TRAIT SELECTION WHEN CULLING U.S. HOLSTEINS

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INTRODUCTION

More traits are emphasized in dairy breeding programs as more data become accessible in national databases. VanRaden (2004) summarized changes in U.S. economic indexes and recent trait weights assigned in indexes of other countries. The US lifetime net merit index has been revised frequently (VanRaden, 2004) to add new traits and to address changes in economics and genetic correlations between traits (Tsuruta *et al.*, 2004).

Assigning economic weights to traits in a breeding index is complex because of difficulty in 1) obtaining sound economic information on benefits and costs associated with most traits and 2) accurately estimating phenotypic and genetic relationships between all traits. Knowledge of which traits are important to dairy producers when culling cows might aid in determining the emphases that artificial-insemination organizations should use when choosing young bulls and graduating progeny-test bulls into active artificial-insemination service. Failure to emphasize the same traits for selecting bulls as for culling cows could result in genetic gains that were less than optimal and obtained at a higher cost than necessary.

Information on relative trait emphases that dairy producers use when culling also could be incorporated into culling-decision software to simplify producer management decisions and thereby increase labor efficiency on the farm. Most dairy producers likely make culling decisions without reviewing all performance traits for each cow in the potential culling pool. An index-style culling guide that incorporates preferred trait emphases for culling would be useful, especially if producers were provided with the flexibility to modify assigned weights.

This study documents 1) emphases currently placed on different yield and fitness traits when culling and 2) trends in trait emphases over the last 20 years.

MATERIAL AND METHODS

Data. Yield (milk, fat and protein), somatic cell score (SCS), days open (DO) and dystocia score (DS) records of U.S. Holsteins that first calved since January 1980 in herds in Dairy Herd Improvement milk-recording programs were obtained from the USDA national lactation database. Only records from first parities prior to October 2000 were included to allow time for cows to complete at least 4 lactations; cows that changed herds during their first 4 lactations were excluded. To ensure that additional records would be included if a cow survived and was retained in the herd, cows were required to be from herds that remained on test for 1600 days after a cow's first calving date. Only records from cows with an identified sire and a first calving age of 15 to 36 months were included. Calving intervals were restricted to 270 to 650 days to ensure that no parities were missing. Number of records with protein information ranged from 17,025 cows with a mean first-parity standardized milk yield of 8269 kg in 1980 to 365,627 cows with mean yield of 11,370 kg in 2000.

Statistical analyses.
Analysis models were similar to the model of Keown *et al.* (1976). Yield records from the USDA database had been standardized for calving age, calving month, milking frequency, lactation length and previous DO; SCS records had been standardized for calving age, calving

month and lactation length. The model to determine selection intensity (mean difference between cows with a successive record and those culled during the immediate lactation) was $Y_{ijk\ell} = H_{ij} + S_k + e_{ijk\ell}$, where $Y_{ijk\ell}$ = yield (milk, fat or protein) or SCS for cow ℓ in herd i, calving season j and survival group k; H = effect of herd-calving season (January to March, April to June, July to September and October to December); S = effect of survival group based on number of parities in herd and e = effect of random error. Separate analyses were conducted to determine relative emphasis given to the same traits when culling during first, second and third lactations. Survival groups were defined to examine whether cows with the best performance during early parities were those that survived the longest. For parity 1, survival groups were S_1 (cow had only a first-parity record), S_2 (cow had only first- and second-parity records), S_3 (cow had only first-, second- and third-parity records) and S_{4+} (cow had ≥4 records); a separate analysis was conducted for survival groups S_1 and S_{2+} (cow had ≥2 records). Survival groups were S_2 and S_{3+} (cow had ≥3 records) for parity 2 and S_3 and S_{4+} for parity 3.

Because USDA records for DO and DS are not standardized for calving age and season, two additional effects were added to estimate selection intensity for DO and DS: $Y_{ijk\ell mn} = A_m + C_n + H_{ij} + S_k + e_{ijk\ell mn}$, where $Y_{ijk\ell mn}$ = DO or DS for cow ℓ that calved in age group m during calendar month n in herd i, calving season j and survival group k; A= fixed effect for age group of calving; C = fixed effect for calendar month; and H, S and e are as defined previously. Calving-age groups for DO and DS were 15 to 22, 23 to 24, 25 to 26, 27 to 28, 29 to 30, 31 to 32 or 33 to 36 months for parity 1, ≤36, 37 to 40, 41 to 44 and ≥45 months for parity 2 and ≤49, 50 to 54, 55 to 59 and ≥60 months for parity 3.

Data for the first 3 parities were analyzed separately and by individual calving year so that changes in selection emphasis could be observed across time. Analysis was limited to calving years prior to 2001 for parity 1, 2002 for parity 2 and 2003 for parity 3 to allow cows an opportunity to survive to ≥4 parities.

To determine relative emphasis among traits, selection-intensity estimates were standardized by dividing by standard deviation for each year, trait and parity. Trait emphases were expressed relative to a value of 100% for milk yield.

RESULTS AND DISCUSSION

Compared with cows culled during first lactation, cows with 2 lactations had higher first-parity milk yield by 609 to 1175 kg from 1980 to 2000; corresponding survival advantages were 642 to 1283 kg for cows with ≥2 lactations, 710 to 1350 kg for cows with 3 lactations and 663 to 1331 kg for cows with ≥4 lactations. Survival-group trends for advantage in first-parity fat and protein yields were similar to those for milk yield. Cows retained for ≥2 lactations had first-parity SCS that were 0.34 to 0.62 lower than those of cows culled during first lactation; cows retained for 3 or ≥4 lactations generally had lower first-parity SCS than did cows with 1 or 2 lactations. In 1980, cows culled during first lactation had 18, 18 and 24 more first-parity DO than those with 2, 3 and ≥4 lactations, respectively; those differences increased to 34, 41 and 52 more DO by 2000. Producers are milking nonpregnant cows longer. Because of the negative genetic relationship between yield and fertility (Dematawewa and Berger, 1998), increased emphasis on milk yield resulted in increased DO despite direct selection for fewer DO when culling. Although DS, which is measured on a 5-point scale from 1 (no problem during calving or unobserved) to 5 (extreme difficulty during calving), has a negative relationship with survival, DS were only slightly lower (0.10 to 0.14) for cows with ≥2 lactations than for cows culled during first lactation. Overall culling rate is not impacted much by DS because of the low frequency of extremely difficult calvings (DS = 5).

Most second-parity differences were within 15% of first-parity differences except for DO and DS. For parity 2, survivor advantage for DO did not increase over time (22 days fewer in 1980 to 36 days fewer in 2000) as much as it did for parity 1 (21 days fewer in 1980 to 43 days fewer in 2000). Second-parity DS differences for cows retained for additional parities over cows that were culled during the current lactation (−0.04 to −0.10) were about half the differences for parity 1. A decrease in DS advantage for parity 2 was expected as calving difficulty is much less of a problem for later parities than for parity 1 (Dematawewa and Berger, 1997).

Advantage of survivors for third-parity yield traits and SCS generally was similar to that for first- and second-parity traits except for a slight decline in survivor advantage for milk and protein yields during the 1980s. Survivor advantage for third-parity DO increased even less (23 days fewer in 1980 to 30 days in 2000) over time than was found for parity 2. The DS differences for third-parity survivors (−0.03 to −0.06) were less than both first- and second-parity differences.

Table 1 shows emphases on yield and fitness traits when culling U.S. Holstein cows during first lactation relative to 100% emphasis for milk yield. Producers valued protein yield similar to milk yield (91 to 101% relative emphasis). Emphasis on fat yield was 74 to 84% of emphasis on milk yield, with slightly less emphasis during the 1990s than the 1980s. Producer emphasis on SCS was 19 to 37% of emphasis on milk yield. First-parity DO received 18 to 30% of emphasis of milk yield between 1980 and 1996. Emphasis on fertility when culling cows increased during the 1990s; DO received 72 to 74% of emphasis on milk yield from 1998 through 2000. The largest increase was between 1996 (30%) and 1997 (61%) when yield records were affected by implementation of best prediction methodology (VanRaden, 1997) to predict 305-day yield from test-day data; thus, the apparent increase in emphasis on reproduction likely is an overestimate of actual change in producer emphasis. Emphasis on DS during first-parity culling was low but gradually increasing (7% in 1980 to 15% in 2000) compared with emphasis on milk yield. Producers continued to emphasize the same traits when culling during second and third lactations (not shown).

Table 1. Emphasis when culling during first lactation on yield traits, SCS, days open (DO) and dystocia score (DS) relative to milk yield by year of first calving

Year of	Relative emphasis (%) on first-parity trait					
first calving	Milk yield	Fat yield	Protein yield	SCS	DO	DS
1980	100	84	97	—	−23	−7
1984	100	83	97	—	−21	−9
1988	100	82	99	−19	−18	−8
1992	100	76	101	−25	−23	−9
1996	100	74	100	−26	−30	−9
1997	100	83	91	−31	−61	−11
1998	100	77	95	−37	−73	−13
1999	100	79	96	−34	−72	−13
2000	100	78	95	−33	−74	−15

CONCLUSION

Producers placed different emphases on yield and fitness traits when culling U.S. Holstein cows, but relative emphasis among traits has remained comparatively consistent since 1980 regardless of parity. Protein yield received nearly the same emphasis (90 to 101%) as milk yield, whereas emphasis on fat yield relative to milk yield was lower (72 to 91%). Emphasis on SCS relative to milk yield was 19 to 33% for parity 1, with even greater emphasis on SCS for later parities (59 to 84%). Although DO for the population has increased over time because of its correlation with milk yield, DO has received considerable culling emphasis since 1997 (61 to 131%), particularly for later parities. Selection emphasis on DS relative to milk yield was low (7 to 19%). Relative emphases that producers place on yield and fitness traits when culling should be considered when determining which traits to emphasize when selecting bulls and could be used in development of software for index-based culling in dairy management systems.

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