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HERITABILITY AND REPEATABILITY OF SOME TYPE APPRAISAL TRAITS*

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In breeding for improved dairy cattle emphasis is placed not only on milk and butterfat production but also on body conformation. In the United States the components of body conformation and desirability are usually referred to as type.

Type was the principal means of appraising cattle in the early days of cattle improvement. In those days the bovine was used not only for milk production but also for draft purposes. Although cattle are no longer used for draft purposes in the United States, it is still common to consider certain features of dairy type in the overall breeding goal.

Generally, dairy cattle with desirable type command higher prices when sold for dairy purposes. This is due in part to the belief that there is a positive relationship between type and milk production. There is also some tendency to assume that better type is positively correlated with longevity. For these reasons type has been included in selection programs in the hope that it would help increase accuracy of selecting more desirable and higher producing dairy cows.

Whether a character can be improved by breeding depends upon the degree to which the character is hereditary. Therefore, it is important to determine the heritability of traits involved in a breeding program. The higher the heritability, the more effective a system of selection. Another important characteristic is the repeatability of the measurement of a trait. Repeatability is the correlation between repeated measurements or estimates of a trait. If this correlation is high, only little additional accuracy is achieved by additional observations. If, on the other hand, repeatability is low, additional accuracy in

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appraising the trait may be obtained by repeating the measurement or observation.

Review of Literature

Some ressearch on heritability of type in dairy cattle has been reported. Studies of the repeatability of type score are not as numerous. This is because official classification as carried out most commonly in the United States is not repeated unless the type score can be improved. As a consequence, repeated independent scores of the same animals are only available in specially planned experiments.

Repeatabilities of components of type score in Holsteins were found by Wilcox *et al.* (16) to range from o. 24 to o. 56. Some of the repeatability estimates were: over-all rating o. 39, mammary system o. 31, and rump o. 56. Benson *et al.* (1) studied type rating of Ayrshire cows and concluded that repeatabilities of single final type ratings were o. 56 when the classification was repeated by the same classifier and o. 48 when the reclassification was by a different classifier. Hyatt and Tyler (5) found that the correlation between repeated classifications ranged between o. 62 and o. 82 when the classifications were made by the same inspector. When different inspectors did the repeat classifications, the correlation between repeated classifications was o. 55. Johnson and Lush (7) also found that repeatability of classification score was higher when the classification was made by the station personnel than when the claasification was made by official, visiting judges.

On the other hand, there is considerable literature about heritability of type in dairy cattle. Wilcox *et al.* (16) have shown that heritability estimates of some type scores in Holsteins were: overall o. 12, mammary system o. 09, and rump o. 19. These estimates are close to Harvey and Lush's (4) findings, which showed a heritability of type in Jersey cattle of o. 14. However, Tabler and Touchberry (14) obtained the value of o. 25 for Jerseys in 1955. Tyler and Hyatt (15) estimated heritability of type ratings in Ayrshire cattle as o. 40 by means of paternal half sib correlations and as o. 28 by means of intrasire regression coefficient of daugters on dam. Freeman and Dunbar (3) using daughter-dam comparisons in the same breed found almost the same results, o. 31 for final rating, o. 32 for rump and thighs, and o. 27 for udder, teats, veins, and quality. Butcher *et al.* (2) found lower heritability values such as final type o. 18, rump and thighs o. 22 , and udder. o. 06 for the same breed. Johnson and Fourt (6) estimated heritabilities of o. 36 for rump, o. 28 for fore udder, o. 35 for rear udder, and o. 35 for final type in Brown Swiss. O'Bleness *et al.* (10) obtained lower figures such as o. 33 for barrel, - o. 05 for front udder and o. 04 for rear udder in Holstein cattle. Other reports about heritability of

type score in Holsteins were givin by Mitchell *et al.* (9) who found 0.31 for rump, 0.12 for mammary system and 0.15 for final rating and by Stone *et al.* (13) who found a value of 0.21 for final type rating. It is evident from these divergent results that estimates of the heritability of the components of type vary considerably.

Experimental Procedures

Data covering 11 years (from 1951 to 1961) were available from special type classifications of the Holstein herds at the North Platte and Scotts Bluff Agricultural Experiment Stations owned and operated by the University of Nebraska. Only cows with type classification records at three years of age were included in this study of heritability estimates and only cows with at least two classifications were included in this study of repeatability estimates. Heritabilities and repeatabilities were computed for each experiment station separately and for both stations together. There were 206 cows at three years of age (199 at North Platte and 97 at Scotts Bluff) sired by 51 bulls qualifying for heritability estimate studies. A large number of these 51 bulls were used in both of the experiment station herds. Two hundred eight cows (107 at Scotts Bluff and 101 at North Platte) with 634 type classifications were available for repeatability studies.

The type classifications were carried out by Dr. Plum from the University of Nebraska, with asistance of experiment station personnel, The herds were visited four times a year at three-month intervals until 1959. After 1959 the herds were visited monthly. Each female in the experiment station herds was classified once a year during the visit that fell closest to the birth of the animal. Head, shoulders, back, rump, barrel, rear legs, front udder, and rear udder were evaluated for type with the grades shown below:

10 Excellent	5 Good
9 Very Good	4 Low Good
8 Low Very Good	3 Fair
7 Good Plus	2 Low Fair
6 Low Good Plus	1 Poor

The "final rating" was obtained by adding the scores for the parts, each part being weighted as follows:

Part	Weight
Head	2
Shoulders	6
Back	8
Rump	12
Barrel	16
Hind Legs	5
Front Udder	28
Rear Udder	23
Total	100

No attepts were made to correct the type scores for effect of age, stage of lactation, season and calendar year. Standard statistical techniques (12) were used for computing means and standard deviations. Heritabilities were computed from intraclass paternal half-sister correlations and repeatabilities were computed from intra cow correlations, as shown by Lerner (8).

Results and Discussion

Heritability: The means and the standard deviations of the scores for the five characteristics at three years of age are shown in Table 1. These results were obtained from 206 cows sired by 51 bulls. The differences in the scores of the same type components between the two experiment stations were very small relative to the standard error of these differences. The means and standard deviations in the two herds are very similar. The average scores for front and rear udder at North Platte were slighly, but not significantly higher than at Scotts Bluff, but rump, barrel, and final ratings were higher at Scotts Bluff. The average classification scores for the two herds combined were 4. 93 (low good) for rear udder, 5.09 (good) for front udder, 5.25 (good) for rump, 6.68 (low good plus) for barrel, and 55.05 (good) for final rating. Rear udder had the lowest and barrel the highest classification scores.

The heritabilities were estimated as four times the intraclass correlations of paternal half sibs and are shown in Table 2.

When the heritability estimates obtained in this study are compared with those reported by other workers there is a large variation between them. Comparing the results obtained from the analyses at the North Platte and Scotts Bluff stations the estimated heritability for rump is larger than all the previous reports (2, 3, 4, 6, 9, 10, 13, 14, 15, 16). The highest heritability given by Johnson and Fourt (6) was 0. 36 found in Brown Swiss. The heritability estimate of barrel obtained in this study was 0.32. O' Bleness *et al.* (10) found a value

of 0.33 for this characteristic. Heritability of fore udder was found to be more than twice the heritability of rear udder. Heritability of rear udder in this study was 0. 26, which is smaller than the previous reports by Freeman and Dunbar (3) and by Harvey and Lush (4). On the other hand, it is larger than the other reports (2, 9, 10, 16) from different dairy breeds . Tyler and Hyatt (15) found it to be 0. 40 by the paternal half sib correlation method.

TABLE 1

Means and standard deviation for four type components and final rating for 3 year old cows

(3 yaşlı ineklerin dört tip özelliğine ve nihai puanına ait ortalama değerler ve standart sapmalar)

Characteristic (Özellik)	Combined herds (Sürüler birarada)		North Platte		Scotts Bluff	
	X	S	X	S	X	S
Rump (Sağrı)	5.25	1.58	4.88	1.55	5.59	1.54
Barrel (Karın)	6.48	1.16	6.32	1.12	6.62	1.19
Front udder (Ön meme)	5.09	1.40	5.16	1.17	5.04	1.58
Rear udder Arka meme)	4.93	1.41	5.00	1.22	4.87	1.55
Final rating (Nihai puan)	55.05	8.68	54.81	7.50	55.27	9.64

TABLE 2

Heritabilities for four type components and final rating
(Dört tip özelliği ve nihai puana ait kalıtım dereceleri)

Herd (Sürü)	Rump (Sağrı)	Barrel (Karın)	F. udder (Ön meme)	R. udder (Arka meme)	Final rating (Nihai puan)
North Platte	0.41±0.38	0.56±0.40	0.70±0.42	0.17±0.36	0.51±0.39
Scotts Bluff	0.38±0.39	0.22±0.37	-0.05±0.33	0.42±0.40	0.13±0.36
Combined (Birarada)	0.55±0.28	0.32±0.26	0.59±0.28	0.26±0.26	0.36±0.27

All heritability estimates, except rear udder, are larger for the North Platte herd than for the Scotts Bluff herd. Since the same selection methods were applied and many of the same bulls used in both herds, the differences in heritability between these two herds might be attributed to herd Managemenet and other environmental factors. Since the samples are small the differences could also be due to sampling errors.

Repeatability: The means and standard deviations of the scores of type components were computed for first records and for second and subsequent records. The results are shown in Table 3.

As seen in Table 3, both means and standard deviations of first, second, and subsequent classification records are similar. The means of second and subsequent records are sligtly, but not significantly higher than the means of the first classification records. The classification scores for the four type components and final ratings for the North Platte herd are higher, but not significantly so, than the means for the Scotts Bluff herd.

The repeatability estimates for the four type scores and final ratings are shown in Table 4. The accuracy of selection is increased by making repeated measurements and the benefit from repeated observations is greater the lower the repeatability. This is obvious, since a high correlation between successive measurements shows that the first contributes nearly all the useful information.

The within-cow-variance in this study was assumed to be entirely environmental, caused by changes in environment between successive measurements, and by variation in the scorers ability to assess the true type. No corrections were made for lactations, pregnancy, ages, or calendar year.

Repeatabilities for both herds together ranged from 0. 26 for barrel to 0. 58 for rump. Wilcox *et al.* (16) reported almost the same range, from 0. 24 to 0.56 in Holstein Cattle. They estimated a repeatability of 0. 31 for mammary system, 0.56 for rump, and 0. 39 for overall rating. The present repeatability estimate for final rating is larger, but Benson *et al.* (1) found the repeatability estimate for final rating in Ayrshire cattle to be 0. 56.

All repeatability and heritability figures for the North Platte herd were higher than those obtained from the Scotts Bluff herd. It appers that non genetic factors of variation are a larger proportion of the total variance in the Scotts Bluff herd than in the North Platte herd.

Summary

Data from 208 Holstein cows sired by 51 bulls with 634 type classification records in the North Platte and Scotts Bluff Agricultural Experiment Stations were analyzed. No corrections were made for age of cow, season, or herd. Scoring was made according to the following scale: 10, excellent; 9, very good; 8, low very good; 7, good plus; 6, low good plus; 5, good; 4, low good; 3, fair; 2, low fair; and 1, poor. Avarage scores for some type components of three-

TABLE 3

Means and standard deviations of some type components for first, and for second and subsequent records

(Birinci; ikinci ve takibeden puvantajlarda bazı tip özelliklerine ait ortalama değerler ve standart sapmalar)

Characteristic (Özellik)	Combined herds (Sürüler birarada)		North Platte		Scotts Bluff	
	X	S	X	S	X	S
First record (Birinci puantaj)						
Rump (Sağrı)	5.42	1.67	5.63	1.71	5.21	1.62
Barrel) (Karın)	6.76	1.30	6.92	1.20	6.62	1.38
F. udder (ön meme)	4.88	1.50	4.96	1.53	4.81	1.48
R.udder (Arka meme)	4.86	1.47	4.98	1.52	4.76	1.43
Final rating (Nihai puan)	55.54	9.08	56.43	9.61	54.70	8.51
Second and subsequent records (İkinci ve takibeden puantajlar)						
Rump (Sağrı)	5.54	1.68	5.80	1.71	5.25	1.63
Barrel (Karın)	6.86	1.14	6.92	1.22	6.81	1.05
F. udder (Ön meme)	4.98	1.33	5.10	1.40	4.87	1.26
R. udder (Arka meme)	4.95	1.38	5.05	1.54	4.85	1.21
Final rating (Nihai puan)	56.12	8.71	57.18	9.65	55.13	7.64

TABLE 4

Repeatabilities of some type component records
(Bazı tip özelliklerine ait kayıtların tekrarlama dereceleri)

Herd (Sürü)	Number of cows (İnek sayısı)	Number of records (Kayıt sayısı)	Rump (Sağrı)	Barrel (Karın)	F.udder (Ön meme)	R.udder (Arka meme)	Final rating (Nihai puan)
North Platte	101	297	0.64±0.10	0.28±0.10	0.46±0.11	0.49±0.09	0.59±0.10
Scotts Bluff	107	337	0.54±0.10	0.25±0.09	0.49±0.08	0.54±0.10	0.48±0.09
Combined (Birarada)	208	634	0.58±0.07	0.26±0.07	0.48±0.07	0.58±0.06	0.53±0.07

year-old cows were: rump 5. 25, barrel 6.48, front udder 5. 09, rear udder 4. 93, and final rating 55. 05. Heritabilities were o. 55 for rump, o. 32 for barrel, o. 59 for front udder, o. 26 for rear udder, and o.36 for final rating. The North Platte herd had higher heritability values than did the Scotts Bluff herd.

Average first classification scores for rump, barrel, front udder, rear udder, and final rating were 5. 42, 6.76, 4.88, 4.86, and 55.54, respectively. Second and subsequent classifications averaged as rump 5.54, barrel 6.86, front udder 4.98, rear udder 4. 95, and final rating 56.12. Second and subsequent averages were slightly but not significantly higher than first classification averages. Repeatabilities were estimated to be as follows: 0.58 for rump, 0.26 for barrel, 0.48 for front udder, o. 52 for rear udder, and 0.53, for final rating.

Özet

Tiple İlgili Bazı Karekterlerin Kalıtım ve Tekrarlama Dereceleri

Amerika Birleşik Devletlerinde Nebraska Üniversitesine bağlı "Nort Platte" ve " Scotts Bluffs" Ziraî araştırma merkezlerindeki 51 boğadan gelme 208 adet Holstein ineğine ait 634 adet puvantaj sonuçları tip puvantajının kalıtım ve tekrarlama derecelerini hesaplamak amacıyla, analize tabi tutulmuştur. İneklerin yaşı, puvantaj mevsimi ve süre farklılığı için düzeltme yapılmamıştır. Puvantajda şu şekilde not verilmiştir: 10, mükemmel; 9 pek iyi; 8, düşük pek iyi; 7, iyiden üstün; 6, düşük iyiden üstün; 5, iyi; 4, düşük iyi; 3, orta; 3, düşük orta; ve 1 , zayıf. Üç yaşındaki ineklerin bazı tip özelliklerine ait ortalama notları şöyledir: Sağrı 5, 25; karın 6, 48; memenin ön yarımı 5, 09; memenin arka yarımı 4, 93; ve nihai puvan 55, 05. Kalıtım dereceleri sağrı için o, 55 karın için o, 32, memenin ön yarımı için o, 59. memenin arka yarımı için o,26 ve nihaî puvan için o, 36 olarak bulunmuştur. "North Platte" sürüsünde kalıtım dereceleri "Scotts Bluff" sürüsündekinden daha yüksek bulunmuştur.

İlk puvantajda verilen notların ortalaması sağrı, karın, memenin ön yarımı, memenin arka yarımı ve nihaî puvan için sırasiyle 5,42 6,76 4,88, 4,86 ve 55,54 idi. İkinci ve müteakip puvantajlarda verilen notların ortalaması ise sağrı için 5,54, karın için 6, 86, memenin ön yarımı için 4,98, memenin arka yarımı için 4,95 ve nihaî puvan için 56,12 olarak hesaplanmıştır. İkinci ve müteakip puvantajlarda verilen notların ortalamaları birinci puvantaj notları ortalamalarından biraz yüksek olmakla beraber aradaki farklar önemli değildir. Puvantajda verilen notların tekrarlama dereceleri sağrı için o, 58; karın için o,26; memenin ön yarımı için o,48; memenin arka yarımı için o, 52 ve nihaî puvan için o,53 olarak hesaplanmıştır.

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