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Productive and Reproductive Performance of Holstein Friesian Cattle in the Hill Country of Sri Lanka

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Abstract: The objective of the study was to assess the productive and reproductive performance of Holstein Friesian dairy cows over a period 11 years (1999-2010) at Bopaththalawa National Livestock Development Board farm. The least square means of total milk yield per lactation (TMY), lactation length (LL), calving interval (CI) and birth weight (BW) were 2704Kg, 342days, 15months and 33Kg, respectively. Age at first calving (AFC), birth weight (BW), lactation length (LL), dry period (DP), calving to service period (CSP) and season of calving (SOC) had significant effect on TMY. The cows calved during the wet season showed significantly higher total milk yield compared to those calved during the hot and humid season. The effect of lactation number (LN), DP, CSP and SOC on LL was significant while none of the factors influenced CI. Sex of the calf and lactation number showed significant effect on birth weight. The average AFC, gestation length (GL), DP and CSP were 41±6 months, 280±5 days, 78±28 days and 101±53 days, respectively. The study reveals that the values for TMY, BW and number of services per conception fall within the average values observed in other tropical countries, though higher values for TMY and BW and lower values for number of services per conception are also reported in the literature. For the traits LL, CI, CSP and AFC the values recorded were higher than the optimal values expected for these traits to maintain high reproductive efficiency. It could be concluded that the factors influencing each and every trait identified in the current study could be used to improve the above traits.

Key words: Holstein-Friesian Cows · Total Milk Yield · Production · Reproduction · Performance

INTRODUCTION

Recent decades have seen a rapid increase in the demand for milk throughout the world, particularly in developing countries and the demand has been met by increased production [1].

The annual per capita consumption of milk in the developed countries (200Kg or more) is much higher than in developing countries (average 40kg) [1]. In Sri Lanka, the milk production is low and it is even below that in most developing countries. Sri Lanka is largely self-sufficient in most animal products apart from dairy. The consumption of dairy products increased dramatically since the country adopted open economic policies in the mid 1970s. Sri Lanka is currently about 15-20% self-sufficient in milk; rest has been mostly met by the use of imported milk powder. At the same time the government has an ambitious target for improvement in the dairy production to increase towards 50% self sufficiency in milk products by 2015. At the current rate of increase in milk production of 1-2% annum, the sector will need to grow at about 15% annually for the next 8 years assuming no increase in total consumption. This is an uphill task given the current state of the industry [2]. The government from the time of independence has recognized the importance of the dairy sector in the country and has taken various policy measures for its development [1]. Exotic dairy breeds have been introduced from time to time in Sri Lanka, a herd of Holstein Friesian cattle are maintained at Bopaththalawa farm. At present Bopaththalawa farm is the major nucleus herd of Holstein Friesian in Sri Lanka. Performance of these animals is affected by many genetic and non genetic factors.

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Production can be increased by increasing the number of animals or improving production per animal through better environment and management practices. Increasing the number of animals is not a desirable proposition as the land resources of the country are very limited and cannot afford allocating more land under fodder production. More effective approach to increase production can be improving environmental condition and management practices coupled with improving genetic potential of dairy animals [3].

Besides their genotype, the performance of dairy animals is also affected by many environmental factors. These environmental factors may suppress the animal's true genetic ability and create a bias in the selection of animals [4]. The periodical evaluation of factors affecting productivity of animals is very important for future planning and management. The purpose of the present study was to determine the reproductive and productive performance of Holstein Friesian cattle and the factors affecting these traits under intensive dairy production system at Bopaththalawa National Livestock Development Board farm in the hill country of Sri Lanka.

MATERIALS AND METHODS

Study Area: Bopathalawa National Livestock Development Board farm is situated in Nuwara Eliya district, Central Province, Sri Lanka at an altitude of 1676m.

The annual rainfall ranged from 2500mm to 3800mm and over 200 to 250 rainy days per annum was experienced by the farm. The monthly mean temperature is between 18°C to 28°C and the minimum temperature varies from 8° – 15°C. Night frost is common in February and March. Humidity ranged between 75% to 85% and from May till September severe storm and misty weather can be expected.

The soil type of the farm was red yellow latosol with low humid clay. The pH of the soil ranged from 3.5 to 5.5.

Herd Management: Various type of pasture and grasses such as Guinea A, Guinea B, Torpedo grass, Paspalam, Kikuyu grass, NP-21, Pusa giant napier (PGN), Alfalfa grass, *Bracheria milliformis*, Clover, CO_3 grass, Rye grass, Bana, Tropical Kudzu, Nandi, Italian rye, guinea and molasses grass are cultivated. Green fodder was chaffed and offered to the animals.

Animals were maintained under intensive and semi intensive systems. High yielding cows were maintained under intensive system where animals were liberally stall fed with green fodders and roughages, concentrates also fed to the animals according to the need. Low yielding and dry cows were maintained under semi intensive system throughout the year, where animals were allowed for grazing in the field, in addition concentrates also was given.

Heifers and dry cows were mainly kept on green fodder and other roughages throughout the year. At the later stage of pregnancy cut and carry system was adopted in addition concentrates given to the pregnant animals. Three weeks before calving there is a special feeding practice called steam up. Where the pregnant animals were fed with high plane of nutrition specially concentrates and minerals. During hot months showering was provided at noon with hose pipes. Calves were weaned after about 10 week of age.

Breeding: Breeding was carried out through artificial insemination however two sweeper bulls were used to cover the failures of artificial insemination and data belonged to both methods were included for analysis.

Data Collection: The data was collected over a period of eleven years (1999-2010) from the history sheets maintained at the farm. The overall data comprised of 635 records of 171 animals. Data on cow identity, bull identity, service date, calving date, lactation number, date of dry off, calf identity, birth weight of calf, sex of calf, lactation length, total milk yield and monthly milk yield were obtained from the history sheets. The variables considered were milk yield, lactation length, birth weight of calves, calving interval, age at first calving, dry period, calving to service period and services per conception. Effects of various genetic and non genetic factors on different dependent variables were studied.

The season of calving and season of dry off period were divided into two groups viz. season 1 (December to February) and season 2 (March to November). The data on age at first calving were split into six classes as follows: class1 (27-31 months), class 2 (32-36 months), class 3 (37- 41 months), class 4 (42-46 months), class 5 (47 – 51 months) and class 6 (above 51months) and dry period was grouped into four classes as follows: class 1 (30-60 days) class 2 (61-90 days), class 3 (91-120 days) and class 4 (above 120 days). The calving to service period was classified into seven classes. Class one comprised of cows having service period up to 60 days and subsequent classes were formed with an interval of 30 days while seventh class comprised of cows having service period more than 210 days. The calving interval was divided into 3 classes as follows: class 1 (<12 months), class 2 (12-13 months) and class 3 (>13 months).

Lactation length was classified into 7 classes. Class one comprised of cows having lactation length between 90 –150 days and subsequent classes were formed with an interval of 50 days while the seventh class comprised of cows having lactation length more than 401 days. Birth weight was divided into 4 classes viz. class one comprised of cows having birth weight between 25-30 Kg the rest of the classes were formed with an interval of 5Kg while the 4th class comprised of cows having birth weight more than 40Kg. Lactation numbers were grouped into 1 to 5 and 6th group consisted lactation number 6 and above. Period was divided into three groups; 1990 -1999 (Group1), 2000 - 2005 (Group 2) and 2006 - 2010 (Group 3).

Statistical Analysis: Data were analyzed using Statistical Analysis System (SAS Version 8). Initially simple descriptive statistics and frequency distributions were used to explore the variability of the different variables involved in the evaluation of the factors influencing productive and reproductive performance. In the next step, General Linear Models were employed to study different dependent variables.

RESULTS

Productive Performance: Descriptive statistics of different productive and reproductive traits of Holstein Friesian cattle are summarized in Table 1.

Milk Yield: The LS mean for milk yield was 2704 Kg per lactation. Significant effect of age at first calving ($P<0.05$), birth weight ($P<0.05$), lactation length ($P<0.01$), season of calving ($P<0.01$), dry period ($P<0.05$) and calving to service period ($P<0.05$) was observed on milk yield.

The effects of different factors on milk yield are given in Table 2.

Lactation Length: The least square mean for lactation length was 342 days. The lactation number ($P<0.05$), calving to service period ($P<0.01$), dry period ($P<0.05$) and season of calving had significant effect on lactation length.

As per the lactation number the longest (389±25) and the shortest (325±27) lactation lengths were obtained for first and second lactation, respectively but the differences between second to sixth lactations were not significant (Table 3).

There was an increase in lactation length from 1st to 3rd class of dry period and for the 4th class there was a significant reduction in the lactation length (Table 3).

Lactation length increased with increasing calving to service period. The longest and the shortest lactation lengths were 402±34 and 273±21 days, respectively (Table 3).

Significantly longer lactation length was observed for season 2 than for season 1.

Birth Weight: Least square mean of birth weight was 33Kg. Birth weight was significantly influenced by lactation number and sex of calf ($P<0.05$).

There was an increasing trend in birth weight with increasing lactation number. But the differences between first and second lactation were not significant whereas the differences among lactation number 3rd to 6th lactation also was not significant (Table 4).

Male calves weighed heavier than female calves (Table 4).

Calving Interval: In the present study the mean calving interval was 15 ± 5 months (457.5±152.5 days) (Table 1).

Reproductive Performance: The average age at first calving was 41±6 months (1250.5± 183 days) (Table 1). The mean for dry period was 78±28 days (Table 1). The mean for calving to service period was 101±53 days (Table 1). The overall mean services per conception were estimated to be 1.8±1.3 (Table 1).

DISCUSSION

Descriptive Statistics: Higher coefficients of variation for descriptive statistics of productive and reproductive traits suggest that there is potential for improvement of these traits through selection. High coefficient of variation may an indication of absence or adequate culling for poor performance. Rigorous culling program will increase the herd's performance as a whole.

Milk Yield: Milk yield observed in this study was (2704kg per lactation) lower than the value 5519 L reported by Kollalpitiya *et al.* [5] in Sri Lanka, the lower value in the present study may be due to the fact all animals were included for the estimation but Kollalpitiya *et al.* [5] used only 50 animals. In other parts of the tropics almost similar value was reported by Satter *et al*. [6] (2772.76±65.00 litres) for Holstein Friesian cows in India. Higher values of overall mean of 5905Kg and 3710 kg were reported by Ajili *et al*. [7] in Tunisian and Tadesse *et al*. [8] in Ethiopia, respectively.

Table 1: Descriptive statistics of different traits of Holstein Friesian cattle at Bopathalawa farm

Variable	N	Mean	SD	CV%
Age at first calving (mon)	171	41	6	15%
Calving interval (mon)	426	15	5	31%
Gestation length (d)	532	280	5	1.9%
Lactation number	625	3.1	2.2	71%
Birth weight (Kg)	564	32	3	10%
Lactation number (d)	523	336	129	36%
Dry period (d)	617	78	28	35%
Calving to service period (d)	542	101	53	52%
Services per conception	616	1.8	1.3	71%
Total milk yield (Kg)	581	2683	1165	43%

N – number of observations, SD – standard deviation, CV – coefficient of variation,

Table 2: Effect of different traits on mean milk yield

Sub class	No of observations	LS means for milk yield	Standard error	Sub class	No of observation	LS means for milk yield	Standard error
Age at first calving				Calving to service period			
1	14	1701a	391	1	69	1736a	294
2	39	2104a	330	2	85	1889a	300
3	101	2187a	293	3	32	2019a	319
4	41	2558b	315	4	26	2586b	330
5	28	2380ac	317	5	9	1944a	429
6	14	1590a	377	6	7	1930a	482
Birth weight				7	9	2502ab	420
1	9	1352a	424	Dry period			
2	33	2242bc	315	1	62	2226ac	293
3	165	2487c	292	2	125	1841b	293
4	30	2265dac	361	3	32	1914abc	324
Lactation length				4	18	2366c	344
1	10	1199a	432	Season of calving			
2	18	1241a	352	1	41	1863a	305
3	31	1892ae	327	2	196	2310b	281
4	51	2375b	311				
5	50	2419b	300				
6	31	2621bc	312				
7	46	2858bd	305				

Means with same letters within a column do not differ significantly

Table 3: Effect of different traits on lactation length

Sub class	No of observations	LS means for milk yield	Standard error	Sub class	No of observation	LS means for milk yield	Standard error
Lactation number				Calving to service period			
1	79	389^{a}	25	1	64	273^{a}	21
2	62	325^{b}	27	2	78	274^{a}	21
3	45	330^{b}	28	3	40	303^{ab}	26
4	20	341^{ab}	36	4	30	338^{bc}	27
5	20	329^{b}	33	5	14	396^{c}	36
6	33	348^{ab}	30	6	18	402^{c}	34
Dry period				7	14	400^{c}	33
1	69	327^{a}	26	Season of calving			
2	140	372^{b}	24	1	52	325^{a}	28
3	37	375^{b}	29	2	207	361	23
4	13	299^{a}	38				

Means with same letters within a column do not differ significantly

Table 4: Effect of different traits on birth weight

Lactation number	Observations	Birth weight	Error
1	26	32.81[a]	0.623
2	83	32.33[a]	0.446
3	61	33.07[b]	0.484
4	40	33.51[b]	0.577
5	33	32.67[ab]	0.593
6	49	33.68[b]	0.549
Sex of calf			
1	151	33.19[a]	0.408
2	141	32.50	0.427

Means with same letters within a column do not differ significantly

Significant effect of age at first calving on milk yield was in agreement with the findings of Izaike *et al*. [9] who indicated that there is a positive correlation between milk production and age of the cows at first calving. Hatungumukama *et al*. [10] in Burundi also reported an increase in milk production with the increasing age at calving in parity 1. An early age at first calving in cows will ensure the quick net return of the capital. A reduced age at first calving will increase the number of calves born for a given number of animals. It also will increase the annual genetic gain due to shortened generation interval.

The significant effect of birth weight on milk yield was in agreement with the results reported by Dunklee *et al*. [11] who said that well- bred and well-managed cows will produce healthy and vigorous neonates with normal birth weight. Higher birth weight has been listed as a good indicator for higher growth rate and thus augmented daily body weight will ensure an early replacements. So the cows produce healthier calves with higher body weight will produce higher milk yield.

Lactation length showed significant effect on milk yield. Lactation length classes were also significant source of variation ($P<0.05$) for milk yield among imported Holstein Friesian cows [4]. Whereas Conceicao *et al*. [12] found that lactation length was not a significant source of variation in milk yield in Holstein Friesian cows. Maximum milk yield was observed in cows with lactation length of >400 days , similar finding was reported by Lateef *et al*. [4]. Lactation length should not exceed the standard length of 305 for cattle breeds because it will increase the calving interval and decrease the number of calves that could be obtained during the life span of a cow.

Significant influence of season of calving on milk yield was in agreement with the findings of Lateef *et al*. [4] in Pakistan. In contrary to the above report non significant effect of season of calving was reported by Tadesse *et al*. [13] in Ethiopia.

In the present study calvers belong to season 2, outperformed season 1 calvers , probably on account of highest rainfall and ample quality green fodder availability during season two. The lower value recorded in season 1 was probably due to low quality and quantity of pasture and fodder availability. Probably the seasonal variation in milk yield could be minimized if proper measures were taken to conserve pasture and fodder when they are in surplus.

Dry period significantly influenced milk yield . In the present study among the first three classes the highest milk yield was obtained for the class one (30-60 days). Annen [14] reported that a dry period, typically 40 to 60 days, between lactations is believed to be required to maximize milk yield in the subsequent lactation. Maryam *et al*. [15] in Iran reported a significant influence of level of milk production on dry period where higher level of milk production was observed for lower value of dry period (68±31 days).

In our study, there was an increase in milk yield from first to third class of the calving to service period but the differences in milk yield was not significant. Maximum milk yield was observed in calving to service period between 121-150 days. Lateef *et al*. [4] also reported significant influence of calving to service period on milk yield where the maximum milk yield was observed for the service period class 180-210 for imported Holstein Friesian in Punjap, Pakistan.

Lactation Length: The least square mean of lactation length (342 days) was almost similar to the value (344 days) reported by Juneja *et al*. [16] for Friesian cows in India. A lower value of 291.86 ± 6.55 days for Friesian cows in Pakistan was reported by Sattar *et al*. [6]. The lactation length in the present study exceeded the optimum value of 305 days required to maintain the optimum calving interval of 12-13 months. The longer least square mean value for lactation length observed in the study reflects that the cows were not allowed to dry off at the proper time and continued to milk for extended period. The shorter lactation length may be due to factors such as improper feeding regimes, inadequate dry period and prevalence of diseases.

The analysis revealed a significant influence of lactation number on lactation length which is similar to the findings of Sattar *et al*. [6] in Pakistan for Friesian cows.

Birth Weight: The least square mean birth weight (33Kg) is little lower than the values 35kg reported by Ibrahim and Zemmelink [17] and 35±3kg reported by Kollalpitiya *et al.* [5], in Sri Lanka and 39.1 kg reported by Shin *et al*. [18] in Korea. A lower value than the present study (25.8kg) is reported by Frietas *et al*. [19] in Venezuela.

Calving Interval: The mean caving interval 457.5±152.5 days is similar to the value (460±99 days) reported by Herath *et al*., [20] in Sri Lanka. A lower value (423±99 days) than the current study is reported by Kollalpitiya *et al.* [5] in the up country of Sri Lanka, however the result is not much reliable as the number of records were only 50. A lower value of 403±86 days also was reported by Maryam *et al*. [15] in Iran for Holstein dairy cows. A higher value of 561.3±18.9 was reported by Amene *et al*. [21] in Ethiopia whereas De Silva and Sathasivampillai [22] reported a calving interval of 16 - 17 months for cows in the upcountry. The calving interval in the present study is above the standard interval of 365 days expected in a well managed farm. This longer calving interval is mainly attributed to the result of longer calving to first service period and days open obtained which could be related to environmental factors, over milking, fertility problem, heat stress, drought and under feeding. Cows with higher calving interval should be identified and measures should be taken to breed animals on time so that their productivity could be increased. Cows that found as repeat breeders and do not respond to treatment should be culled.

Age at First Calving: The average age at first calving (1250.5± 183 days) is lower than the values (1291 days, 43±7.3 months and 1265±24.3 days) reported by Chandrasiri *et al* [23], Weerasinghe *et al*. [24], in Sri Lanka and Amene *et al*. [21] in Ethiopia, respectively and higher than the value (998±145) reported by Kollalpitiya *et al*. [5] in Sri Lanka. In the present study the maximum age at first calving was 58 months and minimum was 27 months. The mean age at first calving (41±6 months) obtained in this study is higher than 29.28±4.01 and 39.2±7.5 months reported for Tunisian Friesian-Holstein cows and Ethiopian Holstein Friesian cows by Ajili *et al*. [7] and Tadesse *et al*. [13], respectively. The higher value may be attributed to factors such as poor nutrition and management practices including poor heat detection at the time of mating the heifers. With good nutrition it is expected that heifers would exhibit fast growth and attain higher weights at relatively younger ages [8]. Under Sri Lankan condition there was a gradual reduction in the age at first calving from the literatures cited from 2007 to 2012. It indicates an improvement in management practices in Sri Lanka.

Dry Period: The mean dry period (78±28 days) is higher than the value of 69 days reported by Maryam *et al*. [15] in Iran. The literature review also showed that the dry period of 43 to 65 days would be near optimal. The cows remaining dry for less than 43 days yielded markedly less milk in the next lactation, whereas dry period longer than 65 days was only moderately detrimental to subsequent lactation yield. The higher value obtained in the study may be due to the deficiencies in confirmation of pregnancy of the cows and not adopting proper milking and dry off schedule. Hence, dry cow management should be improved to shorten the dry period.

Calving to Service Period: The mean calving to service period of 101±53 days is higher than the values of 90.22±55.21 days and 67±38 days for Holstein Friesian cows in Tunisian and Iran reported by Ajili *et al*. [7] and Maryam *et al*. [15], respectively. Kollalpitiya *et al*. [5] reported a calving to first service interval of 84± 23 days for Friesian cattle in the up country of Sri Lanka. The lower values reported here may be due to the fact that here the interval between calving to first service is considered. However, the result obtained from the present study was higher than the optimum value of 45-60 days. So proper post partum cow management system should be adopted to narrow down the present calving to service period to shorten the calving interval. Therefore the ultimate production potential of the cows could be increased.

Service per Conception: The mean service per conception 1.8±1.3 is in agreement with services per conception (1.81±1) reported by Tadsee *et al*. [13] for Friesian cattle in Ethiopia. The overall mean services per conception obtained in this study was lower than services per conception of 2.0 reported in Holstein Friesian dairy cattle in Nigeria by Ngodigha *et al*. [25] and 2.5 for Holstein Friesian in Iran [15]. Successful service or insemination depends on many factors such as quality of semen, skill of the inseminator, proper time of insemination and cows related factors. Management, nutrition and climatic conditions may also affect the success of insemination [8]. The findings of the present study on services per conception suggested comparatively better insemination services at the herds during the period of the study.

CONCLUSION

The values for the traits of the total milk yield, birth weight and number of services per conception fall within the average values observed in other tropical countries. However, there is room for improvement of these traits as higher values are also reported in the literature. For the traits such as lactation length, calving interval, calving to service period and age at first calving the values recorded

in the hill country were higher than the optimum values expected for these trait to maintain proper calving interval, to get maximum number of calves and maximum milk yield for the lifetime of the cows. The study reveals that reproductive and productive traits of Friesian are controlled by genetic and non genetic factors. Paying attention to the factors influencing important traits will pave way for increased production.

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