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Conference paper

BODY SIZE OF LACTATING DAIRY COWS: RESULTS OF DIVERGENT SELECTION FOR OVER 30 YEARS

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Summary

Divergent selection lines of Holstein cows for body size differed for body weight, body dimensions, and calf weight, but did not differ for production or calving ease. Cows in the small line required fewer services to conception during first lactation. Productive life was 88 days (15%) longer for cows in the small line than for cows in the large line.

Keywords: dairy cattle, body size, selection, productive life.

Introduction

North American Holsteins have been selected for increased body size (Mahoney et al., 1986). Scoring of conformation by the Holstein Associations of America and Canada continues to place very favorable ratings on dairy cows with large body size. Consequently, dairy producers in North America are milking cows of larger size than during the 1960's (Boettcher et al., 1993). The objectives of this study were to assess the direct response to divergent selection for body size of dairy cows, to determine the correlated responses for calf size and calving ease, and to compare the divergent lines for survival and reasons for disposal.

Materials and methods

A single experimental herd of Holstein cows at the Northwest Experiment Station (Crookston) of the University of Minnesota was used. During 1966, 60

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cows in the herd were paired by sire and randomly assigned to one of two genetic lines, large or small. Progeny were assigned to the same genetic line as their dams. Cattle were managed together and identically in a tiestall barn. Cow and heifers were periodically added to the herd, were treated as foundation females for the selection project, and were assigned to one of the two genetic lines; however, cows in this study had at least three generations of prescribed project sires.

Sire selection. Mating sires were selected from among the top 50% of active artificial insemination sires in the USA for production. The production criterion changed over the years of the study and, in chronological order, was 1) milk production, 2) dollar value of milk, 3) fat plus protein production, or 4) protein production. All other selection was for size of daughters (large or small). Sires were selected based on standardized transmitting abilities for stature, strength, and body depth with the index: body size = .5(stature) + .25(strength) + .25(body depth). The three most extreme sires for transmitting large and small body size were selected once each year from the summer genetic evaluations of the United States Department of Agriculture (USDA) for production and the Holstein Association of America for body size.

Since the early 1980's, mating within line were completely random, except inbreeding coefficients were not allowed to surpass 6.25%.

Data. Cows used for this study were born after January 1, 1983. Data file 1 included 217 cows born from January 1, 1983 to December 31, 1989; all cows in data file 1 had the opportunity to be in the herd 7 years (84 months) and have been culled. Data file 2 included all cows in data file 1 plus 59 cows (n = 276) born from January 1, 1990 to April 30, 1991; all cows in data file 2 had the opportunity to be in the herd for 6 years (72 months). Data file 3 included all cows in data file 2 plus 121 cows (n = 397) born from May 1; 1991 to November 30, 1994, and many of these cows were still alive. Data file 1 was used to analyze productive life (to 84 months) and reasons for disposal, data file 2 was used to analyze productive life (to 72 months), and data file 3 was used to analyze all other traits.

Traits measured and methods of analysis. All cows were weighed immediately postpartum, as were their calves. Four body dimensions, in addition to body weight, were recorded one month postpartum. The body dimensions were height at the withers, length from withers to pin bones, depth of chest, and circumference of chest. Calving ease was coded on a linear scale from 1 to 5 with 1 for no assistance and 5 for use of a mechanical puller.

Production of milk, fat, and protein was actual production from routine milk recording. Incomplete records were projected to 305 days, and records were required to be at least 90 days. Number of services to conception was recorded. Data file 3 was used for analysis of body weight, body dimensions, calf weight, calving ease, production, and number of services; however, only results from parities one, two, and three are reported. Ordinary least squares was used for analysis with a model that included genetic line (for all traits), age at calving (for body weights and dimensions, calf weight, calving ease, and production), and sex of calf (calf weight).

Reasons for disposal of the 217 cows in data file 1 were assigned to twelve categories. Cows could be culled for one (coded as 1), two (each coded as .5), or three (each coded as .33) reason(s) for disposal. Productive life to 84 months (data file 1) or 72 months (data file 2) was reported in days, and lactations were credited a maximum of 305 days. Ordinary least squares was used for analysis of reasons for disposal and productive life with a model that included only the effect of genetic line.

Results and discussion

Direct response. As expected, least squares means for genetic lines differed ($P<.01$) for all body weights (Table 1). Differences in body weight for genetic lines increased with parity. Ranges for body weights immediately postpartum for parity 1 were 450-822 kg (L) and 416- 720 kg (S), for parity 2 were 514-834 kg (L) and 488-731 kg (S), and for parity 3 were 580- 885 kg (L) and 515-784 kg (S). Phenotypes for body weight for the two lines overlapped tremendously. Table 2 has least squares means for body dimensions of the genetic lines, and all differences were significant.

Table 1. - LEAST SQUARES MEANS FOR BODY WEIGHT OF COWS

	Postpartum (kg)			1-month postpartum (kg)		
Line	Parity 1	Parity 2	Parity 3	Parity 1	Parity 2	Parity 3
Large	609	664	720	559	625	672
Small	558	596	641	507	555	584
Difference	51**	68**	79**	52**	70**	88**

[1]Number of observation postpartum: 159 L, 217 S (1st); 95 L, 126 S (2nd); 53 L,70 S (3rd)
**P<.01.

Table 2. - LEAST SQUARES MEANS FOR HEIGHT, LENGTH, DEPTH. AND CIRCUMFERENCE OF COWS[1]

	Height (cm)			Lenght (cow)		
Line	Parity 1	Parity 2	Parity 3	Parity 1	Parity 2	Parity 3
Large	136.1	137.4	138.6	141.6	147.6	151.4
Small	129.0	130.4	130.9	136.0	141.3	145.0
Difference	7.1**	7.0**	7.7**	5.6**	6.3**	6.4**
	Depth (cm)			Circumference (cm)		
Line	Parity 1	Parity 2	Parity 3	Parity 1	Parity 2	Parity 3
Large	70.9	72.6	74.2	195.1.	200.5	205.7
Small	67.1	68.2	69.5	186.2	190.1	194.0
Difference	3.8**	4.4**	4.7**	8.9**	10.4**	11.7**

[1]Number of observation were 145 L, 210 S (1st); 93 L, 135 S (2nd); and 51 L, 80 S (3rd).
**P<.01.

Correlated responses. Least squares means for calf weight were significantly different and were approximately 2.3 kg for all three parities (Table 3); however, calving ease did not differ for the genetic lines. Least squares means for number of services tended to be higher for all lactations of cows in the large compared to the small line. The means for number of services were significantly different P <.05) for cows during first parity (2.08 L, 1.79 S)

Table 3. - LEAST SQUARES MEANS FOR CALF WEIGHT AND CALVING EASE OF COWS[1]

	Calf weight (kg)			Calving ease		
Line	Parity 1	Parity 2	Parity 3	Parity 1	Parity 2	Parity 3
Large	42.0	44.7	45.5	3.08	1.43	1.45
Small	39.4	42.4	43.0	3.16	1.51	1.36
Difference	2.6**	2.3**	2.4*	NS	NS	NS

[1]Number of observations for calf weight: 163 L, 222 S (1st); 95 L, 126 S (2nd); 54 L, 73 S (3rd)
*P<.05, **P<.01.

Production. The genetic lines did not differ significantly for milk, fat, or protein production. Least squares means for actual 305-day milk production (age adjusted within parity) for first parity were 8492 kg (large) and 8535 kg (small), for second parity were 9578 kg (large) and 9820 kg (small), and for third parity were 9954 kg (large) and 9687 kg (small). Fat and protein production followed the same pattern as milk production.

Reasons for disposal. The large and small lines differed significantly for only three reasons for disposal. Significantly (P<.05) more cows in the small line (11.9%) were culled for udder conformation than were cows in the large line (5.3%). Although distance of the udder floor to the ground was not measured, udders of cows in the small line were expected to be closer to the ground than udders of cows in the large line, because cows in the small line had less wither height. Significantly (P<.10) more cows in the large line (7.4%) versus the small line (2.8%) were culled for problems with locomotion. The legs and feet of cows in the large line carried greater body weight and, therefore, might have been more prone to injury. Also, cows in the large line (8.7%) were culled more frequently (P<.05) than cows in the small line (2.8%) for reasons falling into the "other" category, which included reasons such as kidney and bladder infections, peritonitis, slow milking, and calving on fewer than four quarters.

Productive life. Least squares means for productive life are in Table 4, and differences between the genetic lines were substantial. Productive life to 84 months is essentially the same trait as calculated and evaluated by USDA for distribution to the dairy industry, except we expressed this trait in days rather than in months. Both the 84-month and 72-month measures of productive life differed by about 88 days (2.9 months). The probability from tests of significance for line differences was .13 for the 84-month measure; however, an additional 59 degrees of freedom for tests was provided by the larger data file for the 72-month measure, and difference between the genetic lines was significant (P<.05). The cows in the small line had approximately 15% longer productive lives than cows in the large line.

Table 4. - LEAST SQUARES MEANS FOR PRODUCTIVE LIFE OF COWS

	84-month		72-month	
Line	Days	n	Days	n
Large	624.0	92	570.6	119
Small	712.5	125	658.3	157
Difference	88.5(P = .13)		87.7(P<.0S	

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VELIČINA TIJELA MLIJEČNIH KRAVA U LAKTACIJI: REZULTATI DIVERGENTNE (RAZLIČITE) SELEKCIJE U VIŠE OD 30 GODINA

Sažetak

Sjevernoamerički Holštajn selekcioniran je na povećanje tjelesne dimenzije (Mahoney i sur., 1986.). Bodovanje/skoring konformacije Udruženja Holštajn Sjeverne Amerike i Kanade i dalje daje vrlo povoljnu ocjenu/rejting mliječnim kravama vrlo velikih tjelesnih dimenzija. Prema tome proizvođači mlijeka u Sjevernoj Americi muzu veće krave nego 1960-tih (Boettcher i sur., 1993.). Ciljevi ovog istraživanja bili su ocijeniti izravni odgovor/reakciju na različitu selekciju na tjelesnu veličinu mliječnih krava, odrediti korelativne odgovore za veličinu teleta i lakoću telenja, te usporediti različite linije za preživljavanje i razloge za odstranjivanje.

Linije selekcije Holštajn krava za veličinu tijela razlikovale su se u tjelesnoj težini, tjelesnim dimenzijama i težini teladi, ali nisu se razlikovale u lakoći proizvodnje i telenja. Krave u maloj liniji trebale su manje servisiranja do začeća za vrijeme prve laktacije. Proizvodni život bio je 88 dana (15%) dulji kod krava u maloj liniji nego kod krava u velikoj liniji.

Ključne riječi: mliječmo govedo, tjelesna veličina, selekcija, proizvodni život

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