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Effect of non-genetic factors on herd life, selective value and its components in Holstein Friesian cows

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ABSTRACT

Records of 364 Holstein Friesian cows were analyzed to study the fixed effect of age at first calving, first lactation milk yield, season and year of birth on lifetime traits using general linear model. The overall least squares means were 2,864±63 days, 1,638±58 days, 3.55±0.12, 1.68±0.07, 1.12±0.06 and 0.56±0.03 for longevity, productive herd life, total calves, female calves, selective values and coefficient of gene replication. The cows with ≥1,500 kg first lactation milk yield had minimum longevity of 2,170±329 days as well as shortest productive herd life of 869±330 days. Cows calved at early age had lowest productive herd life of 919±366 days. Lesser number of total and female calves was produced by cows with very short age at first calving. Cows with intermediate first lactation milk yield (2,066–3,195 kg) produced more normal and female calves. Selective values and coefficient of gene replications were not statistically affected by the above non-genetic factors. Year of birth highly influenced all the traits. The study showed that better nutrition and follow-up is needed for cows calving at early age.

Key words: Age at first calving, Birth season, Coefficient of gene replication, First lactation milk yield, Holstein Friesian

The genetic contribution of a cow to the next generation depends upon productive herd life, longevity, total calves born, total normal calves born, total female calves born and selective value (Atrey *et al.* 2005, Kumar *et al.* 2009) and this contribution in the form of living progeny is known as selective value. It is associated with the life time calf production and their survival up to milking age. Hence, the present investigation was undertaken to know the variability in the selective value of Holstein cattle.

MATERIALS AND METHODS

Data on life time performance traits of 364 Holstein Friesian cows spread over a period of 22 years (1987–2009) were collected from Holeta Cattle Genetic Improvement Center, Ethiopia. Age at first calving (AFC) and first lactation milk yield (FLMY) were classified in to different groups based on 1/2σ unit of the trait. Seasons were classified in to dry October to February), short (March to May) and long (June to September) rainy seasons. Longevity was the time interval in years from the date of birth to the date of disposal of cows from herd either due to culling or death. Productive herd life was defined as the number of days from first calving to the date of disposal of cow from the herd. Coefficient of gene replication (CGR) is the additive genetic relationship between adult female and its female descendents reached to milking herd and replacing the cow.

General Linear Model procedures of SAS (2002) was used to study the fixed effects of season and year of birth of cows, age at first calving and first lactation milk yield on longevity, reproductive herd life, selective value and its components (total calves born, total female calves born and coefficient of gene replication) using the following model incorporating all these factors.

RESULTS AND DISCUSSION

Longevity: The longevity of Holstein Friesian cows was 2,864±63 days (Table 1). This estimate was in agreement with the 7.83 years reported in Friesian crosses (Gebeyehu 2005) in Ethiopia and higher than 6.2 years for Frieswal cattle in India (Atrey *et al.* 2005). Shortest and longest longevity were recorded for ≥1,500 kg and ≤5,456 kg FLMY groups, respectively (Table 1). Though longevity had no definite relation with FLMY, cows in intermediate groups had higher longevity in the herd. These results are in agreement with the results of Durocq *et al.* (1988), Rogers *et al.* (1991), Mukherjee *et al.* (1999) and Atrey *et al.* (2005). Season effects

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on longevity of cows were statistically nonsignificant. These findings differed from the findings of Mukherjee *et al.* (1999) and Kumar *et al.* (2009). The decreasing trend in longevity over years could be due to the fact that best available cows might have been brought and maintained as long as they were reproducing at the farm.

Productive herd life: The average productive herd life (PHL) of Holstein Friesian cows at Holeta farm was 1,638±58 days (4.59 years). Higher PHL than the present estimate was observed by Reddy and Basu (1985) in Holstein Friesian crosses, while lower PHL than the present were reported by Singh and Tomar (1989), Mukherjee *et al.* (1999), Atrey *et al.* (2005) and Gebeyehu (2005). Difference in observations of different workers may be due to different management policies and practices adopted by different dairy cattle farm.

Average PHL for different age groups showed that Holstein Friesian cows with lowest AFC (≥886 days) had lowest PHL (919±366 days). Perhaps the cows calved at a very low age could not have attained full mature size, therefore, might have been culled at early lactations, because calving at an immature age weakens the vitality of cows and such animals are likely to suffer with more problems like poor body condition, low milk yield, repeat breeding, infertility and disease susceptibility than cows calved at the mature age. The declining trend of PHL for AFC group above 1511 days could be related to culling, as cows with very high AFC are not preferred in the herd and are culled out earlier than the cows with optimum AFC. Similar results were reported by Durocq *et al.* (1988), Rogers *et al.* (1991), Mukherjee *et al.* (1999) and Atrey *et al.* (2005) as they have observed highly significant effect of AFC on longevity.

The average PHL for different FLMY groups showed that low producers had short PHL, presumably culling of those cows because of poor production. Higher milk producing cows (>4,325 kg) did not have longer PHL, may be because of failure to meet out the production and maintenance requirement of those cows resulting in to ultimate loss of such cows either by mortality or culling. These results also indicated that Holstein Friesian cows with medium milk yield can be managed more effectively to have longer PHL at Holeta farm. However, in order to maximize the genetic contribution from high producing cows, differential treatment based on production level is important. Moreover, improvement of the overall management and health practices will reduce involuntary culling of productive animals. These observations were in conformity with the reports of Rogers *et al.* (1988), Mukherjee *et al.* (1999) and Atrey *et al.* (2005).

Statistically, the season effects on PHL were nonsignificant. These results indicated that there is not much environmental variation between seasons of a year which could be measured on phenotypic scale. The trait was affected by year of birth this could be perhaps due to changed policy for culling of older cows through early replacement by newly calved heifers. Similar year effects were observed by Hedage and Bhatnagar (1985), Reddy and Basu (1985), Tanida *et al.* (1988), Singh and Tomar (1989), Mukherjee *et al.* (1999), and Atrey *et al.* (2005).

Total normal calves born (TCP): The average number of total normal calves produced (TCP) by each Holstein Friesian cows during its herd life was 3.55±0.12. The current finding was closer to the findings of Rawal *et al.* (1993) in Tharparkar (3.68 calves) and Gebeyehu (2005) for various Friesian×Boran crosses (3.58 calves). Higher normal births than the present finding were observed by Singh *et al.* (1997) and Kumar *et al.* (2009). Total number of normal calves produced was highest for intermediate AFC groups of cows. This revealed that cows having optimum AFC had longer PHL. This finding was contrary to the finding of Atrey *et al.* (2005). However, Kumar *et al.* (2009) observed that cows calved early had produced more alive calves in Hariana cattle. The effect of FLMY group on live calves born was significant and cows in the intermediate milk production group produced more normal calves than cows in low and high FLMY groups. This could be associated to the shorter PHL of cows in very low and high milk producing groups. The present findings were in agreement with the Mukherjee and Tomar (1996), Atrey *et al.* (2005) and Kumar *et al.* (2009). Season had no significant effect whereas year of birth significantly influenced on total normal calves born.

Total normal female calves born: The average number of normal female calves born was 1.68±0.07 (Table 1). The present average was lower than those reported by Kumar *et al.* (2009), while higher than those reported by Tomar *et al.* (1996) and Atrey *et al.* (2005). Age at first calving and season of birth did not affect female calf production. The total number of female calves born were higher in cows producing milk in the range of 2,066–2,630 kg (2.17±0.21 calves) and 2,631–3,195 kg (2.01±0.18 calves). This could be due to the longer PHL of such cows producing higher number of normal female progenies. Atrey *et al.* (2005) reported that higher milk producing cows produced more female calves. Non-significant effect of milk yield group on female calf production was reported by Kumar *et al.* (2009). Higher normal and female calves reported for the highest (≤5,456 kg) milk group in this study could be related to the small sampling effect. Nonsignificant effect of birth season on female calves produced was also reported by Gebeyehu (2005) earlier. Year effects were significant and this finding was in conformity with the reports of Mukherjee and Tomar (1996), Kumar *et al.* (2009) and Atrey *et al.* (2005).

Selective value and coefficient of gene replication: Selective value of an animal is the proportionate contribution of the living female progeny to the next generation. A selective value of 1.0 indicated that cow had replaced herself in the milking herd. The average number of female calves reached to the milking herd from each Holstein Friesian cow was estimated to be 1.12±0.06. This indicated that on an average more than one replacement heifer from each HF cow

Table 1. Least squares means for lifetime traits in Holstein cattle

Source	N	Longevity (days)	PHL (days)	Total calves born (TCP)	Female calves born	Selective value	CGR
Overall	364	2864±63	1638±58	3.55±0.12	1.68±0.07	1.12±0.06	0.56±0.03
AFC group		NS	**	**	NS	NS	NS
≥886	35	1748±365	919±366	2.40±0.87	1.27±0.59	0.68±0.52	0.34±0.026
887–1042	73	2246±514	1274±516	2.97±0.26	1.36±0.16	0.87±0.12	0.43±0.78
1043–1198	74	2851±514	1279±516	3.59±0.27	1.60±0.17	1.13±0.16	0.56±0.71
1199–1354	75	3239±518	1970±520	4.36±0.30	2.05±0.18	1.30±0.15	0.65±0.75
1355–1510	58	3400±522	1972±524	4.20±0.28	2.08±0.17	1.51±0.17	0.78±0.76
1511–1666	21	3092±534	1499±536	2.97±0.38	1.28±0.23	0.76±0.18	0.38±0.44
1667–1822	12	3523±557	1781±559	3.33±0.46	1.75±0.41	1.16±0.38	0.58±0.50
1821–1978	7	4102±586	2248±588	4.87±0.48	2.57±0.52	1.85±0.50	0.92±0.75
≤1979	9	3533±497	1385±498	2.33±1.18	1.22±0.80	1.00±0.70	0.50±0.35
FLMY group		***	***	***	**	NS	NS
≥1500	47	2170±329	869±330	2.06±0.26	0.87±0.15	0.59±0.13	0.29±0.12
1501–2065	29	2530±335	1261±336	2.75±0.38	1.55±0.25	0.93±0.20	0.46±0.14
2066–2630	56	3019±319	1760±321	4.08±0.30	2.17±0.21	1.57±0.19	0.78±0.38
2631–3195	67	3115±319	1891±320	4.28±031	2.01±0.18	1.34±0.16	0.67±0.32
3196–3760	70	2941±320	1795±321	3.82±0.28	1.84±0.18	1.22±0.16	0.61±0.31
3761–4325	49	3049±324	1829±325	3.61±0.31	1.61±0.14	1.02±0.17	0.51±0.25
4326–4890	25	2844±b339	1602±340	3.24±0.33	1.44±0.21	0.84±0.17	0.42±0.09
4891–5455	14	2686±361	1498±362	3.21±0.45	1.14±0.37	0.78±0.30	0.39±0.07
≤5456	7	3833±396	2484±325	4.42±0.57	1.71±0.47	1.28±0.36	0.64±0.01
Birth season		NS	NS	NS	NS	NS	NS
Dry	154	2847±97	1624±98	3.50±0.17	1.66±0.10	1.12±0.10	0.56±0.06
Short	87	3008±115	1758±115	3.90±0.25	1.78±0.15	1.19±0.15	0.59±0.08
Long	123	2795±110	1571±101	3.36±0.21	1.65±0.12	1.08±0.10	0.54±0.05
Birth year		***	***	***	***	***	***

*, P≥0.05; **, P≥0.01; ***, P≥0.001 NS, not significant.

reached to the milking herd resulting in increased herd size. Furthermore, it could be possible to practice culling of low producer cows while keeping the herd strength constant. The present observation was in conformity with those of Rawal *et al*. (1993) but higher than those reported by Lathwal (1989), Mukherjee and Tomar (1996) and Atrey *et al.* (2005).

Coefficient of gene replication is the additive genetic relationship between the adult female to next generation through contribution of female progenies. A cow having 0.5 CGR is said to have replicated once or produced 1 female progeny reaching to the milking herd. The average value of CGR (0.56±0.03) estimated for Holstein Friesian herd at Holeta farm, indicated that there was more than one time gene replication from each cow to the future generations in the herd. The present CGR value was higher than those reported by Tomar *et al.* (1995), Mukherjee and Tomar (1996) and Atrey *et al*. (2005). FLMY grouping significantly influenced the CGR. However, this finding was contrary to the non significant effects observed by Mukherjee and Tomar (1996), Kumar *et al.* (2009) and Atrey *et al.* (2005).

Longevity, PHL and total calves born were highest for intermediate AFC and FLMY groups showed the necessity of improving the environment for early calvers and high producers. The continuous decline of lifetime traits through years is an indication of deterioration of management.

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