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Abstract

Phenotypic and genetic correlations were estimated between 48 type appraisal traits and first lactation milk production to determine the importance of appraisal traits in a breeding program from 5,024 records from the New York type appraisal program. Most phenotypic correlations among the type traits were near zero. Depth of udder was the appraisal trait having the highest correlation with first lactation milk (.27) and fat (.23). Multiple correlations of all appraisal traits with first lactation milk and fat were .44 and .40.

Correlations with lifetime variables were calculated from 2,068 records meeting time qualifications. Of the first lactation variables, milk yield had the highest correlation with lifetime milk (.34), and fat yield had the highest correlation with number of lactations (.21). All appraisal traits combined were as effective as production variables in predicting number of lactations.

Genetic correlations suggested that bulls that sire daughters with high production tend to sire daughters with weaker udder attachments. High genetic correlations between first lactation production and lifetime performance support the utility of selection on first lactation production.

Introduction

Genetic progress that can be expected when selecting for two or more traits depends not only upon their respective heritabilities, but also upon their phenotypic and genetic relationships. Some workers have examined the relatonship between type classification scores and lactation milk production. These reports (3, 4, 8, 11, 12, 14, 19, 21, 22, 26) have shown low phenotypic correlations (average, .15) between final score and milk or milk fat yield. A few of these studies calculated phenotypic correlations between production and type categories: general appearance .00 to .17; dairy character .18 to .55; body capacity .08 to .17; mammary system .03 to .28; feet and legs .01 to .09; and rump .00 to .07. O'Bleness, Van Vleck, and Henderson (17) in type appraisal data ignoring age found traits with the highest correlations with milk production to be dairy character (.21) and depth of udder (.19).

A number of workers have shown that high production in first lactation is not inconsistent with long productive life (6, 7, 9, 13, 18, 23, 25). Few studies, however, have examined the relationship between body and udder conformation ratings during the first lactation and lifetime performance. Specht, Carter, and Van Vleck (20) estimated the correlation between first type score and herd life (number of times classified) at .2. Knowing phenotypic relationships between type traits and production can be useful in predicting the lifetime performance for an animal. In this manner such information can aid in making short term management decisions. However, information about genetic relationships are needed to predict changes in various traits that would result from a specific selection procedure.

Genetic correlations between measures of production and final type score have been estimated by several workers (10, 11, 14, 19, 21, 26). These estimates have been variable but average about .10. Most estimates of the genetic correlation between production and categories have been low and positive, but those between production and dairy character have ranged from .20 to .76. O'Bleness et al. (17) reported high genetic correlations with milk production for feeding habits and dairy character. Few type studies, regardless of purpose, have used first lactation data for production and type, and so biases in such results may have developed due to selection.

Genetic correlations between first lactation production and number of lactations have been .60 to .75 (9, 13). Van Vleck et al. (24) cor-

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related the percentage of daughters of Holstein sires having four lactations with the percentage of daughters in 66 type categories measured in the first lactation. Multiple regression on type traits and production accounted for 92% of the variation in percentage of daughters having four lactations. Their study was based on 81 bulls; further examination was necessary.

The purposes of this study were a) to provide additional information on the phenotypic and genetic relationships between first lactation production and type appraisal traits, and b) to examine the relationships between these first lactation variables and lifetime producing ability.

Methods of Analysis

Phenotypic relationships. Observations for cows in 188 herds on the New York special herd type appraisal program were used to calculate phenotypic relationships between first lactation type ratings, first lactation production, lifetime milk, and number of lactations. The data are the same as those used by Norman and Van Vleck (15, 16) except only cows having production data and appraisal scores for all type traits in the first lactation were used. The type appraisal traits were adjusted using age × stage-of-lactation constants (15). First lactation phenotypic correlations were calculated within herd-years from 5,024 cows in 462 herd-year-groups. Correlations associated with lifetime performance were calculated from 2,068 cows in 254 herd-year groups having not only first lactation data but also lifetime information. The lifetime variables, actual cumulative milk production and number of lactations, were used if a cow had the opportunity to be 6 years of age before herd production information terminated (March 31, 1969 or the date that her herd terminated production testing).

The following first lactation variables were used: the 48 type traits defined previously (15), (milk fever was not included due to low frequency); 21 quadratics derived by squaring the numeric values for those type traits having three or more categories and less than 95% of of the observations in the two categories of highest frequencies; milk and fat production measured as the deviation of the 305-day, milked two times a day, mature equivalent record from the adjusted herdmate average, and their quadratics; and fat percentage.

Multiple regression equations were fitted to predict first lactation production from the type appraisal traits, and to predict lifetime milk production and number of lactations from first lactation production and type traits. Attempts were made to determine a small number of independent variables which might be nearly as effective as all of them in predicting. A "Backward Elimination Procedure" as described by Draper and Smith (5) was used which drops in a stepwise manner the variable with the partial regression coefficient whose t statistic was less than the others. This resulted in a minimum reduction in R^2 (multiple correlation squared) at each particular step, but was not initiated until after all variables with t values less than .5 were eliminated in an initial step.

Genetic relationships. Estimates of genetic correlations between the variables were calculated by variance and covariance components from the random effects model previously described (16) which included year, herd, sire and herd × sire effects. There were 3,999 records from daughters of 397 artificial insemination (AI) sires used to calculate the first lactation correlations, and 1,639 records of daughters of 209 AI sires used to calculate the correlations with lifetime variables. The genetic correlations were estimated by

$$r_{g12} = \frac{\sigma_{s12}}{\sigma_{s1} \ \sigma_{s2}}$$

where σ_{s12} is the sire covariance component for traits one and two,

σ_{s1} is the square root of the sire variance component for trait one, and

σ_{s2} is the square root of the sire variance component for trait two.

Results and Discussion

The actual lifetime milk from the 1,639 cows averaged 21,530 kg within 3.55 lactations, with standard deviations of 11,645 kg and 1.64 lactations. This equals an average actual yield of 6,065 kg per lactation. The mean herd life of 3.55 lactations was longer than comparable measurements by Miller et al. (13), probably because cows in herds discontinuing testing were eliminated. Heritability for lifetime milk was .09 and for number of lactations was .11, similar to values by other workers (9,13).

Phenotypic relationships. Only 34 of the 1,128 correlation coefficients among the 48 type traits had absolute values greater than .15 (Table 1). Eight of these correlations were between pairs of traits that were derived from the same original multinomial traits (35 original traits became 49 renamed traits). Most of the others were between traits that aided a similar function, for example, various udder

TABLE 1. Phenotypic correlations between first lactation type ratings that differ substantially from zero[a].

No.	Traits	Other trait numbers and correlations[b]
	Management traits	
1	Excitability	
2	Feeding speed	
3	Mastitis	4 .4
4	Mastitis from injury	3 .4
5	Ketosis	
6	Breeding problems	7 .6
7	Cystic ovaries	6 .6
8[c]	Milking speed	
10	Milk leak	
11[c]	Intensity of edema	13 .8
13[c]	Persistency of edema	11 .8
	Body traits	
15[c]	Body weight	28 .3; 39 .3
17	Sharpness	
18	Typical head	
19	Strength of head	
20	Tightness of shoulder	
21[c]	Arching of back	
23[c]	Straightness of hock	25 .2; 26 .2
25	Straight legs, rear view	23 .2
26[c]	Strength of pasterns	23 .2; 37 .2
28[c]	Depth of body	15 .3; 50 .2
30[c]	Levelness of rump	32 −.3; 33 .6; 35 .3
32	Smooth pelvic arch	30 −.3
33[c]	Height of tail setting	30 .6; 35 .3
35[c]	Height of thurls	30 .3; 33 .3
37[c]	Heel depth	26 .2
39[c]	Upstandingness	15 .3
	Udder traits	
41[c]	Rear udder length	44 −.3; 45 .2; 50 .2; 54 .2
43	Rear udder bulginess	56 −.2
44	Rear udder funnelness	41 −.3
45[c]	Fore udder length	41 .2; 48 −.2
47	Fore udder bulginess	49 −.2; 56 −.2; 58 −.3
48	Fore udder funnelness	45 −.2
49	Udder quality	47 −.2; 50 −.2; 56 .2; 58 .3
50[c]	Depth of udder	28 .2; 41 .2; 49 −.2
52[c]	Forward slope to udder	56 −.2
54[c]	Height of rear udder	41 .2; 56 .3
56[c]	Strength rear udder attachment	43 −.2; 47 −.2; 49 .2; 52 −.2; 54 .3; 58 .4
58[c]	Strength fore udder attachment	47 −.3; 49 .3; 56 .4
60[c]	Udder halving	
62	Udder quartering	
63	Rear teats forward	65 .4
64	Rear teats sideways	66 .4; 68 .2
65	Fore teats forward	63 .4
66	Fore teats sideways	64 .4; 68 .3
67	Rear teat spacing	68 .3
68	Fore teat spacing	64 .2; 66 .3; 67 .3; 69 .2
69	Rear to fore teat spacing	68 .2

[a] Correlation between traits reported if greater than +0.15 or less than −0.15.
[b] Correlations are the decimal numbers.
[c] Type traits having quadratics in the multiple regression analyses, the trait number for each squared term succeeds that for each type trait.

TABLE 2. Phenotypic correlations between first lactation type[a] and production, and lifetime performance.

No.	Traits	First lactation production			Lifetime performance	
		Milk, 70	Fat, 72	Fat % 74	Actual milk, 75	No. of lact., 76
	Management traits					
1	Excitability	.01	−.02	−.04	−.03	−.04
2	Feeding speed	.16	.15	−.03	.09	.06
3	Mastitis	−.05	−.06	−.03	−.06	−.05
5	Ketosis	.08	.07	−.01	.03	.02
6	Breeding problems	.07	.08	.01	−.05	−.07
8	Milking speed	.01	.02	.02	.08	.09
11	Intensity of edema	.12	.10	−.04	−.02	−.03
13	Persistency of edema	.11	.09	−.04	−.06	−.08
	Body traits					
15	Body weight	.08	.09	.02	.01	.00
17	Sharpness	.15	.14	−.04	.16	.13
20	Tightness of shoulder	−.05	−.04	.03	−.01	.00
28	Depth of body	.10	.10	−.01	.02	.00
30	Levelness of rump	.00	.02	.03	.03	.03
32	Smoothness of pelvic arch	−.04	−.02	.04	−.02	−.01
33	Height of tail setting	.00	.02	.03	.03	.03
39	Upstandingness	.05	.03	−.03	.04	.02
	Udder traits					
41	Rear udder length	.14	.14	−.02	.06	.03
45	Fore udder length	.07	.08	.02	.08	.08
47	Fore udder bulginess	.09	.07	−.04	.01	.01
48	Fore udder funnelness	.03	.04	.01	−.03	−.03
49	Udder quality	−.07	−.07	.02	.06	.06
50	Depth of udder	.27	.23	−.09	.03	−.01
52	Forward slope to udder	.08	.06	−.04	−.03	−.05
54	Height of rear udder	.10	.09	−.03	.09	.07
56	Strength R. udder attach.	−.06	−.03	.05	.02	.04
58	Strength F. udder attach.	−.10	−.08	.05	.00	.02
65	Fore teats forward	.04	.04	.00	.00	.01
68	Fore teat spacing	.01	.00	−.02	−.05	−.05
69	Rear to fore teat spacing	.03	.02	−.03	−.01	−.01
	Production traits					
70	Milk, herdmate deviation	1.00	.86	−.31	.34	.20
72	Fat, herdmate deviation	..	1.00	.19	.31	.21
74	Fat percentage	..	..	1.00	−.07	.00
75	Lifetime milk[b]	..	..	..	1.00	.95
76	Number of lactations[b]	..	..	..	..	1.00

[a] Type traits that had partial regression coefficients, linear or quadratic, differing from zero ($P \leq .05$) in any of the multiple regression analyses are included.

[b] Cows had an opportunity to be six years of age before herd production information terminated.

characteristics. The correlation between intensity of edema –11[2] and persistency of edema –13 was highest at .8. The phenotypic correlations of the first lactation type traits with first lactation production and lifetime performance are in Table 2.

Multiple regression coefficients used the entire set of variables to predict: a) first lactation production from the type traits, and b) lifetime performance from first lactation type and production (Table 3). All 69 type traits (48 linear and 21 quadratics) produced multiple correlation coefficients (R) of .44 and .40 with first lactation milk and fat yields. The percentages of the variation in production ex-

[2] Hyphenated number following trait is the trait number in Tables 1, 2, 3, and 4.

TABLE 3. Summary of multiple regression analyses in fitting first lactation type appraisal and production records.

		Multiple correlations				
		First lactation production			Lifetime performance	
List of the independent variables	Total no.	Milk, 70	Fat, 72	Fat % 74	Actual milk, 75	No. of lact., 76
All type and production 1-73	73	. .	. .	. .	.43	.35
6,11-13,17,46,49,70,71	9[a]	. .	. .	. .	.40	. .
6,11-13,17,46,49,70-72	10[a]	. .	. .	. .	. .	.30
All type 1-69	69	.44	.40	.19	.30	.27
2,3,5,6,11,12,14,15, 17,20,28,30-34,42,47, 49-51,53,54,56-58,65, 68	28[a]	.42	. .	. .	. .	. .
2,3,5,6,11,12,15-17, 20,28,30-34,42,45,47- 51,53,54,56-58,65,68	30[a]	. .	.39	. .	. .	. .
1,2,14,31,32,39,40, 47,54,57,69	11[a]	. .	. .	.13	. .	. .
2,3,8,11-13,17,46, 54,56,57	11[a]	. .	. .	. .	.25	. .
2,6,8,11-13,17,46,54	9[a]	. .	. .	. .	. .	.22
Management 1-14	14	.24	.23	.08	.18	.17
Body 15-40	26	.24	.22	.11	.19	.16
Udder 41-69	29	.33	.29	.14	.17	.15
All production 70-73	4	. .	. .	. .	.35	.23
Milk 70,71[b]	2	. .	. .	. .	.35	.23
Fat 72,73[c]	2	. .	. .	. .	.31	.22

[a] These traits had partial regression coefficients differing from zero ($P \leq .05$).
[b] 71 is milk squared.
[c] 73 is fat squared.

plained by type appraisal were 19 and 16% for milk and fat.

The variable elimination method was executed until all 69 variables were removed. The step at which all remaining partial regression coefficients had significant t values ($t \geq 1.96$, giving probability of type 1 error $\leq .05$) occurred when 28 type traits gave a multiple correlation of .42 for first lactation milk. A similar point for first lactation fat occurred when 30 type traits gave a multiple correlation of .39.

The last seven variables to be eliminated were the same for both milk and fat and gave multiple correlations of .38 for milk and .35 for fat. Of these, six were positively correlated with lactation milk and fat yield: udder depth —50, feeding speed—2, sharpness—17, rear udder length—42 squared, intensity of edema —11, and breeding problems—6. Mastitis—3 was negatively correlated with lactation yield.

The type variable having the highest correlation with milk and fat yield (.27 and .23) was udder depth—50. O'Bleness et al. (17) reported corresponding values of .19 and .14 for cows of all ages. Burnside, McDaniel, and Legates (2) estimated the correlations between 305-day milk and two udder traits which are complementary to udder depth as used in this study: udder height (—.29) and udder height minus hock (—.44). The latter simple correlation reported by Burnside et al. (2) was as high as the multiple correlation of all type traits with production in this study. Burnside et al. (2) measured the two udder traits between the 30th and 60th day postpartum, just prior to an afternoon milking.

Atkeson, Meadows, and McGilliard (1) calculated a multiple correlation of .48 for milk production on four classification categories using 444 Holsteins under 3 years of age. Almost all of that relationship was attributed to dairy character. The correlations of sharpness—17 with milk and fat yield in this study were .15 and .14. Correlations of .20 to .55 have been reported (1, 8, 14) using type classification data and dairy character as the best predictor of production. Dairy character is generally considered to be composite of those characteristics which give an indication of milk producing ability. Such ratings were not a good indicator of milk producing ability in this study even after correction for stage-of-lactation at appraisal.

Truncation selection based on type appraisal can give phenotypic improvement in milk production 42% as effective as selection based on the monthly tests. Therefore a type appraisal is clearly not a satisfactory substitute for a milk testing program for measuring phenotypic performance. There is, however, substantial information about a cow's production available through type appraisal. The two type traits which have been effective in predicting producing ability have been udder depth and dairy character rating (1, 2, 8, 14, 17). The results of the regression analyses indicate the udder traits were a slightly better indicator of production than were the management or body traits.

The entire set of type traits accounted for only 3% of the variation in fat percentage (R = .19). The highest simple correlations were with depth of udder–50 and depth of udder squared at –.09, apparently largely as a result of the negative relationship between milk and fat percent and the positive relationship between milk and udder depth. Both variables were eliminated in the reduction procedure for predicting fat percentage indicating a possible weakness of this method of eliminating regression variables.

The linear and quadratic effects of first lactation production and type appraisal accounted for 19% of the variation in lifetime milk production (R = .43). First lactation milk–70 had the highest correlation with lifetime milk, .34. First lactation milk squared was also significant but only raised R to .35. Other variables with significant t values were sharpness–17, udder quality–49, and fore udder length squared–46. Traits detrimental to high lifetime production were persistent edema–13 and breeding problems–6. The linear and quadratic effects of intensity of edema–11 were together influential and indicated cows scoring moderate for intensity of edema had higher lifetime milk than either those scoring none to slight or severe. The nine significant variables gave a multiple correlation of .40. First lactation production variables were more effective in predicting lifetime milk than were first lactation type traits.

Twelve percent of the variation in number of lactations was accounted for by first lactation production and type appraisal traits (R = .35). The regression coefficients for ten production and type traits had significant t values, which indicate these traits influenced the number of lactations in a cow's lifetime. These traits were first lactation fat–72 plus the nine traits that significantly influenced lifetime milk production. First lactation fat–72 and milk yield–70 had simple correlations with number of lactations of .21 and .20. First lactation production (R = .23) and type appraisal ratings (R = .27) appeared to have equal predictive value for the number of lactations that a cow had in her productive life.

Genetic relationships. The genetic correlations between the type traits and first lactation and lifetime variables are in Table 4. The genetic correlation between milk and fat yield was .76 which agrees with .71 to .87 by other investigators (8, 9, 14, 21, 26). The genetic correlation between milk and fat percent was −.37 and between fat and fat percent was .28.

Most of the type traits had genetic correlations with milk yield that were similar to the correlation of the same type traits with fat yield. The genetic correlations of milk and fat yield with sharpness–17 were .34 and .17. The estimates from these data and estimates of .98 and .27 by O'Bleness et al. (17) and .38 by Van Vleck et al. (24) surround those reported from type classification studies (8, 11, 14). The correlations of milk and fat yield with body weight–15 were each .15, similar to the .14 reported by Van Vleck et al. (24). The correlations of excitability–1 with milk and fat yield were .48 and .26, somewhat higher than previous estimates (17, 24) of .05 to .18. The positive genetic relationships between production and excitability suggest that selection based on milk production ignoring disposition might result in more animals with nervous dispositions. The genetic correlations between production and milking speed–8 were low but positive (.21 and .18).

Estimates from this and a previous study (24) suggest negative genetic relationships between production and some body and udder traits generally given positive emphasis in type classification, such as tightness of shoulders–20 and traits characterizing a flat smooth rump–30, 32, and 35. Those traits giving an indication of strength and high carriage of the udder were negatively correlated with production indicating that selection for higher production ignoring udder traits would bring decreases in scores for strength of fore-56 and

TABLE 4. Genetic correlations between first lactation type and production, and lifetime performance.

No.	Traits	First lactation production			Lifetime performance	
		Milk, 70	Fat, 72	Fat % 74	Actual milk, 75	No. of lact., 76
	Management traits					
1	Excitability	.48	.26	−.24	1.43	1.55
2	Feeding speed	.07	.28	.36	.99	.92
3	Mastitis	−.10	−.22	−.10	−.89	−.88
4	Mastitis from injury	−.50	−.66	−.08	−.70	−.56
5	Ketosis	[a]	[a]	[a]	[a]	[a]
6	Breeding problems	−.02	.09	.27	.48	.20
7	Cystic ovaries	.07	.07	.14	−.61	−.79
8	Milking speed	.21	.18	−.04	.82	.93
10	Milk leak	[a]	[a]	[a]	[a]	[a]
11	Intensity of edema	1.23	1.27	−.08	.72	.76
13	Persistency of edema	[a]	[a]	[a]	[a]	[a]
	Body traits					
15	Body weight	.15	.15	.16	.56	.60
17	Sharpness	.34	.17	−.16	1.88	1.34
18	Typical head	.52	−.01	−.75	3.74	3.69
19	Strength of head	.08	.36	.55	−.89	−.92
20	Tightness of shoulder	−.47	−.38	.24	−.49	−.22
21	Arching of back	.19	.24	.15	1.22	.70
23	Straightness of hock	−.05	.12	.23	.31	.17
25	Straight legs, rear view	−.32	−.05	.58	.82	.87
26	Strength of pasterns	−.04	−.06	−.09	.09	.14
28	Depth of body	.16	.14	−.04	−.02	.00
30	Levelness of rump	−.33	−.27	.14	.06	.25
32	Smoothness of pelvic arch	−.18	−.03	.30	−.28	−.43
33	Height of tail setting	−.37	−.33	.13	.04	.28
35	Height of thurls	−.26	−.30	.02	−.42	−.31
37	Heel depth	−.01	.05	.07	−.31	−.41
39	Upstandingness	.02	−.05	−.05	.71	.55
	Udder traits					
41	Rear udder length	.21	.18	.01	.48	.14
43	Rear udder bulginess	[a]	[a]	[a]	[a]	[a]
44	Rear udder funnelness	[a]	[a]	[a]	[a]	[a]
45	Fore udder length	−.54	−.51	.17	.31	.66
47	Fore udder bulginess	−.01	−.36	−.29	−2.57	−2.23
48	Fore udder funnelness	.47	.40	.33	.49	.34
49	Udder quality	−.50	−.31	.17	.99	1.58
50	Depth of udder	.36	.26	−.02	−1.08	−1.36
52	Forward slope to udder	1.48	1.43	.00	.07	−.54
54	Height of rear udder	−.15	−.30	−.15	.25	.10
56	Strength R. udder attach.	−.27	−.21	.16	−.02	.26
58	Strength F. udder attach.	−.71	−.55	.35	2.23	2.36
60	Udder halving	.26	.30	.19	.64	.30
62	Udder quartering	.08	.02	−.01	−.59	−.57
63	Rear teats forward	[a]	[a]	[a]	[a]	[a]
64	Rear teats sideways	.09	.07	.05	−.51	−.58
65	Fore teats forward	−.13	−.10	.06	.10	.23
66	Fore teats sideways	−.03	−.04	.07	.03	−.20
67	Rear teat spacing	−.26	−.08	.40	−.69	−.71
68	Fore teat spacing	.00	.11	.33	−.22	−.30
69	Rear to fore teat spacing	.15	−.07	−.14	1.88	1.43
	Production traits					
70	Milk, herdmate deviation	1.00	.76	−.37	1.14	.90
72	Fat, herdmate deviation	..	1.00	.28	.90	.80
74	Fat percentage	..	..	1.00	−.39	−.20
75	Lifetime milk[b]	..	..	..	1.00	.98
76	Number of lactations[b]	..	..	..	..	1.00

[a] Estimates were imaginary.

[b] Cows had an opportunity to be six years of age before herd production information terminated.

rear udder attachment–58 and height of udder-54, and result in deep udders-50 with a forward slope to the udder floor-52.

Six of the 48 correlations of type appraisal traits with milk and fat yield were imaginary because of negative estimates of sire variance components. Two more, intensity of edema-11 and foreward slope to udder-52, were well above 1.0, thus indicating the sampling variance was quite large. The large sampling variation adds substantially to the difficulty of interpreting the results.

The genetic correlations between the type traits and lifetime milk or number of lactations appeared to be extremely variable due to the smaller number of observations. Although only six of the estimates were imaginary for each, eight more exceeded the theoretical limits for genetic correlations. The genetic correlations of first lactation milk-70 and fat-72 with lifetime milk were estimated as 1.14 and .90, somewhat higher than respective values of .85 and .87 reported by Hargrove, Salazar, and Legates (9). The estimates of genetic correlations of first lactation milk and fat yield with number of lactations were .90 and .80, again slightly higher than values of .62 and .72 by others (9, 13). These high genetic correlations between first lactation production and lifetime performance clearly illustrate the importance of giving considerable selection emphasis to production yield in early life.

The present research seems to substantiate that attention has been given to too many traits in the past. This practice of considering too many traits has resulted in relaxed selection for milk production. The results do not supply adequate evidence to suggest that all management and conformation traits be ignored. Because of high economic values, some low heritability traits such as disposition, mastitis, milking speed, or udder traits should merit some consideration in dairy cattle improvement.

Conclusions

Relationships were examined between first lactation production, type appraisal ratings, and measures of lifetime performance. Most phenotypic correlations between the type appraisal traits were near zero. Some information about a cow's milk and fat producing ability in first lactation is available from a type appraisal. However, this would not serve as a substitute for a monthly testing program. Depth of udder and sharpness were the best predictors of first lactation production.

Of the first lactation variables, milk yield had the highest correlation with lifetime milk production. First lactation fat yield and milk yield had the highest individual correlations with total number of lactations. Together, all of the type ratings were as effective as the production variables in predicting the number of lactations in a cow's lifetime.

Genetic correlations between type and production were estimated, but the sampling variances of the estimates were large. These data suggested that bulls that sire daughters with high production tend to sire daughters with udders lower in rear, weaker in fore and rear attachment, deeper, and sloping forward. Because of the high genetic correlation with lifetime performance, first lactation production appears to be the trait where selection emphasis should be directed. However, serious weaknesses could develop over time if traits such as strength of udder attachments are ignored since they have negative correlations with production.

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