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Components of Variance of Dairymen's Workability Traits Among Holstein Cows

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ABSTRACT

Dairymen of an artificial insemination cooperative subjectively evaluated 5,601 of their cows in first lactation sired by 187 young Holstein bulls for temperament, milking speed, udder, leg and foot problems, and milk production. Exclusive categories were defined for each characteristic. Individual categories were separate traits, and components of variance and covariance were estimated for herd-year of measurement, sire of cow, and residual effects. Variance from sire of cow was less than 3% of the total for all traits so that heritabilities within herd-year were less than .12 for every trait. Variances and covariances were used in a multiple trait sire evaluation procedure to predict frequencies of future daughters for each category.

INTRODUCTION

Increased milk and fat yields have been primary breeding goals for both breeders of registered cattle and commercial dairymen. Nonyield traits also are important, in varying degrees, to breeder and dairyman. Among these are traits which pertain to the ability of the cow to survive and produce and which have been called collectively "dairymen's workability traits" by Eastern Artificial Insemination Cooperative (EAIC). Milking speed, disposition of the cow, and udder function are examples. Some workability traits together with other nonyield traits also have been referred to as "managemental" traits. The possible impact of some of the workability traits on farm profits justifies a closer look at the possibility of improving them through selection.

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Researchers do not agree on what emphasis managemental traits should receive in selection. White (7) reviewed the literature on the relative importance of conformational and managemental traits and concluded that they influence culling decisions but also that ". . . there appears little hope for selection for improvement in most managemental traits as they were measured in those studies." Wagner (6), representing the artificial insemination (AI) industry, stated that these two classes of traits are less important than yield traits, and their secondary priority should be maintained. Johansson (3) considered milking rate worth selecting. Tomaszewski et al. (4) were optimistic about the success of selection for faster milking speed although cost analyses of Blake et al. (1) led to their conclusion "that direct selection for reduced labor inputs to milking would be impractical." Wagner (6) thought temperament might be confounded with management so that selection would not seem beneficial. However, he added that data to determine sires having large percentages of progeny with undesirable temperament would be useful for choosing mates of a bull.

Objectives of this study were to estimate components of variance for traits thought to influence workability, namely, milking speed, disposition of cow, udder workability, and foot and leg problems as well as milk production and to use the variances and covariances to develop a best linear unbiased prediction (BLUP) procedure for sire evaluation of categorical traits (5).

DATA AND METHODS

Measuring the appearance of a cow and associating appearance with her ability to function has been common in the dairy industry for many years. Eastern Artificial Insemination Cooperative broke from this tradition in 1974 by asking members to evaluate daughters of young AI bulls for function. Dairymen's evaluations involved subjectively classifying

TABLE 1. Description of categories of dairyman workability traits and subjective milk production.

Trait	Class	Footnote
Milking speed	1—Faster than average	No trouble
	2—Average	No trouble
	3—Slow	Definite trouble; causes serious inconvenience; may sell because of milking time
Disposition	1—No trouble	Quiet; easy to work with
	2—Slight trouble	Slightly nervous or some inconvenience, but not serious; plan to keep
	3—Definite trouble	Mean or very nervous; difficult to work with; may sell because of disposition
Feet	1—No trouble	Gets around easily; no inconvenience
	2—Slight trouble	Doesn't get around easily or some inconvenience to work with her but not serious; plan to keep
	3—Definite trouble	Difficult for her to get around or causes serious inconvenience to work with her
Legs	1—No trouble	Gets around easily; no inconvenience
	2—Slight trouble	Does not get around easily or some inconvenience to work with her but not serious; plan to keep
	3—Definite trouble	Difficult for her to get around or causes serious inconvenience to work with her
Udder	1—No trouble	Easy to work with
	2—Slight trouble	Some inconvenience but not serious; plan to keep
	3—Definite trouble	Difficult to work with; may sell because of udder
Production	1—Average or above average	
	2—Below average	
	3—Production too low	May sell because of production
Overall satisfaction "Would you like another cow like this one?"	1—Very definite	One of my best
	2—Definitely	Well-liked cow
	3—Probably	Satisfactory cow
	4—Probably not	Don't like cow
	5—Definitely not	Plan to sell

cows in first lactation into defined, exclusive categories for each trait. Descriptions are in Table 1. Dairymen also were asked to indicate overall satisfaction with individual cows by answering the question, "Would you like another cow like this one?" The five responses are in Table 1. Information from the survey was to supplement evaluations by production for approving AI sires for further service.

Data accumulated from questionnaires distributed to farmer members of the cooperative over 1975 to 1979. The questionnaire requested information on first daughters of young and waiting sires. Records by breed were Ayrshire 505, Guernsey 304, Holstein 5601, and Jersey 677. Only Holstein records were used for the detailed study. Frequencies in each category are in Table 2 and are similar for breeds.

To avoid the problem of analyzing ratings arbitrarily assigned to categories and difficulties in interpreting results from such an analysis, each category of a trait was a separate trait scored as zero if absent or one if present. With three categories for each of the five main workability traits, 15 new traits (subtraits) were obtained in addition to subtraits for subjectively scored milk production and 5 other subtraits corresponding to categories of dairymen's overall satisfaction.

A two-way cross-classified model without interaction was

$$Y_{Aijk} = \mu_A + h_{Ai} + s_{Aj} + e_{Aijk}$$

$$Y_{Bijk} = \mu_B + h_{Bi} + s_{Bj} + e_{Bijk}$$

for any two traits A and B where

Y_{Aijk} = presence or absence of trait A for the kth daughter of the jth sire evaluated in the ith herd-year,
μ_A = a constant common to all records in A which corresponds to frequency of the trait,
h_{Ai} = a random effect from the ith herd-year of measurement on trait A,
s_{Aj} = a random effect from the jth sire on trait A, and
e_{Aijk} = a random residual term associated with measurement of the kth daughter of the jth sire in the ith herd-year for trait A.

Similar definitions hold for trait B.

Henderson's Method 1 (2) was used to estimate variances. Covariance between any two traits A and B was computed from the relation

$$\hat{\sigma}_{A,B} = .5(\hat{\sigma}^2_{A+B} - \hat{\sigma}^2_A - \hat{\sigma}^2_B).$$

Heritability was estimated within herd-year as $4\hat{\sigma}^2_s/(\hat{\sigma}^2_s + \hat{\sigma}^2_e)$.

RESULTS AND DISCUSSION

Although categories for each of the workability traits were separate traits, individual subtraits do not offer much to understanding the major trait from which the subtraits were derived. Of much more importance is the complete variance-covariance matrix structure for all subtraits within a major trait which is needed for sire evaluation to predict frequencies of future daughters.

Nevertheless, the percentage of total variance accounted for by sire of cow, herd-year of measurement, and residual effects and the corresponding heritabilities within herd-years are in Table 3. These indicate sires' contributions to variability in the various subtraits are small, generally less than 3%, and suggest little genetic influence on the various subtraits and the major trait from which they were derived. Sampling variances of the variance components were not computed, but the distribution of sires among herd-years suggests reliability of the estimates may be low. Of the 2,686 herd-years included in the data, 1,551 (58%) had only one sire represented, 572 herd-years had two sires, 264 had three, and only 91 herd-years had as many as six sires represented. Absence of such comparisons could lead to decreased reliability for the variances and certainly reduce the number of records with information for prediction of frequencies of future daughters.

The small variances for sires greatly influenced the procedure for sire evaluation (5). The procedure requires the inverse of the sire variance-covariance matrix. Some determinants were so close to zero that inversion was impossible. The problem was bypassed by dropping one or more of the categories. Because one category had to be dropped for all traits at an initial stage to make the variance-covariance matrices nonsingular, when still another category was dropped for traits with three categories,

TABLE 2. Frequency distribution of cows classified in various categories for workability traits and subjective milk production.

Trait, category	Holstein	Ayrshire	Guernsey	Jersey
Disposition				
No trouble	.72	.74	.78	.70
Slight trouble	.25	.24	.21	.26
Definite trouble	.03	.02	.01	.04
Milking speed				
Faster than average	.35	.43	.38	.36
Average	.59	.51	.56	.60
Slow	.06	.06	.06	.04
Udder				
No trouble	.84	.87	.87	.83
Slight trouble	.13	.11	.11	.15
Definite trouble	.03	.02	.02	.02
Feet				
No trouble	.95	.93	.92	.97
Slight trouble	.04	.06	.06	.02
Definite trouble	.01	.01	.02	.01
Legs				
No trouble	.94	.91	.92	.96
Slight trouble	.05	.08	.07	.03
Definite trouble	.01	.01	.01	.01
Milk production				
Above average/average	.79	.74	.73	.73
Below average	.16	.18	.22	.21
Too low	.05	.05	.05	.06
Satisfaction[a]				
Very definite	.23	.26	.20	.23
Definite	.33	.30	.32	.31
Probably	.30	.28	.33	.32
Probably not	.09	.07	.11	.10
Definitely not	.05	.07	.04	.04
No. of records	5,601	505	304	677

[a]Response to question, "Would you like another cow like this one?"

TABLE 3. Percentages of total variance for sire, residual, and herd-years and heritabilities of dairymen's workability traits.

Trait[a]	Percentage accounted for by			Total variance	Within herd-year heritabilities
	Residual	Sire	Herd		
Disposition					
No trouble	83.8	1.5	14.7	.2025	.07
Slight trouble	84.1	1.3	14.6	.1900	.06
Definite trouble	98.5	.0	1.5	.0260	−.01
Milking speed					
Faster than average	80.2	1.8	18.0	.1453	.09
Average	82.0	.9	17.1	.1592	.04
Slow	88.1	2.6	9.3	.0588	.10
Udder					
No trouble	96.4	.4	3.2	.1325	.01
Slight trouble	99.5	.4	.1	.1149	.02
Definite trouble	99.6	−.4	.8	.0242	−.02
Feet					
No trouble	94.4	−.4	6.0	.0453	−.02
Slight trouble	96.0	−.5	4.5	.0377	−.03
Definite trouble	102.4	.0	−2.4	.0081	.0
Legs					
No trouble	94.9	.5	4.6	.0527	.02
Slight trouble	99.3	.2	.5	.0424	.01
Definite trouble	86.0	.9	13.2	.0114	.04
Milk production					
Above average/average	92.3	1.0	6.5	.1672	.05
Below average	93.7	.4	5.9	.1366	.02
Too low	95.7	.6	3.7	.0486	.03

[a]There were 5,601 Holstein cows, 187 sires, 1,850 herds, and 2,686 herd-years.

matrices collapsed to scalars. The consequence was that instead of three predictions for the three categories, only two were obtained, with predicted frequencies for the second and third categories combined. Because sires with high predictions in the third category were potential candidates for culling, the absence of separate predictions for the third category obscured the culling criterion.

While heritabilities for categorically scored traits were generally low, variances and covariances and heritabilities could have been influenced by the design of the survey. The distribution of sires among herd-years was such that there were relatively few comparisons within herd-years; adequate ties among sires are needed for reliable sire variance-covariance matrix. Therefore, estimates should be only a guide until more adequate data are collected and studied. Unless a new study shows significant genetic differences among sires for dairymen workability traits, there is no justification for much emphasis in selection on these traits. The unadjusted frequencies of cows for the various categories were similar for breeds, and conclusions for the Holstein breed may apply to other breeds.

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