B	192.15	151.15	0.046	7	0.036
	M	-227.47	126.92	-0.064	11	0.036

Table 20--Continued

Components		Regres. Coef.	Std. Errors of Coef.	Beta Weights	Beta Weights (% of Total)	Std. Errors of Betas
<u>A.1--Cows 5+ yrs: 144 observations</u>						
<u>Mean production = 14,232 lbs</u>						
$R^2 = 0.15$	C	8,971.55	2,178.68	..	..	..
$R = 0.39$	G	-679.21	559.71	-0.178	14	0.146
	D	1,851.59	511.95	0.319	26	0.088
	B	498.10	479.08	0.099	8	0.095
	M	664.07	730.08	0.197	16	0.216
	FU	-700.65	470.65	-0.196	16	0.132
	RU	133.71	551.45	0.041	3	0.171
	FL	-526.50	421.63	-0.137	11	0.110
	R	-274.05	348.72	-0.078	6	0.099
$R^2 = 0.12$	C	7,701.11	2,070.91	..	..	..
$R = 0.35$	G	-1,126.23	440.31	-0.294	38	0.115
	D	1,944.14	505.90	0.335	43	0.087
	B	493.95	470.92	0.098	13	0.094
	M	173.51	352.19	0.051	6	0.104

Table 21. The correlations between production and the components of type (1,456 observations)

Source	MP	G	D	B	M	FU	RU	FL	R
G	0.06								
D	0.36	0.40							
B	0.09	0.50	0.29						
M	0.03	0.48	0.30	0.27					
FU	-0.02	0.39	0.25	0.24	0.74				
RU	0.05	0.47	0.30	0.30	0.83	0.55			
FL	0.07	0.56	0.24	0.31	0.26	0.21	0.27		
R	0.01	0.64	0.26	0.35	0.35	0.31	0.32	0.29	

Table 22. Beta weights in per cent for milk production by the eight and four components of type

Assigned Values	30	20	20	30	6	7	10	10	30	20	20	30
Components	G	D	B	M	FU	RU	FL	R	G	D	B	M
All ages	11	57	5	2	14	0	4	7	15	69	6	10
<3 yr	5	59	10	1	12	2	5	6	8	72	13	8
3-5 yr	12	51	6	4	14	3	8	1	13	68	7	11
5+ yr	14	26	8	16	16	3	11	6	38	43	13	6

Carter et al. (1965b) obtained similar relationships between type score and production indicating that components of type are essentially independent of production. However, they also agree with this study that dairy character may be a useful predictor of production in the absence of information on production.

Lerner and Donald (1966) in their discussion of type and conformation and the related genetic aspects agree that while there is no genetic antagonism (negative genetic correlations) between good type and high production, the selection for type alone will have little influence on production, and conversely selection for production alone will have little influence on type rating.

The results from this study indicate that the use of the four major components of the score card are just as accurate for prediction of final score as all eight components. The study does imply that classifiers are assigning less emphasis to dairy character and more for general appearance than specified by the score card. With interest in relating type classification to production, the importance of dairy character for the prediction of production would be about as accurate as the total components of the score card.

SUMMARY

The importance of type and its relationship to production has been of interest to dairymen for many years. The first score card for type evaluation was developed on the Island of Jersey in 1834. The Purebred Dairy Cattle Association score card as an aid to evaluation has been accepted by the major dairy breeds of the United States since 1940. The breeds vary in emphasis on the breakdowns and may not use the same terminology to evaluate on the basis of 100 points.

The relationship between the conformation of the dairy cow and her producing ability is generally accepted to be positive but small.

This study examined type data from 96 herds in Michigan, which were classified by nine official classifiers of the Holstein-Friesian Association. The findings agree with the change in procedure of the Holstein association using models with four components of type rather than eight for prediction of type score. Multiple regression coefficients with either model indicate essentially the same degree of accuracy in determining type score. The evaluation of the standard partial regression coefficients (beta weights) expressed in per cent of their total indicates the

emphasis assigned to each component in evaluating type score. The beta weights obtained from the least squares analysis indicate that the weights assigned to the components of type do not agree with the specifications of the score card. Evaluation of the differences by the "Student's" t statistic indicated that the eight type components are significantly different from the specifications of the score card.

In January of 1967 the Holstein association adoption of the "Descriptive Classification" includes only the major four components of type: general appearance, dairy character, body capacity, and mammary system. The beta weights obtained from the least-squares analysis of this model (major four) indicate differences from the score card specifications. Testing these differences by the "Student's" t statistic indicated that the components, general appearance (30 points) and dairy character (20 points) were not weighted by classifiers correctly. However, body capacity (20 points) and mammary system (30 points) are weighted according to the score card. The evaluation of type score by either model indicates that general appearance is receiving emphasis consistently in excess of the score card specifications. Other investigations related to the genetic and phenotypic correlations of type components have also indicated the excess emphasis of this type component.

Dairy character, of the major four components, is consistently receiving less emphasis than is specified.

Of the four type components, dairy character is the least variable, and general appearance and mammary system, the two components receiving the most weight, are the most variable. As indicated by Carter et al. (1965a) dairy character and body capacity are the two traits which show the least variation and are the most heritable. But, classifiers are consistently assigning the least emphasis to these two components. Mitchell et al. (1961) indicated that dairy character also has the highest phenotypic and genetic correlation with milk and butterfat production.

The importance of type components in predicting production was also examined. Type and production information was combined on an individual cow basis for individuals classified and completing a lactation during a twelve month period. The least-squares method indicates the most weight should be given to dairy character to maximize the correlation between final score and production. Particularly true for cows less than five years of age, the results suggested that as much as 50 per cent of the importance should be assigned to dairy character, which agrees with the conclusions of Mitchell et al. (1961). Bayley et al. (1961) arrived at the same conclusion as did Rennie and Raithby (1955) that Holstein type ratings, to reflect production more closely than they do at present, should place more emphasis on dairy character.

LITERATURE CITED

- Bayley, N. D., Parker, J. B., Heidues, T., Plowman, R. D., and Swett, W. W. 1961. The importance of type in dairy cattle breeding and management. U.S.D.A. Tech. Bull. No. 1240.
- Benson, R. H., Tyler, W. J., and Hyatt, G. Jr. 1951. Some causes of variation in type ratings of Ayrshire cows. J. Dairy Sci., 34:502(abstr.).
- Butcher, D. F., Mitchell, R. G., Porterfield, I. D., and Dunbar, R. S. 1962. Heritability, phenotypic and genetic correlations between type ratings and milk fat production in Ayrshire cattle. J. Dairy Sci., 46:971.
- Carter, H. W., Rennie, J. C., and Burnside, E. B. 1965a. Causes of variation in type classification data. J. Dairy Sci., 48:790(abstr.).
- _____, _____, and _____. 1965b. Regressions and correlations between certain type characteristics and between production. J. Dairy Sci., 48:791(abstr.).
- Copeland, L. 1938. The old story of type and production. J. Dairy Sci., 21:295.
- _____. 1941. The relationship between type and production. J. Dairy Sci., 24:297.
- Curtis, R. J., and Rennie, J. C. 1961. The heritability of various type components and their relationship to production in Canadian Jersey cattle. Canad. J. Anim. Sci., 41:23.
- Freeman, A. E., and Dunbar, R. S. Jr. 1955. Genetic analysis of components of type conformation and production in Ayrshire cows. J. Dairy Sci., 38:428.
- Grieve, D. G., Rennie, J. C., and Raithby, G. E. 1958. Heritability of various characteristics of body conformation and their association with progress of Holstein-Friesian cows in Canada. J. Dairy Sci., 41:748.

- Gowen, J. W. 1921. Studies on conformation in relation to milk producing capacity in cattle. J. Dairy Sci., 4:359.
- _____. 1926. Judging of dairy cattle and some of its problems. J. Hered., 17:13.
- Harrison, E. S., Carpenter, J. T., and Strohmeyer, H. A. Jr. 1940. Judging Dairy Cattle. John Wiley & Sons, Inc., London.
- Harvey, W. R., Ross, R. H., and Fourt, D. L. 1953. The importance of judges, heifers, and ages in causing variation in type ratings of young dairy heifers. Proc. West. Div., A.D.S.A., 34th Ann. Meet.
- Harvey, W. R., and Lush, J. L. 1952. Genetic correlations between type and production in Jersey cattle. J. Dairy Sci., 35:199.
- Henderson, H. O., Reeves, P. M. 1954. Dairy Cattle Feeding and Management. John Wiley & Sons, Inc., New York.
- Hyatt, G. Jr., and Tyler, W. J. 1948. Variation in type ratings of individual Ayrshire cows. J. Dairy Sci., 31:71.
- Johansson, Ivar. 1961. Genetic Aspects of Dairy Cattle Breeding. University of Illinois Press, Urbana, Ill.
- Johnson, K. R., and Fourt, D. L. 1960. Heritability, genetic and phenotypic correlations of type, certain components of type, and production in Brown Swiss cattle. J. Dairy Sci., 43:975.
- Johnson, L. E., and Lush, J. L. 1942. Repeatability of type ratings in dairy cattle. J. Dairy Sci., 25:45.
- Kendall, M. G., and Stewart, A. 1961. The Advanced Theory of Statistics. Charles Griffin & Co., London.
- Lerner, I. M., and Donald, H. P. 1966. Modern Developments in Animal Breeding. Academic Press, London and New York.
- Lush, J. L. 1945. Animal Breeding Plans. Ed. 3, Iowa State College Press, Ames, Iowa.
- McGilliard, L. D., and Lush, J. L. 1956. Changes in type classification of dairy cattle. J. Dairy Sci., 34:1015.

- Mitchell, R. C., Corley, E. L., and Tyler, W. J. 1961. Heritability, phenotypic and genetic correlations between type ratings and milk and fat production, in Holstein-Friesian cattle. *J. Dairy Sci.*, 44:1502.
- Prescott, M. S., Price, F. T., and Wing, H. H. 1930. *Holstein-Friesian History*. The Corse Press.
- Porter, A. R., Sims, J. A., and Forman, C. F. 1965. *Dairy Cattle in American Agriculture*. Iowa State Press, Ames, Iowa.
- Rennie, J. C. 1951. Relation between type and butterfat production of Jersey cows in Canada. *Sci. Agr.*, 31:553.
- _____. 1962. Type as we see it. *Hoards Dairyman*, 107:863.
- _____, and Raithby, G. E. 1955. An analysis of the components of type of Holstein-Friesian cows in Canada. *J. Dairy Sci.*, 38:616.
- Stone, J. B., Rennie, J. C., and Raithby, G. E. 1955. A type and production study of Holstein-Friesian cattle in Canada. *J. Dairy Sci.*, 38:616.
- Specht, L. W., Carter, H. W., and VanVleck, L. D. 1967. Type classification scores of New York Holstein cattle. Unpublished data.
- Touchberry, R. W., and Tabler, K. R. 1951. The changes in the type ratings of Holstein and Guernsey cows when rated by the same three judges at two consecutive times. *J. Animal Sci.*, 10:1029.
- Trimberger, G. W. 1958. *Dairy Cattle Judging Techniques*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
- Tyler, W. J., and Hyatt, George Jr. 1948. The heritability of official type ratings and the correlation between type ratings and butterfat production of Ayrshire cows. *J. Dairy Sci.*, 31:63.
- Wilcox, C. J., Pfau, K. O., and Mather, R. E. 1959. Effect of age, season, stage of lactation, classifier, and year on type ratings of Holstein cows. *J. Dairy Sci.*, 42:925.
- Wilson, C. 1952. Why good type. *Jersey Bul.*, 70:1046.

Appendix

Statistical Procedure for Obtaining the Variance of a Ratio

Procedure from Kendall and Stewart (1961)

1. Variance's

$$A) \quad x_1 = b_1'$$

$$b_1' = b_1 \sqrt{SS_{X_1}/SS_Y}$$

$$\bar{x}_1 = b_1'$$

$$V(x_1) = \left(\frac{SS_{X_1}}{SS_Y} \right) C_{11} MS_E = SS_{X_1} C_{11} \left[\frac{SS_Y - SS_R}{SS_Y v_E} \right] = \left[\left(\frac{1-R^2}{v_E} \right) SS_{X_1} C_{11} \right]$$

$$B) \quad x_2 = \sum_{i=1}^3 b_i'$$

$$\bar{x}_2 = \sum_{i=1}^3 b_i'$$

$$V(x_2) = \left[\left(\frac{1-R^2}{v_E} \right) \left\{ \sum_{i=1}^3 (SS_{X_i} C_{ii}) + 2 \sum_{i=1}^3 \sum_{\substack{j=2 \\ i < j}}^3 (C_{ij} \sqrt{SS_{X_i} SS_{X_j}}) \right\} \right]$$

$$C) \quad y = \sum_{j=1}^8 b_j'$$

$$\bar{y} = \sum_{j=1}^8 b_j'$$

$$V(y) = \left[\left(\frac{1-R^2}{v_E} \right) \left\{ \sum_{i=1}^8 (SS_{X_i} C_{ii}) + 2 \sum_{i=1}^8 \sum_{\substack{j=2 \\ i < j}}^8 (C_{ij} \sqrt{SS_{X_i} SS_{X_j}}) \right\} \right]$$

II. Covariance's

$$A) \text{ Cov. } (x_1 y) = \left[\left(\frac{1-R^2}{v_E} \right) \left\{ C_{11} SS_{x_1} + \sum_{j=1}^8 (C_{1j} \sqrt{SS_{x_1} SS_j}) \right\} \right]$$

$$B) \text{ Cov. } (x_2 y) = \left[\left(\frac{1-R^2}{v_E} \right) \left\{ \sum_{i=1}^3 (C_{1i} SS_{x_i}) + 2 \sum_{i=1}^3 \sum_{j=2}^3 (C_{ij} \sqrt{SS_{x_i} SS_{x_j}}) + \sum_{i=1}^3 \sum_{j=4}^8 (C_{ij} \sqrt{SS_{x_i} SS_{x_j}}) \right\} \right]$$

III. Formula (A)

$$V\left(\frac{x_1}{y}\right) = \frac{\left(1-R^2\right)}{v_E\left(\sum_{i=1}^8 b_i'\right)} \left[\left\{ \sum_{i=1}^8 (b_i')^2 \right\} (C_{11} SS_{x_1}) + 2 \sum_{i=1}^8 \sum_{j=2}^8 (C_{1j} \sqrt{SS_{x_1} SS_{x_j}}) \right]_{i < j}$$

$$- 2b_i' \sum_{i=1}^8 (b_i') (C_{11} SS_{x_1}) + \sum_{i=1}^8 (C_{1j} \sqrt{SS_{x_1} SS_{x_j}}) \Big]$$

$$t = \frac{\left(\cancel{b_i'} \sum_{i=1}^8 b_i' \right) - 0.2}{\sqrt{V\left(\frac{x_1}{y}\right)}}$$

IV. Formula (B)

$$\begin{aligned}
 V\left(\frac{x_a}{y}\right) &= \frac{(1-R^2)}{v_E \left(\sum_{i=1}^8 b_i'\right)^4} \left[\left(\sum_{i=1}^8 b_i'\right)^2 \left\{ \sum_{i=1}^3 \sum_{j=2}^8 (SS_{x_i} C_{i1}) + 2 \sum_{i=1}^3 \sum_{j=2}^8 (C_{1j} \sqrt{SS_{x_i} SS_{x_j}}) \right\} + \left(\sum_{i=1}^3 b_i'\right)^2 \right. \\
 &\quad \left. \sum_{i < j} \left\{ \sum_{i=1}^8 (C_{i1} SS_{x_i}) + 2 \sum_{i=1}^8 \sum_{j=2}^8 (C_{1j} \sqrt{SS_{x_i} SS_{x_j}}) - 2 \left(\sum_{i=1}^3 b_i'\right) \left(\sum_{i=1}^8 b_i'\right) \left\{ \sum_{i=1}^3 (C_{i1} S_{x_i}) \right. \right. \right. \\
 &\quad \left. \left. + 2 \sum_{i=1}^3 \sum_{j=2}^8 (C_{1j} \sqrt{SS_{x_i} SS_{x_j}}) + \sum_{i=1}^3 \sum_{j=4}^8 (C_{1j} \sqrt{SS_{x_i} SS_{x_j}}) \right\} \right] \\
 t &= \frac{\left[\left(\sum_{i=1}^3 b_i'\right) \left(\sum_{i=1}^8 b_i'\right) - 0.3 \right]}{\sqrt{V\left(\frac{x_a}{y}\right)}}
 \end{aligned}$$

Symbols for Appendix

b_i = partial regression coefficient

b_i' = standard partial regression coefficient

SS = sum of squares

C_{ii} = coefficient of variance (diagonal element of
inverse matrix)

C_{ij} = coefficient of covariance (off-diagonal element of
inverse matrix)

ν_E = degrees of freedom for error

R^2 = squared multiple correlation coefficient

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