Effects of original source of dairy cows, season and age on milk production in Botswana

G S Mpapho*, L. Dambe and S. J. Nsoso
Department of Animal Science and Production, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana. *Corresponding author: Email: gmpapho@bca.bw

ABSTRACT

The objective of the study was to determine the effects of animal and environmental factors on milk yield of Holstein dairy cows kept under intensive system in Botswana. A total of 768 monthly records of 27 Holstein cows of different parities were recorded over 5 years (2004-2008) at Botswana College of Agriculture (BCA) dairy farm were used. The data was analyzed using General Linear Model of Statistical Analysis System. Higher ($p<0.05$) higher milk yield was recorded in spring (14.42±0.36 kg/d) than in winter (11.27±0.35 kg/d) with other seasons being intermediate. Third parity cows produced more milk (14.65±1.03 kg/d) than first calvers (11.60±0.66 kg/d). Although not significantly ($p>0.05$) different, the third parity corresponded with greater lactation yield than the others. Lactation length for third parity was 369.91±57.20days. Milk yield was significantly higher at 4 years of age (16.02±0.51 kg/d) than at 9 years (10.96±0.79 kg/d) and 10 years of age (5.85±1.15 kg/d). Although the amount of milk produced by cows that were sourced from South African farms (15.26±1.52 kg/d) was higher than those sourced from Botswana College of Agriculture (11.89±1.16 kg/d) and Animal Production Research Unit (11.19±1.20 kg/d), these did not differ significantly. Farms should have more cows lactating in spring and at parities and ages that maximize milk yield.
Keywords: Age, Botswana, dairy cows, milk yield, season

INTRODUCTION

With the increase in human population in Botswana, there is a need to increase milk production to meet the demand for the product. However, there are several factors that may affect milk production in dairy animals in the tropics. These include environmental, management and animal factors. Animal factors such as breed, age, parity and lactation length and environmental factor season have been reported as predominant factors in previous studies on milk production (Johnson *et al.*, 2002; Tekerli *et al.*, 2000). According to Ray *et al.*, (1992), the effect of season in milk yield is dependent upon climatic conditions and cows calving in late autumn to spring produce more milk than cows calving in summer. With regard to age, milk production maintains a plateau for several years after the fifth lactation, and then proceeds to decline beyond 12 years of age (Harding, 1999). Mammary glands increase in size from the first to the fifth lactation, because milk production depends on the udder size and hormonal stimuli, and it is probable that the production pattern in recurring lactations is a reflection of these two phenomena (Harding, 1999). A portion of the increase in milk production is due to skeleton maturation and an increase in body weight, which can accommodate a larger udder (Vite-Cristóbal *et al.*, 2007) and in general milk production increases 30% from the first to the fifth lactation, but the percentage increase in milk yield progressively decreases with age. Zeleke (2007) reported that the production of lower amount of milk during the first parity is logical in that the animals in the first parity is consistent with the fact that animals are still growing and the nutrients are partitioned for body building purposes and milk production. The original source of the animal also affects milk production as it depicts tolerance to environmental conditions, breed strains and heifer management of the sourcing farm.

The objective of the study was to determine the effects of original source of the dairy cows, season, parity, age and lactation length on milk yield in Botswana.

MATERIALS AND METHODS

The study was carried out at Botswana College of Agriculture (BCA) dairy farm at Notwane. The farm kept Holstein breed of dairy cows during the study period. The dairy farm practiced intensive production system. The data consisted of a total of 768 monthly milk records from 27 Holstein lactating cows collected from 2004 to 2008 at BCA dairy farm in Gaborone Region, Botswana. Cows were the progeny of BCA farm, Animal Production Research Unit (APRU) and Republic of South Africa (RSA) farms. Data included calving dates, lactation number, lactation length, and the quantity of milk produced. The weather in daily temperatures in this region range from 19° to 36°C, relative humidity ranged from 48 to 94% and rainfall was approximately 1,232 mm per year. Seasons were summer (November, December and January), autumn (February, March and April), winter (May, June and July) and spring (August, September and October).

The lactating cows at the BCA dairy farm were housed in pens where they were divided into two groups: high yielding and low yielding cows and fed accordingly for the 2004 – 2008 period. The lactating cows had free access to feed on daily basis where they were fed with lucerne *ad libitum* and dairy meal mixed in the farm at 10 kg/day/cow. Water was also provided *ad libitum*. The BCA dairy farm adhered to the management plan of the farm for prevention and control of animal diseases. Routine activities carried out at the dairy farm included tick control, de-worming and disease vaccinations for pregnant cows. The farm used artificial insemination for breeding and semen from different dairy bulls used was bought from Ramatlabama Bull stud. All lactating cows were machine milked twice daily (0600 and 1500h) and milk yields were recorded at each milking session.

The data on month, age, parity, season, lactation length and their interactions from 2004 to 2008 was analyzed using General Linear Model of Statistical Analysis System (SAS) (SAS, 2002-2003). The results reported are least squares means and their standard errors separated using t-test.

RESULTS AND DISCUSSIONS

The month of June resulted in the lowest milk yield as compared to other months. However, the month of September had a numerically higher milk yields (Table 1). In Botswana, June is a dry season while September signifies beginning of the rainy season. The seasonal pattern of rainfall results in large fluctuations in availability and quality of pasture over the year (Javed *et al.*, 2000). The lower milk yield obtained in June and July implies the need for improved quality of feeds during this season of the year.

Table 1: Least square means for the effect of month on average milk yield (kg) for Botswana College of Agriculture dairy herd over the years 2004 – 2008.

Months	Number of records	Average milk yield (kg/day)
January	68	13.25±0.66^{a}
February	64	13.37±0.72^{a}
March	71	12.68±0.67^{a}
April	48	12.15±0.60^{a}
May	56	11.86±0.60^{a}
June	69	10.70±0.61^{b}
July	67	11.25±0.60^{ab}
August	55	14.12±0.62^{a}
September	69	14.96±0.62^{a}
October	71	14.20±0.61^{a}
November	67	14.04±0.59^{a}
December	63	13.02±0.59^{a}

Column means with common superscripts do not differ ($p>0.05$).

The mean milk yield per day was significantly ($p<0.05$) greater in spring and summer season than in winter and autumn seasons (Table 2). The differences in milk yields for different seasons may be due to the quality of the feed in summer and spring ingredients used for feeding dairy animals at dairy farm. However, West (2003) reported that the climatic conditions in the tropics are such that the warm or hot season is relatively long and there is intense radiant energy for an extended period of time. Chamberlain (1989) reported that milk production is most severely affected by seasonal feed changes than any other forms of livestock production because unlike weight gain, milk cannot recover after periods of feed shortage. This was also supported by Garnsworthy and Topps (1982) who mentioned that the main reason for milk production being more severely affected by season than other forms of ruminant production is related to the energy requirements of the dairy cow. Daily milk yield was significantly higher during wet months of spring and summer as compared to dry months of autumn and winter, which conforms to previous findings of Bekele *et al.*, (2002).

Table 2: Least square means for the effect of season on average milk yield (kg) for Botswana College of Agriculture dairy herd over the years 2004 – 2008.

Season	Number of records	Average milk yield (kg/d)
Summer	198	13.45 ± 0.35^{ac}
Autumn	171	12.66 ± 0.38^{ab}
Winter	205	11.27 ± 0.35^{b}
Spring	194	14.42 ± 0.36^{c}

Column means with common superscripts do not differ ($p>0.05$).

Although the average milk yield did not statistically differ by parity ($p>0.05$), lactation yield was slightly higher in third lactation than 1st, 2nd and 4th lactation. Vite-Cristóbal *et al.*, (2007) found the highest milk yield in Holstein and Brown Swiss at third lactation, which was superior by 36% and 74% to the second and the first, respectively. These findings were similar to other studies, which explained highest milk production capacity coupled with greater feed intake in older cows than young ones (Johnson *et al.*, 2002; Epaphras *et al.*, 2004; Bee *et al.*, 2006). Cows in 4th and more lactations were no longer better producers compared to those in their 3rd lactation. In Table 3, lactation length decreased from first to 4th parity. In a study by Vite-Cristóbal *et al.* (2007), lactation number influenced lactation length and lactation length was 30 and 50% superior for the cows of third lactation compared to the second and first respectively.

Table 3: Least square means for the effect of parity, lactation yield and lactation length on average milk yield (kg) for BCA dairy herd over the years 2004 – 2008.

Parity	No. of records	Lactation yield (kg)	Milk yield (kg/d)	Lactation length
1	334	4335.02 ± 464.15^{a}	11.60 ± 0.66^{a}	376.19±36
2	234	4074.30 ± 503.28^{a}	12.70 ± 0.71^{a}	355.78±39
3	134	5365.71 ± 727.75^{a}	14.65 ± 1.03^{a}	369.91±57
4	66	4740.13 ± 985.38^{a}	13.12 ± 1.39^{a}	338.83±77

Column means with common superscripts do not differ ($p>0.05$).

Old age (9 – 10) significantly produced lowest milk yield as compared to other ages (2 – 8) (Table 4). This corresponds with Table 3 where third parity had the highest milk yield. The older age produce less milk through turnover rate of secretory cells, with higher numbers dying compared to the newly produced active secretory cells (Vite-Cristóbal *et al.*, 2007). Fat tissue cells usually replace dead secretory cells. This could also be due to the fact that as animals grow old they secrete less milk as indicated in Table 4 where younger animals of ages 2-5 years produced more milk as compared to older cows of ages 9 -10 years. The results of this study are similar with the findings of Kunaka and Makuza (2005) who stated that the amount of milk produced by the cow increases with advancing age then declines. The difference in the volume of milk is explained by the growth and major body development leading to increase in body weight, jointly with the size of the larger gastrointestinal tract, bowel and larger mammary gland in older cows for the secretion of milk in comparison to younger cows (Tucker, 1982). In Holsteins, the body growth starts in fetal life and continues after the fourth calving. Later, animals use more nutrients for maintenance and other vital organs than for growth (Kunaka and Makuza, 2005). According to Tucker (1982), as the animals reach the physiological maturity, most of the vital organs keep growing in size until they reach an equivalent maturity threshold and thereby depriving the animal of partition of nutrients towards milk yield.

Table 4: Least square means for the effect of age on average milk yield (kg) for Botswana College of Agriculture dairy herd over the years 2004 – 2008.

Age	No. of records	Average milk yield (kg/day)
2	150	15.24±0.56^a
3	175	14.78±0.51^a
4	147	16.02±0.51^a
5	87	15.23±0.55^a
6	78	13.40±0.55^a
7	42	13.83±0.72^a
8	32	12.55±0.82^a
9	39	10.96±0.79^b
10	18	5.85±1.15^c

Column means with common superscripts do not differ (p>0.05).

Year was found to have an effect on milk yield as the highest milk yield was recorded in 2004 than the other years (Table 5). The effect of the year might have been caused by the environmental variables from one year to another as similar to the findings of Osorio-Arce and Segura-Correa, (2002). In their report, they also found that the dry matter availability and quality of forages vary from one year to another due to the effect of environmental temperatures, light supply, availability of water and management practices. In this study, even though records of climatic conditions in the area were not studied, environmental variations could have influenced milk yields. The aging of cows and parity number from 2004 to 2008 also reduced milk yields.

Table 5: Least square means for the effect of age on average milk yield (kg) for Botswana College of Agriculture dairy herd over the years 2004 – 2008

Year	No. of records	Average Milk yield (kg/d)
2004	145	15.39±0.53^a
2005	142	12.74±0.47^b
2006	147	11.92±0.43^b
2007	164	12.74±0.42^b
2008	170	12.70±0.40^b

Column means with common superscripts do not differ (p>0.05).

The origin of an animal did not influence subsequent milk yield of a cow. Milk yields did not differ by farm except in the month of October where it was greater for cows originating from RSA as compared to those from APRU and BCA (Table 6). Seasonally, spring and summer yields for cows from RSA were greater than BCA and APRU farms (Table 7). Body weight at calving and post pubertal growth rate management is important in first lactation milk production. According to MacDonald *et al.* (2005), milk yield increased by 7% in first lactating heifers that were offered a high level of feed. Despite the fact that age at first calving and nutritional status of dairy cows prior to arriving at BCA was not recorded for all the three groups, there is a possibility that it could have influenced the differences observed in Table 6 and 7.

Table 6: Least square means for the effect of month on average milk yield (kg) from cows originating from BCA, APRU and RSA over the period 2004-2008

	ORIGIN		
Months	BCA	APRU	RSA
January	11.42±1.05[a]	13.45±1.30[a]	13.62±0.97[a]
February	11.64±1.19[a]	15.12±1.34[a]	13.05±1.09[a]
March	11.18±1.25[a]	13.03±1.26[a]	13.00±0.97[a]
April	11.42±1.05[a]	11.92±1.26[a]	12.53±0.84[a]
May	12.38±1.02[a]	11.10±1.22[a]	12.02±0.85[a]
June	10.40±0.93[a]	10.45±1.26[a]	11.00±0.91[a]
July	11.49±0.93[a]	9.22±1.26[a]	12.13±0.88[a]
August	13.58±0.96[ab]	10.75±1.39[a]	15.82±0.89[b]
September	14.04±0.90[a]	13.33±1.50[a]	16.50±0.91[a]
October	12.42±0.82[a]	11.26±1.56[a]	16.42±0.89[b]
November	12.16±0.84[a]	14.40±1.39[a]	15.09±0.87[a]
December	11.22±0.84[a]	12.55±1.39[a]	14.33±0.87[a]

Row means with common superscripts do not differ ($p>0.05$).

CONCLUSIONS

There was a trend of producing higher milk yield for dairy cows originating from South Africa relative to month and season which might be an indicator of better heifer growth rate and body weight at first calving. The average monthly milk production for each cow was lowest in June indicating poor nutritional status of animals. Cows that were 9-10 years old produces lower milk yield. It is therefore recommended that the BCA farm should cull all animals that are old in order to maximize production.

Table 7: Least square means for the effect of season on average milk yield (kg) from cows originating from BCA, APRU and RSA over the period 2004-2008

	ORIGIN		
Season	BCA	APRU	RSA
Autumn	11.42±0.66[a]	13.28±0.74[a]	12.18±0.55[a]
Spring	13.28±0.51[a]	11.41±0.85[a]	16.24±0.51[b]
Summer	11.78±0.52[a]	13.47±0.78[ab]	14.40±0.51[b]
Winter	11.37±0.55[a]	10.27±0.71[a]	11.74±0.50[a]

Row means with common superscripts do not differ ($p>0.05$).

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