RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES
PRINT ISSN 2221-1896, ONLINE ISSN 2223-0343
www.roavs.com

Genetic and non-genetic factors affecting production potential of Butana dairy cows at Atbara Research Station, Sudan

T. M. Badri[1], M. Atta[2], Mohamed T. Ibrahim[3] and K. A. Gubartalla[4]

[1]College of Animal Production, Upper Nile University; [2]Administration of Animal Resources, Ministry of Environment, State of Qatar; [3]College of Animal Production Science and Technology, Sudan University of Science and Technology; [4]Atbara Research Station, Animal Resources Researches Corporation

Abstract

Effects of year and season of calving and cows' parity order on milk yield, lactation period, persistency and longevity were studied using 1338 records of 222 Butana dairy cows. Estimates of heritability and repeatability of these traits were also studied. Data were classified according to years of calving into 1949 –1959, 1960-1969, 1970-1979, 1980-1989 and 1990–1999 groups. Further data classification was done according to season of calving into dry summer (March–June), wet summer (July-October) and winter (November-February) groups. Data were also classified according to cow's parity order into ten parity groups. General linear model was conducted to examine the significance of the tested effects. Overall means of total milk yield, lactation period, persistency and longevity were 1709.50 ± 892.10 kg, 248.40 ± 91.30 days, 75.16 ± 48.58% and 6.56 ± 3.18 years, respectively. Milk yield was significantly affected by year of calving and parity order, persistency was not affected by any of the studied factors, while longevity was affected by year and season of calving. Heritability of these traits was low (ranged between 0.01 and 0.14) while repeatability ranged between 0.17 and 0.23. The study concluded that Butana breed are promising dairy cows and their production potential traits were mainly affected by the non genetic environmental factors such as managerial changes during years, seasonal variations and age of cows. However, the traits values were repeatable during the animal's life.

Key words: Butana Cows, Longevity, Lactation Period, Persistency, Milk Yield

Introduction

Cattle population in Sudan is 41.56 million heads (MARF, 2009). Among the indigenous breeds, Butana and Kenana are considered as the dairy cattle of the Sudan. The two breeds constitute about 24% of the total cattle population of the country (Abdel-Aziz et al., 2005). Butana breed inhabits the Butana plain which is a triangle covering parts of the northern, central and eastern regions of the Sudan. Butana cows are well adapted to the semi-arid environment of low rainfall and high temperature. Most of reports on dairy cattle production in Sudan involved crossing indigenous with temperate breeds. Little attention has been paid to the genetic material of indigenous breeds since they have been considered of low productivity.

Length of lactation period is one of the important traits that describe lactation performance potential. According to Bath et al. (1985), the accepted lactation period is 10 months in addition to 5 days of colostrums production. This length enables the standard dry period of 2 months within the standard calving interval of 12 months. Amount of milk produced during lactation is primarily determined by peak yield and persistency (Nebel and McGilliard, 1993). Persistency of milk production is the ability to maintain milk production at a high level after peak production (Tekerli et al., 2000). They also noted that persistency index can be measured by relating yield at any time after peak to the maximum output achieved by the cow. Pre-productive period of a farm animal is the costing phase of its lifespan. The productive period is generally called longevity (Essl, 1998) and its length is a highly desirable trait that affects the overall profitability (Allaire and Gibson, 1992). They added that increase of a herd's longevity increases its mean production, since the number of mature cows, which produce more milk than young cows, is increased. Silva et al. (1986) stated that long life of cows in a herd substantially decreases the replacement costs per lactation and enables a cow to achieve her maximum capacity of performance when attaining full maturity.

Assessment of relative effects of heredity and environment on the production traits of the animals is

greatly aided by estimates of heritability and genetic relationships. Non additive genetic factors (environmental factors) make a relatively larger contribution to phenotypic when the heritability is low (Cameron, 1997). The productive efficiency is a complex phenomenon controlled by both genetic and non-genetic factors, the non- genetic factors being climate, nutrition, and level of management.

The objective of this study is to examine heritability and effects of year and season of calving and cows' parity order on milk yield, lactation period, persistency and longevity of a Butana herd raised in Atbara research station.

Materials and Methods

Data used in this study was 1338 records of 222 Butana cows from Atbara Research Station herd. It covered the period from 1949 to 1999. The station is located in the River Nile State in the northern Sudan, at latitude 17º 42□ N and longitude 33º 58□ E and at altitude 345 meters above sea level. Animals were allowed to graze on *Sorghum bicolor* (Abu-70), *Cyamopsis tetragnoloba* (Guar), *Medicago sativa* (Berseem) and *Sorghum sudanensis* (Grawia) twice daily for four hours (2 hours in the morning and 2 hours in the evening). In addition to grazing system, milking cows were fed on concentrate mixture of 19% crushed sorghum grains, 20% cotton seed cakes, 60% wheat bran, 1% salt. This concentrate diet was offered daily at the rate of 4% of cow's live body weight. Animals were accommodated in groups according to their physiological status such as; weaned and growing calves, heifers, dry and pregnant cows, lactating cows and breeding bulls. Only natural mating was practiced. The cows were allowed to be served after two months post calving, while heifers were usually allowed at first estrus signs appearance. Breeding bulls were selected from progenies of the highest yielding dams in the herd. Animals were usually vaccinated against the major infectious livestock diseases in the Sudan particularly; Hemorrhagic septicemia, Anthrax and Contagious Bovine Pleura Pneumonia**.** Also monthly test for mastitis, theileriosis, and external parasites were done.

For the purpose of this study, data of monthly milk yield of the herd during the period between years 1949 – 1999 were used to calculate the total milk yield, lactation period, persistency index and longevity of each cow. Persistency (%) was calculated according to the following formula:

$$\text{Persistency}(\%) = \frac{\text{Total milk yield (kg)}}{\text{Monthly peak yield (kg/month)} \times \text{Lactation period (months)}} \times 100$$

Longevity (effective productive herd life) was estimated by dividing the days from the first calving to cow's disposal by 365 (Goshu, 2005).

To study effect of year, the data were classified into five period groups according to year of calving. The first period group extended from 1949 to 1959, the second period group covered the period between 1960 and 1969, the third period group extended from 1970 to 1979, while the fourth period extended from 1980 to 1989 and the last period extended from 1990 to 1999. For evaluation of effect of season of calving, the data were classified into three season groups; dry summer season (those calved during the months of March–June), wet summer season (the calvers of the months between July and October) and winter season group (the calvers during the months between November and February). The data were also classified according to cow's parity order into ten parity groups (from the first to the tenth lactations).

Statistical Analysis

General linear model was conducted using *SPSS* computer software (version, 10) to examine the significance of effects of these factors on the examined traits. Duncan's multiple range test was used to test the significance of differences between treatments' means. Heritability was estimated by paternal half-sib analysis as described by (Becker 1975). Repeatability was estimated by intra-cow correlation (components of variance analysis) from the first three records (1st, 2nd and 3rd lactations). Both estimates were done using Harvey (1990) software. The animal model used was:

$$Y_{ijkl} = \mu + YC_i + SC_j + PN_k + AN_l + e_{(ijkl)}$$

Where Y_{ijkl} is the observation for each trait; μ is the overall mean; YC_i is the effect of the ith Year of calving; SC_j is the effect of the jth season of calving; PN_k is the effect of the kth parity number; AN_l is the random effect of the lth animal and $e_{(ijkl)}$ is the residual variation.

Results and Discussion

Results shown in table 1 revealed that the studied milking traits had high coefficients of variation indicating high level of discrepancies among individuals. El Khidir (2009) noted that, for animal production studies, presence of high level of discrepancy of a trait among individuals of a population indicated the good chance of improving this trait by selection. Heritability of the studied traits ranged between low to very low (Table, 1). Heritability estimate of total milk was comparable to 0.032 that reported by Ageeb and Hiller (1991) and to 0.074 that reported by Ishag (2000). Medium heritability (0.29± 0.13) was estimated by El-Habeeb (1991). This variability in heritability estimates of this trait may be attributed to that stated by Falconer (1986). He noted

that heritability estimates for the same trait may not be constant and may show a wide range of variation. Lactation period heritability (Table, 1) did not differ from 0.003 ± 0.078 and 0.044 ± 0.02 reported by Eid (2001) and Musa et al. (2005), respectively. It was lower than the estimates 0.34± 0.25 reported by Ageeb and Hiller (1991). For heritability of persistency of yield, comparable value (0.066) was reported by Ishag (2000) for Friesian x Kenana crossbred cows. Present estimate was lower than the finding (0.40) reported by Wilcox et al. (1971) for Holstein x Friesian in United State of America. Longevity's heritability of the current study was in agreement with the range 0.12- 0.14 reported by Vukaŝinović et al. (1995). It was also higher than that reported by Van Doormaal et al. (1995) (a range of 0.01 to 0.06) for Canadian Holstein. The present low heritability of studied traits indicated the heavy burden of the environmental factors on them (Santoro et al., 2005). Repeatability of milk yield in the current study (Table, 1) was consistent with 0.38±0.063 that reported by El-Amin (1969) for indigenous Sudanese dairy cows. The present estimate was lower than 0.47 reported by Ageeb and Hiller (1991) and 0.581 ± 0.05 reported by Rao and Sundareson (1982) for Friesian cattle. Repeatability of lactation period (Table, 1) was in agreement with the finding of El-Amin (1969) (0.29 ± 0.32), but it was higher than that of Ishag (2000) (0.029 ± 0.063) and Ageeb and Hiller (1991) (0.08). Persistency of milk yield in the current study was found to have repeatability (Table, 1) comparable to that reported by Rao and Sundaresan (1982) for Friesian x Sahiwal crossbred cows (less than 0.2). However it was higher than the finding of Ishag (2000) for Friesian x Kenana crossbred cows (0.042 ± 0.063) and it was lower than 0.60, the finding of Wilcox et al. (1971). The present repeatability estimates indicated that the studied traits were slightly repeatable during the animal's life.

Overall mean of milk yield of this Butana herd was 1709.49 ± 892.09 kg (Table, 1). It was higher than that reported for Butana (1662.57 ± 108.96 of 37.22 % CV) (Musa et al., 2005) and Kenana (1423.58 ± 551.70) (El-Habeeb, 1991) cows in the Sudan. However, it was much lower than the findings of Abate et al. (2010) (2847 ± 632.88 kg) and Ishag (2000) (2417.20 ± 921.00 kg for crossbred Kenana x Friesian cows. The present milk yield was also lower than 5533.14± 1564.03 lb stated by Eid (2001) for pure Friesian in the Sudan. Milk yield in the present study (Table, 2) declined significantly with the advance of years of calving. Similarly, Tekerli et al. (2000) and Musa et al. (2005) stated that the significant effect of year on milking performance traits may be due to the diverse feeding and management conditions as well as annual climate changes. Season of calving did not affect total milk yield. Similar finding was noted by Abate et al. (2010). Total milk yield of the present study was observed to increase significantly with parity order increase (Table, 4) until it reached a maximum yield at the sixth parity. Similar result was reported by Musa et al. (2005) and El-Habeeb (1991). The effect of parity order on the total milk yield could be attributed to the effect of cow's age on the development and regeneration of the secretory tissue of the mammary gland.

The overall mean of lactation period in the present study was 248.40 ± 91.30 days (Table, 1). Comparable results were reported by Musa et al. (2005) for Butana cows (268.17 ± 5.56 days), Alim (1960) for Kenana cows (224.00 ± 82.00), Abate et al. (2010) (9.56 ± 1.018 months = 286.8 days) and Ishag (2000) (291.3 ± 67.2 days) for crossbred Kenana x Friesian cows. Lactation period of Butana dairy cows in the present study was not affected by year of calving (Table, 2), season of calving (Table, 3) and parity order (Table, 4). In the present study, the overall mean of persistency was 75.16 ± 48.58 % (Table, 1). Comparable result was noted by Abate et al. (2010) for crossed Kenana x Friesian cows (74.2 ± 12.9%) and by Ponižil (1989) for crossed Czech Pied x Holstein Friesian x Ayrshire cows (a range of 71.4 – 77.6%). The present study showed that there is no effect due to the non-genetic factors (i.e. year of calving, season of calving and parity number) on milk yield persistency of Butana dairy cows.

Longevity in the current study was 6.56 ± 3.18 years (Table, 1). Comparable result was reported by Trautman et al. (1990). They reported 8.5 years longevity for Simmental cows. The present results were higher than that reported by Gandhi and Gurnani (1990). They reported an average useful life of 1872.98 ± 36.64 days for Sahiwal cows in India. The present values of longevity indicated the long productive life of Butana cows in Atbara Research Station. Longevity in the current study was affected ($P<0.05$) by year and season of calving as illustrated in tables, 2 and 3. These results showed that the highest longevity value was obtained by the group of years (1949-1959), while the lowest longevity value was obtained by group of years (1970- 1979). For season of calving effect, the highest longevity was found for winter calvers (November-February) followed by wet summer calvers (July-October), while the lowest longevity was found for dry summer calvers (March-July).

The present study concluded that Butana cows prove to be promising dairy animals. The studied productive traits in this herd were less inheritable; however, they were repeatable during the life of the animal. The results also concluded that these traits were affected by the environmental factors such as managerial changes during years, seasonal variations and age of the cows.

Table 1: Description of some productive traits of Butana cows raised in Atbara research station during the period 1949-1999

Traits	Means ± SD	CV%	h^2	r
Total milk yield (kg)	1709.50± 892.10	52.2	0.02 ± 0.01	0.23 ± 0.02
Lactation period (day)	248.40 ± 91.30	36.8	0.01 ± 0.01	0.22 ± 0.01
Persistency (%)	75.16 ± 48.58	64.6	0.01 ± 0.01	0.17 ± 0.02
Longevity (year)	6.56 ± 3.18	48.5	0.14 ± 0.03	

SD = standard deviation; CV% = coefficient of variation; h^2 = heritability; r = repeatability

Table 2: Effect of years of calving on some productive traits of Butana cows

Period	No^1	Total milk yield (kg)	Lactation period (days)	Persistency (%)	No^2	Longevity (years)
1949 – 1959	145	1853.8^a	247.43	70.64	21	10.73^a
1960 - 1969	666	1840.8^a	248.78	74.30	106	6.62^b
1970 – 1979	318	1527.9^b	245.27	74.83	61	4.89^d
1980 - 1989	124	1525.5^b	244.58	83.44	21	5.66^c
1990 – 1999	85	1378.2^b	263.73	78.54	13	6.39^b
SE	-	64.51	6.75	3.65	-	0.19
L. Sig.	-	S*	NS	NS	-	S*

In this table and the following; No^1 = Number of observation for total milk yield, lactation period and persistency traits; No^2 = Number of observations for longevity trait; SE = standard error of mean; L. Sig. = level of significance; S* = the factor effect is significant (P<0.05); NS = the factor effect is not significant. (P>0.05); a, b and c: means in the same column with different superscripts are significantly (P<0.05) different.

Table 3: Effect of season of calving on some productive traits of Butana cows

Season	No^1	Total milk yield (Kg)	Lactation period (days)	Persistency (%)	No^2	Longevity (years)
Dry summer	496	1687.4	250.05	72.88	91	5.86^b
Wet summer	314	1717.4	244.10	78.27	60	6.86^a
Winter	528	1724.2	249.34	75.42	71	7.03^a
SE	-	40.72	4.26	2.31		0.12
L. Sig.	-	NS	NS	NS		S*

Table 4: Effect of parity order on some productive traits of Butana cows

Parity	No^1	Total milk yield (Kg)	Lactation period (days)	Persistency (%)
1^{st} parity	220	1355.5^b	235.30	93.40
2^{nd} parity	222	1392.3^b	218.82	83.17
3^{rd} parity	216	1744.6^a	241.47	76.36
4^{th} parity	184	1819.1^a	257.79	65.69
5^{th} parity	146	1975.6^a	267.13	65.06
6^{th} parity	128	2035.1^a	276.85	66.43
7^{th} parity	99	1827.5^a	255.05	68.08
8^{th} parity	63	2013.7^a	273.52	68.50
9^{th} parity	38	1736.1^a	261.29	66..63
10^{th} parity	22	1457.9^b	251.61	72.27
SE	-	96.05	10.05	5.44
L. Sig.	-	S*	NS	NS

References

Abate, A. L, Atta M. and Anthony, R.N. 2010. Seasonal variation of milk persistency of Kenana × Friesian crossbred dairy cows under confinement feeding in a hot environment. *Anim Scie Journal*, 1(1): 13–18.

Abdel-Aziz, B.E., Ali, T.E. and Ahmed, F.A. 2005. A study of some factors affecting the age at first calving and the calving interval of different Sudan Zebu Breeds. *Journal of Animal and Veterinary Advances*, 4 (7): 668 - 675

Ageeb, A.G., and Hiller, J.K. 1991. Effects of crossing local Sudanese cattle with British Friesian on performance traits. *Bulletin of Animal Health and Production*, 39 (1); 69–76.

Alim, K.A. 1960. Reproductive rates and milk yield of Kenana cattle in Sudan. *Journal of Agricultural Sciences (Camb)*, 55: 183–188.

Allaire, F.R. and Gibson, J.P. 1992. Genetic value of herd life adjusted for milk production. *Journal of Dairy Science*, 75, 1349 - 1356.

Bath, D.L., Dickerson, F.N., Tuker, H.A. and Appleman, R.D. 1985. Dairy cattle: principle practices problems, profits (3rd edition). Lea and Febiger. Philadelphia.

Becker, W.A. 1975. Manual of quantitative genetics. Washington State Univ. Press, Pullman, Washington.

Cameron, N.D. 1997. Selection indices and predication of genetic merit in animal breeding. CAB International, 198 Madison Avenue, New York 1016- 4341

Eid, I.I. 2001. Estimation of genetic and non- genetic parameters for pure Friesian cattle in the Sudan. M. Sc. thesis. University of Khartoum, Sudan.

El Khidir, O.A. 2009. Elementary statistics and experimental design. 2nd Edition. Sudan Currency Printing Press. ISBN: 978-99942-938-6-5. pp 147.

El-Amin, F.M. 1969. Environmental and genetic factors influencing reproduction and milk yield of Sudan indigenous dairy cattle. Thesis of M. Sc. Faculty of Veterinary Science, University of Khartoum, Sudan.

El-Habeeb, E.A. 1991. Variation in reproductive and milk production traits in Butana and Kenana dairy cattle in the Sudan. M. V. Sc. Thesis, University of Khartoum-Sudan

Essl, A. 1998. Longevity in dairy cattle breeding: A review. University of Agricultural Sciences, Vienna. *Journal of Livestock Production Science*, 57: 79 - 89.

Falconer, D.S. 1986. Introduction to quantitative genetics, 2nd Edition. Longman Scientific and Technical, London.

Gandhi, R.S. and Gurnani, M. 1990. Factors affecting lifetime traits in Sahiwal cattle. *Asian Journal of Dairy Research*, 9 (4): 211- 218.

Goshu, G. 2005. Breeding efficiency, lifetime lactation and calving performance of Friesian-Boran crossbred cows at Cheffa farm, Ethiopia. *Livestock Research for Rural Development*, 17, Article 73.

Harvey, W.R. 1990. User's guide for mixed model least squares and maximum likelihood computer program (PC-2 version), USDA-ARS. Ohio State University, Columbus

Ishag, I.A. 2000. Impact of Genetic and non-genetic factors on productive and reproductive traits of crossbred cows raised under Sudan condition. M. V. Sc. thesis, University of Khartoum – Sudan.

MARF, 2009. Ministry of Animal Resources and Fisheries, Khartoum (Sudan), department of statistics. *Statistical Bulletin for Animal Resources* issue No. 19.

Musa, L.M.A., Ahmed, M.K.A., Peters, K.J., Zumbach, B. and Gubartalla, K.E.A. 2005. The reproductive and milk performance merit of Butana cattle in Sudan, *Archive Tierz Dummerstorf,* 48(5):445–459

Nebel, R.L. and McGilliard, M.L. 1993. Interaction of high milk yield and reproductive performance in dairy cows. *Journal of Dairy Science*, 76: 3257-3268.

Ponižil, A. 1989. Milk yield of three breed crossbreds of Friesian, Ayrshire and Czech Pied cattle. *Animal Breeding Abstract,* 31 (4):12 - 16.

Rao, M.K. and Sundareson, D. 1982. Factors affecting shape of lactation curve in Friesian x Sahiwal crossbred cows. *Indian Journal of Dairy Science*, 35 (2): 160- 167.

Santoro, K.R.; Barbosa, S.B.P. Santos, E.D.S. and Brasil, L.H.D.A. 2005. Heritabilities of non linear growth curve parameters in Zebo breeds, in Parnambuco State, Northeastern Brazil. *Revista Brasileria de Zootecnia* 34 (6) pp 2280

Silva, H.M., Wilcox, C.J., Spurlock, A.H, Martin, F.G. and Becker, R.B. 1986. Factors affecting age at first parturition, lifespan and vital statistics of Florida Dairy Cows. *Journal of Dairy Science*, 69: 470.

Tekerli, M., Akinci, Z., Dogan, I. and Akcan, A. 2000. Factors affecting the shape of lactation curves of Holstein cows from the Balikesir Province of Turkey. *Journal of Dairy Science*, 83: 1381 – 1386.

Trautman, J., Trakowski, J. and Szwast, M. 1990. The average longevity and performance of Simmental cows, and reasons for culling. Akademia Rolnycza, Lublin Poland, 46 (8) 298 - 301. *Animal breeding Abstract*, 20: 934.

Van Doormaal, B.J., Schaeffer, L.R. and Kennedy, B.W. 1995. Estimation of genetic parameters for stay ability in Canadian Holsteins. *Journal of Dairy Science*, 68: 1763.

Vukašinović, N., Moll, J. and Künzi, N. 1995. Genetic relationships among longevity, milk production, and type traits in Swiss Brown cattle. *Livestock Prod. Sci.*, 41, 11 – 18.

Wilcox, C.J, Gaunt, S.N., and Farthing, B.R. 1971. Genetic interrelationships of milk composition and yield. *South. Coop. Series Bull.* 155. P: 33.