January 1986

Heritability Estimates for First Lactation Milk Yield of Registered and Nonregistered Holstein Cows

J. C. Schneider
Cornell University

L. Dale Van Vleck
University of Nebraska-Lincoln, dvan-vleck1@unl.edu

Heritability Estimates for First Lactation Milk Yield of Registered and Nonregistered Holstein Cows

J. C. SCHNEIDER and L. D. VAN VLECK
Department of Animal Science
Cornell University
Ithaca, NY 14853

ABSTRACT

Heritabilities of milk yield and fat test were estimated from first lactation records of 196,672 Holstein daughter-dam pairs separately for registered and nonregistered cows for four milk yield groups and by years of freshening of the daughter. The model included herd-season and sire of the daughter. Heritability estimates were similar for registered and nonregistered cows averaging about .33 for milk yield and .62 for fat test. Estimates of heritability increased slightly over time for both milk yield and fat test. Heritability of fat test was similar for all groups. Heritability estimates for milk yield, however, averaged about .25 in low, about .35 in middle, and about .40 in high groups.

INTRODUCTION

Heritability estimates for milk yield generally have been larger at higher production than at lower production (3, 7, 8, 12). Estimates from daughter on dam regression usually are larger than from paternal half-sib correlation (7, 8, 12), probably partially due to reduction in the sire component of variance resulting from selection of sires and dams of bulls entering sire proving programs (2, 9). Therefore, estimates from daughter on dam regression may be more representative of genetic variation than estimates from sire components of variance unless non-additive genetic or cytoplasmic effects are important (1, 11) or unless treatment of daughters is based on dams' performance. One criterion to consider when deciding whether to use only grade daughters to evaluate bulls for return to service is the heritability associated with grade (nonregistered) and registered cows. Similarly, any differences in heritability may be a criterion to use when choosing grade and registered cows as dams of bulls (10).

The purpose of this study was to compare heritability estimates from daughter on dam regression for grade and registered cows at different milk yield groups and by year of freshening of the daughter.

MATERIALS AND METHODS

The data set has been described by Mirande and Van Vleck (7) and consists of first lactation, 2×, 305-d, mature equivalent (ME) records from the Northeast Dairy Records Processing Laboratory of 667,913 artificially sired Holstein cows. From these 196,672 daughter and dam matches were made on a within herd basis. A dam could be matched with more than one daughter, but each daughter and dam match would be included in a different yearly analysis. Each herd was assigned to one of four production groups for each year of the data from the rolling herd average for milk yield as of May of the year of freshening of the daughter. The rolling herd average is based on actual milk yield from all cows in the herd including first and later lactations. For each year the average and standard deviation of the rolling herd average was calculated from the complete data set. The production groups were assigned corresponding to three dividing points: the average minus one standard deviation, the average, and the average plus one standard deviation. These dividing points are given by Mirande (6). Heritability estimates were obtained from twice the residual covariance between daughter and dam records divided by the residual variance of dam records. Twice the residual covariance was estimated by subtracting the residual variances from both daughter and dam records from the residual variance obtained from analysis of the sum of daughter and dam records. The model used for both daughter and dam records was the herd-season (December through April and May through November) of freshening of the daughter and the sire of the

Received November 13, 1985.

daughter. This procedure allowed the same computer program used to estimate variance components to be used to estimate covariance components. The sire effect on the dam's record is a dummy effect included for computing convenience. The model assumes that dams having a daughter freshening, for example in herd-season 1, all freshen in the same herd-season. Therefore, the estimate of the residual variance for dam records may be slightly overestimated (4). Daughters were required to freshen at least 18 mo after their dams.

Logarithmic and square root transformations of milk yield were also analyzed. Heritabilities are not reported, however, because they followed the same pattern by year and production group as for untransformed records, although the transformations resulted in slightly smaller heritability estimates with estimates for the square root transformation being intermediate to heritability estimates from untransformed and log transformed records (12). Estimates over years were averaged by weighting by the reciprocal of the squared standard error of the estimates. Examination of heritability estimates plotted by year led to averaging the estimates for milk yield for two 5-yr periods. Estimates summarized are for years 1973 through 1982. Earlier years had small degrees of freedom for residual variances, in most cases less than 100 for each production group by registry status combination.

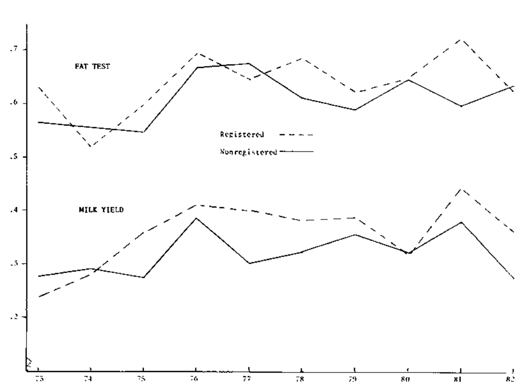

Figure 1. Estimates of heritability for milk yield and fat test from daughter on dam regression for registered and nonregistered Holsteins.

RESULTS AND DISCUSSION

Estimates of heritability for milk yield and fat test for registered and nonregistered cows when production group was ignored are in Figure 1. Standard errors of the estimates ranged from .02 to about .04. Differences between estimates of heritability from registered and nonregistered cows are small, although the estimates from registered pairs are generally slightly larger than from nonregistered cows. As with previous studies with these data (4, 12) the estimates are on the high side of other studies (5), averaging about .33 for milk and .62 for fat test.

Table 1 shows estimates and their standard errors averaged over 5-yr periods by production group. Averages for 1973 through 1982 and for 1965 through 1982 are also given. The period 1965 to 1972 was marked by small degrees of freedom, by some estimates of heritability less than zero and others greater than 1, and by large standard errors. Thus, more reliance is put on estimates from 1973 through 1982.

No particular pattern appears for the estimates for fat test. Estimates for registered cows were, on average, somewhat larger than for nonregistered cows. No consistent patterns with production group or time are apparent, although estimates for registered cows in the low production group are noticeably smaller, although the difference is not statistically significant, than other estimates.

Heritability estimates for milk records from registered and nonregistered cows are similar, although estimates for registered cows are somewhat larger than for nonregistered cows in the middle production groups. Heritability estimates are considerably smaller for the low group than for higher production groups for both registered and nonregistered cows. Heritability for the highest production group is consistently larger than for the middle production groups, although the increase is smaller from middle to high groups than from low to middle groups. Estimates for the two middle groups are similar but with a tendency for larger heritability for the higher production group.

Weighted regressions of heritability estimates on time were generally positive but very small for combinations of production group and registration status. In any case, there is no

TABLE 1. Estimates of heritability (and standard errors) for first lactation milk yield and fat test for registered and nonregistered cows in four production groups averaged over indicated years of freshening of daughters.

Weighted averages of inclusive years	Registered				Nonregistered			
		Production group				Production group		
	Low	Mid low	Mid high	High	Low	Mid low	Mid high	High
	Fat test							
1973–1977	.55 (.07)	.59 (.03)	.64 (.02)	.61 (.03)	.68 (.06)	.61 (.03)	.57 (.03)	.64 (.04)
1978–1982	.59 (.07)	.66 (.02)	.68 (.02)	.70 (.02)	.65 (.04)	.62 (.02)	.63 (.02)	.62 (.03)
1973–1982	.57 (.05)	.63 (.02)	.66 (.01)	.66 (.02)	.66 (.03)	.61 (.02)	.61 (.02)	.63 (.02)
1965–1982	.55 (.04)	.63 (.02)	.66 (.01)	.66 (.02)	.65 (.03)	.56 (.02)	.68 (.02)	.66 (.02)
	Milk yield							
1973–1977	.22 (.06)	.33 (.03)	.37 (.02)	.35 (.03)	.24 (.06)	.31 (.03)	.28 (.03)	.42 (.04)
1978–1982	.24 (.07)	.36 (.03)	.39 (.02)	.43 (.03)	.28 (.04)	.34 (.02)	.34 (.02)	.38 (.03)
1973–1982	.23 (.05)	.35 (.02)	.38 (.02)	.40 (.02)	.26 (.04)	.33 (.02)	.32 (.02)	.40 (.02)
1965–1982	.30 (.04)	.34 (.02)	.37 (.01)	.37 (.02)	.25 (.03)	.32 (.02)	.33 (.02)	.40 (.02)

evidence that heritability estimates are decreasing with time.

CONCLUSIONS

Heritability as estimated from daughter on dam regression is similar for registered and nonregistered cows for milk yield and fat test. This result suggests that bull dams can be selected from and, if daughter-dam heritability reflects the proportion of genetic variance in the population, that bulls can be proved with comparable accuracy in registered and nonregistered populations. Cytoplasmic (1) and maternal effects (11), however, may cause estimates from daughter-dam regression to be larger than from the intra sire correlation. Heritability of fat test appears similar for all production groups as measured by rolling herd average for milk yield.

Heritability estimates for milk yield for both registered and nonregistered cows agree with previous estimates that indicate differences in heritability for different production groups should be considered in sire and cow evaluation and selection (10).

ACKNOWLEDGMENTS

The authors gratefully acknowledge the National Association of Animal Breeders and Eastern Artificial Insemination Cooperative, Inc., Ithaca, NY, for partial financial support of this research and the support of the honors program of the College of Agricultural and Life Sciences.

REFERENCES

1 Bell, B. R., B. T. McDaniel, and O. W. Robison. 1985. Effects of cytoplasmic inheritance on production traits of dairy cattle. J. Dairy Sci. 68:2038.

2 Cochran, W. G. 1951. Improvement by means of selection. Page 449 *in* Proc. 2nd Berkeley Symp. Math. Stat. Prob.

3 Danell, B. 1981. Evaluation of sires on first lactation yield of Swedish dairy cattle. Thesis, Swedish Agric. Univ., Uppsala.

4 DeVeer, J. C., and L. D. Van Vleck. 1985. Estimation of heritability by daughter on dam regression using different models. J. Dairy Sci. 68(Suppl. 1):217. (Abstr.)
5 Maijala, K., and M. Hanna. 1974. Reliable phenotypic and genetic parameters in dairy cattle. Page 541 *in* 1st World Congr. Genet. Appl. Livest. Prod., Madrid.
6 Mirande, S. L. 1984. Trends in genetic and phenotypic variances in milk, fat and fat test production in Holstein cattle. M.S. Thesis, Cornell Univ., Ithaca, NY.
7 Mirande, S. L., and L. D. Van Vleck. 1985. Trends in genetic and phenotypic variances for milk production. J. Dairy Sci. 68:2278.
8 Powell, R. L., and H. D. Norman. 1983. Heritabilities of milk and fat yields according to herd average yield. J. Dairy Sci. 66(Suppl. 1)123. (Abstr.)
9 Robertson, A. 1977. The effect of selection on estimation of genetic parameters. Z. Tierz. Zuchtungsbiol. 94:131.
10 Van Vleck, L. D. 1985. Selecting optimum fractions of bull dams from two populations with different heritabilities and variances. J. Dairy Sci. 68(Suppl. 1)218. (Abstr.)
11 Van Vleck, L. D., and G. E. Bradford. 1965. Genetic covariances among relatives for dairy lactation records. Genetics 52:385.
12 Van Vleck, L. D., L. R. Cox, and S. L. Mirande. 1985. Heritability estimates of milk production from daughter on dam regression by year and management level. J. Dairy Sci. 68:2964.